DOCTORAL DISSERTATION

Study on the Configuration and Composition of Spaces of Nursing Homes in Japan

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Abstract

With the aging world and the improvement of people's living standards, the quality of elderly life is gaining more attention. The nursing home as an important carrier for the life of the elderly, the reasonable configuration and composition of its spaces have become a subject that needs to be explored. Based on Japanese n
ursing homes, this paper explores the spatial configuration and spatial layout in the modern nursing homes in two directions. The one direction is to summarize typologically the configuration of functional spaces and the location relationship between the key functional spaces in modern Japanese nursing homes. The aims are to capture what functional spaces need to be provided and how big these functional spaces are required to support the life of the elderly in a modern nursing home, and to understand the organizational approaches of the designers in the layout of these functional spaces. The other direction is to explore the spatial layouts of modern Japanese nursing homes from a logical perspective within the theoretical framework of space syntax, seeking to contribute to a better understanding of nursing home morphology.

The results indicate that nursing homes are not just assemblage of individual spaces but intricate pattern of organized space, governed by rules and conventions about the size, configuration and spatial layouts of spaces, which kinds of the spaces should be equipped, which activities go together, how large of the space is appropriate and where guests are received. In terms of functional space composition, (1). To constitute a complete nursing home, rooms, activity space, common bathroom, common toilet, and staff space are essential; (2). The room with 18 m2, which is equipped with toilet, dresser and storage is the most popular to be used; (3). The most important function of the activity space in the nursing home is as a dining room; (4). The kitchen and the office are the most prominent places where the staff work in the nursing home; (5). On the average, the reference ratio of area zoning within the nursing home tends to be closer to 24:13:8.5:3.5:1 (Private space: Transition space: Common space: Staff space: Service space); (6). In all floor, the position of shared space and entrance should have buffer space, such as hall or relative short corridor, which can keep a certain privacy and keep convenience at the same time. In most nursing home, strip type is chosen as the plan type.

In terms of spatial configuration, the case studies show that the spatial organisation of nursing homes exhibits two types of frame structure: weak spatial frame and strong spatial frame, which provide residents with a very different experience of wayfinding. However, the structure of the nursing home space as a whole is one of relatively weak spatial differentiation. Spatial organisation in the form of mechanical solidarity is often used in nursing homes. Service spaces, or even activity spaces, to which people come in most cases because of the function of these spaces, rather than the natural gathering of residents to these spaces in their daily movements. However, in the horizontal plane, the corridor is one of the most important transition spaces where residents' flows intersect. So, the layout of the corridor therefore has a great influence on the layout of the space within the plan of the nursing home. The studies show that changing the number of corridor or corridor

combination of corridor has a greater impact on wayfinding of the residents in the plan than changing the spatial distribution, the residents can find their destinations more easily in the plan consisting of fewer corridors. A design principle for the nursing home is to improve accessibility of the spaces by minimizing the use of corridors within the plan or using ring-corridor when the corridors increase and then to maintain an even plan design by adjusting the spatial distribution.
The architecture educators, particularly those who are interested in the design of nursing homes, may benefit from this study. The design of a nursing home should be based on a human-centred philosophy, and aim to provide the best possible living experience for the residents. However, the design process of a building is certainly influenced by many factors such as local regulations, the requests and preferences of the residents, investors′ requirements, building regulations, etc. The final building that is presented to us is created by the architects after balancing all these factors. Finally, the article clarifies typologically and logically the composition and order of spaces in modern Japanese nursing homes, giving us a deeper understanding of the principles of nursing home design. The expectation is to generate enlightening information and guidance for designing nursing homes in the future.

Keyword: Nursing home, Spatial configuration, Spatial layout, Spatial order, Typology, Logic, Space Syntax.

CHAPTER 1
INTRODUCTION

1. Introduction

1.1. Research background

1.1.1. Overview of Japan's ageing society

The World Health Organization (WHO) reports in Ageing and Health that the rate of population ageing is now accelerating rapidly around the world, with 125 million people aged 80 years today and the number of people in this age group reaching 434 million worldwide by 2050. Meanwhile, the world's total population aged 60+ is expected to reach 2 billion by 2050 (compared to 900 million in 2015) and 80% of the older people will be living in low- and middle-income countries which to some extent lack robust social protection facilities. The shift in distribution of a country's population towards older ages is visible as an achievement of public health policy and socio-economic development, but it also poses a challenge to society and has an impact on almost all aspects of society. In some poorer countries or regions, due to a lack of adequate social security systems, many older people do not even have access to the basic resources necessary to ensure a meaningful and dignified life. To respond to the challenges posed by ageing, the World Health Organization has advocated five priority areas for action: 1. Commitment to Healthy Ageing; 2. Aligning health systems with the needs of older populations; 3. Developing systems for providing long-term care; 4. Creating age-friendly environments; 5. Improving measurement, monitoring, and understanding.

Nursing homes are an important component of the social service system in dealing with the population ageing. A nursing home is a facility or a built environment that can provide long-term or short-term accommodation and daily living care for elderly or disabled people. However, the development of nursing homes is also uneven, as well as showing very different characteristics, due to the factors such as differences in service content and market positioning, or differences in the level of development and culture of different countries and regions. Japan is one of the first countries to suffer from the problem of ageing, having entered the ageing society as early as in the 1970s, and its elderly population has been increasing annually since then. Subsequently, the development of nursing homes gradually received the attention of the government and companies, and after nearly 20 years of exploration and development, the standards and systems of Japanese nursing homes took shape and became perfected in the 1990s. Today, Japan is at the forefront of the world in many areas of elderly care institutions, including the concept of ageing, systems, and services. Therefore, the study and exploration of Japanese nursing homes has very profound implications for the development of nursing homes in countries or regions around the world.

The world population is aging rapidly. Today the older population (aged 65 and over) represents 7 percent or more of the total population in many parts of the world— one notable exception is Africa and parts of Asia, and Latin America and the Caribbean. By 2050, only 33 countries are projected to have an older population comprising less than 7 percent of their total population, a substantial reduction from 115 such countries in 2015. At the same time, the share of the older population will exceed 21 percent in 94 countries, including 39 countries with 28 percent or more of their total population being older.

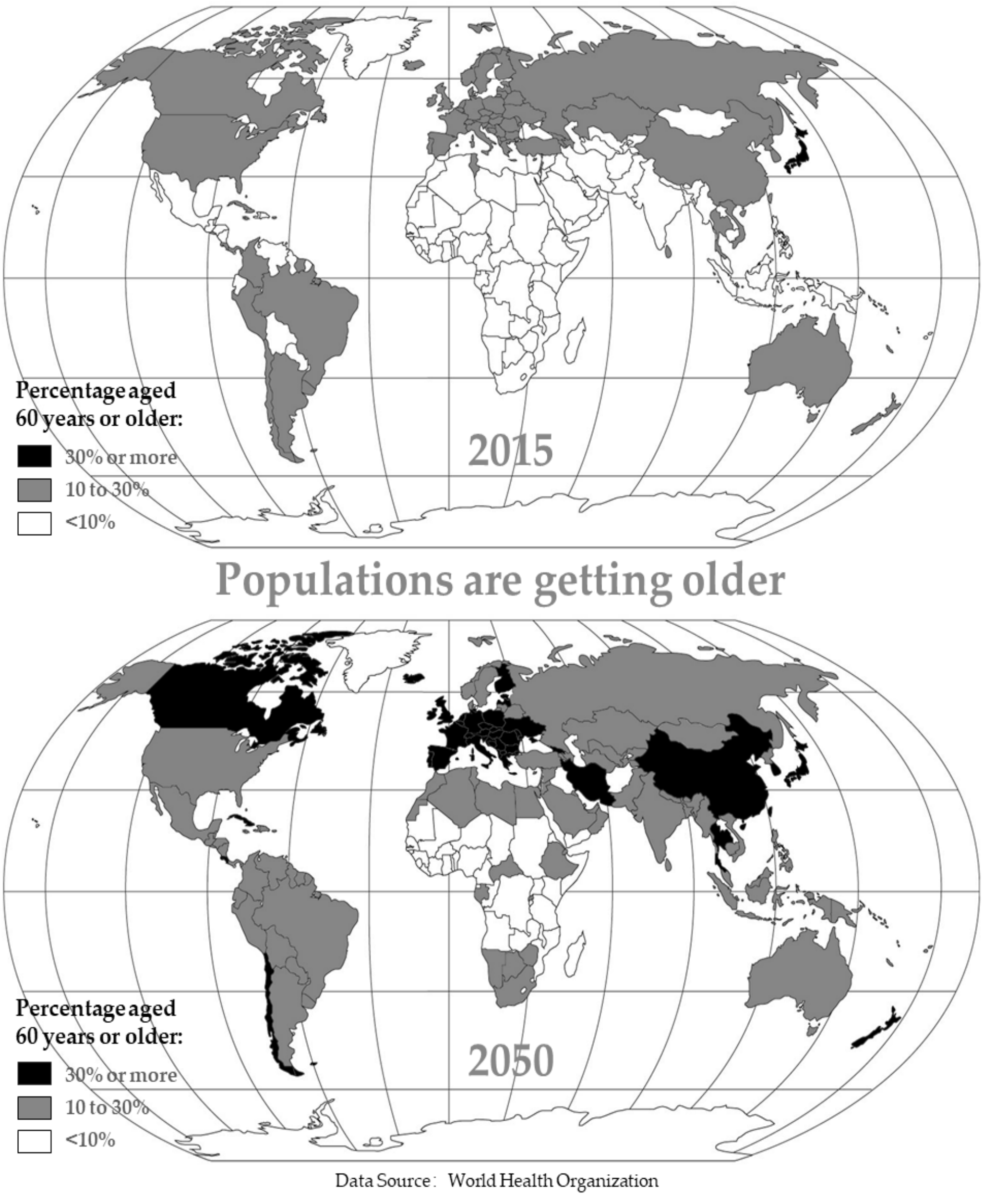


Figure 1-1 The trend of population aging

Table 1-1 Total Population and Population Aged 65 and Over by Sex: 2015, 2030, and 2050

(Numbers in millions)

Year	Total population			Population aged 65 and over			Percentage aged 65 and over		
	Both sexes	Male	Female	Both sexes	Male	Female	Both sexes	Male	Female
2015………	7,253.3	3,652.0	3,601.3	617.1	274.9	342.2	8.5	7.5	9.5
2030………	8,315.8	4,176.7	4,139.1	998.7	445.2	553.4	12.0	10.7	13.4
2050………	9,376.4	4,681.7	4,694.7	1,565.8	698.5	867.3	16.7	14.9	18.5

Data Source: U.S. Census Bureau, 2013; International Data Base.

From the figure 1-1, among the 7.3 billion people worldwide in 2015, an estimated 8.5 percent, or 617.1 million, are aged 65 and older. The number of older people is projected to increase more than 60 percent in just 15 years—in 2030, there will be about 1 billion older people globally, equivalent to 12.0 percent of the total population. The share of older population will continue to grow in the following 20 years—by 2050, there will be 1.6 billion older people worldwide, representing 16.7 percent of the total world population of 9.4 billion. This is equivalent to an average annual increase of 27.1 million older people from 2015 to 2050.

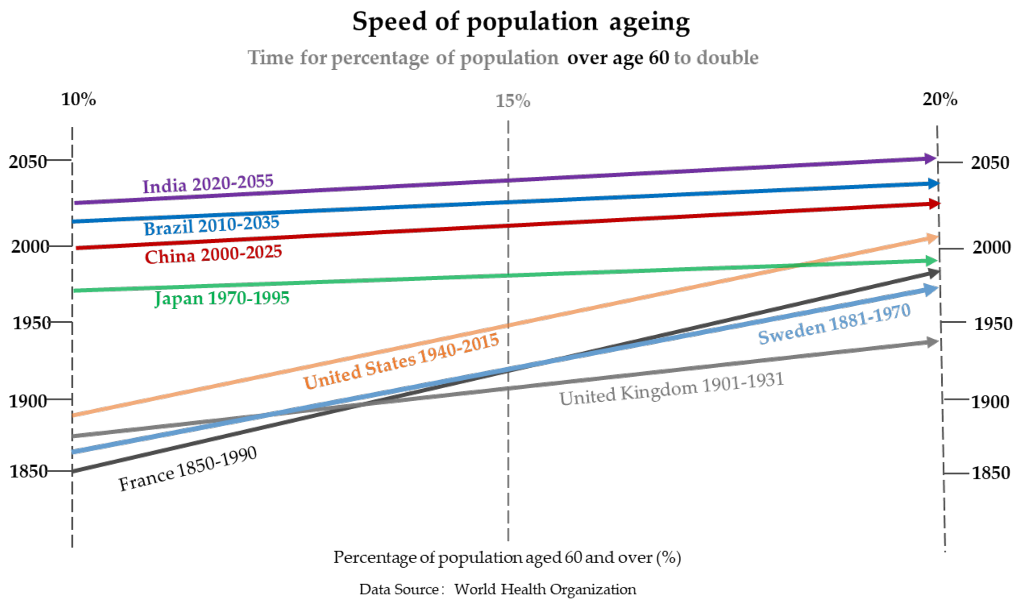


Figure 1-2 The speed of population aging

In 2005, there were 25.56 million elderly people out of a total population of 127.65 million; in 2020, there will be 34.56 million elderly people out of a total population of 124.11 million; and the burden on society is gradually increasing. According to the 2005 statistics, the average life expectancy in Japan is 78.56 years for men and 85.52 years for women, an increase of 0.84 years for men and 0.092 years for women compared to the 2000 figures. After the Second World War The average life expectancy in 1947 was 50 years for men . 06 years for men and 53.96 years for women. Over the past 60 years, the average life expectancy in Japan has increased by 28.50 years for men and 31.56 years for women.

The 2006 Vital Statistics Profile of Japan shows that the causes of death in order of prevalence are malignant neoplasms accounting for 30.4% of all deaths; heart disease coincidentally .9%; cerebrovascular disease Diseases n . 1%. In 1935, Japan's advanced ageing rate was 4 . 7 per cent, and then gradually increased as the mortality rate declined and the ageing rate reached 23.1 per cent in 20ro, a rare world This is a rare level in the world. In addition, the rate of ageing is compared with the time it takes for the rate to exceed 7% and reach a multiple of 14%, 1 year in France, 85 years in Sweden, 47 years in the UK and 40 years in Germany. In France, it took 1 year, in Sweden 85 years, in the United Kingdom 47 years, in Germany 40 years, and in Japan, it was over 7% in 1970 and reached 14% in 1994, 24 years later. The above shows that Japan has the highest rate of ageing in the world. Japan has the highest rate of ageing in the world.

Japan is the world's oldest society in terms of average life expectancy, the number of senior citizens and the rate of ageing. The reasons for the aging of Japan's small number of children. In 1946, Japan enacted the Life Protection Law based on the three basic principles of state responsibility, equality and minimum living standards. In 1946, the Law on the Protection of Life was established based on the three basic principles of state responsibility, equality and minimum living standards. The Child Welfare Law of 1947, the Welfare for the Physically Handicapped Law of 1949, the revision of the Life Protection Law of 1950, the Social Welfare Business Law of 1951, and the Social Security Law of 1951, The Social Welfare Law of 1951 and the establishment of the nursing care insurance system in 2000 made it possible to include elderly care in public social insurance.

1.1.2. Reform of the medical system to cope with the development of an ageing society

In developed countries, the cost of medical care for the elderly is increasing every year due to advances in medicine and the increasing proportion of elderly people in the population. This is a common phenomenon not only in Japan but also in developed countries in recent years. In the recent economic downturn in Japan, the increase in national medical costs has exceeded the increase in national income. This means that the financial burden of medical care has increased, leading to an increase in the financial burden on the state. In addition, the financial burden on families and distribution problems have also come to the fore. In order to solve these economic problems, it is necessary to reform the health care system, including curbing the growth of health care costs, improving the efficiency of health care, and strengthening the health insurance system financially. One of the problems is the possibility that patients will not be able to cope with the increased burden on themselves. In particular, how to deal with the resulting impact on low-income people is an important issue for the government to consider. At present, Japan is one of the developed countries where the proportion of medical expenses to GDP is low. Secondly, the establishment of a system for managing the total cost of medical care. By limiting the total amount of medical expenses in the health insurance system, it is possible to manage the finances directly and effectively. However, it may not be possible to guarantee adequate medical care and changes in medical needs may not be acceptable to the public. The problem of the health care supply system is closely related to health care finance. In addition to the fact that there are more beds and fewer medical staff than in other developed countries, the competition between medical institutions is fierce, and that the number of beds and doctors varies from one region to another, the cost of medical care varies greatly from region to region due to differences in patient access and treatment patterns, which has had an impact on the establishment of a characteristic medical supply system in some regions. In recent years, with the gradual expansion of patient choice, the standardisation of treatment and IT is not yet sufficient, not only in terms of clinical indicators, information on the professionalism and technical strength of medical staff, but also in terms of the operational status of medical institutions, which needs to be published through a comprehensive information system. Therefore, there is a need to gradually establish a systematic and complete medical management system.

1.1.3. Problems of an ageing society in Japan

In a country or a region, an elderly population of more than 7% is called a senior society; more than 14% is called a senior society, and more than 21% is called a super senior society. In Japan, the elderly population was 4.7% in 1935, but grew to 21.5% in 2007, making it a very old society. In Japan, the Ministry of Internal Affairs and Communications announced on 19 September 2020 that the number of people aged over 65 was approximately 29.44 million more than the 460,000 in 2009. Ageing of society, The number of elderly people living alone is gradually increasing. In 1955, there were 425,000 households living alone; in 1965, there were 799,000 households; and in 2005, there were 3.86 million households. In 2005, there were 3.86 million households. Traffic fatalities among elderly drivers are also increasing year on year. Statistics show that of all traffic fatalities, those over 65 years of age account for 41% of all traffic fatalities. 41% of all fatalities. . 5% of all traffic fatalities.

Since 2009, cognitive function tests have been added to the renewal of driving licences for people over 75 years of age, due to the decline in cognitive and motor functions with age and the memory loss associated with ageing.

As of October 2008, the total population of Japan was 127.69 million, of which 2,822,000 were aged 65 or older. The proportion of elderly people in the total population (the elderly rate) is 22.1%, i.e. one in five people is elderly or older. Among the elderly population, there are 7 million people aged 65-74 years old, accounting for 11.7% of the total population, and 13.22 million people aged 75 years or older, accounting for 1.04% of the total population, the first time that the proportion of elderly people in the later stages of life exceeds 10%.

The proportion of older people is more than 10% for the first time; it is expected to reach 25.2% in 2013; 33.7% in 2035; and 40.5% in 2055, reaching a level where two out of five people in the country will be aged 65 or older. Statistics for 2007 show that the average life expectancy in Japan is 79.19 years for men and 85.99 years for women. Life expectancy is expected to reach 83 years for men and 85.99 years for women by 2055. The average life expectancy is expected to reach 83.67 years for men and 90.34 years for women by 2055.

1.2. Research hypothesis and purpose

With the population ageing world and improvement of people′s living standards, the quality of daily life for older people is gaining more attention. The nursing home is an important carrier for the life of the elderly, its configuration and spatial layout are the key factors affecting the comfort of the inhabitants. Japan has developed a sophisticated and stable system of nursing homes over several decades, where the nursing home is representative and informative all over the world.

So, what is the system and policy of nursing home in Japan like? Is there a relatively consistent system in terms of rent fee, staff ratio, building structure and building scale (size or the number of rooms)? Should nursing homes consist of a similar type of functional spaces in addition to the residents′ rooms? Do these nursing homes have a similar rules or patterns in term of spatial layout or the organization of spaces? And why are these rules or patterns of spatial layout or of the organization of spaces more popular to be used?

Regarding these questions, the study attempts to explore typologically and logically the configuration of space, the location relationship between spaces and spatial order in Japanese nursing homes, and aims to capture what functional spaces need to be provided and how big these functional spaces are required to support the life of the elderly in a modern nursing home, and to understand the organizational approaches of the designers in the layout of these functional spaces. And the study demonstrates the patterns of spatial organization of Japanese nursing homes from a combination approach of practice and theory, seeking to contribute to a better understanding of nursing home morphology and design principles. Finally, it is hoped that the study will generate enlightening information and guidance for the future nursing home design for the development of nursing homes in other countries.

1.3. Methodology and theory

1.3.1. Methodology

The research in this paper is carried out in both typological and logical directions. Typology is the study of types or the systematic classification of the types of something according to their common characteristics. In the direction of typological research on the objects, the quantitative research method is combined in this paper to investigate systematically the experience of existing observable objects by means of statistics, mathematical calculations, etc., so that produce data in numerical form, and then analyses, groups, generalizes and summarizes with the help of statistics, finally, the hope is that the data will yield an unbiased result that can be generalized to this whole field or to a larger group. In the direction of logical research on the objects, the internal space of nursing homes is translated into a justified graph by space syntax theory in this paper. The arrangement rules of the spaces inside the nursing home are presented in numerical form. Then these data are analyzed with the help of statistics. The expectation is that these data will produce objective results. Finally, the typology in this paper is based on an empirical orientation, while the logic is based on a theoretical one, so the substantive approach of this paper is to explore the composition of the nursing home space from a practical and theoretical perspective together.

1.3.2. Theory

Space syntax is a set of theories and techniques about space and society for analyzing spatial layouts and human activity patterns in buildings and urban areas. The theory was first introduced in the 1970s by Bill Hillier at the Bartlett School of Architecture, University College London, and has now developed into a complete theoretical system, a mature methodology, and specialized software techniques for spatial analysis. As a new language for describing architectural and urban spatial patterns, the basic idea is threefold: space itself is subject to geometric laws and therefore has its own geometric laws; people know how to use spatial laws to carry out everyday activities, including socio-economic activities, such as the basic spatial links between left, right, up and down, and will use spatial relationships creatively to achieve socio-economic ends; the geometric laws of space itself will limit the way people use spatial laws, and the ways in which space can be combined are not infinite, but limited. The theoretical foundations of spatial syntax include:

1. the natural laws of space, including the basic geometric relationships of division, reproduction, and connection of space (including topological geometry, etc.).
2. the individual's perception of space and the influence of society on space
3. the impact of space on individuals and society

Extended theories include: natural transport, cities for economic travel, spatial specificity of different cultures, two-layer networks in cities, different points of attraction in spatial structure, home and dwelling, spatial patterns of crime, interaction of transport and land use, ubiquitous centrality, sustainability of space, self-organizing structures of morphology, language of spatial patterns, etc. These theories deal with: 1. spatial commonalities that transcend cultures; 2. spatial identities of different cultures; 3. the interaction between space and society at the level of collective relations rather than at the level of the individual; 4. collective complex relations stemming from individual behavior, with the former constraining the latter to some extent.

The space referred to in spatial syntax is not only the mathematically measurable objects described by Euclidean geometry, but also the topological, geometric, and physical distance relationships between spaces. It is not only concerned with local spatial accessibility, but also emphasizes the spatial accessibility and correlation of the whole. This approach to spatial analysis is commonly used for buildings and cities, across different scales, from individual buildings, to areas of the city, entire cities, or even entire regions.

The general method of the space syntax is that spaces can be broken down into components, analyzed as networks of choices, then represented as maps and graphs that describe the relative connectivity and integration of those spaces. When using space syntax to analyze a case, four steps are generally comprised:

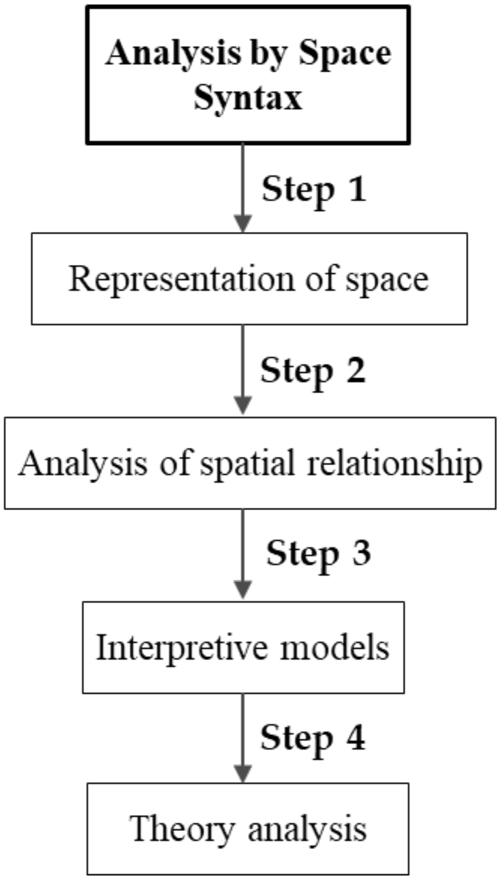


Figure 1-3 The steps of the analysis by space syntax

1. The representation of space. Spatial elements are represented by their geometric form and how people experience them. They can be geometrically derived (for example, points, axesline segments, convex spaces and isovist) or functionally defined.

2. Analysis of spatial relationships. The relationships between spatial elements are determined by their configuration. These relationships can be analyzed objectively using a variety of measures, including Integration and Choice. These two measures reflect two fundamental elements of human movement: the selection of a destination measures the ease of access (integration), and the selection of a route measures the passing flow(choice).

3. Interpretive models. Spatial models are developed to analyze, describe, explain and predict different types of spatial and socio-economic phenomena. In practice, models are created to study empirical phenomena such as urban movements, urban crime, and centrality as a process as well as for general processes such as spatial comprehensibility.

4. Theories. Theories of the relationship between space and social patterns are developed to explore whether and how space is internalized in the socio-economic processes through creating a built environment. This is accomplished in two ways. Firstly, theories can be used to find commonalities in modelling patterns across functions and cultures. Secondly, theory can use space syntax tools to explore what happens to spatial patterns if objects in space are unfolded and shaped in different ways.

1.4. Previous research

The theory of spatial syntax embodies the ineffable spatial configuration and allows for the analysis of the relationships between its components. Space in spatial syntax is not only the actual measured spatial scale, but also the topological relations of the elements of the configuration, their generalized distances and their relation to the actual scale.

1.4.1. Overview of foreign research on spatial syntactic theory

In 1899, SchlWer published his famous paper 'The Layout of Towns', which marked the birth of urban morphology as a discipline. 1984 saw the emergence of a new quantitative approach to urban morphology - space syntax - represented by B. Hillier and J. Hanson. Hanson.

The theory of spatial syntax was developed in the 1970s, and in 1984 B. Hillier and J. Hanson co-authored The Social Logic of Space, which marked the formal creation of the theory of spatial syntax. Since that book, B. Hillier and his colleagues at Bartlett School of Architecture, University College London, have been concerned with the role that space plays in the form and function of buildings and cities. The most critical research in this regard has been the development of the concept of 'spatial composition'. On this basis, many scholars have carried out empirical studies. J. Hanson has conducted a number of empirical comparative analyses of the relationship between spatial configurations and social culture at the architectural level, the most important of which is in His most important work, Decording Homes and Houses, published in 1998, systematically explains the relationship between spatial configurations and the social logic of various types of buildings, finding that the complex relationships between spaces allude to the way human society perceives and organises space, and are highly consistent with the social, economic and cultural distribution of space.

There are two major events in the development of the theory of spatial syntax that have played an important role in its advancement. One is the International Symposium on Spatial Syntax, which has been held every two years since 1997. The second was the establishment in 2010 of an academic journal of its own on space syntax. At the same time, the theory of space syntax is increasingly being applied in the practical work of space syntax consulting firms. The coexistence of theoretical and practical values has led to the growing strength of the school.

In 2018, Nahyang Byun et al. studied Korean residential units and explored spatial configurations. Space analysis aims to identify the relations between society and space. Space analysis results let us identify the characteristics of the targeted space and subsequent human activities based on the notion of social relationship. The reason authors try to understand spatial structure lies in that it is the intrinsic attribute of physical built environment. This research looks into apartment houses, a widespread form of housing in Korea, in an attempt to investigate the social logic lying in its domestic space by measuring the spatial configuration. This research is based on empirical data and uses a quantitative methodology; Space Syntax. Characteristics of spatial structure in apartment units and their meanings were identified through this research. The implication of the living room-centered layout type most common in Korean apartments was discussed from the viewpoint of the domestic space genotype.

Yurdagül Görücü* M. Serhat Yenice et al. in 2019 studied a comparative analysis of the spatial characteristics of apartment buildings in the city of Gaziantep, Turkey. Analyzing the planning and design process, basic principles, and the change-transformation process of the apartment type residential buildings in Turkey, Gaziantep. The scope of the research consists of residential buildings built in the post-Republican period in Gaziantep. The basic materials of the research are zoning-city plans, plan explanation reports, plan diagrams of buildings and photographs based on field research. The method of the research is based on a comparative analysis of spatial changes in apartment buildings according to historical background.

2015, Saeid Alitajer et al. studied the behavioural patterns of private residential space configurations in Iran. The Iranian concept of home goes far beyond physical aspects, and its essence is interwoven with the spiritual nature of humankind. This concept has gained new meanings with the modernization and industrialization of societies. In Iranian architecture, every need is realized in socio-physical systems as well as in design issues. Therefore, spatial relationships are central to architecture, especially residential architecture that addresses a great proportion of an individual's daily life.Space syntax seeks to explain how spatial configurations express social or cultural meanings. One such meaning is confidentiality, which was mainly introduced into Iranian architecture as a result of religious beliefs. In Iranian architecture, confidentiality is viewed from the aspect of privacy. This case study makes use of description, analysis, and logical reasoning. The objective is to analyze behavioral patterns in the spatial configurations of traditional and modern houses in Hamedan. In so doing, library research, software simulation with the UCL Depthmap package, and comparison techniques are utilized.The findings indicate that the spatial configurations of houses have changed in the course of time. In terms of the indices of spatial configurations, however, the striking difference between traditional and modern houses in Hamedan revolves around the integration and equivalence of all spaces in a house. In other words, the hierarchy of access to spaces and the recognition of territories are limited in modern houses. Hence, privacy in modern houses fades.

Similarly in 2021 Pedram HESSARI et al. studied the architectural construction and configuration of traditional Iranian houses. The cities of Dezful and Boroujerd can be considered a treasure trove of traditional houses in Iran whose social, functional, and cultural roots are reflected in their architectural body. Traditional housing includes and expresses the life- styles and behavioral systems of its inhabitants. Therefore, by analyzing the spatial structure in different traditional dwellings, we can understand the structural differences in them. The main purpose of this study is to identify and express the structure and spatial differences in traditional housing in Dezful and Boroujerd, which have many differences in terms of environmental structure. This study seeks to answer the question: What are the differences between structural patterns and spatial configuration in traditional housing in Dezful and Boroujerd? The method of this research is generally qualitative and software that includes analytical-descriptive approaches and logical reasoning. First, using observation, field survey, and library studies, the desired maps are obtained and the research parameters such as spatial integrity, visual privacy and control, and access are determined. In the next step, the maps of selected research houses are analyzed and analyzed in Space Syntax software, which is specialized software for space syntax, and the patterns of spatial configuration in traditional houses of Dezful and Boroujerd are expressed. The results show that the permeability and readability of more spaces due to the depth of each space and better spatial perception by individuals in traditional houses in Dezful is more than traditional houses in Boroujerd. In contrast, in traditional houses in Boroujerd, spatial stratification and spatial hierarchy, the creation of public and private layers due to the shape and type of housing, and also environmental security in the resi- dential complex is more than the examples of traditional housing in Dezful.

Douglas Amedeo examines a case study on classroom layout in 2015. Five different layouts were examined in this study to address that question. Perceptions of how classroom spatial layouts differ in the way they influence teaching and learning activities were elicited from primary teachers and evaluated in terms of their educational perspectives. They were uncovered by assessing teachers' beliefs about properties of various spatial designs, evaluating their spatial layout preferences, and by evoking their comments about the relative merits each layout has with respect to facilitating the conduct of activities in the classroom. The information collected in this way was evaluated and integrated with the use of similarity coefficients, q-mode factor analysis, and multi-dimensional scaling. Results from the case study strongly suggest that teachers perceive the influences exerted by various classroom spatial layouts on teaching and learning activities to differ, but their perceptions of such differences are clearly qualified by their educational perspectives.

Design with space syntax analysis based on building information Model"Towards an interactive application of building information model in early design process". This paper introduces a new framework to enable user-friendly space syntax analysis during the initial design stage. It assists designers, without in-depth knowledge on space syntax, to evaluate and compare design outcomes rapidly. The framework is realized by integration between space syntax and building information model in which space topology is autonomously retrieved. A BIM modeler so called 'ArchiSpace' has been developed to demonstrate the applicability of the framework to design practice. Our experiment shows that designers can use the modeler to analyze their design alternatives instantly at any moment during the initial design stage. Therefore, users can generate and evaluate their design alternatives simultaneously without distraction and tedious work on the space syntax analysis in detail.

Eddie Damavan examines the spatial patterns of street corridor (Case study: S. Perlman Street, Semarang, Central Java, Indonesia)，The purpose of studying space pattern in S. Parman Street Corridor Semarang is actually to examine the link between economic and social factors of community, space pattern, and the impact on the existing regulation. The methodology used in this study is a rationalistic approach by applying qualitative paradigm in relation to the purpose of the study. This approach needs theoretical framework that based on the experts' theories, to be constructed become grand concepts with holistic study [1]. According to the result and the analysis, the author found that corridor space pattern in S. Parman Street is closely related to the economic status and social life of the people. Some of the reasons could be that the economic condition may encourage people to optimize and expand their lots to build new buildings included the activities support facilities inside their lot which very much different from the original building. People could also rebuild their own house basically because of their needs and their ability to financing the process of rebuilding. Besides, the social life of these people are already changed and such condition will then influence the existancy of their buildings or even their lots. It is therefore, the changes of the economic status and social life of the people will directly provide an impact of the spatial pattern and the size of the building. Furthermore, there were some changes particularly on the function of the buildings along the corridor which were housing before. Almost 75% of the buildings changed into various functions, such as office buildings, business, services, hotels, etc. These developments actually did not match with the land use regulation of the local government for this area which should be settlement and not for mixed use. The deviation of this development process in the corridor of S. Parman Street is one of the consequences of the economic status and social level of the people.

Investigating the role of semi-open spaces on the sociability of public libraries using space syntax (Case Studies: Sunrise Mountain and Desert Broom Libraries, Arizona, USA). Despite the positive efforts made in recent years, active public libraries are still faced with challenges in attracting and retaining their users through the provision of up-to-date services to meet their scientific, cultural and recreational requirements. Accordingly, the need to create spaces with the approach of sociability in public libraries seems to be necessary. In this way, the Space Syntax method, as a predictor of the social aspects of architectural spaces, has been used in order to evaluate the role of semi-open spaces on the sociability of public libraries in the existing and hypothetical models using Depthmap. Finally, the findings of the two simulated models were examined and compared with each other using SPSS and the independent sample t-test. The findings from the Sunrise Mountain Library analysis indicated that in the existing model, the integration level was 20.49. However, after eliminating the semi-open spaces, the level of integration decreased to 15.48. Also, the findings obtained from the Desert Broom Library indicated that in the existing model, the integration level was 10.10. However, in the hypothetical model, its degree of integration changed to 8.15. Results show that semi-open spaces have a positive effect on the sociability of public libraries.

Space syntax in architectural design. In architecture, design begins by generating ideas and continues by transforming them to concrete spatial formations. Architects learn about the design problem by creating alternatives and testing them in order to gain desired spatial formations. A comprehensive architectural knowledge helps architects in this process. This knowledge is a synthesis of practice and theory, in other words mystery and certainty, intuition and science, experience and research. Architects must proceed in two ways and bring all components together in a creative way. This paper aims to explore contribution of a scientific, and research based approach, namely space syntax, in the design process. Space syntax is based on configurational theory of space and attempts to decode spatial formations and their impacts on human activity. By the development of new techniques for representing and analysing space, space syntax appears as a tool for architects to explore their design ideas and understand possible effects of their proposals. By illustrating a link between research and design, this study attempts to create new horizons for those professionals in architectural practice as well as academics in architectural education.

Reflection of cultural practices on syntactical values: An introduction to the application of space syntax to vernacular Malay architecture. This study introduces the basic concepts and terminologies regarding space syntax research through a simple spatial configuration. The concepts are elaborated for intricate configurations. This study aims to deepen the understanding of how syntactical analysis can extract social information embedded in traditional architectural practice in the Malay Archipelago. The basic terminologies are outlined, and the sequential procedure for analysis is described along with its interpretation in the context of actual social phenomena. Result shows that the syntactical properties of a particular configuration within a particular region reflect the traditions of the people in that region. This study serves as a basis for the future study of the applications of space syntax to diverse spatial configurations in the Malay Archipelago.

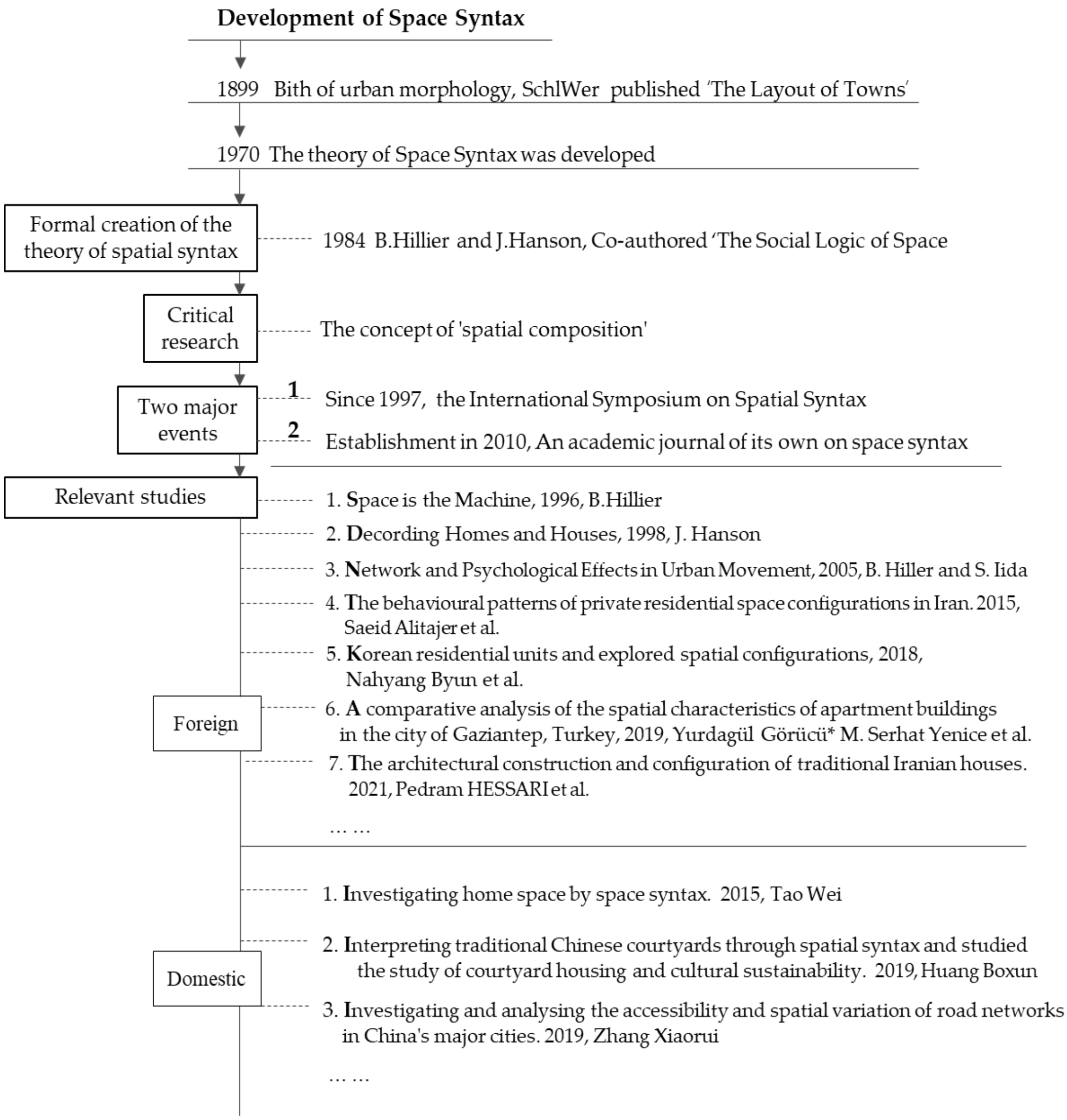


Figure 1-4 The development of space syntax

1.4.2. Overview of domestic research on spatial syntax theory

The study of spatial syntax theory in China first began when Zhao Bing translated Bill Hillier's article "Spatial Syntax - A New View of the City", which introduced this seemingly unorthodox theory to the Chinese academic community.

The theoretical study of spatial syntax by Chinese scholars includes Professor Duan Jin's Spatial Syntax and Urban Planning at the School of Architecture, Southeast University, in which he cites and translates the theory of spatial syntax. Professor Zhang Yu and Professor Wang Jianguo's 'Re-discussions of Spatial Syntax' introduces the current development of spatial syntax theory and reviews its latest practical achievements. They focus on spatial analysis methods such as convexity, axis, visual area and overlapping convexity, and point out that spatial syntax is a method of quantitative analysis of spatial configurations based on a combination of topological calculation methods and visual perception theory. Cheng Mingyang's "The Study of Spatial Syntax Theory and Architectural Space" analyses foreign architectural space from various aspects based on spatial syntax theory, with a view to providing reference for the study of architectural space in China. Wang Song's 'The Grouping of Traditional Chinese Architecture - An Analysis of Spatial Syntax Dynamic Networks' analyses traditional Chinese dwellings and traditional Chinese gardens. Yi Mengxi's 'Spatial Syntax' Analysis of the Public Space Organisation of Convention and Exhibition Buildings' analyses the spatial organisation of the Changsha Meixi Lake International Convention and Exhibition Centre based on the theory of spatial syntax, and provides a reference for the design of convention and exhibition buildings. Sun Peng's 'Spatial Syntax Theory and Traditional Spatial Analysis Methods for Chinese Classical Gardens - A Study of the Spatial Environment of the Chengde Summer Resort' compares spatial syntax theory with traditional analysis methods in the study of classical gardens, and ultimately seeks to obtain a method that is more usable and operational in traditional Chinese naturalistic gardens. The study of the spatial environment of classical Chinese gardens is compared with the traditional methods of analysis, and ultimately seeks to develop a methodology for the use of spatial syntax in traditional Chinese naturalistic gardens that is both more accessible and more operational.

In 2019 Huang Boxun interpreted traditional Chinese courtyards through spatial syntax and studied the study of courtyard housing and cultural sustainability. The United Nations and local governments have supported a four-point sustainable development framework, including environmental responsibility, economic viability, social equity, and cultural vitality. This study is based on the theoretical framework of sustainability to study the traditional Chinese siheyuan residence. Space syntax attempts to explain how spatial structures express social or cultural significance, such as the hierarchical relationship and privacy in it. The main purposes of this study are: To analyze the spatial topological layout of traditional siheyuans by using the space syntax theory, and thus deduce the cultural connotation embedded in traditional siheyuans; compare and analyze the spatial morphology and behavior patterns of traditional and modern houses; explore how to integrate courtyard features into contemporary design and promote cultural sustainability. This study expounds the concept and application of syntactic analysis, and the relationship between the syntactic attributes of specific buildings in a particular area, and the culture and life of the local people within that area. As time goes by, the spatial form of houses has changed. However, in terms of spatial allocation index, the significant difference between traditional residences and modern residences lies in the integration and equivalence of all spaces in residences. We can learn from the cultural values of traditional siheyuans, meaning.

Chen Huajie explores the spatial structure of the commodity trading market based on the spatial syntax using Yiwu International Trade City as an example. The integrated method of GIS and spatial syntax was used to quantitatively analyse the spatial structure characteristics of the interior of Yiwu International Trade City and to discuss the application of spatial syntax in the study of the spatial structure pattern of the commodity trading market.

Tao Wei has used the spatial syntax to investigate home space in 2015. As a spatial system that connects residential buildings to their occupants, the differences in the composition of domestic spaces can reflect different socio-cultural logics. As a theoretical method for quantitative analysis of urban morphology, the spatial syntax has the advantage of both quantitative and qualitative analysis when studying the spatial patterns of homes in relation to their socio-cultural logic. While the use of spatial syntax in the study of home (family, home, house) has become increasingly sophisticated overseas, it has not yet been addressed in related work in China. Firstly, the basic process and ideas of spatial syntax research on home are described; secondly, based on the analysis of foreign research, the "genotype" of home, the "constant" and "transformation" of home, and the "duality" of home are discussed. Secondly, based on a review and analysis of relevant foreign studies, we summarise and conclude three aspects: the "genotype" of home, the "constancy" and "transformation" of home, and the "duality" of home, and find that the "space" in spatial syntax is different from and complementary to the "space" in traditional geography. It is found that "space" in spatial syntax and "space" in traditional geography are both different and complementary; that there is a relationship between different ethnic cultures, lifestyles and their home space; and that the grouping of home space in the same cultural context is contemporary.

Zhang Xiaorui investigates and analyses the accessibility and spatial variation of road networks in China's major cities.

Given the current lack of accessibility research on road networks in 36 major cities in China,the accessibility and its spatial difference were measured by using space syntax and Moran index. The purpose is to provide an important decision-making basis for the Chinese government to grasp the accessibility level of China’s urban roads in general and formulate urban traffic development policies. The results show that the mean value of the global integration average is only 1.0009, indicating that the accessibility level is not optimistic in general. The accessibility of 36 major cities was divided into four levels: very low, low, high, and very high. Only four cities, namely Beijing, Shijiazhuang, Xi’an, and Zhengzhou, were at a very high level. The spatial differences of accessibility presented a spatial pattern of “middle-high, east-middle, and west-low”. The global integration average, intelligibility, and synergy had significant global spatial autocorrelation, while the local spatial agglomeration distributions of these three indexes were dominated by high-high types. The five cities of Beijing, Shijiazhuang, Hohhot, Taiyuan, and Zhengzhou constituted the core area of high-value clustering of local spatial autocorrelation and presented a spatial form of inverted “T” shape. The research still has some limitations. The reasons for the low accessibility of developed cities, such as Guangzhou and Nanjing, are worth further analysis. Besides, the main possible influencing factors affecting accessibility, such as urban road density and spatial form, are also worthy of further analysis.

Wang Haiyang analyses the town expansion intensity index and its application of spatial syntax in the analysis of town expansion based on spatial syntax The Expand Intensity Index (EII) is a common indicator used to characterise the extent and speed of urban expansion, but it is a simple description and analysis of physical and spatial changes from the perspective of urban expansion, i.e. changes in urban land area, ignoring human perceptions in space. It fails to reveal the characteristics of urban expansion from the perspective of the drivers of urban expansion, and lacks in-depth research on the evolution of the external spatial pattern of the city, and cannot reflect the activities of people in the expanding urban space. This paper proposes a new spatial syntax expansion intensity index (SS-EII) based on the spatial syntax of the driving role of transport networks on urban expansion. SS-EII includes syntactic variables that reflect the degree of spatial agglomeration and dispersion, and can be used to analyse, for example, changes in spatial accessibility. In contrast to the traditional sprawl intensity index, SS-EII is based on a spatial syntax that calculates sprawl intensity in terms of the drivers of urban sprawl, focusing not only on the results of urban sprawl, but also on the role of traffic in guiding the pattern and direction of urban sprawl and the changes in human subjective perception of urban space. The results of the study show that SS-EII can be used to analyse and compare the expansion rate and construction status of the built-up area in different directions.

A brief analysis of spatial constitution and functional organization of museum architecture: A case study on museums in Hefei. Cultural architecture, specially, museum architecture, is of significant social value and importance for the improvement of city image, and for the optimization of people's living environment. Consequently, it is significant to analyze such kind of architecture from various perspectives so as to explore its spatial constitution and functional organization. This paper generalizes and puts forward methodology to design interesting exhibition space, convenient traffic space and diversified rest space.

1.4.3. Overview of elderly research.

Low birth rates and higher life expectancy are transforming the composition of world population, with a marked transition towards a much older population structure, a development al- ready apparent, for example, in several EU Member States. The population of the EU-28 on 1 January 2017 was estimated at 511.5 million, with a percentage of elderly people (aged 65 or over) of 19.4%, showing an increase of 0.2 percentage points compared with the previous year and an increase of 2.4 percentage points compared with 10 years earlier. Another aspect of population aging is the progressive aging of the older population itself, as the relative importance of the very old is growing at a faster pace than any other age segment of the EU's population. As a result, the share of older people in the total population will increase significantly in the coming decades, as a greater proportion of the post-war baby-boom generation reaches retirement. The share of those aged 80 years or above in the EU-28's population is projected to more than double between 2017 and 2080, from 5.5% to 12.7%.1 Similar conditions are typical of main industrialized nations, like USA, China and Japan, where the percentage of aging population is expected to rapidly grow (up to 37.70% in 2050 in Japan2), despite, in some cases, a population decrease is forecasted (like in Japan).

Aging processes result in some degree of decline in cogni- tive capacity, usually including the following symptoms: forget- fulness, decreased ability to maintain focus, decreased problem solving capacity. If left unchecked, these symptoms often progress into more serious conditions, such as dementia and depression, or even Alzheimer's disease (AD).3 Mild Cognitive Impairment (MCI) is a condition in which people face memory problems more often than that of the average person their age. These symptoms, however, do not prevent them from carrying out normal activities and are not as severe as the symptoms for Alzheimer's disease. Symptoms often include misplacing items, forgetting events or appointments, and having trouble finding words [1]. According to recent research, MCI is seen as the transitional state between cognitive changes of normal aging and Alzheimer's disease.4

If these warning signs are not timely caught and turn out into more severe diseases, then this will imply a significant decrease in the quality of life for both elderly people and their relatives, but it also creates a burden for national health services, which must face an evolving scenario for interventions. Given that the demand for health care rises with age, countries with rapidly aging populations must allocate more money and resources to their health care systems. With health care spending as a share of Gross Domestic Product (GDP) already high in most advanced economies, it is difficult to increase spending while ensuring high quality services in the case of publicly funded or government- administered health care systems.5 Additionally, the health care sector in many advanced economies faces common issues, including labour and skills shortages, increased demand for long-term home-care systems and the need to invest in new technologies. All of these cost escalators make it more difficult for existing systems to handle the increased prevalence of age-related chronic diseases, therefore, in a very near future, aging population is going to become an economic concern for all the citizens and one of the greatest social andA growing number of elderly people (65+ years old) are affected by particular conditions, such as Mild Cognitive Impairment (MCI) and frailty, which are characterized by a gradual cognitive and physical decline. Early symptoms may spread across years and often they are noticed only at late stages, when the outcomes remain irrevocable and require costly intervention plans. Therefore, the clinical utility of early detecting these conditions is of substantial importance in order to avoid hospitalization and lessen the socio-economic costs of caring, while it may also significantly improve elderly people's quality of life. This work deals with a critical performance analysis of an Internet of Things aware Ambient Assisted Living (AAL) system for elderly monitoring. The analysis is focused on three main system components: (i) the City-wide data capturing layer, (ii) the Cloud-based centralized data management repository, and (iii) the risk analysis and prediction module. Each module can provide different operating modes, therefore the critical analysis aims at defining which are the best solutions according to context's needs. The proposed system architecture is used by the H2020 City4Age project to support geriatricians for the early detection of MCI and frailty conditions.

The ageing trend is one of the major national conditions in China, and with the increasing number of elderly people, the issue of old age is now a major concern. In recent years, with the progress of the times and the continuous improvement of living conditions, people are putting forward higher requirements for the future of retirement and quality of life. However, the current design of nursing homes is not optimistic, the architectural model is still at the traditional monotonous level, almost uniform, and not carefully designed according to the wishes, habits and pleasures of the local elderly, which does not provide a comfortable and pleasant living environment for the elderly and makes them resistant to nursing homes. The design of new homes should be modern and up-to-date, meeting the physiological and psychological needs of the elderly. For this reason, architects should put more effort into the design of nursing homes and integrate the concepts of intensive design and green energy conservation into the whole process of nursing home design, so as to further improve the quality of life of the elderly. This paper briefly discusses the study of intensive architectural design and green energy conservation in nursing homes. The construction industry has a very large role in the consumption of resources in the building process, and the huge energy consumption in the construction industry will also bring a huge load to the natural environment. China's large population base and rapid population growth result in high resource consumption and low resource regrowth rates. China is a vast country, with great differences in natural, human and socio-economic conditions from region to region. Only when the elderly accept the concept of energy-efficient design from the bottom of their hearts will they be able to reflect green in more of their buildings. Developing green buildings in China with low consumption as the core The essence of green building is to reduce the consumption of resources and improve the efficiency of resource use during the whole life cycle of building activities, and to build a healthy and environmentally friendly living environment.On the other hand, the use of renewable energy sources such as solar energy should be promoted rapidly in the largest share of the middle and low-end market, with the main green building advocating the reduction of use and rational use of resources. For example, the use of condensation heat from air conditioning as an auxiliary heat source for domestic hot water, hot water from solar and geothermal energy for daily use, and solar photovoltaic systems to support electricity for daily use. Self-healing concrete can be used in practice by embedding optical fibers in the concrete to constantly monitor the stresses on the components under load.

The emphasis on 'holistic design' is on the principle of appropriate technology, which means using technology that is as close as possible to local industry, equipment, materials and labour standards, adapting to local conditions, actively adapting to the environmental conditions of the building site, and maintaining local culture and traditions. Holistic design is the application of economically viable technologies and building materials to create a green building system throughout the life cycle of a building, taking into account the global environment and resources. The establishment of a green building system is a highly complex systemic project. It requires not only environmental engineers and architects to apply sustainable design methods and approaches, but also decision-makers, management bodies, community organisations, owners and users to be environmentally aware and to participate in the whole process. The involvement of this multi-level partnership requires that a clear outcome of the environmental assessment of the building be established and agreed upon throughout the process.

Older People's Perception of Changes in Their Living Environment after Relocation: A Case Study in Beijing, China. Abstract: Beijing has been experiencing population ageing and rapid urbanization processes. Older people's living environment has changed dramatically. This research aims to understand the older people's perception of the changes in their living environment, the determinants of age-friendly living environment, and the impact path before and after their relocation in Beijing. The quantitative analysis is based on 353 valid questionnaires collected in four sample communities in Beijing. By using descriptive analysis and structure equation modeling (SEM), the results show that the living environment gets improved after relocation except accessibility to health care facilities. The cultural environment of the communities has significant impacts on the age-friendliness of the living environment. The physical environment of communities is able to improve the living environment indirectly through promoting the community cultural environment. This study sheds light on future research on age-friendly living environment for the ageing population in Beijing. This study found that the community environment improved in general after relocation, and 73% of participants reported that their living environments were more age-friendly after relocation. In terms of the components of community environments, facilities and community-built environments were improved most, whereas community cultural environment and services were less improved. In addition, in this research, older people had poorer accessibility to the health care facilities after relocation. The results of SEM show that the improvements in community-built environments had the most significant influence on the community environment in general, followed by older people's interpersonal communication, recreational activities, accessibility to community information, living conditions, and the community health care services. The results of the model show that the improvements in community-built environments had indirect impacts on the perceptions of the changes in the community environments in general through the cultural environments. Therefore, the perception of community environment was influenced by the sociocultural environment, and improving the sociocultural environment of the communities was able to significantly improve the older people's perception of community environment in general. The improvements in health care services within the community were important for the construction of an age-friendly community. The findings of this research show that the accessibility to health care facilities was poorer after relocation. Older people would have more demands on the health care resources as they age, which ranked first among all the demands and followed by instrumental supports and demands on emotional support [74].

Additionally, there are also some limitations in this study. Firstly, during the sampling process, due to the restriction of the number of interviewers and time, all of questionnaire information was verbally collected in a public space like residential communities and parks. Therefore, most of older people being recruited were relatively healthy and capable of participating in outdoor activities. The oldest-old and those with relatively poor health status were underestimated. Moreover, older people tend to have more challenges in adapting to new living environment and higher demand for an age-friendly environment. Secondly, the survey only collected information on older people's subjective perception, such as self-rated health status, comments on the age-friendliness of the environment, and so on. Thus, other indicators can be applied to objectively assess older people's health status and the changes in community environment in the future study.

Miyako AKIBA published a paper" A study on the actual conditions of unit-type nursing homes" in 2012. This paper aims to clarify the present conditions and problems of the unit type nursing home throughout Japan. The number of the staffs and the fixed placement affected care and the making of living environment. Fixed placement was in particular indispensable to bathing care and excretion care, an atmosphere built on living room. Since staff placement less than two people is necessary to perform fixed placement smoothly, the review of the current standard related to staff placement is necessary. In the private room, dementia can have lived with one's life rhythm and a family can be easy to visit. In other words, the private room is effective for improvement of the quality of life of the elderly. In private room, the occupancy rate of the low-income person is low, then an effort to meet the demand of the low-income person is necessary.

This study performed analyses of floor plans using 490 floor plans of Elderly Housing with Supportive Services (hereinafter.Sakojyu).obtained by a complete enumeration survey on all Sakojyu as of Dec. 31st, 2012 to see the current physical settings. The area of dwelling units were focused on 18.0-19.0mi adopting the relaxed criterion. The unit plans of 18-19mi were focused in 1R type, and facilities set were limited . Comparison between areas of dwelling unit and common space led four groups: small unit & small common, small unit & large common, large unit only, and large unit & common. The small unit & smallcommon group occupied 27.8% of the the 490 Sakyojyu , and had machinery baths in 21.0% of the group. kitchens were set in less than 70%. The results shows some of current Sakojyu is similar to the spatial composition of nursing homes based on lump treatment before the introduction of Unit Care.

Elderly Housing with Supportive Services (hereinafter, Sakojyu), established in year 2011 by the amended Act on Securement of Stable Supply of Elderly Persons' Housing, is a housing form with accessible structure to support elderly persons' security. As of May 31st, 2014, 4555 Sakojyu were registered, which supply 146,544 dwelling units.These numbers are in increase for elderly persons' relocation. A previous survey showed 75% of them had dwelling units of below the basic area criterion, 25 mi , and 60% had no kitchens, and 77% had no bathrooms in dwelling units, which explains the mainstream of Sakojvu have adopted the relaxed criterion. It is unclear that the current Sakojyus serve as housings for early relocation and for those on waiting lists of nursing homes to fully support elderly persons' living security.This study performed analyses of foor plans obtained by a complete enumeration survey on the registered 2055 Sakojyus as of Dec. 31st, 2012. Collected questionnaires were 948 (46%), 490 (23.8%) of them were sent back with analyzable foor plans with clear dimensions. Dimensions, general outlines of buildings, dwelling units, common space, and spatial composition of the 490 plans were analyzed in this study. The area of dwelling units was focused on 18-19mi adopting the relaxed criterion. Dwelling units of 18-19 mi had front width of 3m-below 3.5m, and their unit plans were focused on 1R type with toilets, storages, and wash stands. As for units over 25mi , front width was increased to the range of over 3.5m and below 4m, and were focused on IK type with the above mentioned three unit installations plus kitchens and bathrooms, 50% of the units had no balconies, 95.1% of Sakojyu had dining rooms. area per dwelling unit was seen in the range of over 2ni and below 3ni. 60% had over 3mi for the area of dining room and living room per dwelling unit, and the rest, 10%, had no other places to stay besides dining rooms. Comparison between areas of dwelling unit and common space led four groups : small unit and small common, small unit and large common, large unit and common, and large unit only, Small unit and large common, a group for the sum of the area of a dwelling unit below 25 m and the area of common space per dwelling unit to be over 25mi, was counted most. This group had decentralized dining rooms, which is close to the plan of Unit-type facilities for the elderly. It also had toilets accessible for wheelchair users and machinery baths, which can be explained to gain improved housing environment. Small unit and small common, 27.8% of the Sakojyu, 40 % of this group was also close to Unit'type nursing homes, but the rest, 60%, had centralized dining rooms similar to the conventional-type facilities before the introduction of Unittype, Machinery baths were less set and 30% of the group had no common kitchens. The relaxed area criterion was not fully reflected on this group and it needs to improve its housing environment, and large unit and common had accessible toilets and bathrooms, and machinery baths, in addition to common dining rooms, which indicates this group can serve as the housing for the residents with declining physical functions. In 1899, SchlWer published his famous paper 'The Layout of Towns', which marked the birth of urban morphology as a discipline. 1984 saw the emergence of a new quantitative approach to urban morphology - space syntax - represented by B. Hillier and J. Hanson. Hanson.

The theory of spatial syntax was developed in the 1970s, and in 1984 B. Hillier and J. Hanson co-authored The Social Logic of Space, which marked the formal creation of the theory of spatial syntax. Since that book, B. Hillier and his colleagues at Bartlett School of Architecture, University College London, have been concerned with the role that space plays in the form and function of buildings and cities. The most critical research in this regard has been the development of the concept of 'spatial composition'. On this basis, many scholars have carried out empirical studies. J. Hanson has conducted a number of empirical comparative analyses of the relationship between spatial configurations and social culture at the architectural level, the most important of which is in His most important work, Decording Homes and Houses, published in 1998, systematically explains the relationship between spatial configurations and the social logic of various types of buildings, finding that the complex relationships between spaces allude to the way human society perceives and organises space, and are highly consistent with the social, economic and cultural distribution of space.

There are two major events in the development of the theory of spatial syntax that have played an important role in its advancement. One is the International Symposium on Spatial Syntax, which has been held every two years since 1997. The second was the establishment in 2010 of an academic journal of its own on space syntax. At the same time, the theory of space syntax is increasingly being applied in the practical work of space syntax consulting firms. The coexistence of theoretical and practical values has led to the growing strength of the school.

In 2018, Nahyang Byun et al. studied Korean residential units and explored spatial configurations. Space analysis aims to identify the relations between society and space. Space analysis results let us identify the characteristics of the targeted space and subsequent human activities based on the notion of social relationship. The reason authors try to understand spatial structure lies in that it is the intrinsic attribute of physical built environment. This research looks into apartment houses, a widespread form of housing in Korea, in an attempt to investigate the social logic lying in its domestic space by measuring the spatial configuration. This research is based on empirical data and uses a quantitative methodology; Space Syntax. Characteristics of spatial structure in apartment units and their meanings were identified through this research. The implication of the living room-centered layout type most common in Korean apartments was discussed from the viewpoint of the domestic space genotype.

Yurdagül Görücü* M. Serhat Yenice et al. in 2019 studied a comparative analysis of the spatial characteristics of apartment buildings in the city of Gaziantep, Turkey. Analyzing the planning and design process, basic principles, and the change-transformation process of the apartment type residential buildings in Turkey, Gaziantep. The scope of the research consists of residential buildings built in the post-Republican period in Gaziantep. The basic materials of the research are zoning-city plans, plan explanation reports, plan diagrams of buildings and photographs based on field research. The method of the research is based on a comparative analysis of spatial changes in apartment buildings according to historical background.

2015, Saeid Alitajer et al. studied the behavioural patterns of private residential space configurations in Iran. The Iranian concept of home goes far beyond physical aspects, and its essence is interwoven with the spiritual nature of humankind. This concept has gained new meanings with the modernization and industrialization of societies. In Iranian architecture, every need is realized in socio-physical systems as well as in design issues. Therefore, spatial relationships are central to architecture, especially residential architecture that addresses a great proportion of an individual's daily life.Space syntax seeks to explain how spatial configurations express social or cultural meanings. One such meaning is confidentiality, which was mainly introduced into Iranian architecture as a result of religious beliefs. In Iranian architecture, confidentiality is viewed from the aspect of privacy. This case study makes use of description, analysis, and logical reasoning. The objective is to analyze behavioral patterns in the spatial configurations of traditional and modern houses in Hamedan. In so doing, library research, software simulation with the UCL Depthmap package, and comparison techniques are utilized.The findings indicate that the spatial configurations of houses have changed in the course of time. In terms of the indices of spatial configurations, however, the striking difference between traditional and modern houses in Hamedan revolves around the integration and equivalence of all spaces in a house. In other words, the hierarchy of access to spaces and the recognition of territories are limited in modern houses. Hence, privacy in modern houses fades.

Similarly in 2021 Pedram HESSARI et al. studied the architectural construction and configuration of traditional Iranian houses. The cities of Dezful and Boroujerd can be considered a treasure trove of traditional houses in Iran whose social, functional, and cultural roots are reflected in their architectural body. Traditional housing includes and expresses the life- styles and behavioral systems of its inhabitants. Therefore, by analyzing the spatial structure in different traditional dwell- ings, we can understand the structural differences in them. The main purpose of this study is to identify and express the structure and spatial differences in traditional housing in Dezful and Boroujerd, which have many differences in terms of environmental structure. This study seeks to answer the question: What are the differences between structural patterns and spatial configuration in traditional housing in Dezful and Boroujerd? The method of this research is generally qualitative and software that includes analytical-descriptive approaches and logical reasoning. First, using observation, field survey, and library studies, the desired maps are obtained and the research parameters such as spatial integrity, visual privacy and control, and access are determined. In the next step, the maps of selected research houses are analyzed and analyzed in Space Syntax software, which is specialized software for space syntax, and the patterns of spatial configuration in tradi- tional houses of Dezful and Boroujerd are expressed. The results show that the permeability and readability of more spaces due to the depth of each space and better spatial perception by individuals in traditional houses in Dezful is more than traditional houses in Boroujerd. In contrast, in traditional houses in Boroujerd, spatial stratification and spatial hierarchy, the creation of public and private layers due to the shape and type of housing, and also environmental security in the resi- dential complex is more than the examples of traditional housing in Dezful.

Douglas Amedeo examines a case study on classroom layout in 2015. Five different layouts were examined in this study to address that question. Perceptions of how classroom spatial layouts differ in the way they influence teaching and learning activities were elicited from primary teachers and evaluated in terms of their educational perspectives. They were uncovered by assessing teachers' beliefs about properties of various spatial designs, evaluating their spatial layout preferences, and by evoking their comments about the relative merits each layout has with respect to facilitating the conduct of activities in the classroom. The information collected in this way was evaluated and integrated with the use of similarity coefficients, q-mode factor analysis, and multi-dimensional scaling. Results from the case study strongly suggest that teachers perceive the influences exerted by various classroom spatial layouts on teaching and learning activities to differ, but their perceptions of such differences are clearly qualified by their educational perspectives.

Design with space syntax analysis based on building information Model"Towards an interactive application of building information model in early design process". This paper introduces a new framework to enable user-friendly space syntax analysis during the initial design stage. It assists designers, without in-depth knowledge on space syntax, to evaluate and compare design outcomes rapidly. The framework is realized by integration between space syntax and building information model in which space topology is autonomously retrieved. A BIM modeler so called 'ArchiSpace' has been developed to demonstrate the applicability of the framework to design practice. Our experiment shows that designers can use the modeler to analyze their design alternatives instantly at any moment during the initial design stage. Therefore, users can generate and evaluate their design alternatives simultaneously without distraction and tedious work on the space syntax analysis in detail.

Eddie Damavan examines the spatial patterns of street corridor (Case study: S. Perlman Street, Semarang, Central Java, Indonesia)，The purpose of studying space pattern in S. Parman Street Corridor Semarang is actually to examine the link between economic and social factors of community, space pattern, and the impact on the existing regulation. The methodology used in this study is a rationalistic approach by applying qualitative paradigm in relation to the purpose of the study. This approach needs theoretical framework that based on the experts' theories, to be constructed become grand concepts with holistic study [1]. According to the result and the analysis, the author found that corridor space pattern in S. Parman Street is closely related to the economic status and social life of the people. Some of the reasons could be that the economic condition may encourage people to optimize and expand their lots to build new buildings included the activities support facilities inside their lot which very much different from the original building. People could also rebuild their own house basically because of their needs and their ability to financing the process of rebuilding. Besides, the social life of these people are already changed and such condition will then influence the existancy of their buildings or even their lots. It is therefore, the changes of the economic status and social life of the people will directly provide an impact of the spatial pattern and the size of the building. Furthermore, there were some changes particularly on the function of the buildings along the corridor which were housing before. Almost 75% of the buildings changed into various functions, such as office buildings, business, services, hotels, etc. These developments actually did not match with the land use regulation of the local government for this area which should be settlement and not for mixed use. The deviation of this development process in the corridor of S. Parman Street is one of the consequences of the economic status and social level of the people.

Investigating the role of semi-open spaces on the sociability of public libraries using space syntax (Case Studies: Sunrise Mountain and Desert Broom Libraries, Arizona, USA). Despite the positive efforts made in recent years, active public libraries are still faced with challenges in attracting and retaining their users through the provision of up-to-date services to meet their scientific, cultural and recreational requirements. Accordingly, the need to create spaces with the approach of sociability in public libraries seems to be necessary. In this way, the Space Syntax method, as a predictor of the social aspects of architectural spaces, has been used in order to evaluate the role of semi-open spaces on the sociability of public libraries in the existing and hypothetical models using Depthmap. Finally, the findings of the two simulated models were examined and compared with each other using SPSS and the independent sample t-test. The findings from the

Sunrise Mountain Library analysis indicated that in the existing model, the integration level was 20.49. However, after eliminating the semi-open spaces, the level of integration decreased to 15.48. Also, the findings obtained from the Desert Broom Library indicated that in the existing model, the integration level was 10.10. However, in the hypothetical model, its degree of integration changed to 8.15. Results show that semi-open spaces have a positive effect on the sociability of public libraries.

Space syntax in architectural design. In architecture, design begins by generating ideas and continues by transforming them to concrete spatial formations. Architects learn about the design problem by creating alternatives and testing them in order to gain desired spatial formations. A comprehensive architectural knowledge helps architects in this process. This knowledge is a synthesis of practice and theory, in other words mystery and certainty, intuition and science, experience and research. Architects must proceed in two ways and bring all components together in a creative way. This paper aims to explore contribution of a scientific, and research based approach, namely space syntax, in the design process. Space syntax is based on configurational theory of space and attempts to decode spatial formations and their impacts on human activity. By the development of new techniques for representing and analysing space, space syntax appears as a tool for architects to explore their design ideas and understand possible effects of their proposals. By illustrating a link between research and design, this study attempts to create new horizons for those professionals in architectural practice as well as academics in architectural education.

Reflection of cultural practices on syntactical values: An introduction to the application of space syntax to vernacular Malay architecture. This study introduces the basic concepts and terminologies regarding space syntax research through a simple spatial configuration. The concepts are elaborated for intricate configurations. This study aims to deepen the understanding of how syntactical analysis can extract social information embedded in traditional architectural practice in the Malay Archipelago. The basic terminologies are outlined, and the sequential procedure for analysis is described along with its interpretation in the context of actual social phenomena. Result shows that the syntactical properties of a particular configuration within a particular region reflect the traditions of the people in that region. This study serves as a basis for the future study of the applications of space syntax to diverse spatial configurations in the Malay Archipelago.

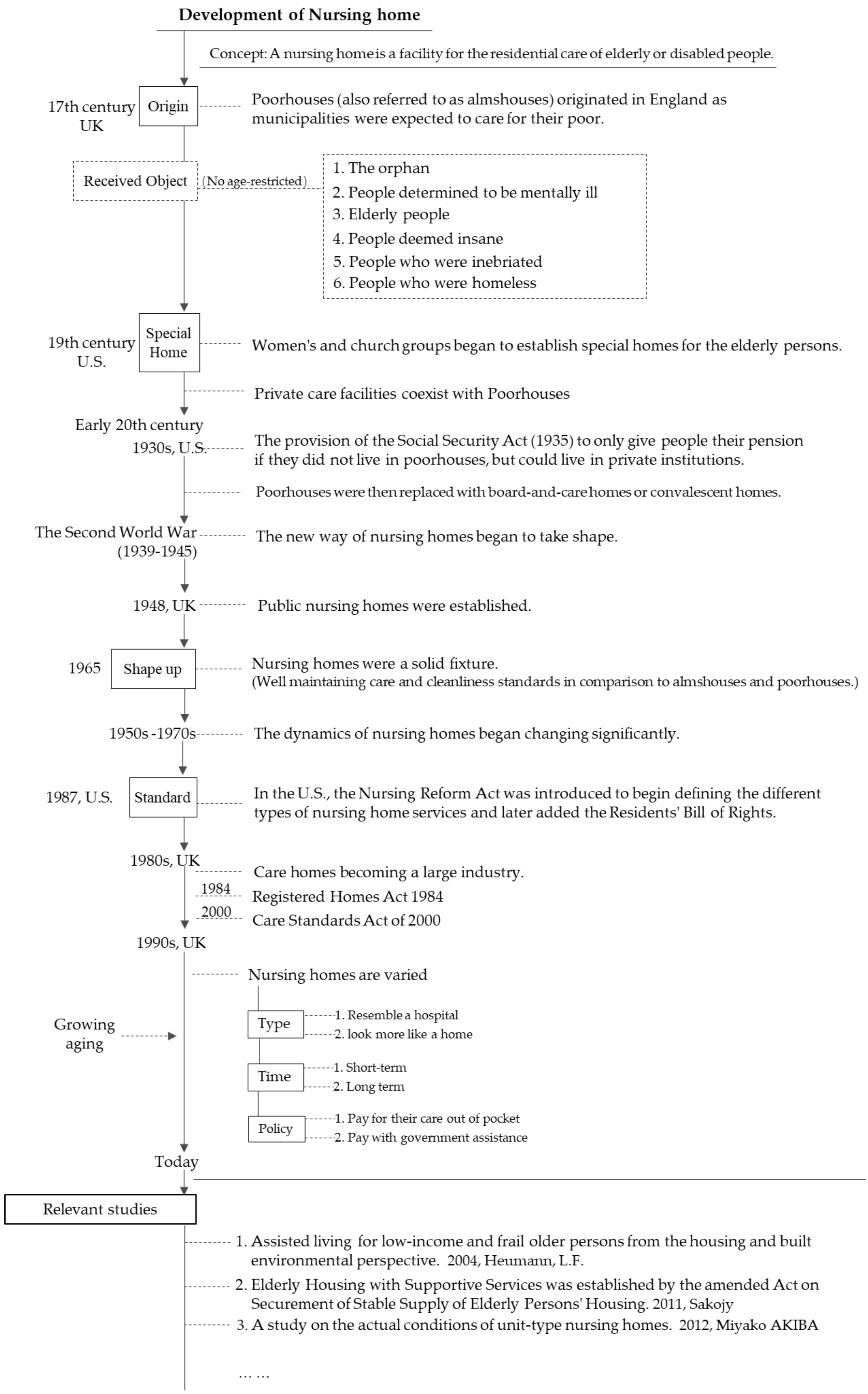


Figure 1-5 The development of nursing home

1.5. Comparison of the methods.

The physical environment was identified by the WHO in 1994 as one of the most important factors affecting quality of life. The physical, mental and social well-being of older people is closely related to the physical environment in which they live, so the quality of the physical environment has a direct impact on the physical and psychosocial well-being of older people living in care facilities of all kinds. However, the quality of the architectural design of elderly care facilities in China is currently judged by technical standards rather than by the impact of the environment on people after use. Moreover, there is a discrepancy between what architects see as the needs of users and what they actuallywant. Therefore, there is a need for systematic and scientific environmental assessment tools to guide and evaluate the design and built environment of all types of elderly care facilities in order to improve the quality of life of the elderly living there.

The impetus for overseas research on care-based living environment evaluation tools came from society's concern for the needs of older people. In the United States, the initial design of residential care facilities was based on hypothetical needs. With the introduction of the Medicare Act, the Medicaid Act and federal housing regulations, attention to the needs of older people, research into the impact of the physical environment and the enhancement of design gradually gained importance. In this context, research on the systematic structure of environmental design elements and evaluation tools for various types of senior living facilities was developed to address key technical issues in environmental research.

In the late 1970s, the first environmental assessment tool for welfare facilities emerged in the USA, the Multiphasic Environmental Assessment Procedure (MEAP). By the late 1980s, the Therapeutic Environment Screening Scale (TESS) was introduced in the USA. In the 1990s, the Scales for the Assessment of Environments for the Confused Elderly (SAECE) were developed in the UK, and in the US, the Behavioural Model of Environment (BME) was developed to assess memory care environments. "The Environment-Behavior Model (E-B Model) and the Professional Environmental Assessment Procedure (PEAP). In the new century, tools are emerging at a faster pace and expanding in scope, with the UK's Sheffield Care Environment Assessment Matrix (SCEAM) and the Design Audit Tool (DAT). Design Audit Tool (DAT) in the UK, the Environment Audit Tool (EAT) in Australia, the Environmental Quality Assessment Tool (EQAT) in the USA, and the Environmental Quality Assessment Tool (EQAT) in the USA. "Environmental Quality Assessment for Living (EQUAL) and the Hospice Environmental Assessment Protocol (HEAP). Protocol (HEAP). The rapid emergence of these tools indicates that they are increasingly being used as a key technique for empirical research, and are being taken seriously by academic groups, care providers, regulators and architects.

Scale for the Evaluation of the Care Environment for the Cognitively Impaired Elderly (SAECE)

The SAECE was developed in 1992 by experts in the field of medicine and health in the UK to provide a systematic assessment of the quality of the living environment of elderly people with cognitive impairment in long-term hospitalisation, based on the environmental assessment methods available at the time [20]. As such, it was aimed at the ward environment of care homes at the time, and included not only the physical but also the social environment.

Table 1-2 Information on the Caring for the Elderly Residential Environment Assessment Tool

Tool name		Tool information				
		Develop year	Country	Developer's field	Environmental object	Tool forms
Integrated Environmental Assessment	MEAP	1979	USA	Psychiatry, Behavioural Sciences	Physical environment, operational services, social environment of welfare facilities	Scale Questionnaire
	SCEAM	2003	UK	Architecture, Geriatrics, Statistics	The physical environment of care facilities	Scale
	EQUAL	2006	USA	Public Health, Environmental Psychology	he physical environment of care facilities	Scale
Evaluation of care settings for the cognitively impaired elderly	SAECE	1992	UK	Neurology, Sociology	The physical environment, operational services, and social environment of a memory care unit	Scale Questionnaire Interview
	E-B Model	1994	USA	Geriatrics, Statistics, Sociology	The physical environment of the memory care facility/unit	Scale
	PEAP	1999	USA	Architecture, Geriatrics, Epidemiology	The physical environment of the memory care facility/unit (unfolded in the wider context of	Scale Interview

					social, organisational management)	
	EAT	2003	Australia	Nursing	The physical environment of memory care facilities/units (latest version)	Scale
	TESS-NH/ RC	1989 1991 2005	USA	Family medicine, geriatrics, sociology, environmental psychology, public health, statistics, etc.	The physical environment of the memory care facility/unit	Scale
	DAT	2008	UK	Architecture, Nursing	The physical environment of the memory care facility/unit	Scale Interview
Evaluation of the hospice environment	HEAP	2016	USA	Architecture	The physical environment of a hospice facility for the elderly	Scale Interview

Although initially developed to evaluate institutional care facilities, there are examples in the literature of SAECE being used to evaluate non-medical facilities: in a project to evaluate the environment of 46 care homes for older people in the UK, feedback from the application of SAECE made the scale In a project to evaluate the environment of 46 care homes for the elderly in the UK, the feedback from the SAECE made the scale easy to use and the results provided a good distinction between the quality of the environment. The SAECE can therefore be used as a useful tool for comparing institutional and home based environments. At the same time, the literature also points out the disadvantages of the tool: as the evaluation process relies on subjective judgement, the evaluator may be biased in his or her scoring when knowing the type of facility to be evaluated, which may lead to biased results.

Environmental Assessment Tool (EAT)

The EAT was developed by Professor Richard Fleming's team at the University of Wollongong in the late 1980s, initially for rural hospitals in New South Wales, with the aim of using the EAT assessment to improve the environment in wards for older people with cognitive and other mental illnesses. The EAT was published by the NSW Department of Health in 2003 to guide the conversion of hospital wards into memory care units. The EAT is now used primarily for the environmental assessment of home based memory care facilities. Although the indicators are based on expert opinion, a large body of empirical data has been accumulated over the last 30 years to support the suitability of the indicators. Although the indicators are generated based on expert opinion, a large amount of empirical data has been accumulated over the last 30 years to support the suitability of the indicators. The evaluation process does not require the evaluator to interact with people, nor does it rely on subjective judgement, and therefore does not require the evaluator's professional background. In a research project on memory care facilities in Australia, two evaluators described the application of the EAT as described the application of the EAT as "relatively easy and quick to master". However, it has been argued that the lack of communication with the user reduces the difficulty of evaluation and ignores the user's perspective.

The developers have positioned the tool as being more appropriate for use in Australian home-based aged care facilities. However, it has also been argued that a single tool is not sufficient to describe the complexity of the needs and problems of all types of older people with cognitive impairment, and this was complemented by the development of the EAT-HC in 2015, which evaluates the care environment for older people with mobility impairment.

The methods used for the study of the physical environment of buildings are diverse. In the study of the physical environment of nursing homes, SCEAM (Sheffield Care Environment Assessment Matrix) and EAT (Environmental Audit Tool) are two of the more commonly used methods. SCEAM is a method for recording the characteristics and use of a nursing home, often used in combination with other methods, and preferring to be adopted for research on aspects of care. EAT works by creating design-related questions that incorporate the lived experiences of the residents of the nursing home, then using questionnaires to obtain data to assess the design quality of the building, and finally clarifying the spatial relationship between the residents and their physical environment. In assessing the spatial arrangement of nursing homes, EAT focuses more on the design details and relies on the sense of the residents. Space syntax techniques for the analysis of spatial layouts were the first to demonstrate, in a numerical way, clear and systematic relations between spatial design and observed functioning across a range of building and urban types. The main interest of space syntax is the relation between human beings and their inhabited spaces. And space syntax research aims to develop strategies of description for configuring inhabited spaces in such a way that underlying social meaning can be enunciated. In addition, space syntax attempts to constitute a configurational theory in architecture by generating a theoretical understanding of how people make and use spatial configurations. It leads to the study of architecture intuition with its rational and more rigorous creation, then makes the deployment of non-discursive intuition more rational and therefore more discursive. In the study of the built physical environment, spatial syntax is often used to study people's activity and movement in space. For instance, Saif et al. investigated the topological knowledge of hospital layouts and obtained the result that spatial layout can predict

Table 1-3 A comparison of two assessment tools for the evaluation of the physical environment of nursing homes with space syntax

Tool name		Evaluation projects	Advantages	Disadvantages
Scale for the Evaluation of the Care Environment for the Cognitively Impaired Elderly	SAECE	Environmental needs - privacy, humanity, sense of community, comfort, security, safety and health, perception of external environment, choice and control, support for physical limitations, support for cognitive impairment, support for staff Environmental elements - base location, outdoor environment, spatial form and flow of the building, activity spaces, bathrooms and toilets	The feedback from the SAECE made the scale easy to use and the results provided a good distinction between the quality of the environment.	As the evaluation process relies on subjective judgement, the evaluator may be biased in his or her scoring when knowing the type of facility to be evaluated, which may lead to biased results.
Environmental Assessment Tool	EAT	Safety, pleasant size and scale, accessibility by sight, avoidance of over-stimulation, highlighting of beneficial stimuli, promotion of movement and activity, sense of familiarity, optionality for solitude and socialising, provision of community links, opportunities for home-like living	The evaluation process does not require the evaluator to interact with people, nor does it rely on subjective judgement, and therefore does not require the evaluator's professional background. Relatively easy and quick to master.	Lack of communication with the user reduces the difficulty of evaluation and ignores the user's perspective.
Space Syntax	Space Syntax	Spatial accessibility, for the wayfinding behaviour of people in space	The main interest of space syntax is the relation between human beings and their inhabited spaces. aims to develop strategies of description for configuring inhabited spaces in such a way that underlying social meaning can be enunciated. Focusing on studying people's activity and movement in space.	Lack of communication with users and lack of detailed differentiation of space dimensions and functions.

people's wayfinding behaviour in buildings; Kali studied museum building design and exhibition layout, and demonstrated that museums can convey their intended messages and meanings through the interplay of spatial layout and exhibit display; Byun et al. examined the social logic of the activities of Korean family members using spatial syntax. Lee interpreted the sustainability of three buildings from the degree to which the space attracts people together by using spatial syntax theory. Therefore, Space syntax is advantageous for the study of spatial layout from the perspective of people's movement paths through spaces.

1.6. Research framework

This research consists of four chapters. The first chapter is devoted to introducing this research, including the background to the study, the purpose of the study, the object of the study, the methodology and theory of the study, and previous research relevant to this thesis. Chapter 2 is made up of two main sections. The first section summarizes in detail the configuration of functional

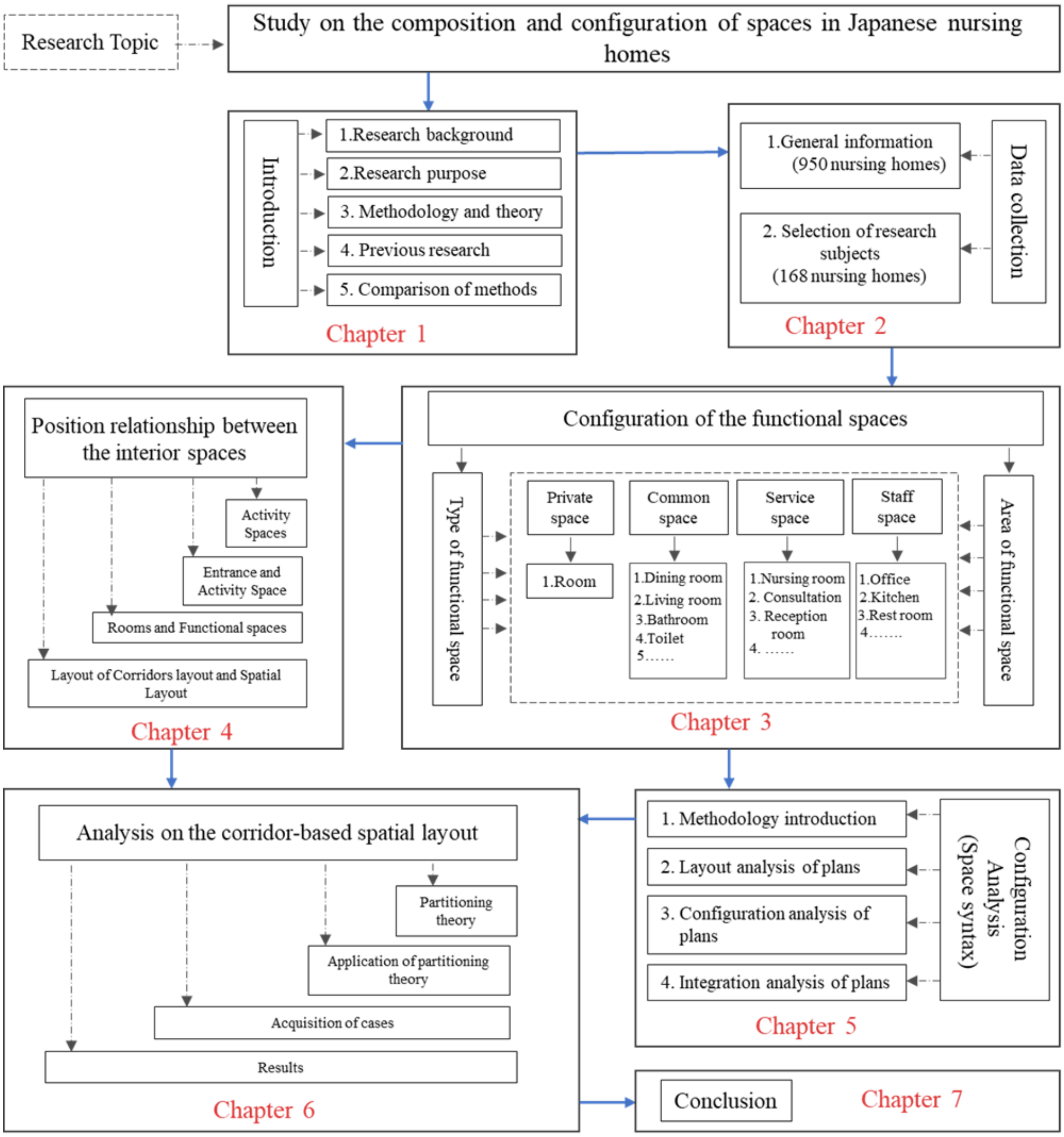


Figure 1-6 Research framework

spaces in nursing homes. This part of the study focuses on the type and size of the functional spaces. The other section explores the spatial relationships of the internal spaces of nursing homes. This part of the study includes the spatial relationship between functional spaces and transitional spaces and the spatial relationship between functional spaces. The research in Chapter 3 focuses on exploring the rule and order of spatial organization within nursing homes. The research involves the exploration of spatial types and the rules of spatial arrangement in nursing homes within the framework of spatial syntax theory. The last chapter is about a summary of the whole article and a discussion of future.

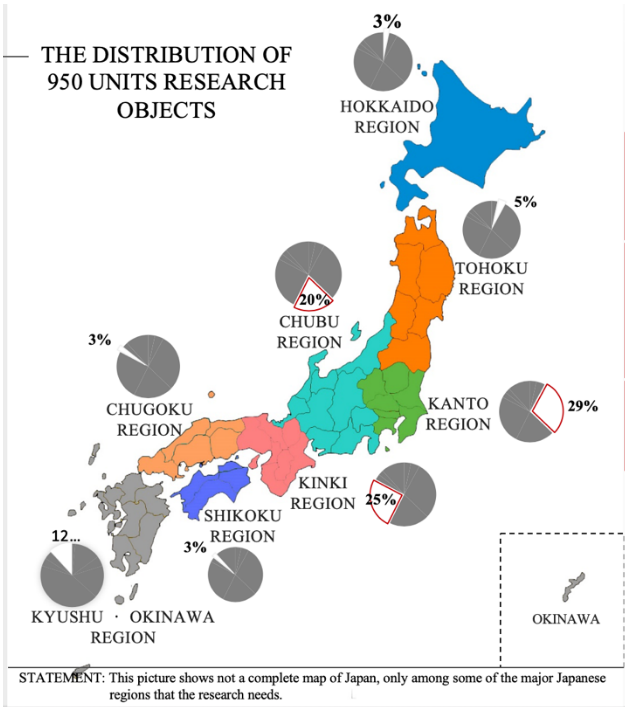
CHAPTER 2
DATA COLLECTION

2. Data collection

After decades of development, Japan now has a sophisticated and mature system of nursing institutions, and has developed a variety of nursing homes to meet the different needs of the residents. Currently in the Japanese market, depending on the investor, there are public nursing facilities established by the government and civil elderly facilities established by companies or individuals. Public nursing facilities primarily accommodate the elderly people with special or serious illnesses who require special care. But the service target of civil elderly facility is for a wide range of older people throughout Japanese society. As a result, the civil elderly facility accounts for around 90% of the market share of Japanese nursing homes. Among the civil elderly facilities, different types of nursing homes have developed depending on factors such as the level of care required by the elderly and the philosophy of the facility services. And this study focuses on the civil nursing homes.

2.1. Location

Nearly 1000 civil nursing home were surveyed for this study by using the internet, mail and relevant journals. Total 950 civil nursing homes from all regions of Japan, 44 cities, with the proportion of nursing homes chosen from each region indicated in the graph (see Figure 2-1). The majority of the nursing homes comes from Kanto Region, Kinki region and Chubu Region. The most nursing homes are chosen from Kanto region, which have 278 units, and occupy about 29% of all, most of which are from Kanagawa (84 units), Chiba (65 units) and Tokyu (42 units). 25% of the nursing home are from Kinki region which has 241 units, 188 of which are from Osaka. 192 nursing homes which occupy about 20% of all are from Chubu Region, of which Aichi provides the most nursing homes (86 units). In other 8 regions, with the exception of Fukuoka, which provides 112 nursing homes which takes 12% of all, all other regions offer a small sample of data.



LOCATION	NUMBER		
HOKKAIDO REGION	32	Hokkaido	32
TOHOKU REGION	43	Akita	4
		Iwate	5
		Fukushima	6
		Yamagata	6
		Aomori	7
		Miyagi	15
KANTO REGION	278	Tochigi	6
		Ibaraki	13
		Saitama	34
		Gunma	34
		Tokyo	42
		Chiba	65
		Kanagawa	84
CHUBU REGION	192	Toyama	5
		Yamanashi	7
		Niigata	8
		Ishikawa	10
		Nagano	12
		Mie	14
		Gifu	23
		Shizuoka	27
		Aichi	86
KINKI REGION	241	Shiga	4
		Nara	9
		Wakayama	13
		Kyoto	13
		Hyogo	14
		Osaka	188
CHUGOKU REGION	27	Shimane	1
		Hiroshima	1
		Okayama	5
		Tottori	5
		Yamaguchi	15
SHIKOKU REGION	25	Ehime	5
		Tokushima	7
		Kagawa	13
KYUSHU · OKINAWA REGION	112	Okinawa	3
		Saga	5
		Miyazaki	7
		Kagoshima	10
		Ooita	12
		Kumamoto	20
		Fukuoka	55

Figure 2-1 The distribution of 950 nursing homes

2.2. Rent Fee

The cost of a nursing home for the elderly is one form of measuring the overall national economy of the country or region. It gives an indication that how much is relatively reasonable to charge for a nursing home and how much the elderly or their children can afford to spend on a nursing home.

During the survey, we found that in a nursing home, the resident's rooms which are equipped with different functional space or have different size, normally have different prices that the elderly should spend. So, a range of minimum and maximum prices is included to represent the monthly cost of a nursing home stay. On the question of the cost of admission to the 950 nursing homes, the cheapest monthly fee the elderly spend was 36,000 yen, the most expensive room costs up to 1,833,000 yen per month. Although it seems to be a wide variation in price, 98.6% of nursing homes are equipped with the room in the price range of 50000 yen to 300000 yen, about 70% of which are equipped with the room in the price under 400000 yen. Since in each nursing home the lower priced rooms are in the majority and the more expensive ones are generally only a few, it is more objective and informative to observe the smallest prices. In addition, to get a clearer picture of the prices of nursing homes, we have divided 950 samples into 7 groups based on the lowest price of room in the nursing home. 7 groups consist of 0-50,000 yen, 50,001-100,000 yen, 100,001-150,000 yen, 150,001-200,000 yen, 200,001-250,000 yen, 250,001-300,000 yen and above 300,000 yen. Clearly, the most nursing homes, about 51.2% of all, has the room with the price per month between 100,001 to 150,000 yen, followed by the price between 150,001 to 200,000 yen at 20.2%, and by the price between 50,001 to 100,000 yen at 19.7%. Similarly, the group with the price less than 50,000 yen as well as than greater than 300,000 account for a very small number, 0.5% and 0.74% respectively. So, more than 90% of the nursing homes have the prices of the room between 50,001 to 100,000 yen, and the average maximum price and minimum price focus on between 194,000 to 134,800 yen.

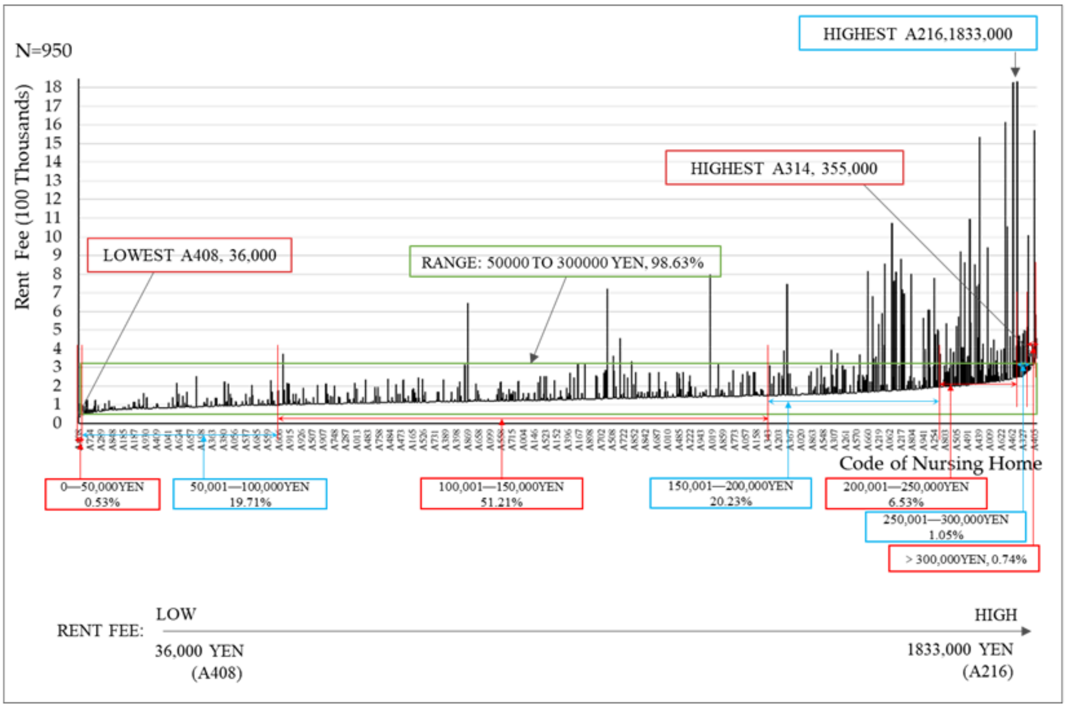
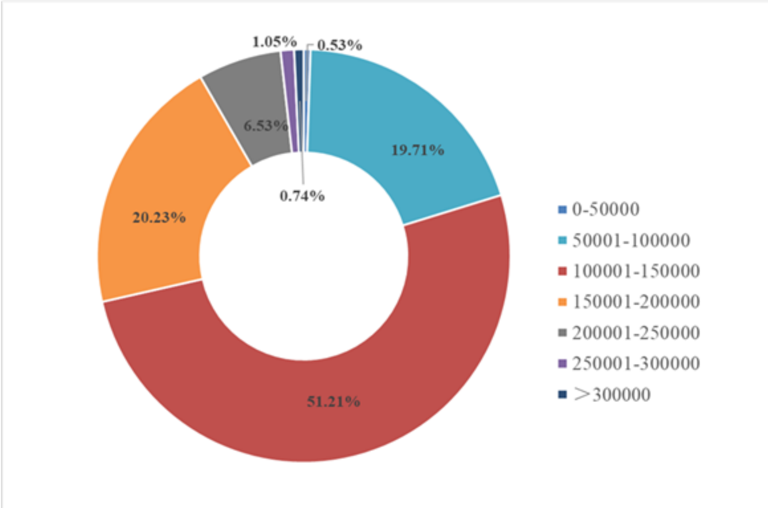


Figure 2-2 Distribution about the rent fee of nursing homes (Max, Min))



RANGE/YEN	NUMBER
0-50000	5
50001-100000	187
100001-150000	486
150001-200000	192
200001-250000	62
250001-300000	10
> 300000	7

Figure 2-3 Distribution about the ratio of the range of rent fee of nursing homes

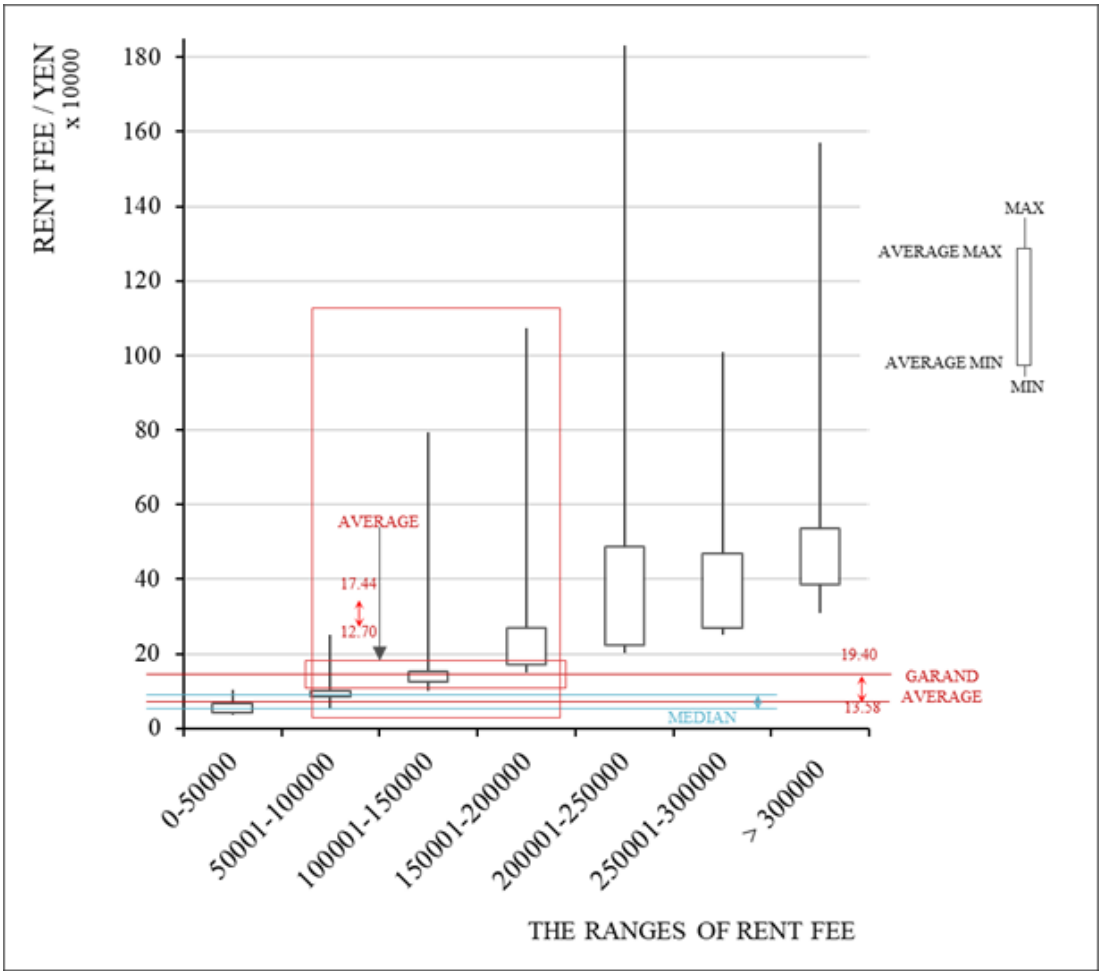


Figure 2-4 Distribution about the ranges of rent fee of nursing homes

2.3. The Staff

The ratio of the number of staffs to the number of residents in a nursing home gives a certain indication of the level of care in the nursing home. Only 364 of the 950 nursing homes provided us with the information on the number of staffs, possibly due to the commercial confidentiality or privacy concerns.

Purely in terms of numbers, a nursing home is staffed with 70 employees, while one employs only 2 staffs. The number of staffs is inseparable from the scale of the nursing home and it is inaccurate to analyze only in terms of the number of staffs. Therefore, the ratio of the number of staffs to the number of residents is used as the basis for data analysis in this section. In 364 nursing homes, the highest ratio is 1.480, which means that there is an average of 1.5 staffs taking care one elderly person, indicating the very high level of care in that nursing home. But in a nursing home, only 0.07 staff in average looks after an elderly, which is lowest ratio of all and low level of care. The highest and lowest ratios only represent the two extremes of the ratio of the staff to residents in the nursing home. In order to have a clear and more objective view and analysis of the staffing ratios on nursing homes, we have divided 364 nursing homes into 11 groups based on the ratio. 11 groups include below 0.1, 0.1-0.19, 0.2-0.29, 0.3-0.39, 0.4-0.49, 0.5-0.59, 0.6-0.69, 0.7-0.79, 0.8-0.89, 0.9-0.99 and above 0.99. The figures show that the ratio the nursing home has focus on four groups consist of group 0.2-0.29, group 0.3-0.39, group 0.4-0.49 and group 0.5-0.59. Total 274 nursing homes have the ratios between 0.2 to 0.59, occupy 75.3% of all, of which 126 nursing homes taking 46% of 274 nursing home and 34.6% of all have the ratio in the group 0.3-0.39. And the groups which have the ratios less than 0.2 or higher than 0.59 are gradually reduced. This suggests that in average an elderly person can get the care by 0.2 to 0.6 staff in a nursing home is the relatively standard level of care currently in Japanese nursing homes.

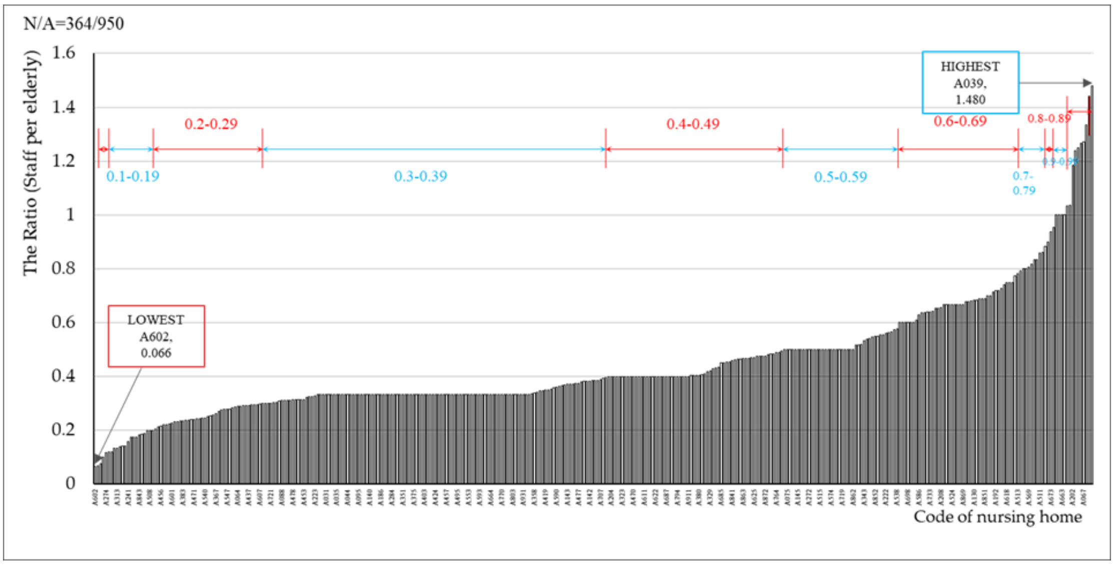
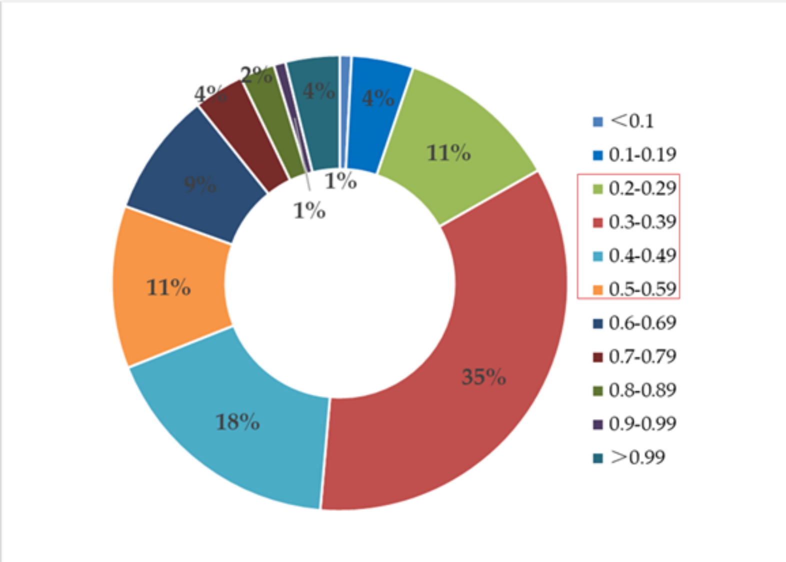


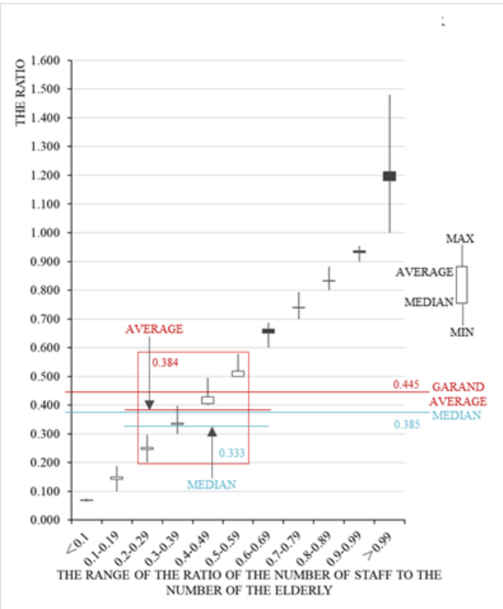
Figure 2-5 Distribution about the ratio of the number of staffs to the number of the elderly

Furthermore, for the four groups with the higher number of nursing homes, including group 0.2-0.29, group 0.3-0.39, group 0.4-0.49 and group 0.5-0.59, the average staffing ratio for each group is 0.25, 0.34, 0.43 and 0.52. The overall average staffing ratio of four groups is 0.445, with a median value of 0.385. This indicates that the recommended staffing ratio of around 0.4 for a nursing home is relatively reasonable and economical.



RANGE	NUMBER
< 0.1	3
0.1-0.19	16
0.2-0.29	42
0.3-0.39	126
0.4-0.49	64
0.5-0.59	42
0.6-0.69	32
0.7-0.79	13
0.8-0.89	9
0.9-0.99	3
> 0.99	14

Figure 2-6 The ratio of the number of staffs to the number of the elderly (analysis)



RANGE	MIN	AVERAGE	MAX	NUMBER
< 0.1	0.066	0.069	0.075	3
0.1-0.19	0.100	0.149	0.188	16
0.2-0.29	0.200	0.252	0.296	42
0.3-0.39	0.300	0.338	0.397	126
0.4-0.49	0.400	0.428	0.494	64
0.5-0.59	0.500	0.518	0.577	42
0.6-0.69	0.600	0.650	0.688	32
0.7-0.79	0.700	0.740	0.793	13
0.8-0.89	0.800	0.833	0.882	9
0.9-0.99	0.900	0.931	0.955	3
> 0.99	1.000	1.181	1.480	14

Figure 2-7 Distribution about the ratio of the number of staffs to the number of the elderly

2.4. The year and structure

This section examines the year of construction of the nursing home building. 944 of 950 nursing homes provided us the information on the year the nursing home opened. From the graph we can see that the number of nursing homes in Japan was increasing slowly until 2008, and since 2009, a large number of new nursing homes have been adding ever year. Of which 82.3% of the all nursing home opened concentratedly on the decade of 2009-2018. This seems to be closely related to the fact the ageing of Japan is once again increasing due to the impact of the advanced ageing of fewer children. As the data was collected in mid-2019, the number of new nursing homes built in 2019 is on the low side.

In terms of the structure, with the exception of 29 nursing homes for which no explicit construction information was provided, the rest of the nursing homes consisted of three main types of structure, namely steel, reinforced concrete and wooden. Each of these three structures has its own advantages and disadvantages. Advantage of steel structure: high strength, high strength to weight ratio, good plasticity and toughness, homogeneous material, in line with mechanical assumptions, safe and reliable, factory production with high degree of industrialization and fast construction. The disadvantages include not fire resistant, easy to rust and poor corrosion resistant. The main advantages of reinforced concrete are its high strength and stiffness, good resistant to earthquakes and impacts, good durability and fire resistant, plasticity of the mix, easy sourcing of raw materials. The disadvantages include high dead weight, low tensile strength and be prone to cracking. Advantages of wooden structure are easy to construct, can be reused after removal, flexible structure with good earthquake resistance, flexible frame construction. However, the limitations of the wooden structure include vulnerable to insects and decay, not resistant to water and fire. Therefore, the nursing homes made up of all three types of structure are prevalent, with the largest number of nursing homes made up of pure steel, at around 40.5%. 29.1% of nursing homes are made up of pure reinforced concrete and 26.1% of nursing homes consist of wooden structures. Totally, the structure that 95.7% of nursing homes are made up of belong to the three types of structure. The small number of remaining nursing homes consist mixture of two or three of the three types of structure.

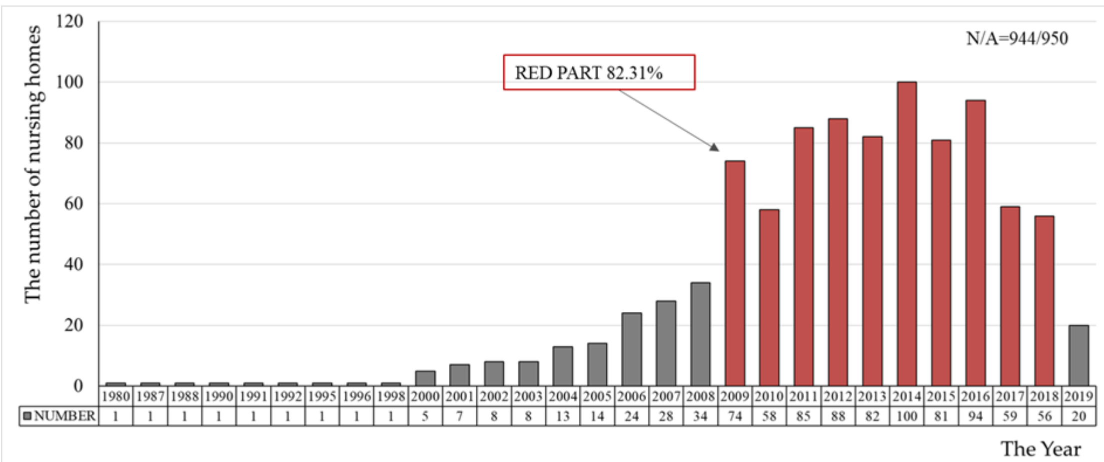


Figure 2-8 Distribution about the year the nursing home opened

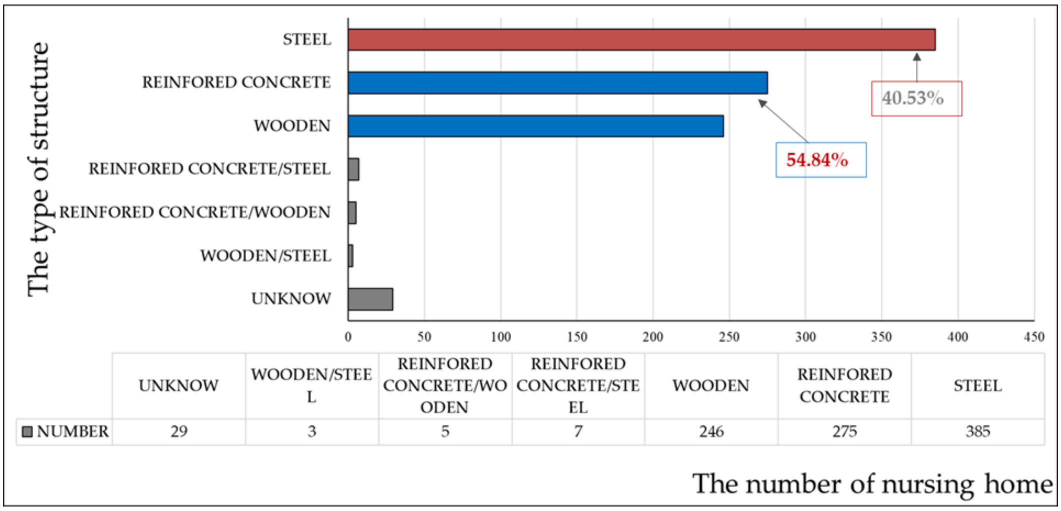


Figure 2-9 Distribution about the structure of nursing homes

2.5. The Floor

There are many variations in the number of floors in the nursing home from 1 to as high as 19. However, the most (815) of nursing homes taking 85.79% of all are spread between 1 and 4 floors, of which the most nursing homes have the floors with 2 floors and 3 floors, respectively 288 nursing homes taking 35.33% of 815 unit, 30.32% of all, and 255 nursing homes taking 31.29% of 815 unit, 26.84% of all. Relatively few nursing homes have one or four floors, respectively 129 nursing homes taking 13.58% of all, and 143 nursing homes taking 15.05% of all. The number of nursing homes decreases as the number of floors increases above 4 storeys. This seems to indicate that relatively low floors are friendly to the older person's experience of living in a nursing home.

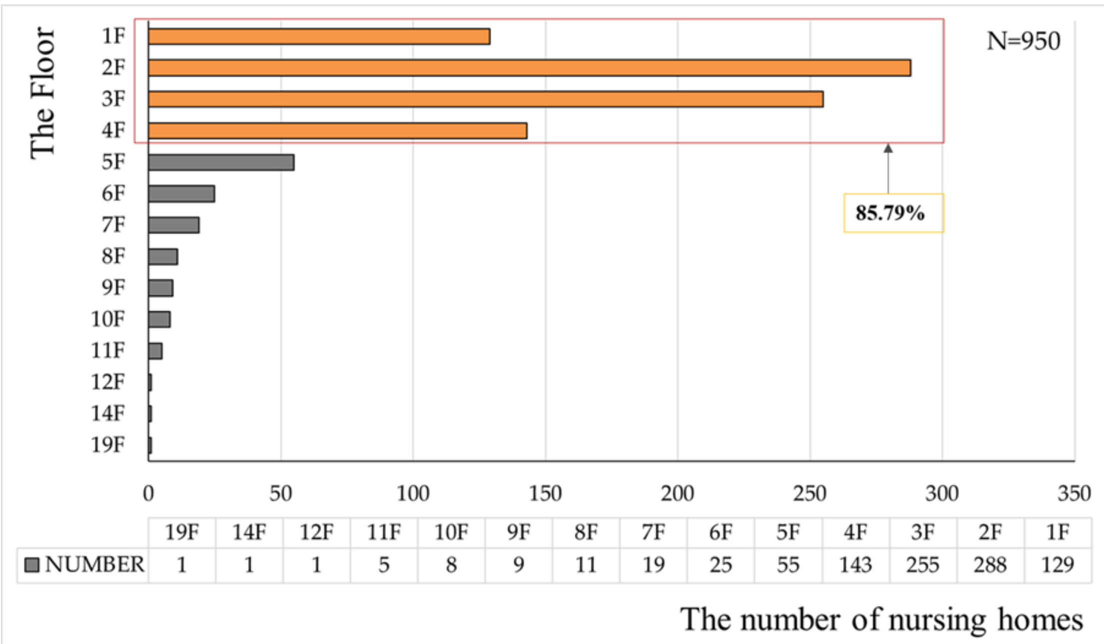


Figure 2-10 Distribution about the floor of nursing homes

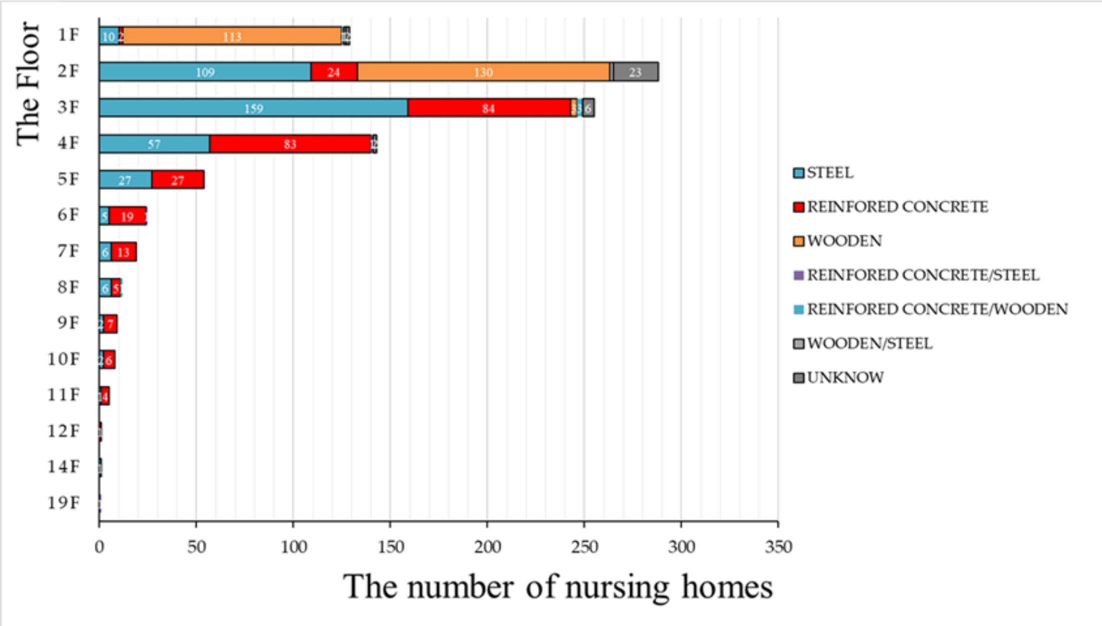
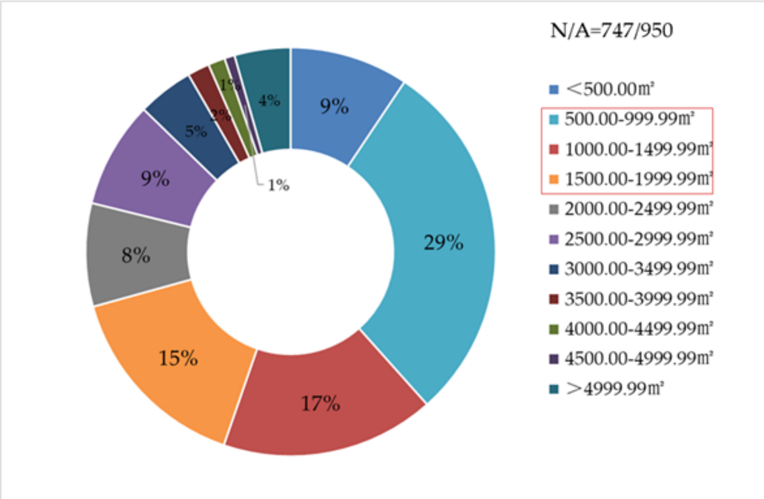


Figure 2-11 Distribution about the relationship between the floor and structure

In addition, the figure shows a clear correlation between the floor height of the nursing home and the structure of the nursing home. The vast majority of 1-storey nursing homes, and almost half of 2-storey nursing homes, are made up of wooden structure. Once the floors are above the second floor, there are very few nursing homes made of wooden structure, instead they are made of steel and reinforced concrete. Similarly, nursing homes consisting of steel structure are very common below 6 floors and above 1 floor, with steel structure gradually disappearing as higher floors become available. From the 3rd floor onwards, the advantages of reinforced concrete seem to emerge, accompanied by a gradual increase in the proportion of nursing homes that have its composition.

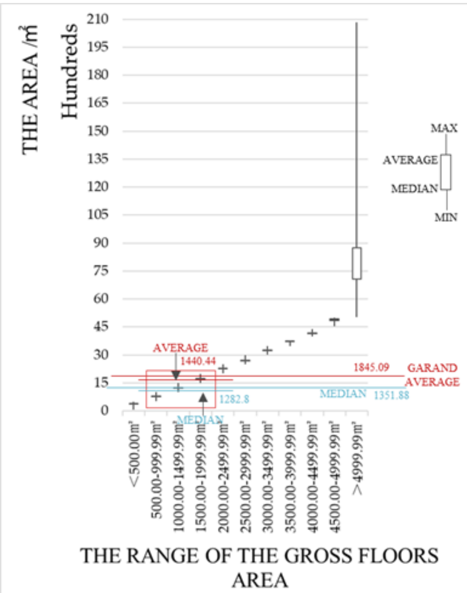
2.6. The scale of building

This section analyses the scale of the nursing home in terms of the gross floor area of the building and the number of resident's rooms equipped. Firstly, 747 of 950 nursing homes provided us the information on the gross floor area of the building, the smallest nursing home is only 71.19m², while the largest reaches 20,826.7 m², which is a huge difference. Similar to above, here we have divided the 747 nursing homes into 11 groups depending on the gross floor area of the building. 11 groups include group below 500.00 m², group 500.00-999.99 m², group 1000.00-1499.99 m², group 1500.00-1999.99 m², group 2000.00-2499.00 m², group 2500.00-2999.99 m², group 3000.00-3499.99 m², group 3500.00-3999.99 m², group 4000.00-4499.99 m², group 4500.00-4999.99 m² and group above 4999.99 m². The largest number of nursing homes are located in three groups, namely group 500.00-999.99 m², group 1000.00-1499.99 m², group 1500.00-1999.99 m². There are 217 nursing homes taking 29% of all, 126 nursing homes taking 17% of all and 115 nursing homes taking 15% of all, totally 457 nursing homes taking 61% of all which is more than half. In addition, around 65 nursing homes occupying about 9% of all are distributed in group below 500.00 m², group 2000.00-2499.00 m² and group 2500.00-2999.99 m² respectively. There are relatively few nursing homes that are larger than 3000 m². Furthermore, the average of the gross floor area of the building of three groups is 798.12 m², 1239.02 m², 1739.04 m², with 797.04 m², 1245.35 m², 1729.94 m² in median value. And the overall average of the gross floor area of the building of the three groups is 1845.09 m², with a median value of 1351.88 m². This shows that relatively small and medium sized nursing homes are more favoured by the market in terms of the gross floor area of the building.



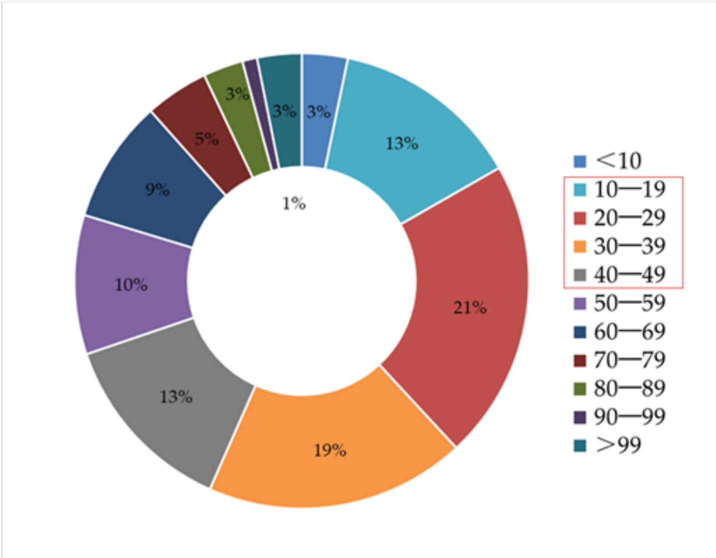
RANGE/㎡	NUMBER
＜500.00㎡	70
500.00-999.99㎡	217
1000.00-1499.99㎡	126
1500.00-1999.99㎡	115
2000.00-2499.99㎡	61
2500.00-2999.99㎡	63
3000.00-3499.99㎡	33
3500.00-3999.99㎡	13
4000.00-4499.99㎡	10
4500.00-4999.99㎡	6
＞4999.99㎡	33

Figure 2-12 Distribution about the gross floor area of the nursing homes



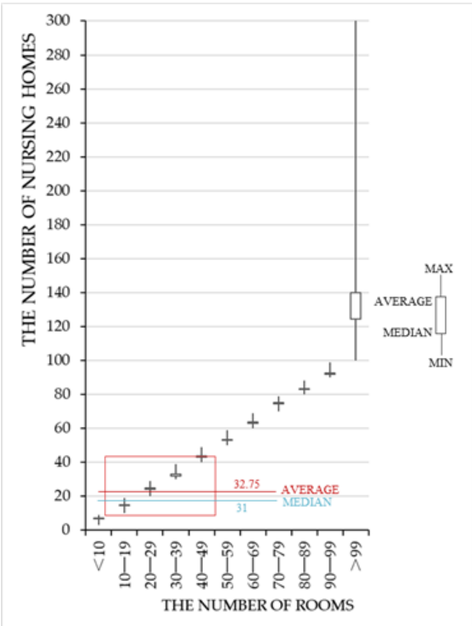
RANGE/㎡	NUMBER	MEDIAN/㎡	MIN/㎡	MAX/㎡	AVERAGE/㎡
＜500.00㎡	70	382.99	71.91	499.92	352.71
500.00-999.99㎡	217	797.04	509.3	999.91	798.12
1000.00-1499.99㎡	126	1245.35	1003.62	1497.62	1239.02
1500.00-1999.99㎡	115	1729.94	1500.69	1994.8	1739.04
2000.00-2499.99㎡	61	2283.88	2000.55	2499.22	2260.16
2500.00-2999.99㎡	63	2682.92	2503.56	2997.74	2716.93
3000.00-3499.99㎡	33	3247.54	3006.62	3473.72	3241.57
3500.00-3999.99㎡	13	3736.83	3552.24	3997.13	3742.30
4000.00-4499.99㎡	10	4162.31	4000.83	4401.3	4181.03
4500.00-4999.99㎡	6	4951.47	4532.8	4986.01	4853.76
＞4999.99㎡	33	7064.57	5029.45	20826.7	8748.68

Figure 2-13 Distribution about the gross floor area of the nursing homes



RANGETI	NUMBER
< 10	31
10—19	128
20—29	203
30—39	176
40—49	125
50—59	94
60—69	83
70—79	43
80—89	27
90—99	10
> 99	30

Figure 2-14 Distribution about the number of rooms in nursing homes



NUMBER OF ROOMS	NUMBER	MEDIAN	MIN	MAX	AVERAGE
< 10	31	7	3	9	7.13
10—19	128	15	10	19	14.8
20—29	203	25	20	29	24.09
30—39	176	32	30	39	33.04
40—49	125	43	40	49	43.63
50—59	94	53	50	59	53.37
60—69	83	63	60	69	63.54
70—79	43	75	70	79	74.35
80—89	27	83	80	88	83.26
90—99	10	92	90	99	92.7
> 99	30	124.5	100	300	140.1

Figure 2-15 Distribution about the number of rooms in nursing homes

In terms of resident's rooms, the smallest nursing home is equipped with only 5 resident's rooms, the largest one is equipped with up to 300 resident's rooms. We then divided 950 nursing homes into 11 groups based on the number of rooms, including group below 10, group 10-19, group 20-29, group 30-39, group 40-49, group 50-59, group 60-69, group 70-79, group 80-89, group 90-99 and group above 99. The most nursing homes are equipped with the number of rooms between 10 and 49, totally 632 nursing homes taking 66.53% of all. Of which 128 nursing homes with 13.47% of all and 20.25% of 632 are located in group 10-19, 203 nursing homes with 21.37% of all and 32.12% of 632 are in group 20-29, 176 nursing homes with 18.53% of all and 27.85% of 632 are in group 30-39 and 125 nursing homes with 13.16% of all and 19.78% of 632 are in group 40-49. The remaining nursing homes are gradually decreasing as the number of rooms increases. In addition, during the average number of rooms of four groups which has the most nursing homes is 14.8, 24.09, 33.04 and 43.63, with 15, 25, 32 and 43 in median value. And the overall average of number of rooms of the four groups is 32.75, with a median value of 25. This shows that it is relatively reasonable and economical to equipped with between 25 and 32.75 in a nursing home.

2.7. The rooms

This section analyses the problems associated with rooms in terms of the type of room and the dimensions of the room. In terms of the type of room, firstly, we look at the 11 group in the resident's room of section 2.6. Depending on the number of people the room can accept at the same time, we have divided the types of room into the single room, the couple room and the other room. A lot of nursing homes are equipped with several types of room at the same time. However, the majority of nursing homes are usually equipped mainly with the single room, while only a smaller number of other types of room, mainly the couple room, are available for couples. Similarly, there are total 39140 rooms in 950 nursing homes, 95.63% of which are the single room, 4.26% are the couple room.

NUMBER OF ROOMS	SINGLE ROOM	COUPLE ROOM	OTHERS
< 10	26	8	5
10—19	122	21	5
20—29	202	33	1
30—39	176	32	0
40—49	124	31	0
50—59	94	39	0
60—69	83	17	0
70—79	43	9	0
80—89	26	9	0
90—99	10	4	0
> 99	30	13	0

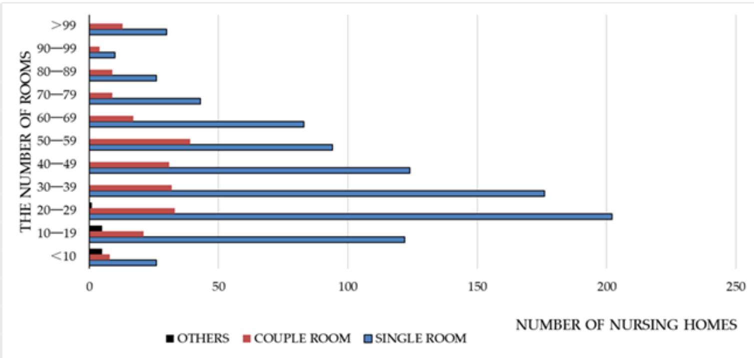


Figure 2-16 Distribution about the number of rooms in nursing homes

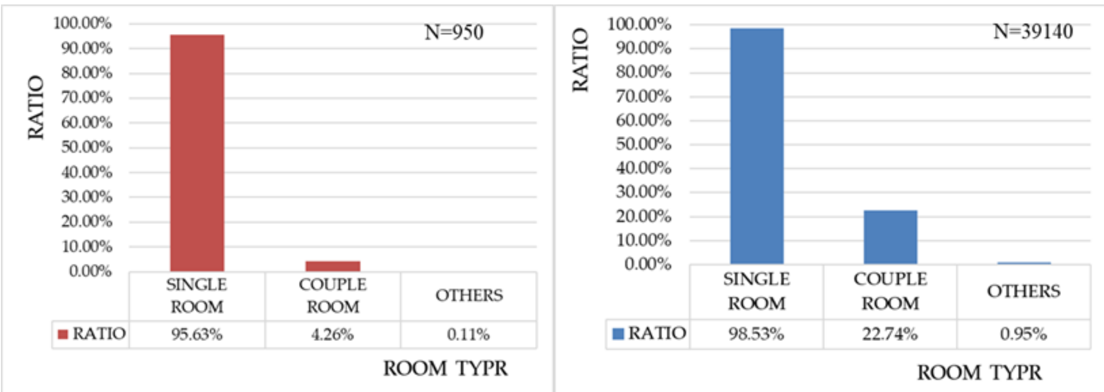
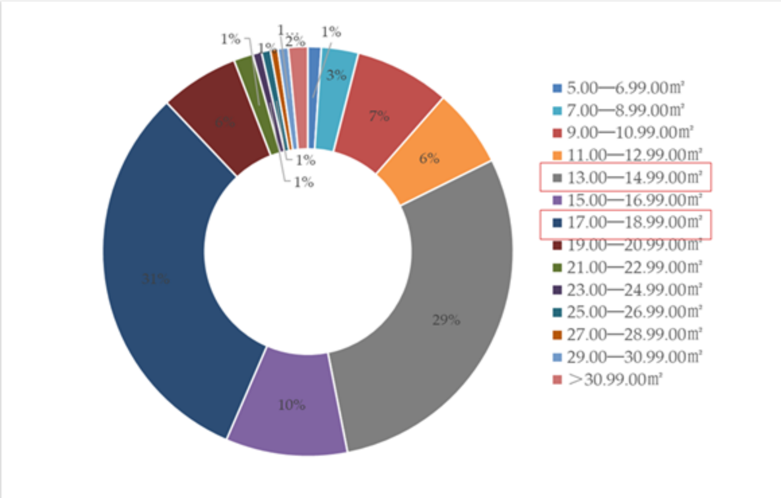
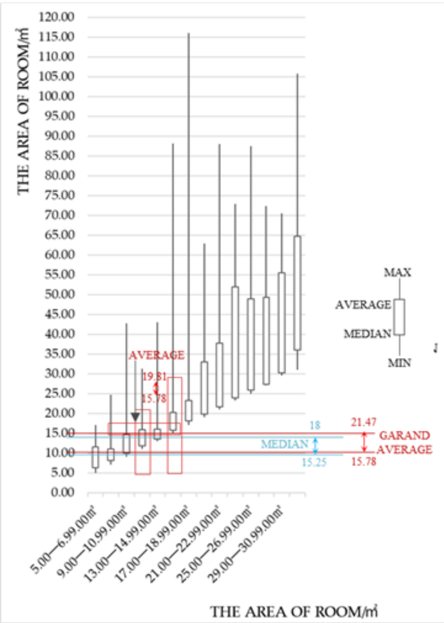


Figure 2-17 Distribution of room type on nursing home and about the total rooms



THE AREA OF ROOM/㎡	NUMBER
5.00—6.99.00㎡	9
7.00—8.99.00㎡	25
9.00—10.99.00㎡	64
11.00—12.99.00㎡	53
13.00—14.99.00㎡	250
15.00—16.99.00㎡	82
17.00—18.99.00㎡	269
19.00—20.99.00㎡	53
21.00—22.99.00㎡	13
23.00—24.99.00㎡	6
25.00—26.99.00㎡	6
27.00—28.99.00㎡	5
29.00—30.99.00㎡	7
＞30.99.00㎡	13
TOTAL ROOMS	855

Figure 2-18　Distribution about the area of rooms the nursing home are equipped



THE AREA OF ROOM/㎡	NUMBER	AVERAGE MIN/㎡	MIN/㎡	MAX/㎡	AVERAGE MAX/㎡
5.00—6.99.00㎡	9	6.23	5.00	17.00	11.51
7.00—8.99.00㎡	25	8.10	7.04	24.63	11.02
9.00—10.99.00㎡	64	10.01	9.00	42.70	14.62
11.00—12.99.00㎡	53	11.77	11.00	31.30	15.81
13.00—14.99.00㎡	250	13.53	13.00	43.02	16.01
15.00—16.99.00㎡	82	15.73	15.00	88.17	20.21
17.00—18.99.00㎡	269	18.07	17.00	116.01	23.21
19.00—20.99.00㎡	53	19.85	19.00	62.80	33.04
21.00—22.99.00㎡	13	21.68	21.00	88.00	37.66
23.00—24.99.00㎡	6	23.93	23.30	72.90	51.94
25.00—26.99.00㎡	6	25.91	25.00	87.47	48.91
27.00—28.99.00㎡	5	27.28	27.00	72.35	49.29
29.00—30.99.00㎡	7	30.24	29.56	70.52	55.54
＞30.99.00㎡	13	35.94	31.00	105.74	64.68
TOTAL ROOMS	855	15.79			21.49

Figure 2-19　Distribution about the area of rooms the nursing home are equipped

In terms of dimensions of the room, the smallest room a nursing home is equipped is only 5 m², while the largest room is as large as 116 m². Then 950 nursing home are divided into 14 groups based on the size of room. 14 groups are made up of group 5.00-6.99 m², group 7.00-8.99 m², group 9.00-10.99 m², group 11.00-12.99 m², group 13.00-14.99 m², group 15.00-16.99 m², group 17.00-18.99 m², group 19.00-20.99 m², group 21.00-22.99 m², group 23.00-24.99 m², group 25.00-26.99 m², group 27.00-28.99 m², group 29.00-30.99 m² and group above 30.99 m². The most nursing homes which are equipped with the size of room between 13.00 m² and 14.99 m² occupy 29% with 250 nursing homes, the second more nursing home which equipped with the size of room between 17.00 m² and 18.99 m² take 31% with 269 nursing homes. In addition, 6%, 6%, 7% and 10% of nursing homes are equipped with rooms of 11 to 12.99 m², 19 to 20.99 m², 9 to 10.99 m² and 15 to 16.99 m² respectively. Nursing homes equipped with rooms of less than 9 m² and more than 20.99

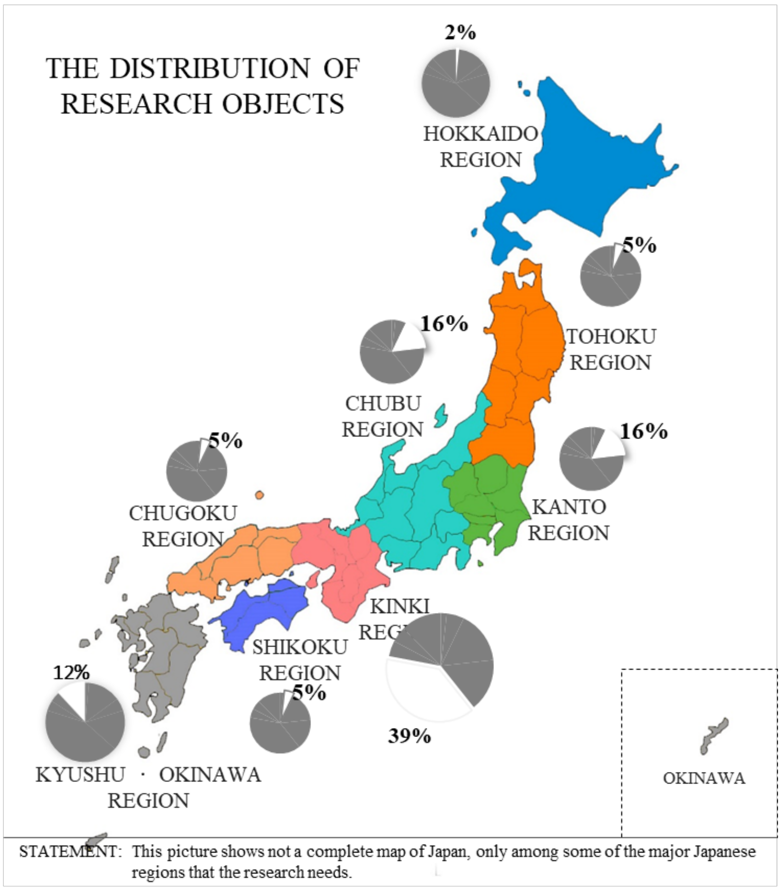
m² are in the minority.

Furthermore, the average of the size of room in group 13.00-14.99 m² and group 17.00- 18.99 m² is 13.53 m² in minimum and 16.01 m² in maximum, and 18.07 m² in minimum and 23.21 m² in maximum. And the overall average of the size of room in group 13.00-14.99 m² and group 17.00-18.99 m² is 15.78 m² in minimum and 21.47 m² in maximum, with the median value of 15.25 m² in minimum and 18 m² in maximum. This suggests that the size of room of 15.25 m² and 21.47 m² are relatively reasonable and economical, and are the standards commonly used in current Japanese nursing homes.

2.8. The research objects

In the early stage of the study, nearly 1000 commercial nursing homes are surveyed through email enquiries, web searches and reviews of relevant books and magazines. Finally, only 168 nursing homes provided us with clear and detailed floor plans. These 168 nursing homes are drawn from 34 cities in 8 regions of Japan. The figure shows the locations of these nursing homes: Hokkaido Region (3 units); Tohoku Region (9 units) includes Miyagi (6), Akita (2), Fukushima (1); Kanto Region (27 units) includes Kanagawa (8), Chiba (8), Tokyo (4), Gunma (4), Saitama (3); Chubu Region (27 units) includes Aichi(12), Shizuoka (4), Gifu (4), Niigata (3), Toyama (2), Ishikawa (1), Nagano (1); Kinki Region (65 units) includes Osaka (55), Kyoto (5), Hyogo (3), Wakayama(1), Shiga(1); Chugoku (8 units) includes Tottori (4), Yamaguchi (3), Okayama (1); Shikoku Region (8 units) includes Kagawa (4), Tokushima (4); Kyushu and Okinawa Region (21 units) includes Fukuoka (13), Kumamoto (2), Kagoshima (2), Saga (2), Miyazaki (1), Ooita (1).

The years these study objects were built rang from 1991 to 2020, with 81% of the nursing homes concentrated between 2005 and 2018 as shown in Figure 1-2. And 168 nursing homes are mainly made up of steel, reinforced concrete and wooden, of which 94 (55.95%) are made up of pure steel, followed by 34 (20.23%) and 30 (17.86%) with wooden structure and reinforced concrete structures respectively as shown in Figure 1-3. Figure 1-4 shows that the distribution of building stories from 1 to 10 stories for the 168 objects, with the majority (about 90%) concentrated below 5 stories, while 29% and 31% of the objects have 2 and 3 stories respectively. Figure 1-5 and 1-6 show the scale about the 168 nursing homes includes the gross floor area of the nursing home and the number of rooms the nursing home is equipped with.



Region	Number (NR)	Location	Number (NR)	Region	Number (NR)	Location	Number (NR)
Hokkaido	3	Hokkaido	3	Kinki	65	Nara	1
Tohoku	9	Fukushima	1			Shiga	1
		Akita	2			Wakayama	2
		Miyagi	6			Hyogo	4
Kanto	27	Saitama	3			Kyoto	6
		Gunma	4			Osaka	51
		Tokyo	4	Chugoku	8	Okayama	1
		Chiba	8			Yamaguchi	3
		Kanagawa	8			Tottori	4
Chubu	27	Ishikawa	1	Shikoku	8	Kagawa	4
		Nagano	1			Tokushima	4
		Toyama	2	Kyushu · Okinawa	21	Miyazaki	1
		Mie	2			Kagoshima	2
		Niigata	2			Kumamoto	2
		Gifu	4			Oita	2
		Shizuoka	4			Saga	2
		Aichi	11			Fukuoka	12

Figure 2-20 The distribution of 168 objects

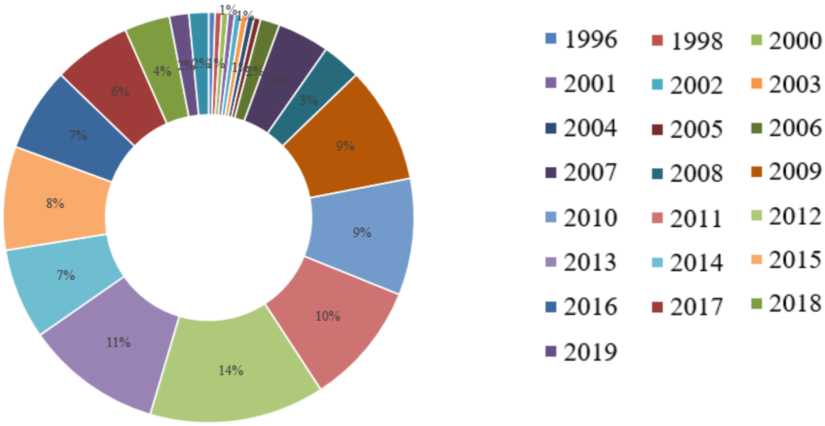


Figure 2-21 The year the nursing home was built (N=168)

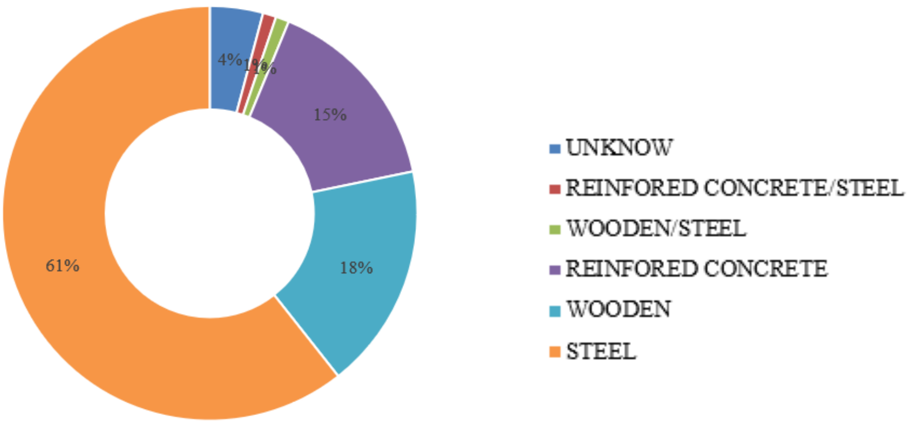


Figure 2-22 The structure the nursing home was made up of (N=168)

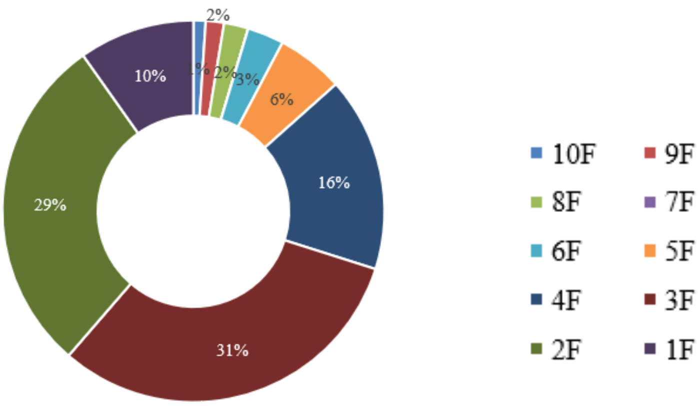


Figure 2-23 The building story the nursing home has (N=168)

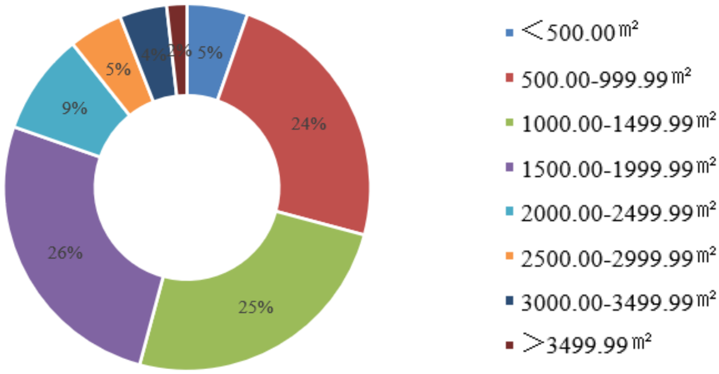


Figure 2-24 The gross floor area of the nursing home (N=168)

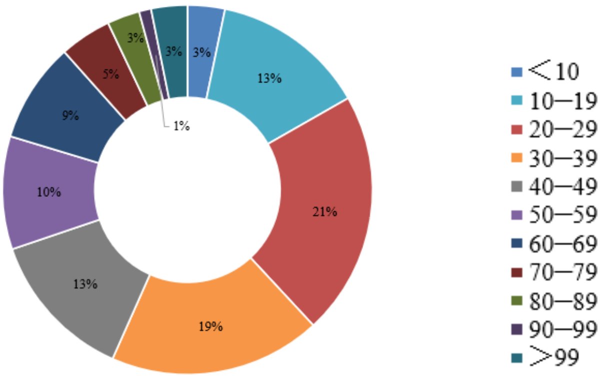


Figure 2-25 The number of rooms the nursing home is equipped with (N=168)

The sizes of these nursing homes are distributed between 218.51 m² and 12901.2 m² in term of size, with almost 85% of them concentrated between 500 m² and 2500 m² in size. In terms of the number of rooms, the smallest nursing home has only 5 rooms, while the largest nursing home is equipped with 200 rooms, and almost 85% of the nursing homes are equipped with between 10 and 70 rooms. In summary, the objects of this study are comprehensive in terms of sources of data, locations, the years of construction, construction materials, stories, and scales.

2.9. Results

Although 950 samples in this study is relatively small for a study of thousands of nursing homes in Japan, these samples including a variety of civil nursing homes were collected from various regions of Japan, by all kinds of ways including the internet, e-mail and relevant books and journals, So, these samples are relatively reliable and representative. This study in chapter 2 begins with a global analysis of the 950 initial sample in terms of the rent fee, the ratio of the number of staffs to the number of residents, the year of opening, the structure, the number of floors, the scale of building including the gross floor area of the building and the number of resident′s rooms the nursing home equipped, and the type and size of the rooms, to gain a preliminary understanding of the current policy, fees the elderly spend, the speed of development of nursing homes and level of care for nursing homes in Japan now. From the 950 samples, 168 nursing home with detailed information were then screened. These nursing homes were provided with the full floor plans where the detailed functional spaces were labelled, and with a variety of basic information about the nursing home, for the rest of study.

What spaces are the interior of a nursing home made up of, how big functional spaces are available to meet the living needs of the residents in the nursing home, and how are these spaces placed in relation to each other? Does the spatial distribution within the nursing home follow certain rules or patterns? And why are these patterns so widely adopted? In Chapters 3 and 4, this paper analyzes and summaries typologically and empirically the composition of the types and dimensions of the functional spaces in the nursing homes, and the relationship between the position of these functional spaces, based on detailed plans of 168 nursing homes. In Chapters 5 and 6, the article explores the rules of spatial distribution within the six nursing homes by using the theory of space syntax, and interprets the choice of corridor-based spatial layout.

CHAPTER 3
THE COMPOSITION OF THE NURSING HOME SPACE

3. The composition of the nursing home space

This chapter will introduce summarize typologically the configuration of functional spaces and the spatial relationship between the interior spaces in modern Japanese nursing homes. In term of the configuration of functional spaces, this study will focus on the number and size of the functional spaces. Architecture, as a container that embraces human life and culture, has always been inseparable from its practical scope, although it has been renewed over generations in line with material civilisation, social evolution and the demands of spiritual culture. The specific purpose of architecture and the requirements of its use generally lie in its function. Building functions include: physical, physiological and social life as well as spiritual life.

Nursing homes, which usually provide centralised living and care services for the elderly are some of the community services that provide accommodation and daily living care for the elderly. Generally speaking the main composition of a nursing home consists of considerations such as the public hall aspect and the interior aspect. The public hall is generally on the light side, with plenty of sunlight. Indoor aspect: in the chess room and pantry and other entertainment space the elderly are prone to a pleasant mood. Safety aspects: Overcoming the silver digital divide is a prerequisite for seniors to successfully receive virtual elderly services. The silver digital divide refers to the cognitive barrier caused by the elderly's lack of understanding of modern smart technology due to factors such as age and education. Older people have limited channels to learn about virtual elderly care services, and some of them are more conservative in their thinking, weaker in their ability to learn new knowledge and accept new technology, and reluctant to fully trust intelligent devices due to frequent fraudulent incidents on the Internet.

Currently, with the emergence of an ageing population, many young people with busy work schedules tend to consider sending their services into nursing homes. A major consideration in this is the issue of nursing home conditions, and it is believed that in the future, along with the improvement of the overall standard of nursing homes, they will be more and more popular and of interest to more and more people. This chapter looks at the layout and function of nursing homes. It also summarises the size of existing nursing home rooms.

Architectural space is an artificial form of space. In order to meet the various needs of production and life, people use materials and elements to create different forms and styles of space. The external space of a building is formed by the trees, mountains, water, streets and squares in the surrounding environment; the internal space of a building is formed by walls, floors, roofs, doors and windows. Therefore, architectural space is a collective term for the external space and internal space of a building, but whether it is the design of external space or internal space, the connotation of its design is the infinite imagination and creation of space.

The design of the interior space of a modern building is a highly comprehensive system project, which includes not only the visual environment and engineering technology, but also the physical environment such as sound, light and heat, as well as the psychological environment and cultural connotation such as atmosphere and mood, etc. In any case, the starting point and destination of the design of the interior space of a building can only serve people and interpersonal activities. Therefore, the design of the interior space of a building should not only meet people's physical and psychological needs, but also deal with the relationship between people and the environment and interpersonal interaction on the premise of being people-oriented, and be able to solve various requirements such as the use of function, economic efficiency, comfort and beauty, and environmental atmosphere.

3.1. The configuration of functional spaces

The nursing home is a social welfare-built environment as an alternative place of residence that specially provides comprehensive assistance in daily activities, complex care, and nursing needs for the elderly. Normally, in addition to providing necessary living facilities, nursing homes are equipped with some basic care facilities and employ professional caregivers to offer 24-hour assistance for the elderly. Besides, the staff who maintain the normal operation of the nursing home and provide logistical support to the residents are also indispensable for the nursing home. As a result, a variety of functional spaces are formed in the nursing home according to the object of use, the function of the service, etc. It can be said that the nursing home is like a mini-community dedicated to the elderly.

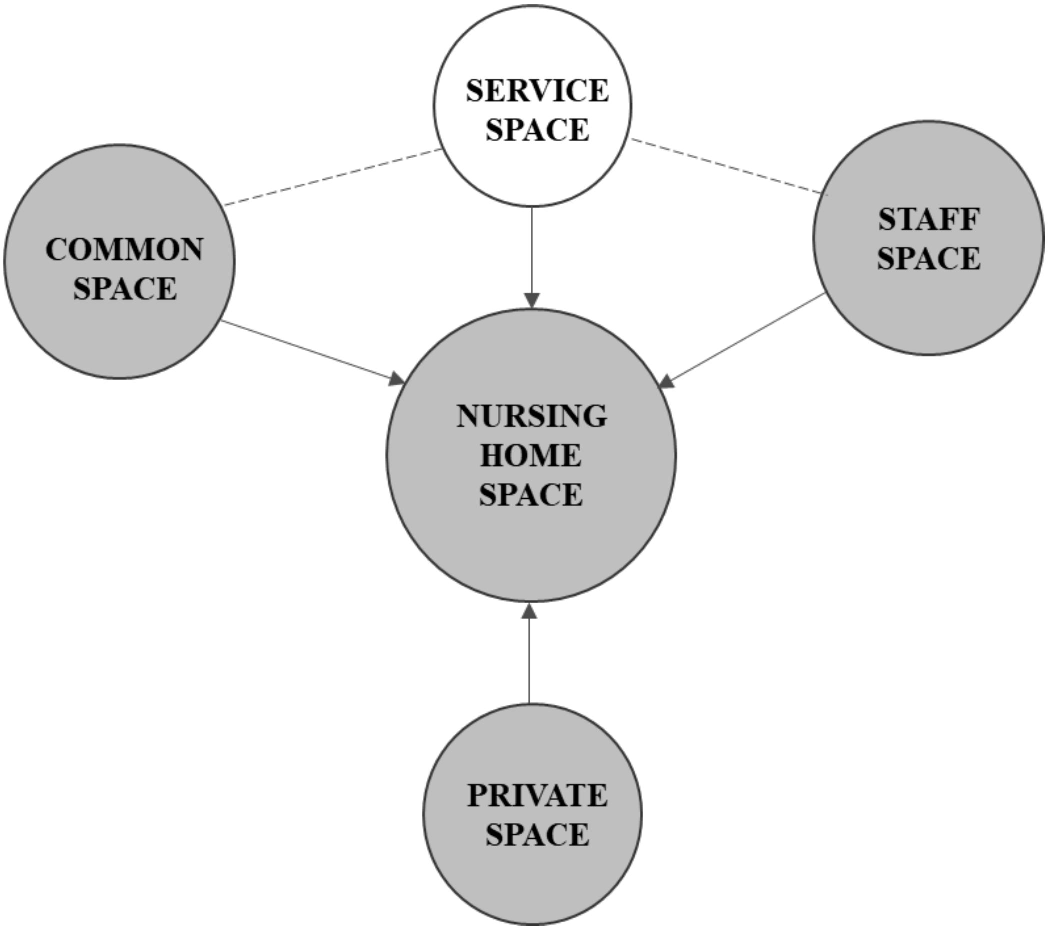


Figure 3-1 Schematic diagram of the spatial composition of the nursing home

Table 3-1 Configuration of the functional spaces (N=168)

The type of space	Functional space	The number of nursing home
Private space	Room	168
Common space	Common toilet	168
	Common bathroom	167
	Dining room	149
	Laundry	131
	Communication space	72
	Rehabilitation area	56
	Multi-space	55
	Living room	36
	Washing space	30
	Rest space	30
	Entertainment room	14
	Guest room	6
	Smoking space	5
	Watering room	4
	Cloak	4
	Study room	2
	Café space	1
	Flower room	1
	Sunshine room	1
Service space	Consultation	110
	Nursing room	82
	Reception room	18
	Beauty salon	15
Staff space	Office	162
	Kitchen	159
	Dressing room	135
	Rest room	119
	Staff station	52

Depending on the nature of the functional space, the space of a nursing home is made up of four categories of space as shown in Figure 2-1. A private space is a place in which the occupant carries out private activities and which cannot be shared with others, and is represented by a personal living room. Common space is a place that can be used by all residents in the nursing home, such as the dining room, living room, etc. Service space refers to the place where the staff and caregiver can interact with visitors or residents for extended periods of time, and it is between common space and staff space in nature, represented by nursing room, consultation room, etc. A staff space is a

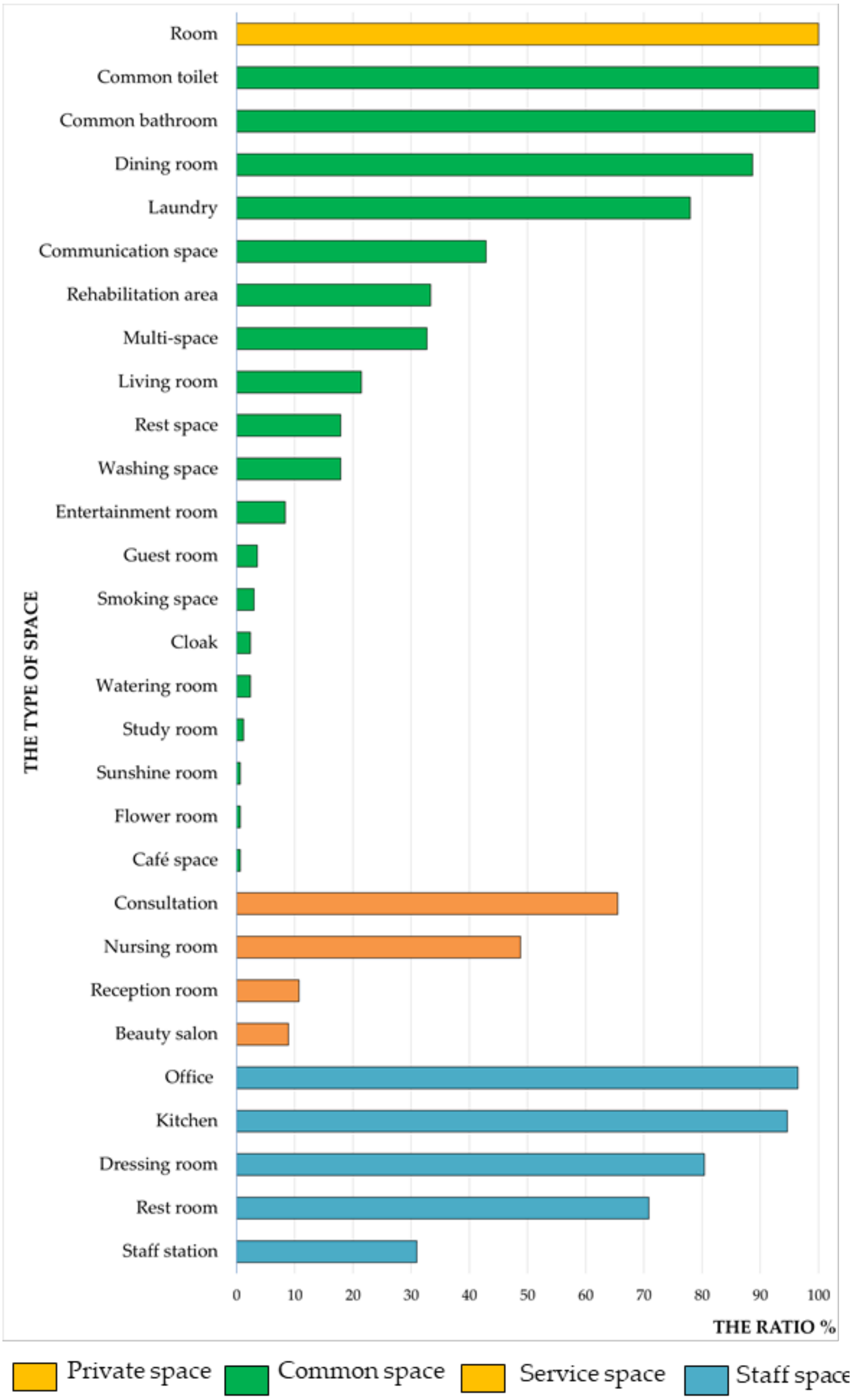


Figure 3-2 The proportion distribution of functional spaces in nursing homes (N=168)

dedicated space for employees to work or rest and is usually off limits to others, represented by office, kitchen, etc. In addition to these four types of space, some nursing homes have additional facilities such as clinics, shopping centers and day care centers attached to them. These additional facilities do not primarily serve the residents of the nursing home, but only provide supplementary services, and some even exist independently, so they are not included in this study.

What functional spaces do four types of spaces specifically consist of? A statistical survey of the functional spaces within 168 nursing homes reveals that the composition of functional spaces within nursing homes is very rich, and the types of functional spaces vary from different nursing homes. 168 nursing homes consist of a number of spaces from the 29 functional spaces as shown in Table 2-1. In the space classification, the private space consists of rooms, the common space contains 19 functional spaces, the service space consists mainly of 4 functional spaces and 5 functional spaces make up the staff space. Figure 2-31 shows the proportion distribution of functional spaces in nursing homes. The rooms provide accommodation for the residents and are essential in a nursing home. In terms of common spaces, each nursing home is equipped with common toilet, 99.4% of nursing homes have common bathroom, nearly 90% and 80% of the homes are equipped with the dining room and laundry for the residents respectively, and the residents can communicate with each other in communication space, doing rehabilitation exercises in rehabilitation area and take serval activities in multi space within around 40% of nursing homes, about 20% of nursing homes provide living room, rest room and washing room for the residents,

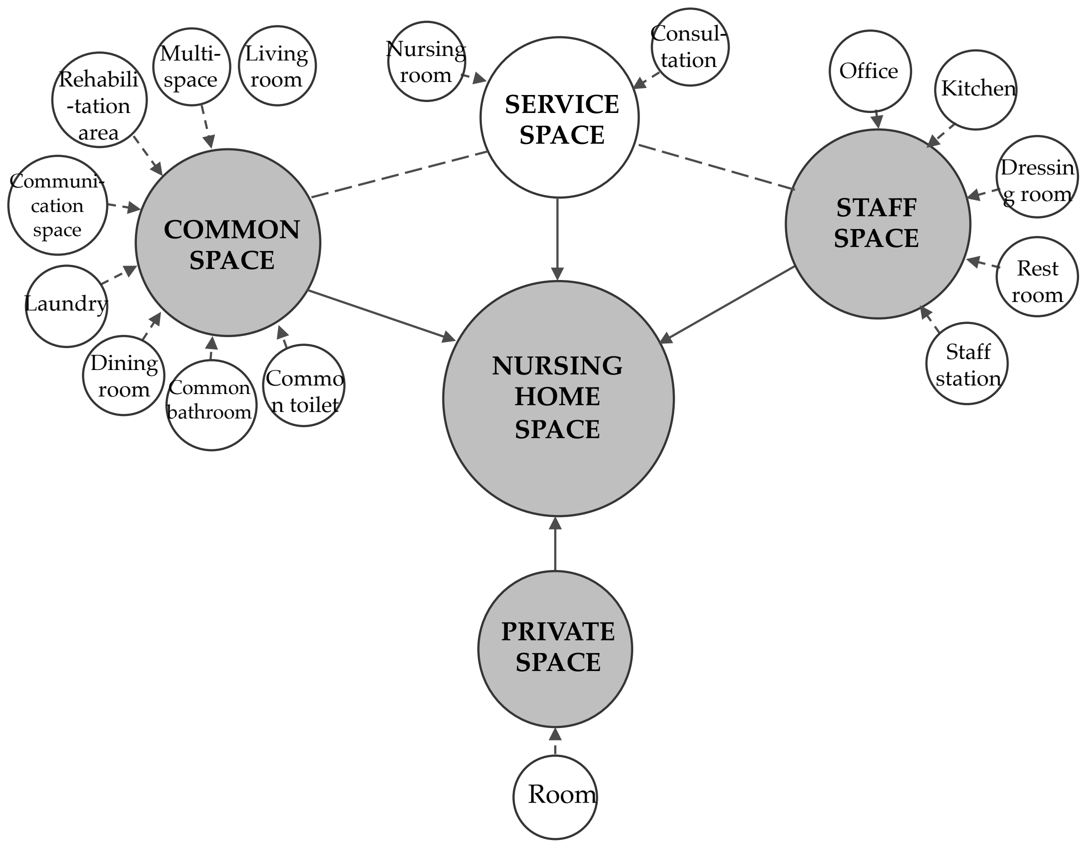


Figure 3-3 Schematic diagram of the composition of key functional spaces in the nursing home

finally, few nursing homes are equipped with gust room, smoking room, study room, sunshine room, and flower room.

In terms of service spaces, nearly 65% of the nursing homes have consultation rooms, caregivers can provide care for residents in the nursing rooms within around 50% of nursing homes, and around 10% of nursing homes provide a reception room specifically for visitors, at last, in less than 10% of nursing homes, the residents have access to services such as hair care without leaving the nursing homes. In terms of staff space, 96% of nursing homes have an office to manage the day-to-day operations of the nursing home, and nearly 95%of nursing home have the capacity to provide meals d to the residents by themselves, 80% of nursing homes provide staff with a special dressing room, as well as around 70 % of nursing homes with a place for staff to rest, and finally in about 30 % of nursing homes, staff can work at a special duty station to respond to emergencies in the daily movement of the elderly. In summary, the room, common toilet, common bathroom, office and kitchen can be considered as indispensable (more than 90%) functional spaces in the nursing home, followed by (50% to 90%) the dining room, laundry, consultation, staff dressing rooms and staff rest room, the third (20% to 50%) are the communication space, rehabilitation room, multi-space, nursing room and staff station, finally, the functional spaces which are equipped in less than 20% of nursing homes are regards as non-essential spaces. If the functional spaces which are adopted by more than 20% of nursing homes are treated as key spaces, then this means that a well-established nursing home is generally made up of the 16 functional spaces mentioned above as shown in Figure 2-23.

The nursing home as an alternative place of residence that specially provides comprehensive assistance in daily activities, complex care, and nursing needs for the elderly, which is equipped with a variety of functional spaces like a mini-community dedicated to the elderly. While overall, the nursing home consist of four types of spaces, in addition to the private space consisting of the resident's room that is necessary for the elderly in a nursing home, a type of space is called common space which can be shared to be used by all the residents in the nursing home. The common space is made up two types of spaces, one is activity space where the residents can enjoy eating, entertaining, doing some rehabilitation and communicating, such as the dining room, the rehabilitation area, the communication space, and the living room. The other one is supporting space that can provide residents with some functional spaces, may not be equipped in the room, for assisted living, such as the common toilet, the common bathroom, and the laundry. A type of space named service space, which is not as public as the common space. This type of space is mainly available to residents, employees, or visitors at specific times or for specific events. For instance, the nursing home where the caregivers work and offer services for the residents who need medical help, such as daily health check. The last type of space called staff space, is a place where the staff deal with all matters relating to the nursing home, such as the office, the kitchen, and the staff rest room.

3.2. Private space: room

The room is the main component of the nursing home and the place where the resident spends the most time. What functional spaces (excluding furniture and electrical appliances) are generally provided in the rooms of a Japanese nursing home today? A total of 8,520 rooms in 168 nursing homes have been counted, classified, and analyzed here. Firstly, 81% of the rooms are single rooms that can only accommodate a single occupant, 18% of the rooms can be shared by a couple and very few can accommodate more than three occupants at the same time as shown in Figure 2-4. The total area of rooms in nursing homes ranges from 6.5% to 85.6%, with an average of 47.6%, and more than half of these nursing homes allocate between 20% and 50% of their area to room. Secondly, in terms of the room size, the smallest room is just 5 m², while the largest room is a whopping 88 m², the average of the room is 15.6 m², with around 90% of the rooms concentrated between 9 and 21 m², and furthermore, rooms with an area of 17 to 18 m² occupy the largest number of rooms, nearly 25% as shown in Figure 2-5. Thirdly, these rooms are normally configured with several of the following seven functional elements, such as living space (L), storage (S), toilet (T), dresser (D), kitchen (K), bathroom (B), Living room (LR). And these rooms are then divided into 14 categories as shown in Table 2-2, depending on the variability of the functional elements equipped in the room. Of these room types, type 6 (L+T+D) and type 7 (L+T+S+D) are the two most commonly used in nursing homes, accounting for 43.51% and 31.1% respectively. The other 12 room types are used by a smaller number of nursing homes as shown in Figure 2-6. According to the usage rate of the individual functional elements, the order of these elements is as followed: living space (100%) > dresser (94.5%) > toilet (87.7%) > storage (44.2%) > kitchen (12.6%) > bathroom (6.5%) > living room (1.9%), Figure 2-7. In this order, it can be seen that in addition to the basic living space, the toilet which meet the basic physical needs of the residents and dresser for daily washing are essential

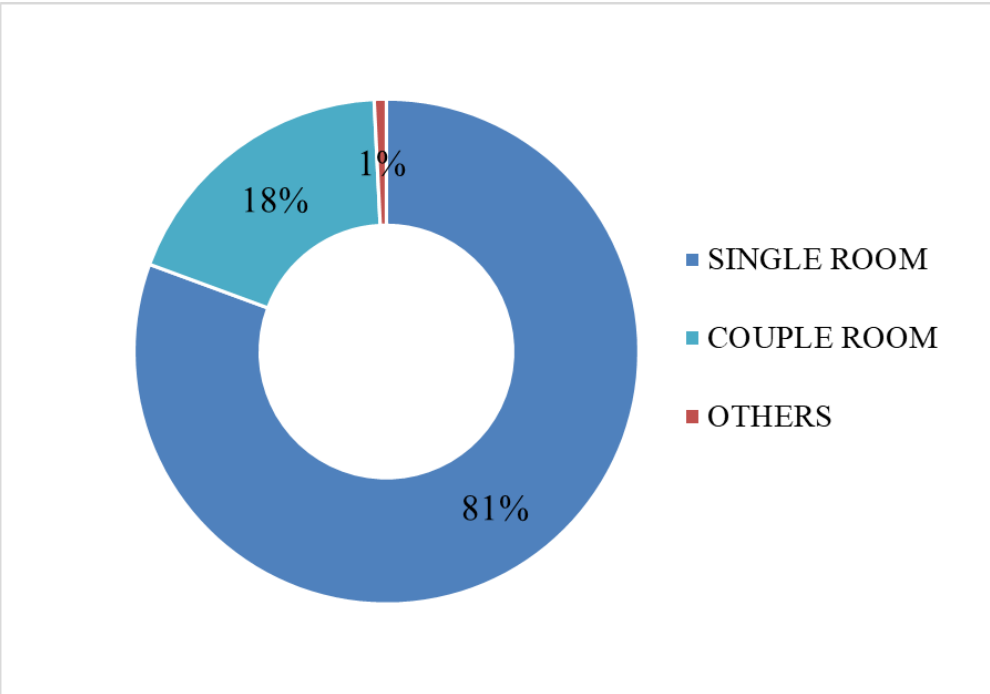


Figure 3-4 The ratio distribution of the room types (N=8520)

for the configuration of a modern Japanese residential nursing home. Finally, Figure 2-8, combined with Figure 2-5 and Figure 2-6, clearly shows that rooms of type 6 and type 7, which remain between 17 m² and 18 m² in size, are currently the most commonly used in residential nursing homes in Japan.

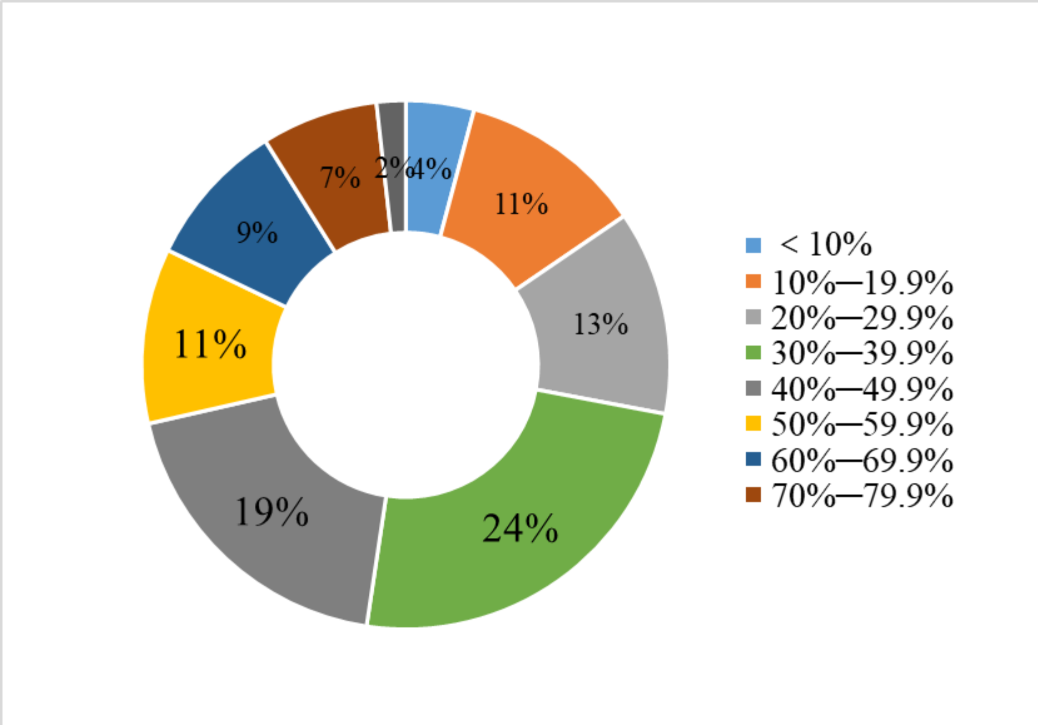


Figure 3-5 The ratio distribution of the area of the total room (N=168)

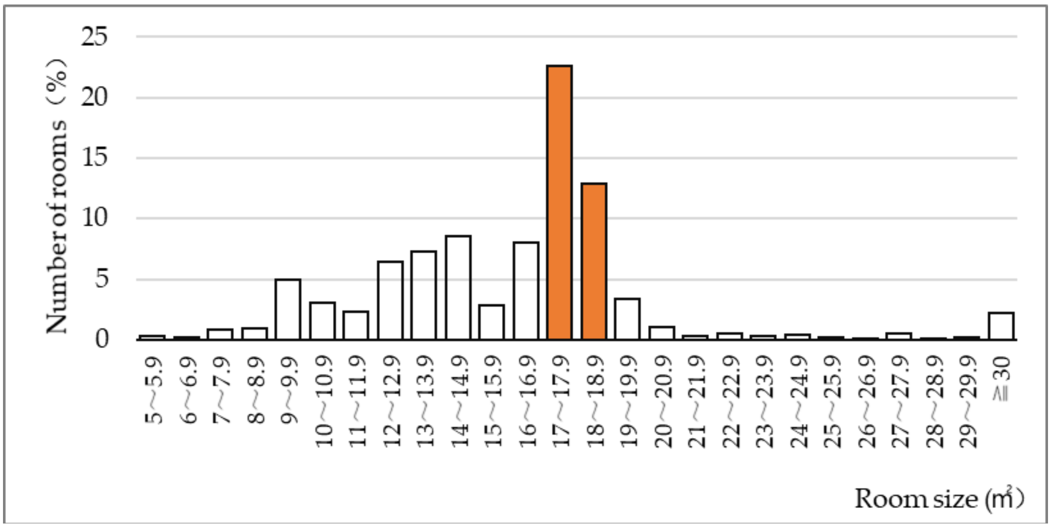
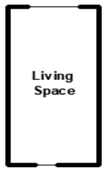
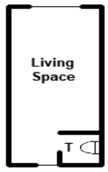
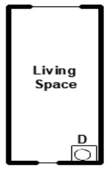
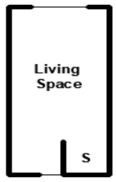
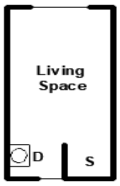
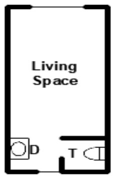
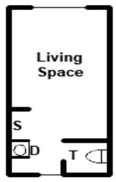
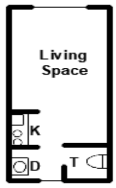
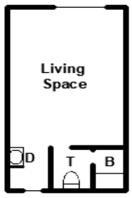
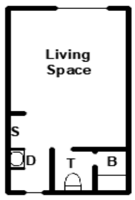
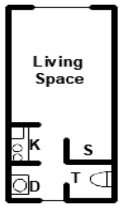


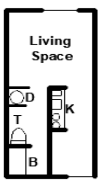
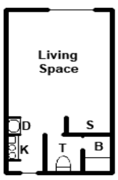
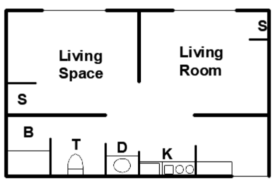
Figure 3-6 The ratio distribution of the room sizes (N=8520)

Table 3-2 The configuration of the room (S=1/200, N=8520)

Type	T1	T2	T3	T4
Diagram of room				
Composition of room	L 11.6 ㎡	L+T 12.2 ㎡	L+D 12.6 ㎡	L+S 11.9 ㎡
Ratio of room	3.9%	0.2%	3.88%	1.3%

Type	T5	T6	T7	T8
Diagram of room				
Composition of room	L+S+D 13.27 ㎡	L+T+D 17.7 ㎡	L+T+S+D 17.5 ㎡	L+T+D+K 20.2 ㎡
Ratio of room	3.2%	43.5%	31.1%	1.9%

Type	T9	T10	T11
Diagram of room			
Composition of room	L+T+D+B 22.2 ㎡	L+T+S+D+B 22.5 ㎡	L+T+S+D+K 21.3 ㎡
Ratio of room	0.2%	0.1%	4.5%

Type	T12	T13	T14
Diagram of room			
Composition of room	L+T+D+K+B 27.5 ㎡	L+T+S+D+K +B 25.9 ㎡	L+T+S+D+K+B+ LR 35.7 ㎡
Ratio of room	1%	3.2%	2%

L=Living space T=Toilet S=Storage D=Dresser K=Kitchen B=Bathroom LR=Living room

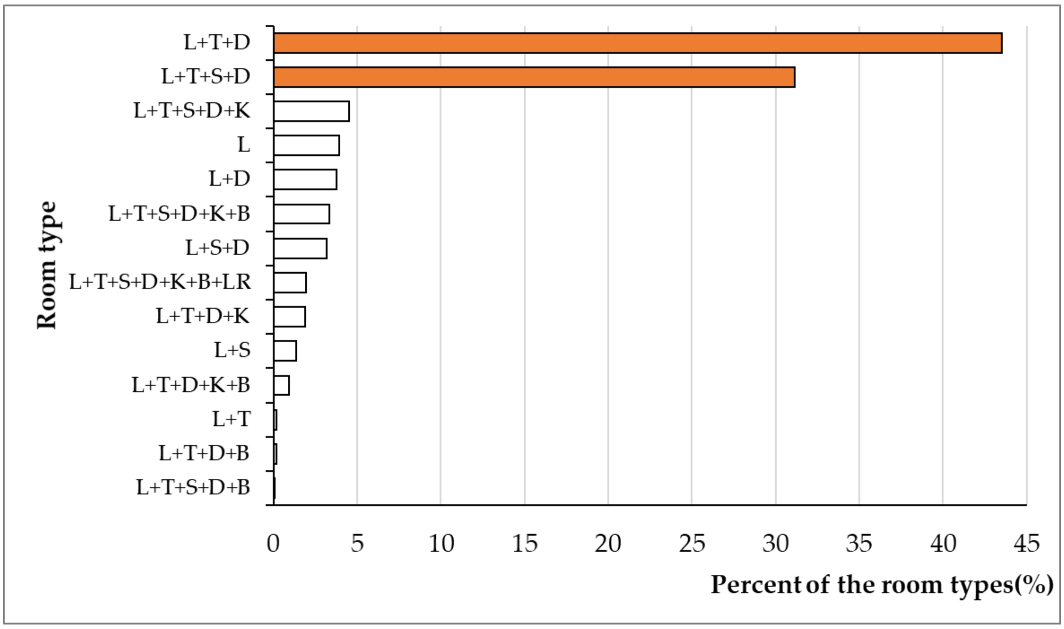


Figure 3-7 The ratio distribution of the room types (N=8520)

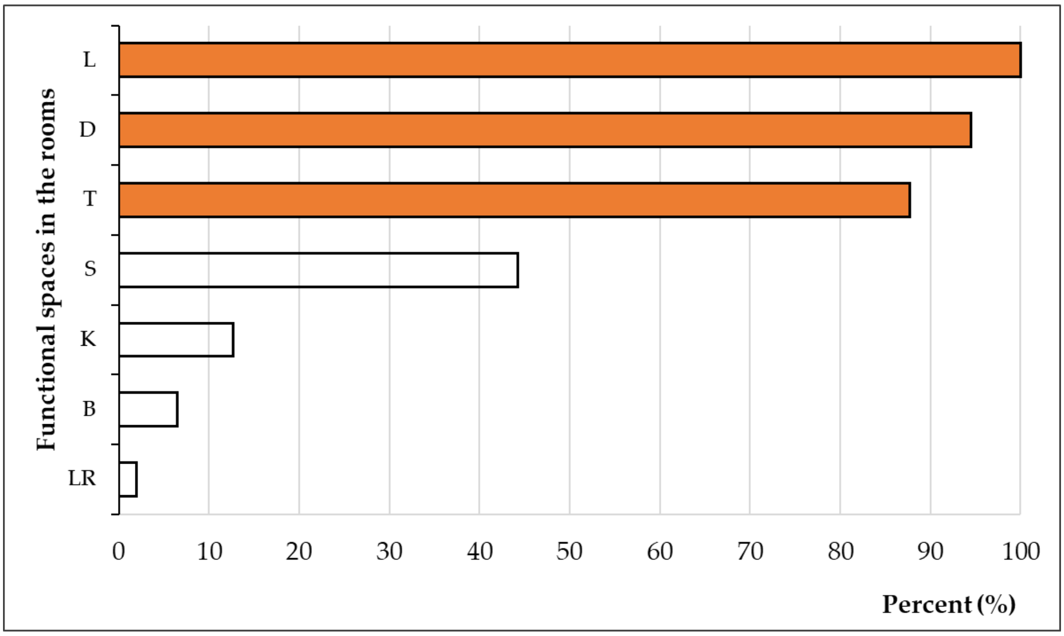


Figure 3-8 The ratio distribution about the functional space the room is equipped with (N=8520)

The room, as the main space in a nursing home, although its function is to provide living space for the residents, in different nursing homes or even within a nursing home, different types of rooms are equipped to meet the needs of the residents. Firstly, the vast majority of rooms equipped in the nursing homes belong to the single room which provides separate living space for only one resident. But there are also a number of nursing homes that provide rooms for more than one person, most of which belong to the couple room which can provide a place for couples to live, and very few nursing homes are equipped with the room for more than two people. This seems to indicate that the approach of sharing living space with someone but a partner is unpopular and perhaps even difficult to be accepted by Japanese elderly people, even though it can reduce the rent payment. Therefore, it suggests that maintaining the independence and privacy of the living space is a relatively dominant consideration when a Japanese nursing home is designed. Secondly, the room can be classified into 14 categories, depending on seven functional spaces (consisting of living space (bedroom), storage, toilet, dresser, kitchen, bathroom and living room) the room are equipped with. In addition to the living space (bedroom), the majority of rooms have the dresser and the toilet, around half have the storage, and a few are equipped with the kitchen, the bathroom and the living room. Beside, the room type (living space + toilet + dresser) and room type (living space + toilet + dresser + storage) occupy a dominant position in all room types. This suggests that in addition to the bed, the toilet and the dresser are essential spaces to facilitate the daily living of the elderly, although in many nursing homes, the common toilet with the dresser is provided. Conversely, the bathroom, also a very private space, should be equipped in the room in principle, but seems to be less indispensable perhaps as the bathroom is used relatively infrequently and the elderly people need more assistance when they use the bathroom, in contrast, the elderly people can be better assisted in the common bathroom. The reason why the number of rooms with the storage isn't probably related to the fact that the storage can be replaced by some furniture without having to make space for it during the design. In addition, most of the nursing homes can deliver meals for the residents in a uniform manner, so naturally the kitchen in the room isn't as important. The size of room would increase due to the configuration of the living room, so that the price of the room would be higher, which can result in a higher cost for the elderly or their children or the government.

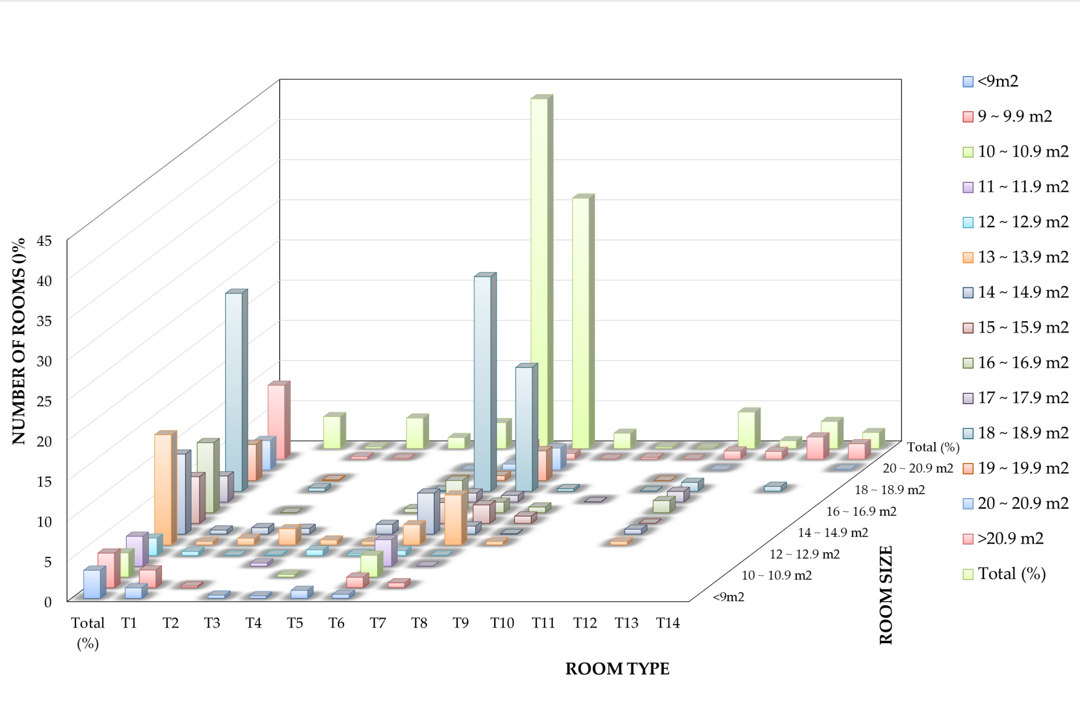


Figure 3-9 The ratio distribution about room size and room types (N=8520)

3.3. Common space: Activity spaces

An activity space is a public place where all residents can stay for long periods of time and engage in group activities including entertainment, rehabilitation, and communication. Of 19 functional spaces that make up the common space, the dining room (D), rehabilitation area (R), communication space (C), multi-space (M) and living room (L) are the five main types of activity space. The result of the survey of 168 homes shows that each nursing home is equipped with at least one activity space for the residents, with the majority of them placing the activity space on the entrance storey, a few even having activity spaces on each floor, and three nursing homes have the most activity spaces, as many as 9 units, but nearly 90% of the nursing homes are equipped with fewer than four activity spaces as shown in Figure 2-9. In total, there are 372 activity spaces in 168 nursing homes, with an average of 2.21 activity spaces allocated to each nursing home.

In terms of the size of the activity space, one nursing home has only 19.41 m² of total activity space, while another has up to 446.94 m² of total activity space, and in all objects, the area of activity spaces occupies the nursing home from 3.4% to 52.6%, with an average of 11.6%, and nearly 80% of these nursing homes allocate between 5% and 15% of their area to the activity space. The size of the activity space is often dependent on the scale of the nursing home, so the total activity space of the per resident in a nursing home is a more objective indicator of the standard of activity space provision in modern Japanese nursing homes. Of the 168 research objects, one nursing home provided 11.69 m² of activity space per resident, which is the most, while 1 m² of activity space per resident is the least a nursing home offers, and the average is 3.38 m². On the whole, most (58.4%) nursing homes provide activity space for residents at a rate of 2 to 4 m² per person as shown in Figure 2-10

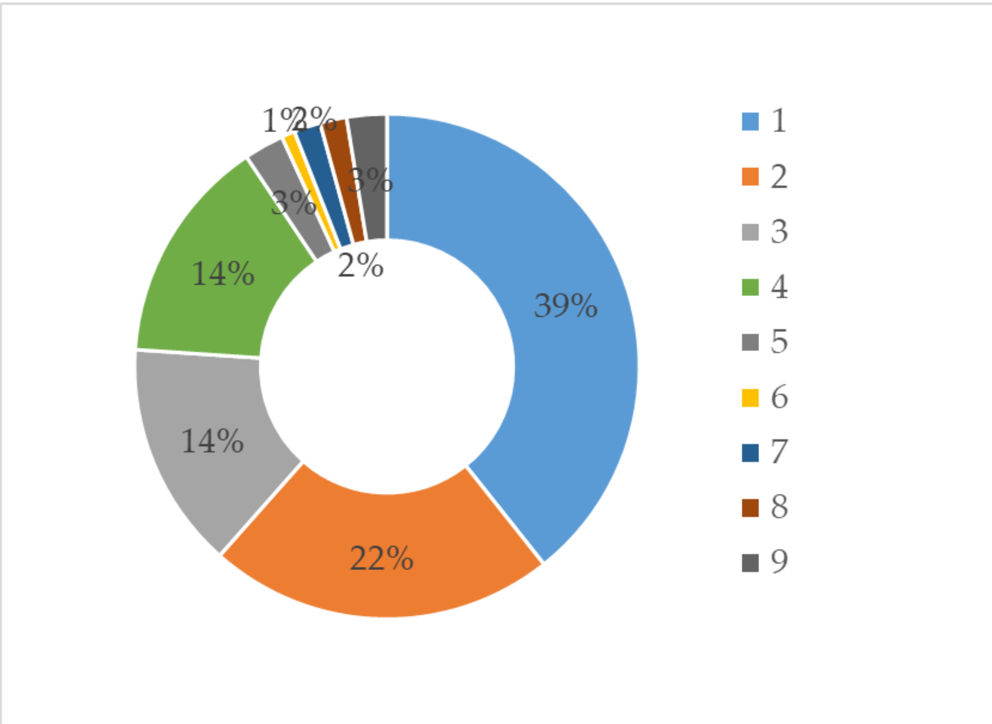


Figure 3-10 The activity spaces the nursing home has (N=168)

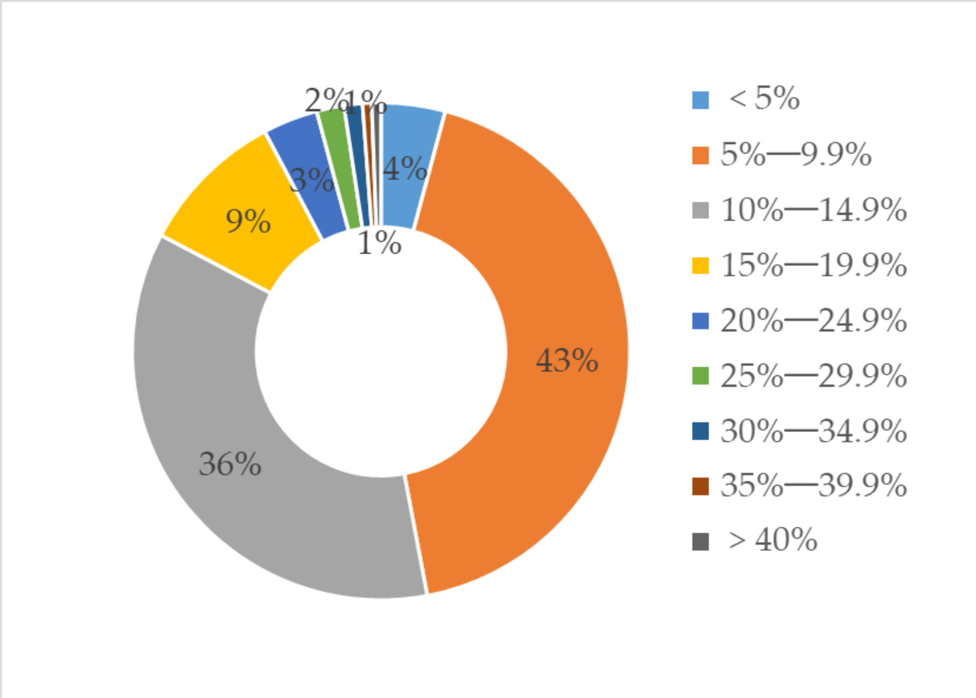


Figure 3-11 The ratio distribution of the area of the activity space (N=168)

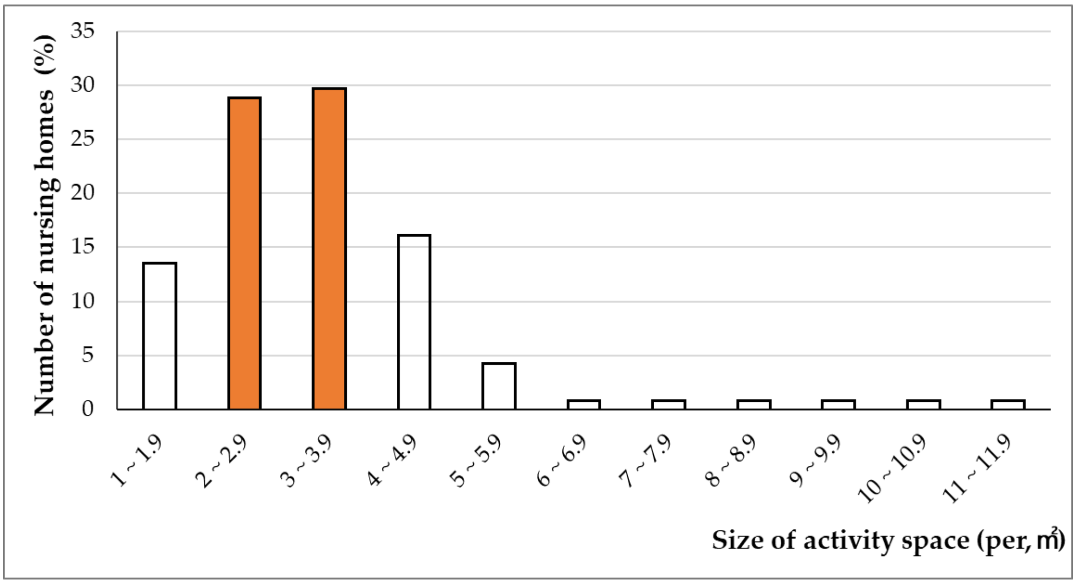


Figure 3-12 Area of activity space per person the nursing home has (N=168)

By the nature of the five functional spaces, these spaces have certain commonalities, so that in many nursing homes, one activity space often takes on multiple functions. According to the combination of these 5 functional spaces, there are 12 types of activity spaces in 168 nursing homes as shown in Table 2-3. From Figure 2-11, firstly, it can be clearly seen that of all the activity spaces, the space which has the function of a dining room occupies the most, nearly 60%, and that nearly half of them are in principle dedicated to the dining room, while the other half can be used for activities in addition to eating. And this equates to an average of 1.26 dining rooms per nursing home in quantitative terms. Secondly, 30% of the activity space can be used as a place for residents to communicate. On average, 1.52 nursing homes are equipped with an activity space with a communicative role. Around 20% of the activity spaces are dedicated to communication space. Thirdly, the space with rehabilitation function and the space with living room function occupy 15.3% and 14.3% of the activity space respectively, and these two spaces will be set up in one of the three nursing homes on average. Finally, the multi-function space is inherently composite spaces that can be used as versatile spaces, such as for eating, chatting, etc. In addition, it is also important to note that these activity spaces themselves are rather vaguely defined. Although the drawings provided by the nursing home label an activity space as being for only one functional activity, in fact this space can actually be used for another activity simply by moving the furniture within it. So, we do not conclude that a nursing home does not have a communication space, then there is no place to offer the residents to communicate for long periods of time. For example, elderly people living in it can also communicate in the canteen, even though this space may only be marked as a dining room on drawing. However, we can infer from Figure 2-11 that when designing a nursing home, the dining room is the first activity space considered by the designers, followed by the communication space, the rehabilitation area and living room may be arranged according to the designer's preference and the requirements of the nursing home, and the multifunctional space is considered more as a supplementary activity space.

The common space, in general, there are 19 types of function spaces, the most common of which are the activity space, the common toilet, the common bathroom and the laundry, depending on the composition of the different nursing homes. Firstly, each nursing home is equipped with at least one, an average of 2.21 activity spaces for the residents. It suggests that the activity space for residents to stay for long periods of time or to hold activities are essential spaces for nursing homes. The activity space is mainly made up five types of space consisting of the dining room, rehabilitation

Table 3-3 The diagrams of activity space types

Diagram	**D**	**D+R**	**D+C**	**D+L**
Type	T1	T2	T3	T4
Diagram	**D+E**	**L+C**	**D+R+C**	**C**
Type	T5	T6	T7	T8
Diagram	**M**	**L**	**R**	**C+R**
Type	T9	T10	T11	T12

D= dining room C=communication space M=multifunction space L=living room R=rehabilitation area E=entertainment space area, communication space, multi-function space and living room depending on the function. But in many nursing homes, an activity space normally takes on more than one function, and the activity space can be classified into 12 types of space based on the functions it can provide. However, the dining room is the main function to be provided in most activity spaces and even each nursing home perhaps is quipped with 1.26 dining room in average. Therefore, this indicates that it is a higher priority to provide a place for residents to have their meals when designing a nursing home. Apart from the dining room, Although the activity space may appear to be used for relatively few other functions, in essential, the activity space is a space that can be used flexibly in a nursing home. In some nursing homes, the space is only marked as the dining room on the floor plan, but it can also used as a communication space where the residents can talk with each other before or after dinner, and can even be used as a place for doing some rehabilitation or holding some festive activity by switching or moving the equipment or furniture within the space.

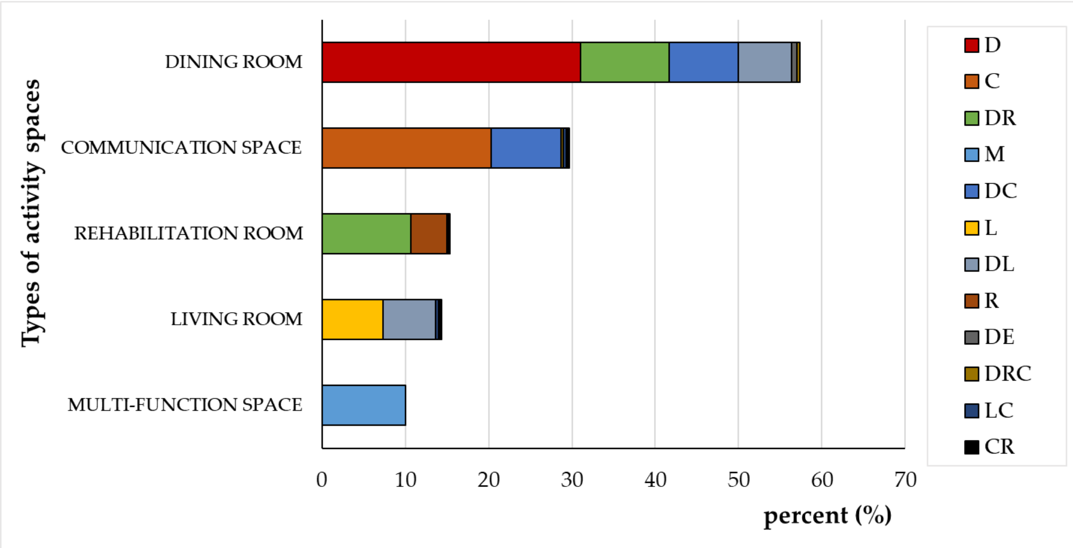


Figure 3-13 The proportional distribution of 12 types of activity spaces (N=372)

3.4. Common space: Common toilet

A common toilet in a nursing home is a place used to provide a toileting function while the resident is moving around in a communal environment. Each of the 168 nursing homes is equipped with a common toilet, and one of the nursing homes is equipped with as many as 17 common toilets. To a large extent, the number of common toilets in a nursing home is determined by whether the room in the nursing home are provided with the toilet facility. If the room do not have toilet space, the common toilet in that nursing home is for shared use by the residents of several rooms, then the number of common toilets will increase. However, in most nursing homes, the rooms are equipped with private toilets. In total, there are 617 common toilets in 168 nursing homes, on average, each nursing home has about 3.67 common toilets, and about 65% of nursing homes are equipped with less than four common toilets as shown in Figure 2-14. In terms of area, the common toilet occupies a very small part of the space in the nursing home, between about 0.24% and 4.32%, and the average is 1.36%, with close to 80% of nursing homes having less than 1.5% of the space occupied by common toilets.

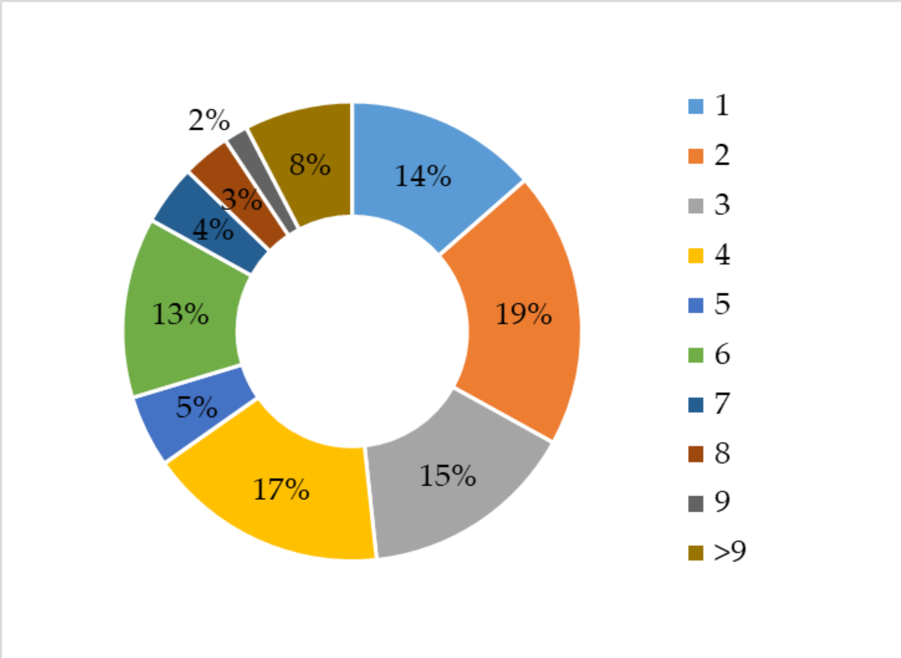


Figure 3-14 The number of common toilets the nursing home has (N=168)

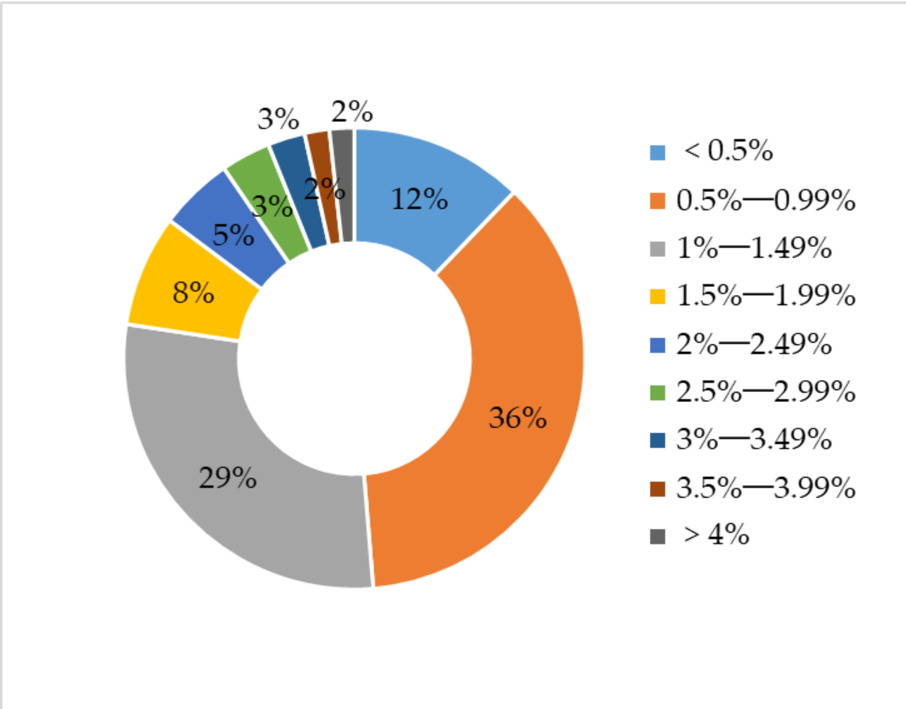
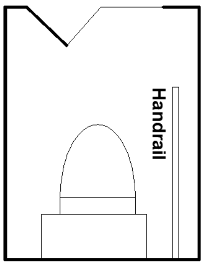
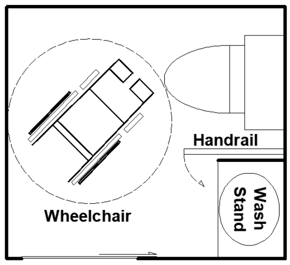
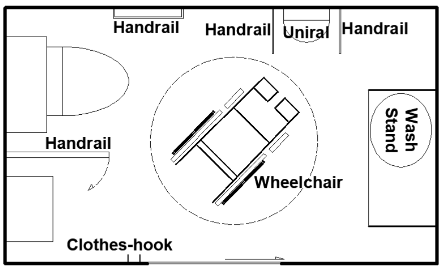


Figure 3-15 The ratio distribution of the area of common toilets (N=168)

Of all the public toilets, the smallest is only 0.57 m², while the largest is 12.99 m². The reason for this huge disparity is the extent to which the facility inside the common toilet is well equipped. And these common toilets are divided into three types according to the facilities they are equipped with inside as shown in Table 2-4. The first type is called an ordinary toilet and is equipped only with the most common auxiliary facilities such as handrails; The second type, called wheelchair used toilet, is wheelchair accessible and is equipped with a washbasin and handrails; The third type is called multi-function toilet, which are equipped with a full range of auxiliary facilities, including wheelchair access, urinals, washbasins, sinks and handrails. The wheelchair used toilet is the most common of the three types of common toilets equipped in nursing homes, with nearly 93% of nursing homes being equipped with it. The next most common type of toilet is the ordinary toilet, which is found in nearly 50% of nursing homes. The last is the multi-function toilet, which is available in 30% of nursing homes as shown in Figure 2-15. In terms of numbers, the majority (75.68%) of common toilets are wheelchair used toilets, followed by ordinary toilets, but only occupying around 12%, and the least are multi-function toilets at 7.57% as shown in Figure 2-16. It should be noted that in some of the drawings provided by the nursing homes, there are some common toilets that are not clearly labelled as to which type of toilet, so the actual situation is likely to be greater than the above values, but thankfully the number of unlabeled toilets is very small, about 4.5% of the total.

In terms of size, there are major differences between these three types of common toilets. The ordinary toilet, due to the limited support facilities it provides, have a smaller area, generally between 0.57 m² and 3.78 m², with an average area of 2.34 m²; The wheelchair used toilet, which needs to provide enough space for wheelchair operation, has a larger space and tends to have a space area between 1.66 m² to 10.2 m², with an average of 4.04 m²; The multi-function toilet normally has a very large space for various aids and wheelchair operation, the largest one being 12.99 m² and the smallest one being 23.92 m², the average size is 5.3 m² as shown in Figure 2-17.

Table 3-4 The diagrams of common toilet

Diagram		
Type	T1 Ordinary toilet	T2 Wheelchair used toilet
Diagram		
Type	T3 Multi-function toilet	

As for exploring the wheelchair used toilet which account for the largest proportion in terms of the size distribution, and as can be seen in Figure 2-18, 89.49 % of the toilet is mainly concentrated between 2 m² and 5.9 m².

In terms of size, there are major differences between these three types of common toilets. The ordinary toilet, due to the limited support facilities it provides, have a smaller area, generally between 0.57 m² and 3.78 m², with an average area of 2.34 m²; The wheelchair used toilet, which needs to provide enough space for wheelchair operation, has a larger space and tends to have a space area between 1.66 m² to 10.2 m², with an average of 4.04 m²; The multi-function toilet normally has a very large space for various aids and wheelchair operation, the largest one being 12.99 m² and the smallest one being 23.92 m², the average size is 5.3 m² as shown in Figure 2-17. As for exploring the wheelchair used toilet which account for the largest proportion in terms of the size distribution, and as can be seen in Figure 2-18, 89.49 % of the toilet is mainly concentrated between 2 m² and 5.9 m².

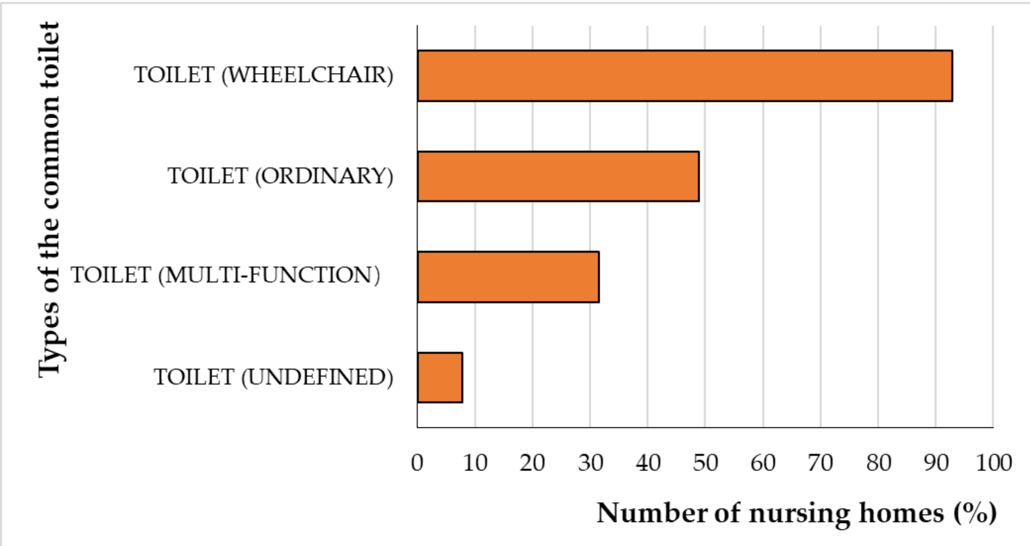


Figure 3-16 The type of common toilet the nursing home is equipped with (N=168)

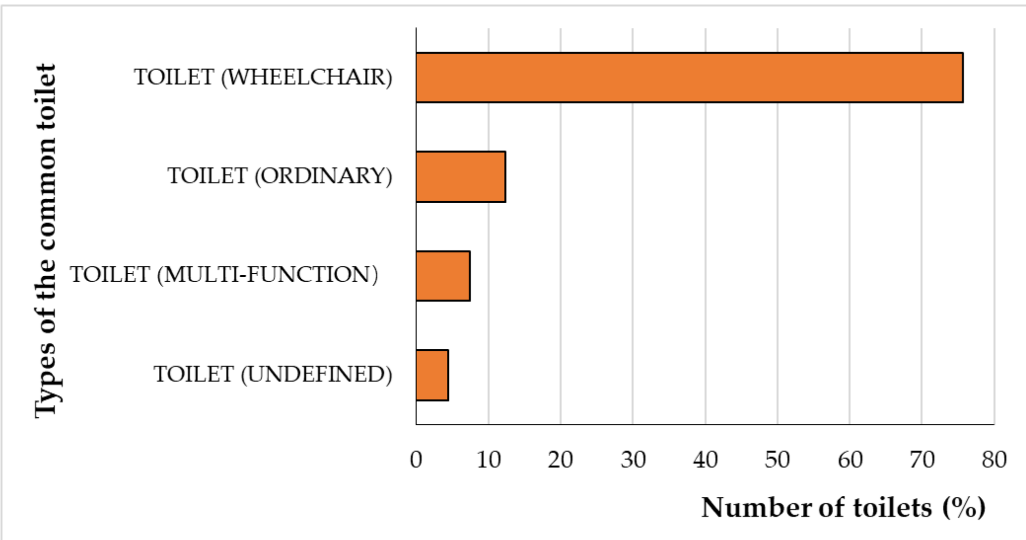


Figure 3-17 The ratio distribution about the type of common toilet (N=617)

In nursing homes, the elderly are the main service users of common toilets, so the configuration of barrier-free facilities is crucial. The ordinary toilet is limited in function due to its small space and rudimentary aids, and generally used by elderly people who are in good health and do not require wheelchairs. The multi-function toilet has a very good range of aids, but due to its higher cost and the larger amount of space it requires, normally the toilet is not economical for most nursing homes. The wheelchair used toilet is equipped with enough aids for the majority of elderly people, and takes up less space and cost less in equipment than these in multi-function toilet. Hence the wheelchair used toilet is the designers' first choice when designing common toilets in nursing homes.

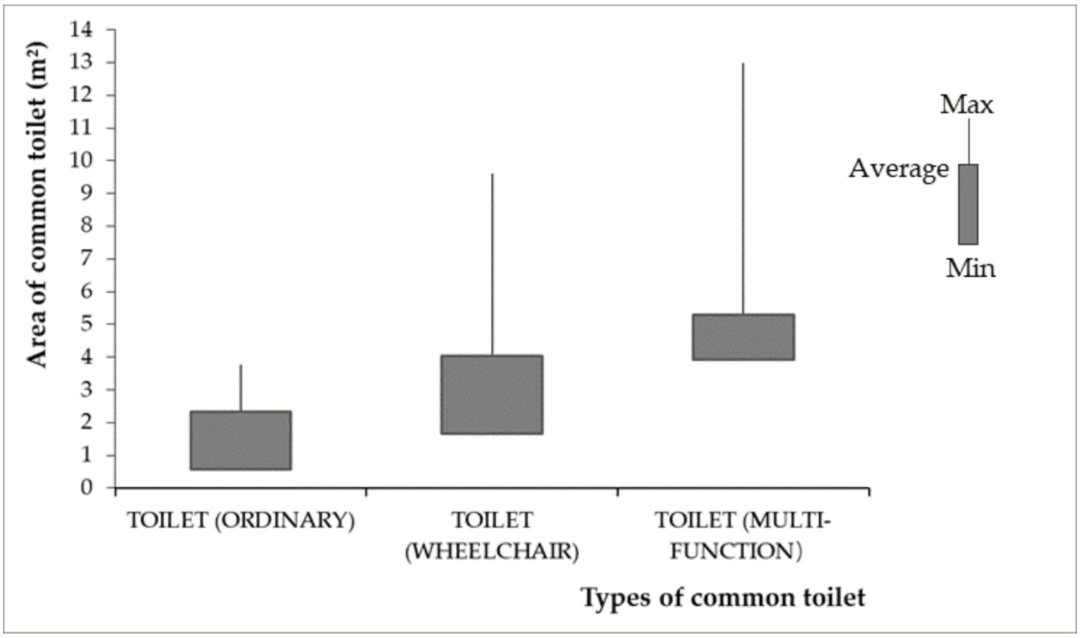


Figure 3-18 The area distribution of different types of common toilet (N=617)

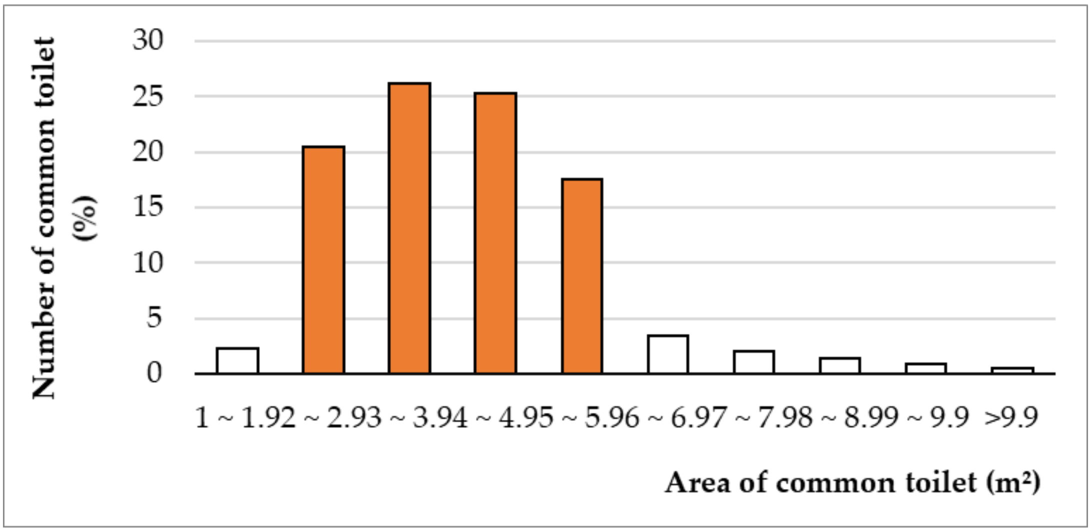


Figure 3-19 The area distribution of the common toilet (wheelchair used) (N=467)

The number of common toilets in a nursing home is closely related to the scale of the nursing home and whether the resident′s rooms are equipped with private toilet. If a nursing home is large and equipped with more activity space, or if the rooms in the nursing home aren′t equipped with private toilets, the home will accordingly increase the number of common toilets to meet the needs of the residents. The nursing home is generally equipped with three types of common toilet including ordinary toilet, wheelchair used toilet and multi-function toilet, to facilitate the different needs of residents. Of which the majority of common toilets are of the wheelchair used toilet, while the other two are relatively few in number and most of the nursing home are equipped with the common toilet can be available for wheelchair. It means that barrier-free design is an important consideration for the common toilet, as well as an essential design criterion for nursing home.

Although the ordinary toilet with simpler equipment requires less floor space and is more economical, it has an obvious limitation which can only be used by those who are relatively healthy residents, so it is less commonly used in the nursing home. Conversely, the multi-functional toilet, although very well equipped with equipment, is also less used in nursing homes. This is due to the fact that this kind of common toilet takes up more space, and are more expensive and less cost effective.

3.5. Common space: Common bathroom

The common bathroom in the nursing home is a place for all residents to wash their bodies. The common bathroom is usually made up of two parts, a bath for bathing and a dressing room for drying and changing clothes. As less than 10% of rooms are equipped with a private bathroom, it is said that in the vast majority of nursing homes the residents have to go to the common bathrooms for their bathing. In all research objects, only one nursing home does not have a common bathroom, while one nursing home is equipped with as many as 7 common bathrooms.

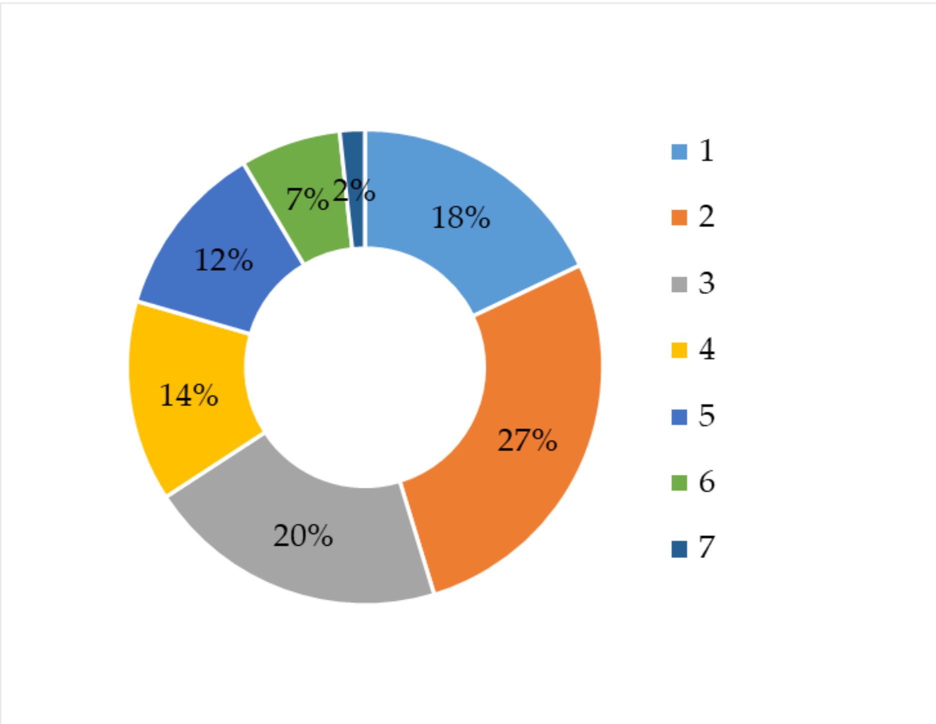


Figure 3-20 The number of common bathrooms the nursing home has (N=167)

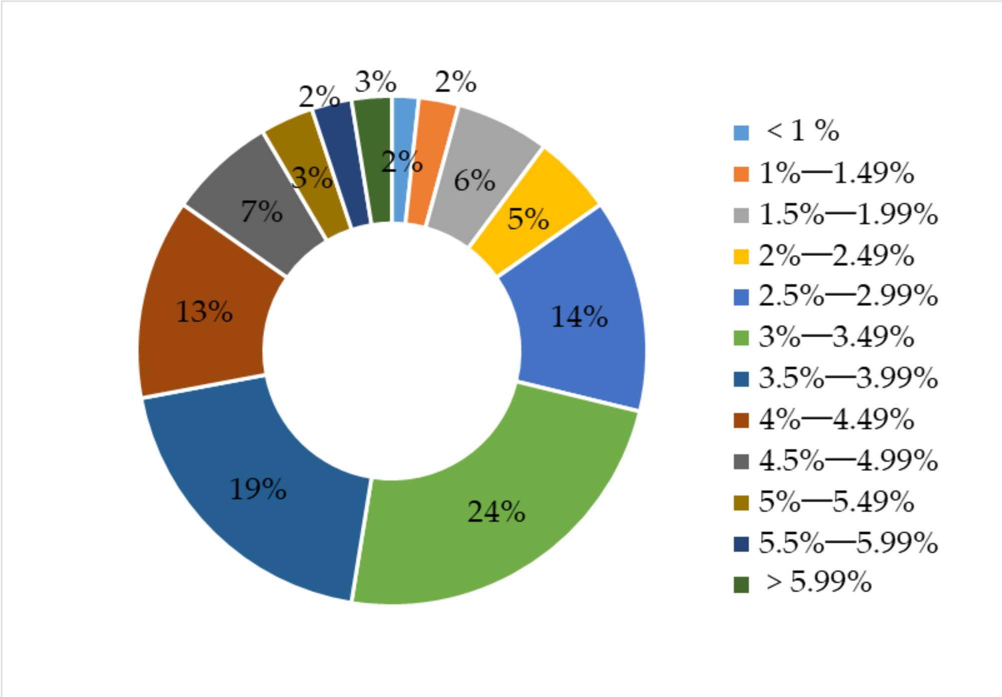


Figure 3-21 The ratio distribution of the area of common bathroom (N=167)

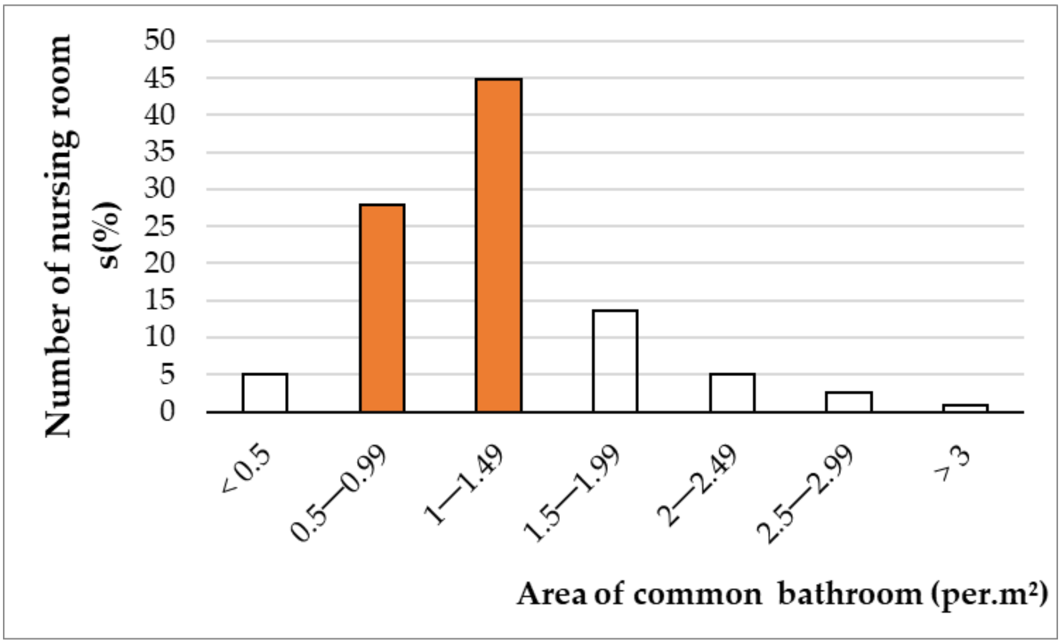
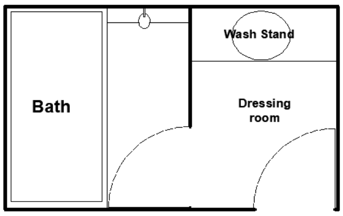
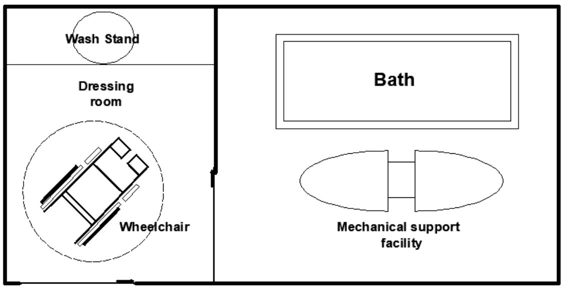
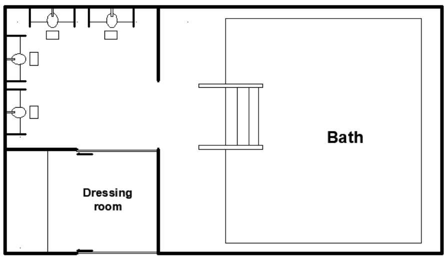
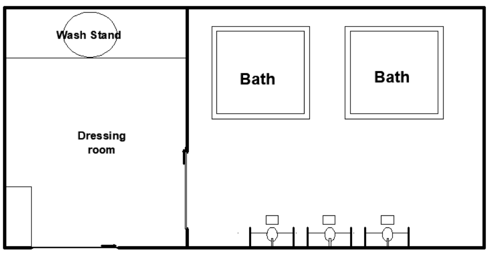


Figure 3-22 Area of common bathroom per person the nursing home has (N=167)

There are a total of 504 common bathrooms in 167 nursing homes, with an average of 3 common bathrooms per nursing home. In terms of numbers, nearly 66% of nursing homes are equipped with less than 4 common bathrooms as shown in Figure 2-19. The area proportion occupied by common bathrooms in the different nursing homes is distributed between 0.75% and 12.56%, and the average is 3.05%, but in nearly 70% of nursing homes, the common bathroom occupies the total floor space between 2.5% and 4.5% as shown in Figure 3-21. n terms of common bathroom area per person, one nursing home provides the most affluent common bathroom area for its residents, amounting to 3.064 m² per person, while one nursing home provides only 0.27 m² of common bathroom space per person for each resident, and the average is 1.22 m². However, the majority (72.88%) of nursing homes provides the residents with 0.5 m² to 1.5 m² of common bathroom space per person as shown in Figure 3-22.

Table 3-5 The schematics of common bathroom

Type	Schematic
T1, (U) Unit bathroom	
T2, (S) Special bathroom	
T3 (SP) Spring bathroom	
T4, (M) Multi-person bathroom	

In all common bathrooms, there are four main types of common bathrooms, depending on the facilities and functions that are available in the bathroom space as shown in Table 2-5. The first type is the unit bathroom (U) with simple bathing facilities and only one person can use it at any one time; The second type is the special bathroom (S), equipped with specialist aids and is accessible to wheelchairs, to assist elderly people which are difficult in bathing by themselves; The third is the spring bathroom (SP), equipped with a hot tub in which the occupants can enjoy the hot springs; The last type is the common bathroom (C) with multiple baths for several people to use at the same time. Of the four types of common bathroom, the unit bathroom is the most widespread in nursing homes, with nearly 80% of nursing homes equipped with it; The second is the special bathroom, which appears in nearly 60% of nursing homes; While only around 20% of nursing homes are equipped with a spring bathroom or a common bathroom (C) as shown in Figure 2-22. It should be mentioned that nearly 1.59% of common bathrooms are not indicated as a type on the drawings of some nursing homes. It may slightly affect the above data.

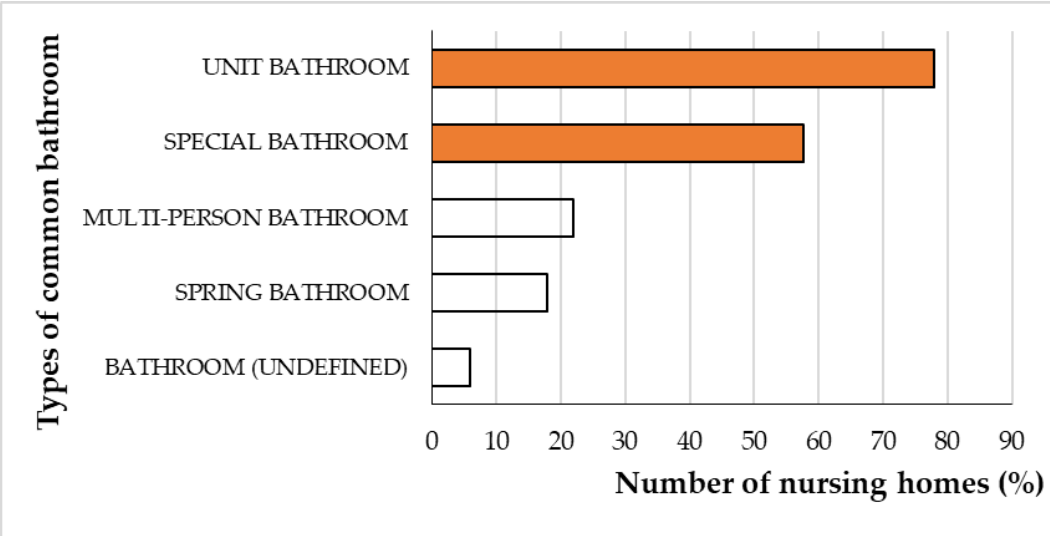


Figure 3-23　The type of common bathroom the nursing home is equipped with (N=167)

In addition, in some nursing homes, several different common bathrooms will share a dressing room, thus creating a group of common bathrooms. Depending on the combination of common bathrooms, a total of 8 group types of common bathrooms are available in 496 common bathrooms as shown in Table 2-6. And Figure 2-23 shows that the majority (95.86%) of common bathrooms consist of a single type of common bathroom, with only a few common bathrooms combining several types of common bathroom. Of these types of the common bathroom, more than 60% of common bathrooms are unit bathrooms, followed by special bathrooms, but only around 20%, the third are spring bathrooms and common bathrooms, both with less than 10%, while the other types of combined bathroom account for only a very small percentage. Of the 475 common bathrooms that consist of a single type of bathrooms, there is a huge difference in size between the different types of bathrooms. The unit bathroom is overall the smallest of the four types of common bathrooms, generally has between 3.63 m^2 and 20.26 m^2, with an average of 10.54 m^2; The size of the special bathroom is distributed between 6.77 m^2 and 31.85 m^2, and the average size is 17.98 m^2

which is slightly less than twice the average size of a single bathroom; The average size of the common bathroom is 31.33 m², much larger than the former two kinds of bathroom, and the size is distributed between 6.87 m² and 59 m²; The largest spring bathroom is 84.24 m², while the smallest is only 14.45 m², with an average size of 42.72 m², the largest of the four kinds of bathrooms.

The common bathroom is one of the most important spaces that make up a nursing home and is one of the most used by the residents. The popularity in nursing homes and number of unit bathrooms reveal that the privacy is an important consideration for designers when designing the common bathrooms in nursing homes, and show that the unit bathroom is more flexible in terms of layout, can be spread out in a nursing home for the convenience of the residents. The popularity of special bathrooms in nursing homes shows that the barrier-free facility is an important principle for designers to follow when designing nursing homes. However, in terms of numbers, each nursing home is generally equipped with one special bathroom to ensure that some elderly people who cannot do the bathing themselves are taken care of. But as the special bathroom requires expensive facilities and takes up more space, it cannot be spread out in a nursing home like the unit bathroom. The spring bathroom and common bathroom require larger spaces, so they are generally equipped in larger nursing homes.

Table 3-6 Group types of common bathroom

Diagram	**U**	**S**	**M**
Type	T1	T2	T3
Diagram	**SP**	**S+C**	**S+SP**
Type	T4	T5	T6
Diagram	**S+M+SP**		**S+U+SP**
Type	T7		T8

U= unit bathroom S= Special bathroom C= Common bathroom SP= Spring bathroom

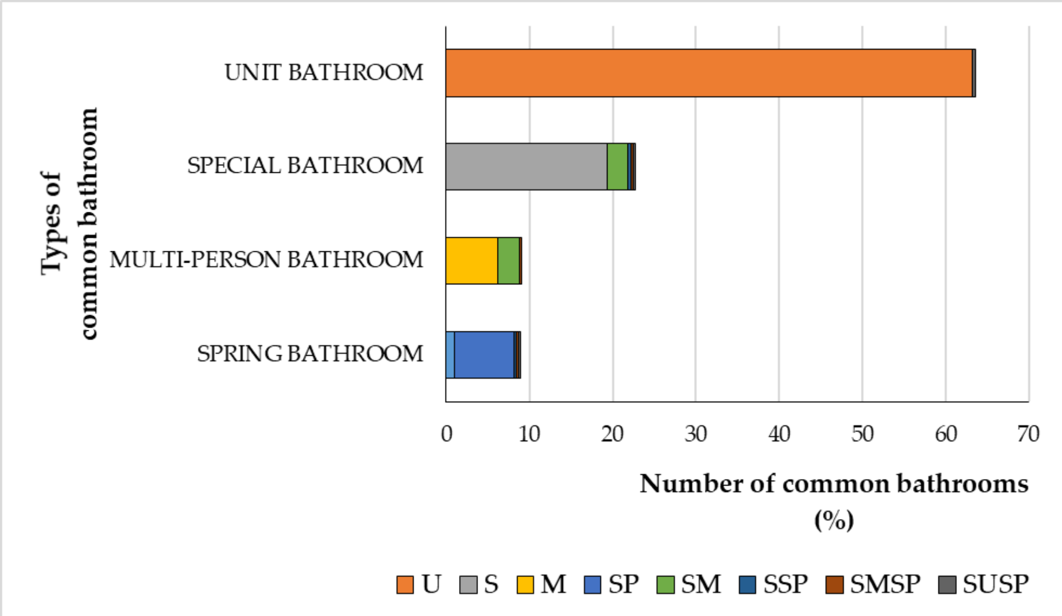


Figure 3-24 The distribution of different types of common bathroom (N=475)

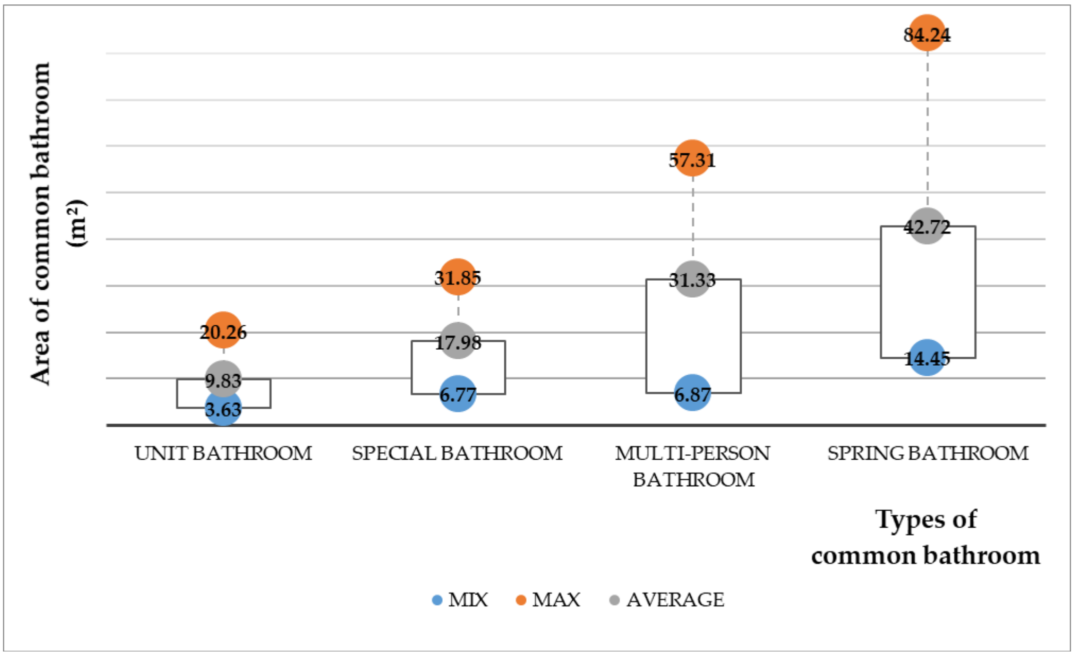


Figure 3-25 The area distribution of different types of common bathroom (N=475)

Only a small number of resident's rooms are equipped with private bathrooms, so in most nursing homes residents bathe in common bathrooms. Four types of bathrooms, including the unit bathroom, the special bathroom, the common bathroom and the spring bathroom, are frequently used as the common space in the nursing home, of which the unit bathroom with good privacy and simple support facilities and the special bathroom with full assistive devices are the most common in the nursing home. The common bathroom and the spring bathroom with the hot spring, which can be used by more than one person at a time, are relatively uncommon. In terms of number, there are also many more unit bathrooms and special bathrooms than the other two, in particular, the unit bathroom account for over 60% of the total. These can indicate two points, the first point is that privacy is an important design element in the design of common bathrooms, as most healthy elderly people prefer to enjoy bathing alone, the second point is that the accessibility is still an important principle in the design of common bathroom and that the special bathroom can assist residents with reduced mobility to complete their baths. While the common bathroom and the spring bathroom, which lack privacy, are less indispensable, even the spring bathroom offers the hot spring with wellness benefits. Based on the result that a nursing home is equipped with about three common bathrooms in average, the pattern, that the common bathroom the nursing home is equipped with, can be inferred is that a special bathroom with a number of unit bathroom is equipped in a nursing home to meet the bathing needs of the residents. Furthermore, it is common in nursing homes for different types of common bathrooms to share a dressing room, especially between the other three types of common bathrooms in addition to the unit bathroom, proving once again the importance of independence and privacy for the common bathroom.

3.6. Common space: Laundry

A laundry room is a place where clothes are washed, a laundry room in a nursing home usually consists of a space equipped for washing equipment and a space for drying clothes. Of all the research objects, 131 (78%) nursing homes have a dedicated laundry room for the residents. Some of these nursing homes have more than one laundry room, and one nursing home even has as many as 6 laundry rooms for the residents.

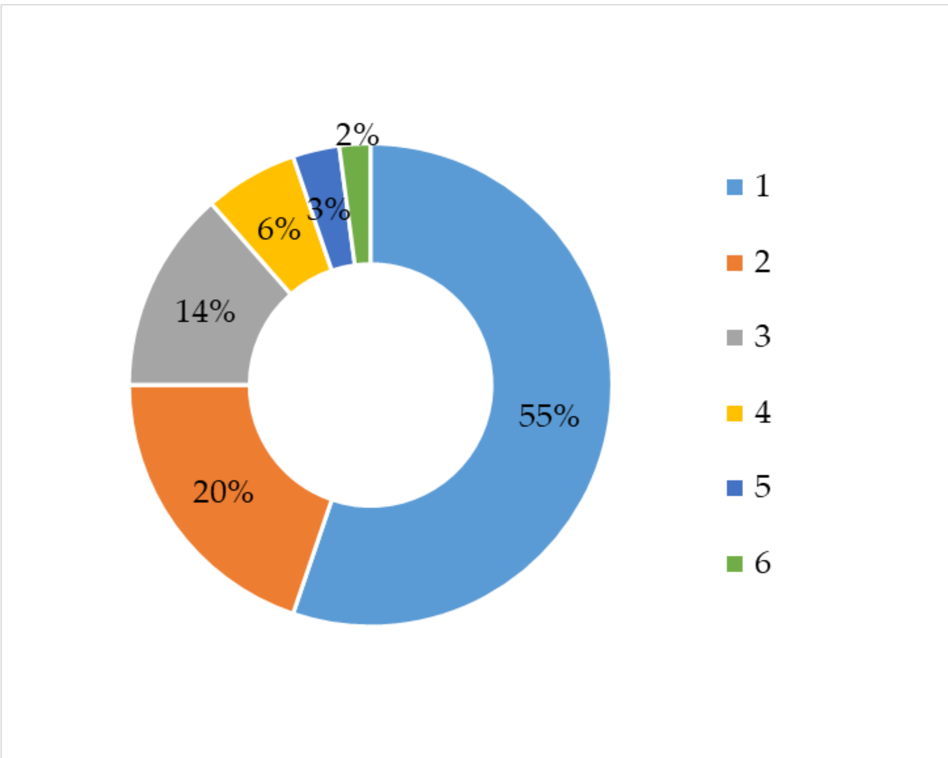


Figure 3-26 The number of laundries the nursing home has (N=131)

In total, there are 197 laundry room in 131 nursing homes, of which 15 laundry rooms in 7 nursing homes are set up in the dressing rooms of common bathrooms. On average, 1.5 laundry rooms are set up in each nursing home, with most (90%) nursing homes equipped with less than three laundry rooms and about half of the nursing homes having only one laundry room as shown in Figure 2-25. The area of laundry room typically takes up between 0.14% and 5.92% of the nursing home space, with the average being 1%. In 83% of nursing homes, the laundry room takes up less than 2.5% of the space, with around 60% of nursing homes being designed to allocate around 0.5% to 1.5% of the space to the laundry as shown in Figure 2-26.

In terms of the size of the laundry room, the largest laundry room has 37.6 m² and the smallest is only 2.03 m², with an average of 9.27 m². Figure 2-27 shows that 96.3% of laundry rooms are less than 20 m² in size, with 50% of laundry rooms concentrated between 5 m² and 9.9 m². The size of the laundry room usually depends on the scale of the nursing home. In many nursing homes, the laundry room does not have a dedicated drying area and the residents usually take their washed clothes to the balcony or their own room to dry, so that these laundry rooms will be smaller than those with a drying area. The size of the laundry room shown here can only be used as a reference and should be adjusted to take account of the actual situation when designing.

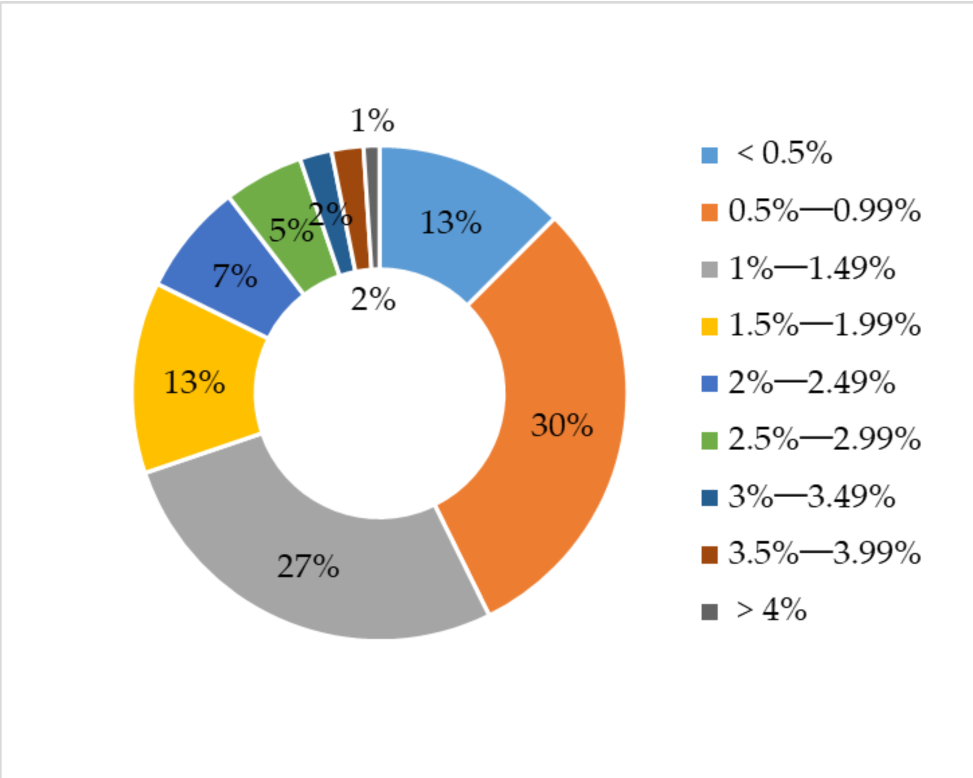


Figure 3-27 The ratio distribution of the area of laundry (N=131)

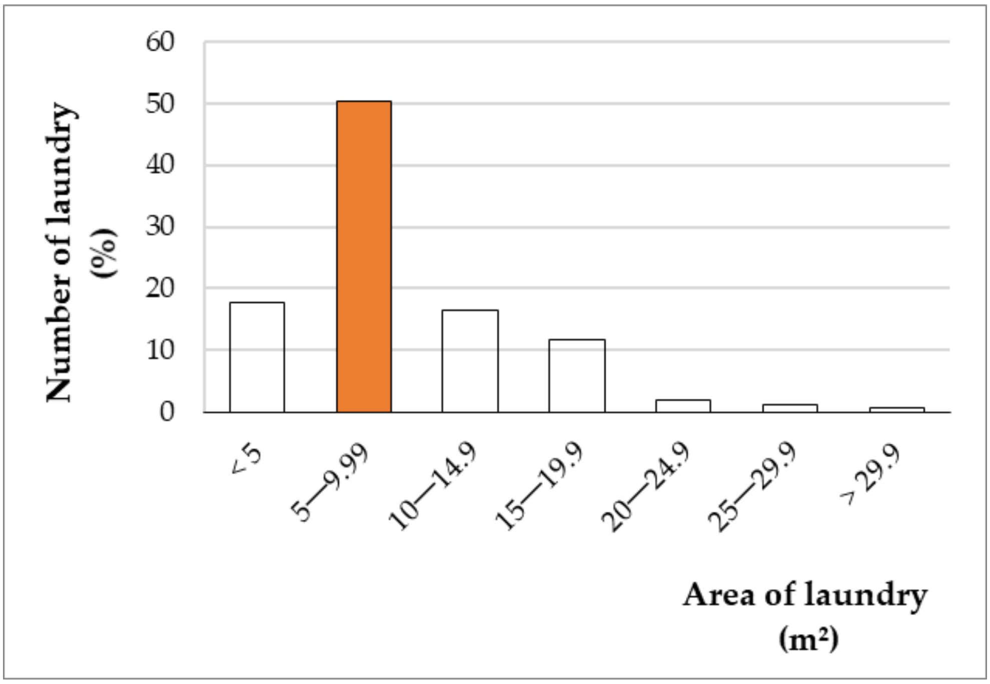


Figure 3-28 The area distribution of the laundry (N=182)

Most nursing home have a dedicated laundry room for residents, but many of these are not paired with a dedicated drying room, which seems to feeds into the fact that most resident's rooms in nursing homes do not require individual laundry machines and that residents often need to take their dirty clothes to a special laundry room for washing. It also suggests that many of the laundry rooms are equipped with dryers so that residents can dry their washed clothes without having to dry them in the drying room, or residents can dry their washed clothes in their own rooms, which would have the advantage of avoiding mixing up residents' clothes while maintaining their privacy.

3.7. Service space: Consultation room

A consultation room is a place where consultation services are available. In the nursing home, the consultation room is generally a place for staff to have formal conversations with visitors or residents, it is also used as a reception room in some nursing home. Of all the research objects, 110 (65.5%) nursing homes have a consultation room. In total there are 111 consultation rooms in all nursing homes, only one nursing home is furnished with more than one consultation room. 8 consultation rooms in 8 nursing homes are marked as shared with reception rooms.

In 110 nursing homes, the area of the consultation rooms occupies between 0.18% and 2.71% of the nursing home space, with an average of 0.89%. In 90% of the nursing homes, the space occupied by the consultation room is less than 2%, and in 43.3% of the nursing homes, the space occupied by the consultation room is concentrated between 0.5% and 0.99% as shown in Figure 2-28. The size of the consultation rooms is distributed between 3.63 m² and 29.11 m², with an average of 11.51 m². 73.13% of the consultation rooms have an area of 5 m² to 19.9 m², with 40.3% concentrated between 5 m² and 9.9 m² and 32.84% between 10 m² and m² as shown in Figure 2-29. The main target of the consultation room is for visitors who are interested in information about the nursing home, so that the functional concerns of the consultation room take precedence over the allocation of space, hence here the size of the consultation room can provide a more meaningful reference for the designer when designing a nursing home.

The consultation room and the nursing room are the most common. The consultation room can be used as a place with multi-purpose services, to receive the visitor, or as a relatively private place for the resident to talk with each other or to communicate with the staff and the visitor. To some extent, therefore, the function of the consultation room is duplicated by that of the reception room, which is probably one of the reasons why most nursing homes aren't equipped with a reception room.

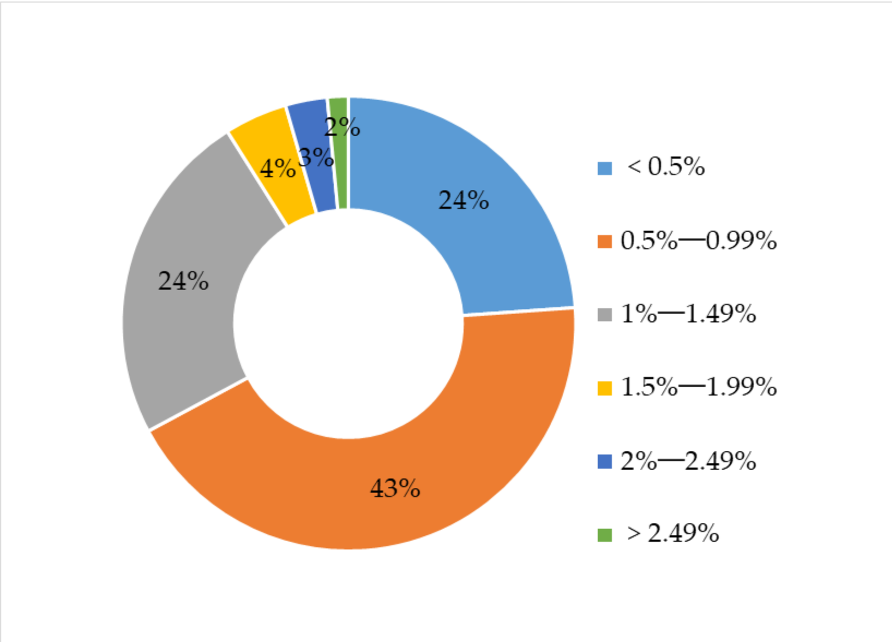


Figure 3-29 The ratio distribution of the area of consultation room (N=110)

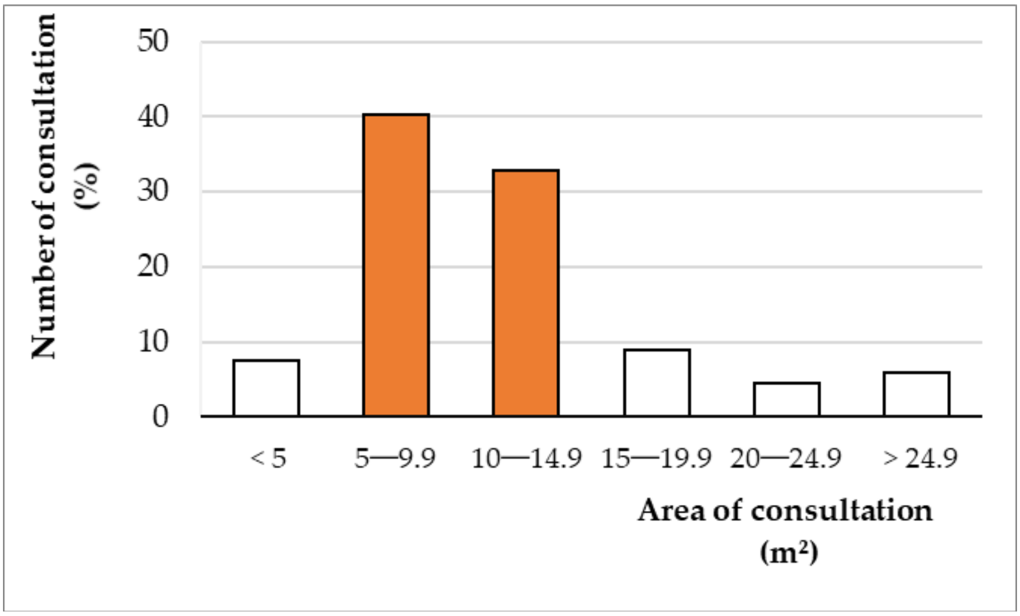


Figure 3-30 The area distribution of the consultation room (N=111)

3.8. Service space: Nursing room

In the nursing home, the nursing room is a place where the caregivers provide the residents with services such as daily health checks. Nearly half of the 168 nursing homes (82 units) provide a dedicated nursing room for the residents. The area of nursing rooms occupies the space of nursing home ranges from 0.15% to 12.45%, with an average of 1.13%. In 82.69% of nursing homes, the space occupied by the nursing room is less than 2%, and the space occupied b the nursing home is concentrated between 0.5% and 0.99% in 42.3% of nursing homes as shown in Figure 2-30. In total, there are 82 nursing rooms in 82 nursing homes. The largest nursing room is 42.37 m² and the nursing is only 2.26 m², the average being 11.97 m². 76.92% of the nursing rooms are between 5 m² and 20 m² in size, of which 34.62% are concentrated between 5 m² and 9.9 m², 25% are distributed between 10 m² and 14.9 m², and 17.31% are concentrated between 15 m² and 19.9 m² as shown in Figure 3-31.

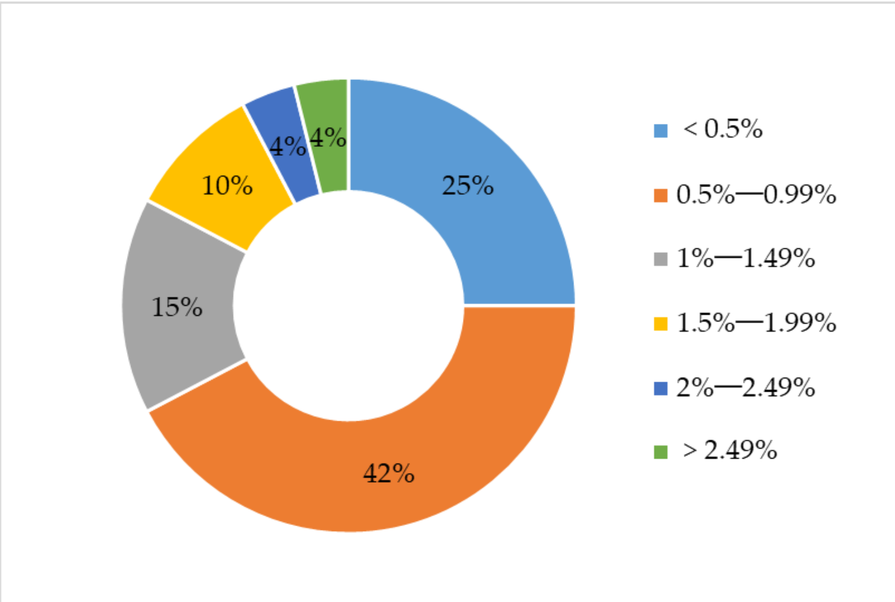


Figure 3-31 The ratio distribution of the area of nursing room (N=82)

The nursing rooms are intended for the residents. In some nursing homes there is a staff rest room for the caregivers to rest or be on duty in the nursing room, so that the nursing room may be larger than others. In general, the nursing room is similar in size and ratio of space to the consultation room in the nursing home. Similarly, when designing a nursing home, designers are more concerned with the need for a functional space of the nursing room than with the size of the space. Therefore, the results here may have a reference for the size of a nursing home.

Although Japanese nursing homes have regular cooperation with nearby hospitals, most are equipped with a dedicated space for caregivers with professional qualifications to stay for long periods of time, even some have several nursing rooms in different locations. In some nursing homes, the nursing room is integrated with the space of office. The function of the nursing room is to provide the residents of the nursing home with the basic daily medical needs. For a group of people with relatively fragile health, a stationary medical station in the nursing home not only provides a stable place to monitor the health of the residents, but also to cope with any unexpected situations. The nursing room is therefore an important design element of Japanese nursing homes.

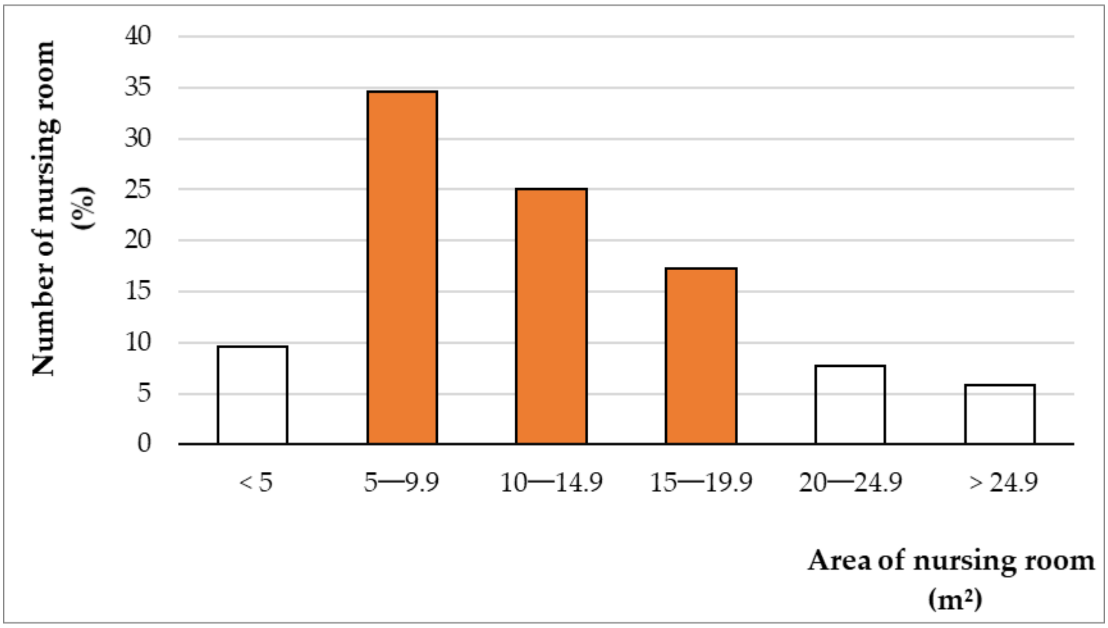


Figure 3-32 The area distribution of the nursing room (N=82)

3.9. Staff space: Office

The office is a place where the staff deal with all matters relating to the nursing home, including staff deployment, reception of visitors and management of the daily lives of the residents. Of 168 nursing homes, there are 200 offices in total. In 6 nursing homes, the office is arranged separately from the main building. One nursing home has as many as four offices and the majority (96.6%) of nursing homes have less than two offices, with 80% having only one service room as shown in Figure 3-33.

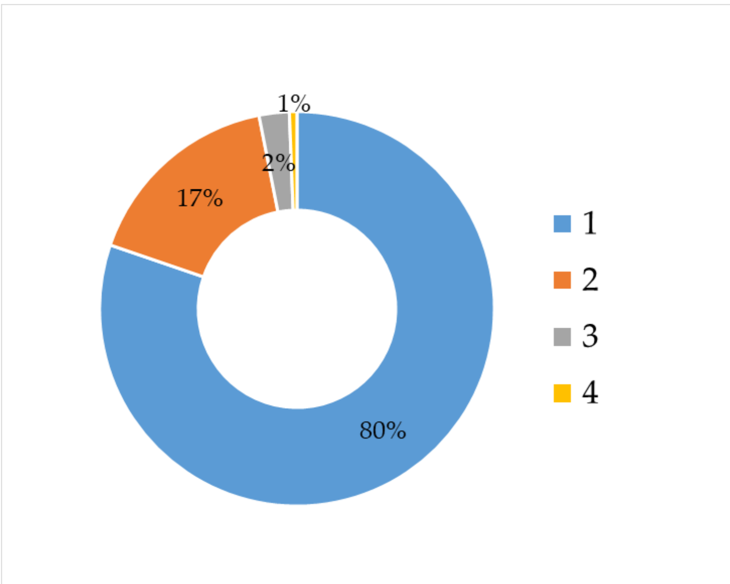


Figure 3-33 The number of offices the nursing home has (N=162)

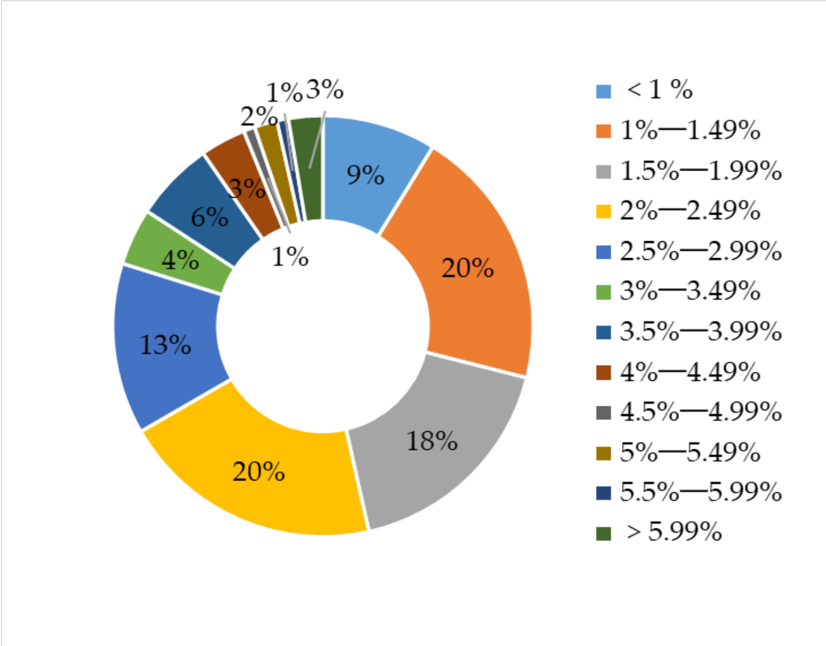


Figure 3-34 The ratio distribution of the area of office (N=162)

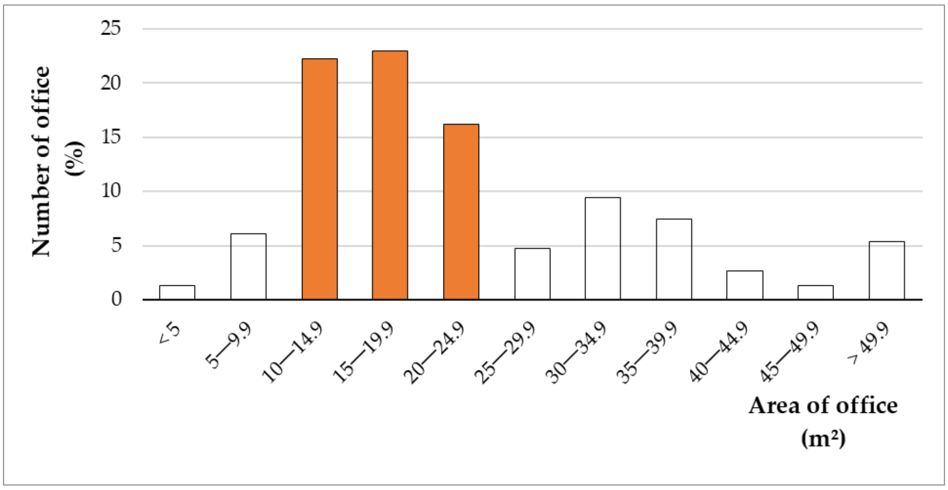


Figure 3-35 The area distribution of the office (N=200)

The office occupies an average of 2.35% of the nursing home's space, and in one nursing home the office occupies up to 9.54% of the total space, while in another nursing home it occupies only 0.11%. Overall, most (71.05%) nursing homes allocate between 1% and 3.5% of their space to office as shown in Figure 2-33.

In nine nursing homes, the office is divided into a space for managing the internal matters of the nursing home and a space for managing matters of outside visits. Figure 2-34 shows that the area distribution of the office. The size of the office is distributed between 3.49 m^2 and 87.06 m^2, with an average of 23.55 m^2. More than half (61.49%) of the offices are between 10 m^2 and 25 m^2 in size. The size of the office depends on the number of staff in the nursing home. In general, the larger the nursing home, the more staff it needs. Therefore, based on the results given here, the size of the office is then adjusted depending on the actual scale of the nursing home when designing.

Dedicated staffs are indispensable to maintain the normal day-to-day operations of the nursing home, as well as providing appropriate services to the residents. The office is the most basic staff space equipped in a nursing home and is the primary space provided for the staff to work. Some offices can also be used as nursing rooms. In a few homes there are more than two offices, one for staffs to work on external matters such as advice from outside and visits, and the other for staffs to work on internal matters such as assisting residents and consulting with them.

3.10. Staff space: Kitchen

The kitchen is where the staff in the nursing home process the food for the residents. 94.6% of the 168 nursing homes are equipped with kitchens and have the capacity to provide food for the residents by themselves. There are a total of 170 kitchens in 159 nursing homes, of which one nursing home is equipped with three kitchens and most (93.7%) of the nursing homes are equipped with only one kitchen as shown in Figure 2-35. 159 kitchens are self-contained kitchens with clear boundaries from the outside space and 11 kitchens are open kitchens that can be used freely by the occupants. The area of kitchens occupies between 0.33% and 12.1% of the nursing home's space, with an average of 2.7%. In 85.84% of nursing homes, the area of kitchens is concentrated between 1% and 3.5%, and the space occupied by the kitchens between 2% and 2.49% in 24.78% of nursing homes as shown in Figure 2-36. The kitchens in different nursing homes vary considerably in size. The largest kitchen has 102.36 m^2 of space, the smallest only has 7.67 m^2 and the average is 34.56 m^2. Of all kitchens, 84.12% are distributed between 10 m^2 and 59.9 m^2, with 68.24% concentrated between 10 m^2 and 39.9 m^2 as shown in Figure 2-64.

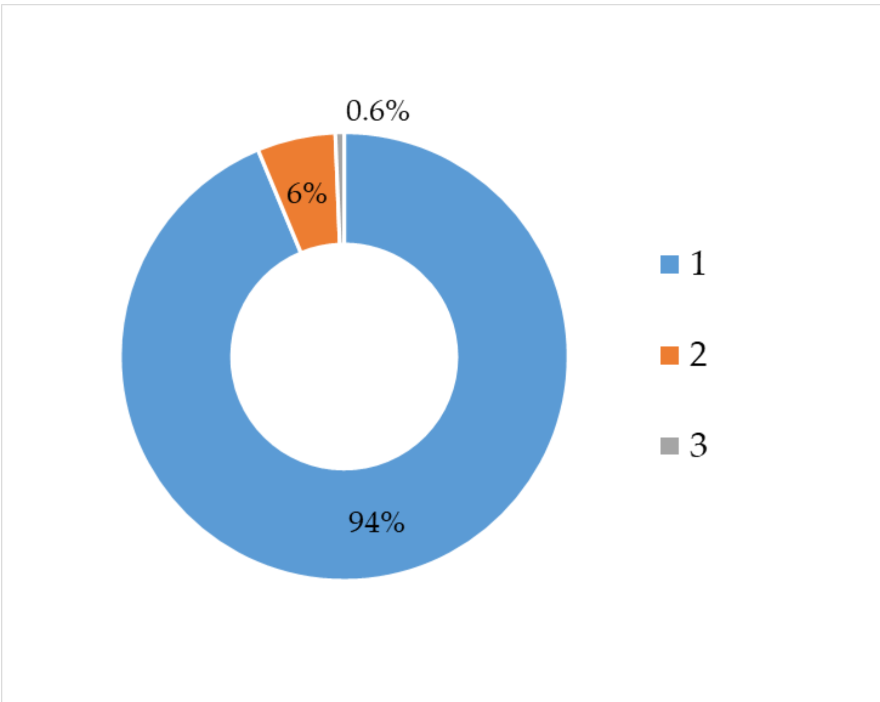


Figure 3-36 The number of kitchens the nursing home has (N=159)

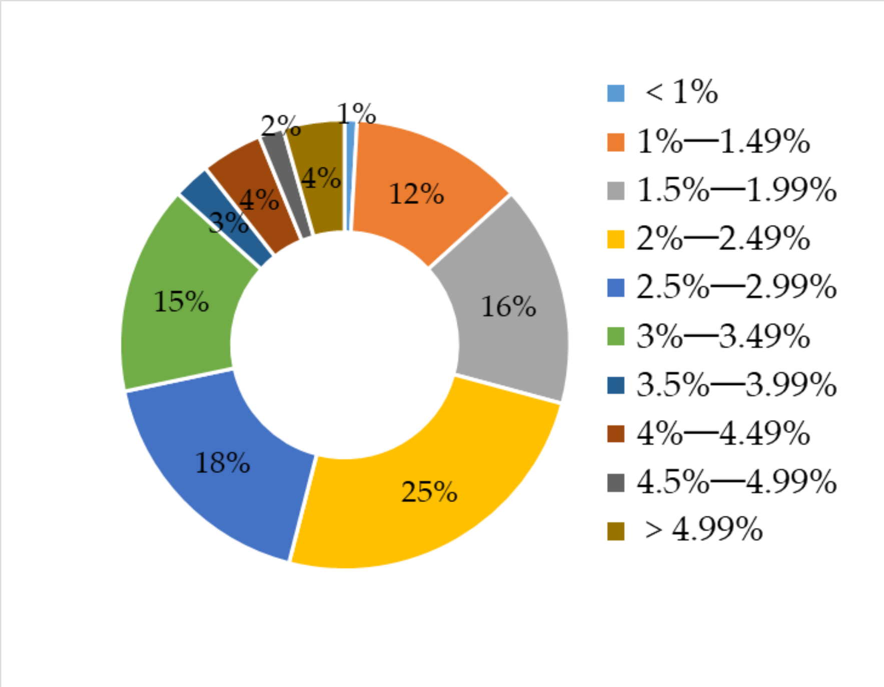


Figure 3-37 The ratio distribution of the area of kitchen (N=159)

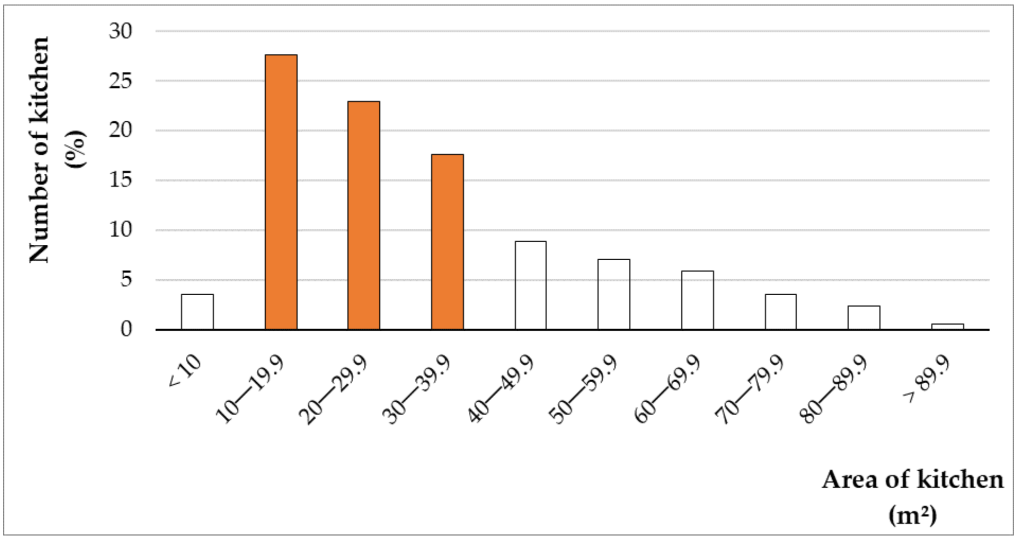


Figure 3-38 The area distribution of the kitchen (N=170)

Providing seniors with a good mix of healthy food is one of the key objectives of a nursing home, and some homes even employ dieticians to provide a good mix of food for their residents. The kitchen is therefore an integral part of the home's function, but the size of the kitchen is inextricably linked to the size of the home and designers need to consider the specific circumstances when designing.

The kitchen is another important staff space, usually accompanying the dining room, in which staffs can prepare meals for the residents. Although in some nursing homes, the kitchen is open for residents to use freely, so that they can participate in the preparation of meals and feel more at home, the kitchens with some dangerous appliances are still unsafe places and require good hygiene conditions, where residents are more likely to be injured and where it is more difficult for residents to control the hygiene conditions and make the food more vulnerable to contamination. This is why most kitchens in nursing homes are clearly demarcated from the outside and don't allow access to residents.

3.11. Staff space: Rest room (staff), dressing room (staff), staff station

The staff rest room is a dedicated place for staff to rest, the staff dressing room is a place for staff to change into their work clothes and the staff station is a place for staff to work on duty. Normally a nursing home is equipped with at least one of three functional spaces, and these three spaces are the main staff spaces in addition to the office and kitchen. These spaces take up an average of 2% of the space in a nursing home, in one nursing home they take up as much as 6.37% of the space, but in another, only 0.08%. Figure 2-38 shows these spaces occupy between 0.5% and 2.99% in 77% of nursing homes and between 0.5% and 1.99% in 52.7% of nursing homes. In terms of size, these spaces depend mainly on the scale of the nursing home and are distributed between 3.57 m^2 and 121.16 m^2, with an average of 31.65 m^2. Since in many nursing homes the staff rest room includes functional spaces such as the dressing room, staff toilet and even staff station, but in some nursing homes these spaces are arranged separately, hence the size of each functional space will not be explored further here.

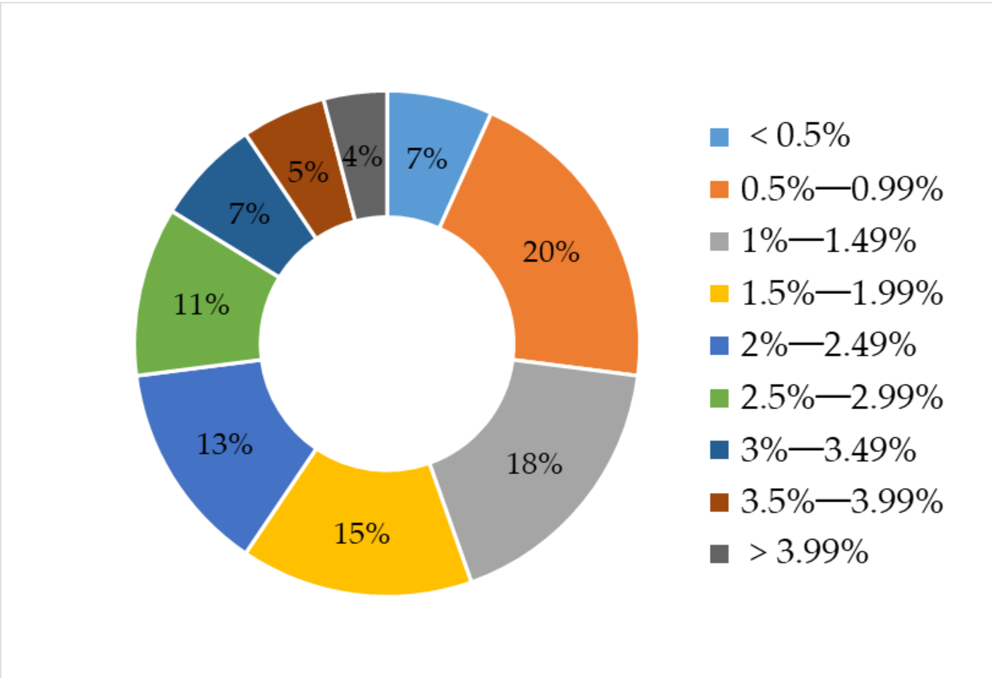


Figure 3-39 The ratio distribution of the total area of rest room (staff), dressing room (staff)

In many nursing homes, a number of auxiliary spaces specifically for staff use are equipped in, such as the staff rest room, which provide a place for staff to rest and in which they can take a short break or spend the night, and then the dressing room where staffs can change their clothing when they come to work or at the end of the day. The two types of staff service spaces are placed in the same space or integrated in the office in some nursing homes. The staff station, a third type of staff service space which is more common in nursing homes, seems to be an extension of the function of the office. This type of space is generally embedded in the residents' living area in homes. The presence of the staff station allows the staff to intrude into the residents' living area, seemingly breaking the relative independence of the residents' living area, but serving to monitor the residents' daily activities and to be able to provide for their needs in a timely manner. This seems to indicate that the design of a nursing home has always given priority to the idea of providing quick assistance to the residents.

3.12. The area of the key function spaces in the nursing home

We have detailly explore 15 function spaces in the type, size from section 2.1.1 to section 2.1.10. Figure 2-39 shows the area ratio of these key function spaces in the nursing home. Undoubtedly, the rooms occupy the most space in nursing homes, with an average of 47.6%, followed by activity space, which on average takes up around 12% of the space in nursing homes, and other functional spaces occupy only a minority of the space in the nursing home. Overall, these functional spaces occupy around 74% of the space in the nursing home. While 26% of the nursing home's space is allocated mainly to transitional spaces including corridors, stair, halls, etc. Almost all the spaces in the nursing home are set up around the residents' lives. The most important form of resident life is rest and activity, so the rooms and activity spaces closest to the residents' lives form the main space, and then some secondary space for living are distributed along with this main body, the spaces furthest away from the residents' lives are the staff spaces. The connection between these spaces cannot be made without the existence of transitional spaces. In terms of area distribution, the average area of transitional spaces is second only to the area of rooms. This indicates that the size of the transitional space is also an important point to note when designing a nursing home, even though it does not function as a function space and seems to be a rather wasteful space, but sufficient space has to be left for it. At last, the reference ratio of area zoning within the nursing home tends to be closer to 24:13:8.5:3.5:1 (Private space: other space (transitional space): common space: staff space: service space).

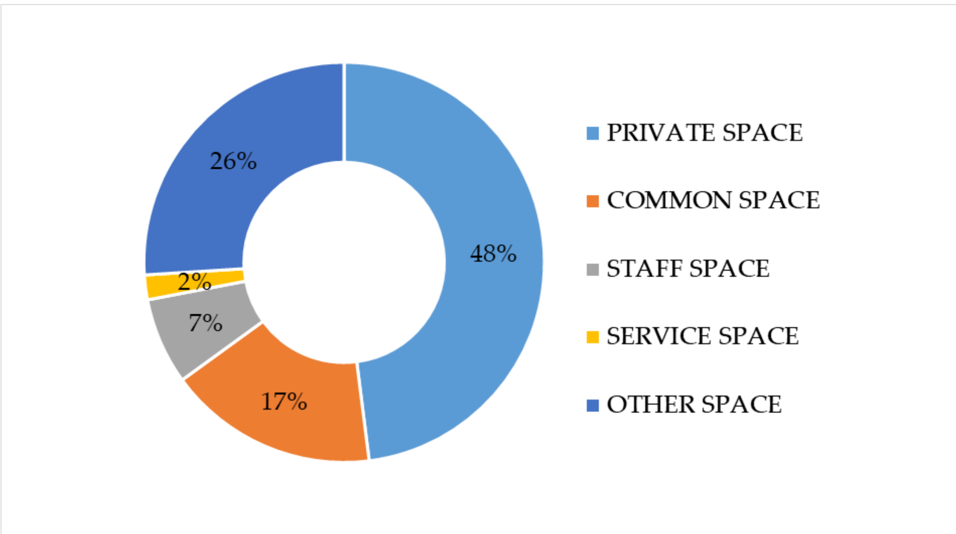


Figure 3-40 The area ratio of the four spaces in the nursing home (N=168)

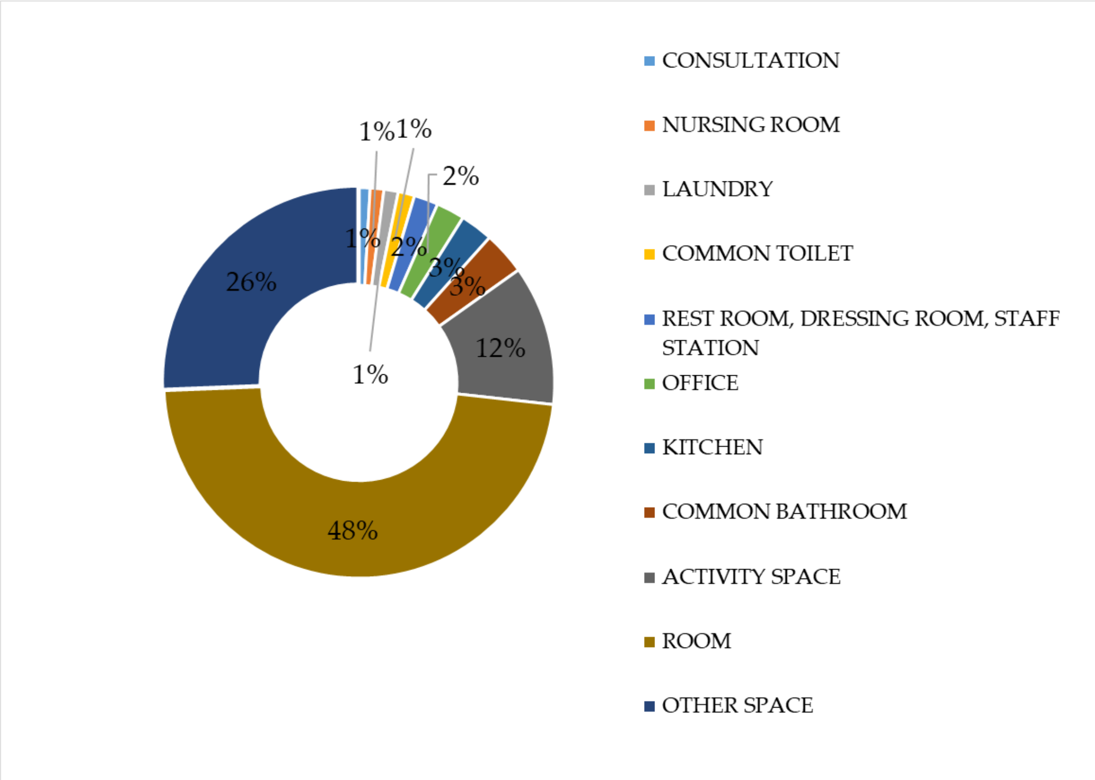


Figure 3-41 The area ratio of the key function spaces in the nursing home (N=168)

In detail, the room in the private space, which are the most dominant space in a nursing home, but the percentage of total space occupied varies greatly, for a maximum of 85.6% to a minimum of 6.5%. However, overall, the total space of the room account for 47.6% of the nursing home in average, suggesting that room space is the most important component of a nursing home. Although the size of individual rooms is as varied as the type of rooms, the majority of rooms are concentrated between 9.1 m² and 20 m², in particular, the number of rooms of around 18 m² has a dominated position in all rooms. This indicates that a room with around 18 m² is the most appropriate choice in Japanese nursing homes today, both in terms of economy and in terms of the living experience of the residents.

Apart from the rooms, the activity space in the common spaces is the largest functional space in a nursing home. Although it varies in different nursing homes, on average it occupies approximately 11.6% of the total space. On a per capita basis, each resident has approximately 3.38 m² of activity space. It means that it is currently reasonable to design nursing homes with around 10% of space, and with 3 m² per person, for residents to carry out their activities. The common toilet occupies a very small part of the nursing home, on average about 1.36% of the total space, although in some nursing homes with more common toilets, the space can occupy up to 4.32% of all space. The size of the different common toilets varies according to the number of facilities they are equipped with, but in general the size of the three types of common toilets is close to 2.34 m² for the ordinary common toilet with the most simplified facilities, 4.04 m² for the wheelchair accessible toilets with simple support facilities, and 5.3 m² which is the largest for the multi-purpose toilets with the most complete facilities. When designing a nursing home, it is relatively reasonable to allocate around 3.05% of the total space and 3.064 m² per person to the common bathroom. The unit bathroom in general has the smallest area, and the other three common bathrooms have a relatively larger area, but there is no fixed standard and it is still dependent on the designer's overall control in the design. The size of the laundry room usually depends on the scale of the nursing home. However, on average, the laundry room generally takes up around 1% of the area of a nursing home, with most of them averaging around 9 m² each. Overall the majority of conversation rooms are concentrated between 5 m² and 14.9 m², with an average of 11.51 m², occupying approximately 0.89% of the area of the nursing home. The plan for the allocation of space to the nursing room in the nursing home is similar to that of the laundry room and the conversation room, with an average of around 11.97 m² each, taking up around 1.13% of the total area.

The office, which is the most important part of the staff space and one of the most vital functional spaces in a nursing home, accounts for a very small part of the nursing home, with an average of only 2.35% of the total space, and an average of 23.55 m² each. In terms of floor space ratio, the space allocated to the kitchen is relatively similar to that allocated to the office, at around 2.7% which is only slightly higher that the ratio of space allocated to the office. However, in term of area, each kitchen has an average of 34.56 m², which is over 10 m² more than the average area of each office. This suggests that the allocation of functional spaces, such as offices and kitchens, varies considerably from different nursing homes, and is influenced by uncertainties such as the designer's preference. This is also evidenced by the area ration of the other spaces in the staff space. Due to the distribution of these spaces in nursing home is relatively complex, in this paper their areas are integrated in such a way that, on average, these space account for about 2% of the space with more than 30 m² in each nursing home.

Chapter 4
THE SPATIAL RELATIONSHIP BETWEEN THE INTERIOR SPACE

4. The spatial relationship between the interior spaces

The relationship between architectural design and internal space

The internal space of a building is what we usually call the interior space, which is separated from the natural space by certain material materials and technical means for certain purposes or functions. The internal space of a building has the closest relationship with people and has the greatest influence on them. It is usually presented in a beautiful form to meet people's spiritual feelings and aesthetic requirements, while satisfying their functional requirements.

The combination and form of the internal space of a building

The internal space of a building can be divided into single space and composite space in general: single space refers to the individual space with relatively independent functions; composite space is a group combination of multiple spaces. Internal space can be divided into virtual space, staggered space, recessed space, convex space, sunken space, psychedelic space and floor space in terms of morphological characteristics. Virtual space must rely on the revelation of some forms, it can be formed by partitions, furniture, furnishings, greenery, water bodies, lighting, colour, materials and other factors, requiring people to delineate the space through association and "visual completeness", lacking a strong limited scope, is a kind of "psychological space It is a "mental space", an ideal space. Psychedelic space, on the other hand, is a space that seeks mystery, turbulence, light, unpredictability and surreal effects.

The analysis of interior space aims to develop a sense of space and to enhance the designer's ability to control and use space as a design element. For the architect, it is important to learn to use space as a design tool. At present, architecture has developed into a whole new era, where designers are not only able to combine environmental space with various new materials, techniques and different light effects, but also to express people's spirituality, individuality and ecological awareness through architecture. People's grasp of space is no longer just to meet the needs of general functions, but to create interesting, tasteful and meaningful psychological Space is also a new realm that people are constantly pursuing.

4.1. The schedule of activity in nursing homes

In chapter 3, we have looked in detail at the various functional spaces that make up the nursing home in term of size and types. A nursing home is like a small community dedicated to serving the elderly, which provides comprehensive functional spaces for the residents to do various activities. The schedule of the residents in the nursing home shown in Figure 4-41 is a summary of the activity schedules for the elderly provided by 168 nursing homes. The schedule illustrates the variety of functional spaces involved in the life of the elderly in a nursing home. First of all, in a nursing home, the elderly usually wakes up between 6 and 8 o'clock and have a wash, receive their daily health check in their rooms. Then waiting for breakfast, during which time the elderly may stay in their rooms or in the living room, etc. Second, the nursing home will provide breakfast for the elderly in the ding room between 8:00 and 10:00 am. This is a relatively generous period; the elderly may return to their rooms or may chat with others after breakfast. Third, between 10am and 12am, the nursing home will arrange rehabilitation exercises for the residents in the rehabilitation area, after which a bath will be arranged for the elderly. Fourth, the elderly has their lunches in the ding room between 12:00 and 13:00. Fifth, after lunch, the nursing home may arrange some group activities

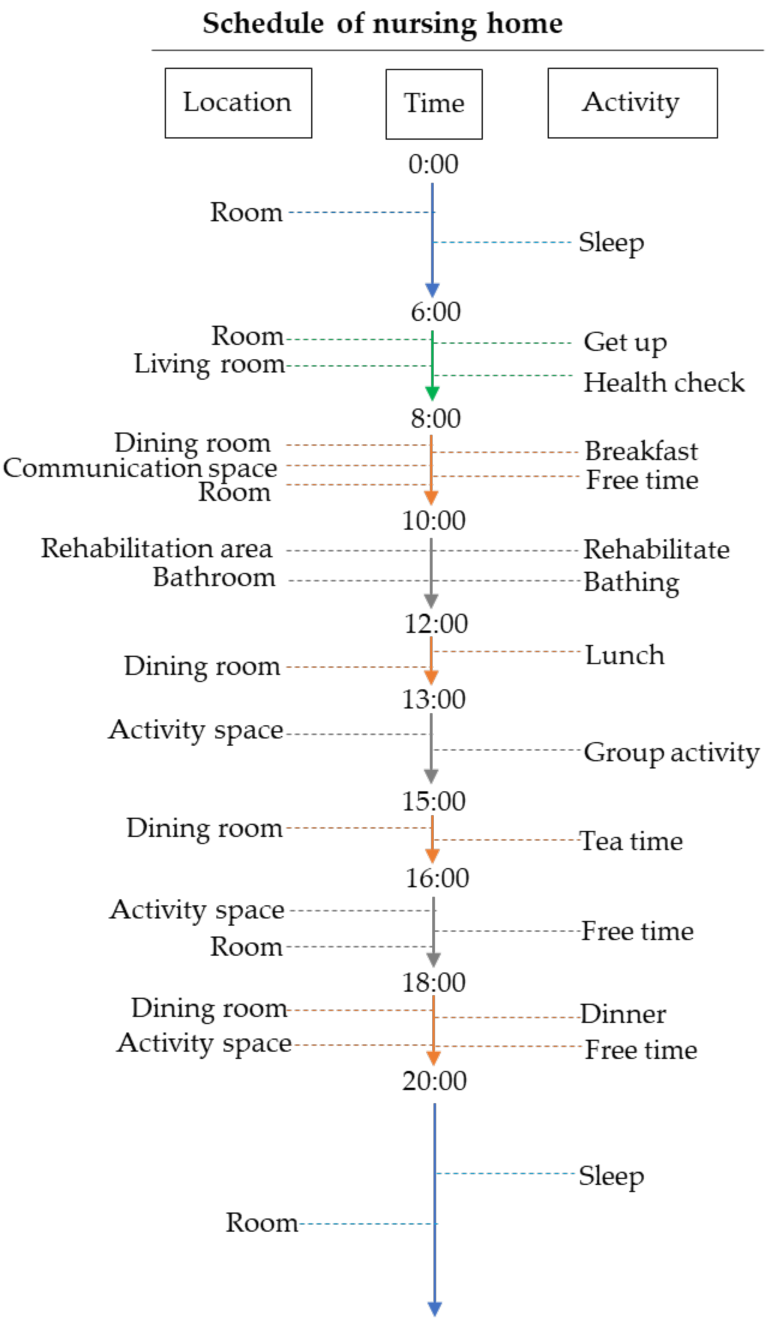


Figure 4-1 The schedule of the resident in the nursing home

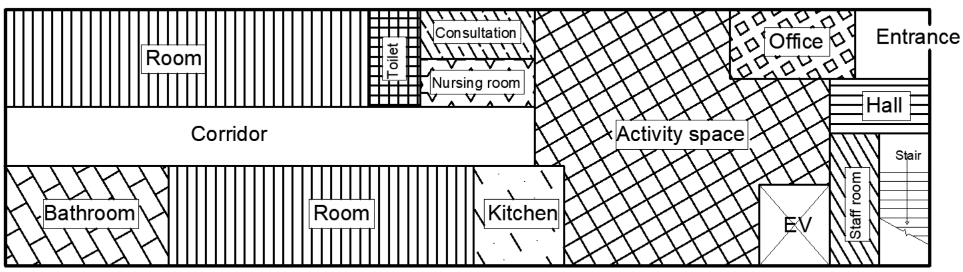


Figure 4-2 Diagram about the distribution of the interior spaces in the nursing home

for the residents between 13:00 and 15:00. Sixth, the elderly has an hour for tea time, between 3pm and 4pm. Seventh, the time between 4pm and 6pm is free, during which the elderly can do whatever they like. Eighthly, the nursing home will provide dinner for the elderly between 6pm and 8pm. Finally, at around 8pm, the elderly usually returns to their rooms to prepare for bed.

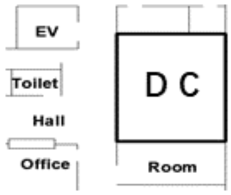
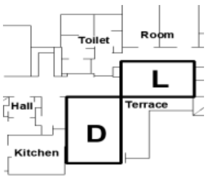
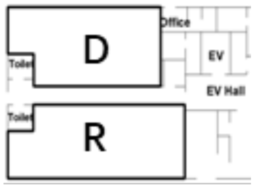
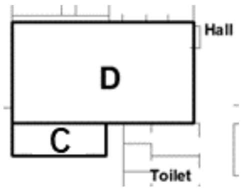
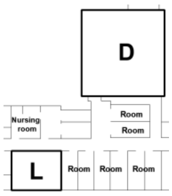
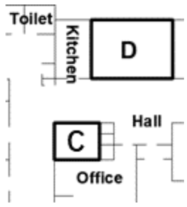
The life of the elderly is closely linked to the functional spaces in a nursing home. The layout of the functional spaces will influence the life experience of the elderly in a nursing home. So, what is the layout of functional spaces in a mature nursing home system. In terms of how long the occupants stay, how often they use, rooms are where older people spend most of their time and, of common spaces, activity spaces such as dining room are the most frequently used by older people. It can be said that rooms and activity spaces are the two most important functional spaces that make up a nursing home. Therefore, we can infer that the other functional spaces in the nursing home are distributed with these two functional spaces as the core. Figure 2-42 shows a possible spatial distribution of a nursing home which involves the key functional spaces. The rooms and the activity spaces are connected by a corridor, the common bathrooms are arranged closer to the rooms, but the hall, consultation room, office, elevator, etc. are arranged around the activity spaces. However, how these functional spaces are distributed in relation to each other in all nursing homes needs to be further explored by the district.

4.2. Spatial relationship between activity spaces

The activity space is where the elderly carries out various activities and is an important spatial component of the nursing home. The activity space is made up of four clearly defined functional spaces: the dining room, the living room, the communication space, and the rehabilitation area. The dining room is the most common functional space equipped in nursing homes and is an activity space which is most frequently used by the elderly. Each of these four functional spaces has a different function in which the elderly engages in different activities. Therefore, the elderly may move frequently between the dining room and other activity spaces in their daily lives in the nursing home. That is, the position relationship between the dining room and the rest of activity spaces is one of the most important factors influencing the movement trajectory of the elderly in the nursing home. So, how is the spatial relationship between the dining room and the rest of the activity spaces arranged in a mature care home system?

Of the 168 nursing homes, 235 floor planes have a dining room or a living room or a communication space or a rehabilitation area. In these floor planes, there are three types in relation to the spatial relationship between the dining room and the living room, the rehabilitation area, the communication space as shown in Table 2-7. The first type is the shared type, which means that the dining room provides a place for communication or rehabilitation area or living in addition to a place for dinner. The second type is the adjacent type, which means that the commnication space or rehabilitation area or living room has a specific area, but is arranged near the dining room. The last type, called the separated type, means that the commnication space or rehabilitation area or living room is arranged separately from the dining room, with a long distance between them. Although the shared type is opposite of the separated type, both types are used extensively in the layout of activity spaces at same time. The shared type is used in 44% of floor plans, and the separated type is adopted

Table 4-1 The classification of the spatial relationship between the dining room and the living room, the rehabilitation area, the communication space (N=235)

Type	a. Shared type (44%)		D L/R/C
Description	The dining room is shared with the rehabilitation area or the communication space or the living room.		
Sketch map	 (a-1)	 (a-2)	 (a-3)
Usage ratio	12.67%	14.66%	16.67%
Type	b. Adjacent type (2.75%)		D ¦ L/R/C
Description	The rehabilitation or the communication space or the living room is adjacent to the dining room and there is a clear boundary between them.		
Sketch map	 (b-1)	 (b-2)	 (b-3)
Usage ratio	0.34%	0.69%	1.72%
Type	c. Separated type (53.25%)		D --- L/R/C
Description	The dining room is separated from the rehabilitation area or the communication space or the living room.		
Sketch map	 (c-1)	 (c-2)	 (c-3)
Usage ratio	4.81%	15.56%	32.88%
D=Dining room L=Living room R=Rehabilitation area C=Communication space			

in around 53.25% of floor plans. But in the floor plans with the shared type, the plans where the dining room and the communication space are arranged in a space occupy in proportion a litter more than others, and the palns where the dining room and the living room are arranged in a space occupy in proportion is similar to the plans where where the dining room and the rehabilitation area arranged in a space. While in the floor plans with the separate type, the plans where the dining room is arranged separately from the communication space occupy in proportion high more than others. In addition, the plans with the adjacent type only occupy very few.

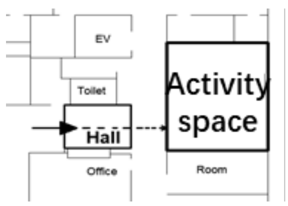
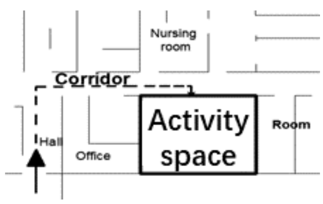
Overall, the idea for the spatial layout of the dining room and rehabilitation area or communication space or living room diverges considerably in the design. In terms of the living room, more designers are willing to attach the function of the living room to the dining room when designing. But for the communication space, there are more planes with this space than the living room, with a small number of communication rooms sharing a space with the dining room, more being arranged away from the dining room. This means that the distribution of communication spaces in the nursing home is more dispersed, and the fact that most of the opportunities for communication between occupants occur randomly. Therefore, the distribution of the communication rooms is also more scientific in this way. Finally, regarding the rehabilitation area, the two relationships between the rehabilitation area and the dining room are indistinguishable. This shows that for both treatments of the rehabilitation area are acceptable.

The functions of the different types of activity spaces vary, the most common and important activity space in a nursing home is the dining room. Moving around the different activity spaces within a nursing home is one of the important routs of movement for residents. It is therefore highly likely that the relationship between the location of the different activity spaces will have an impact on the movement of residents within the nursing home. When a nursing home is equipped with more than one type of activity space, the most common layout is to distribute them in different areas and keep a distance between them. In this layout, the dining rooms are generally arranged in areas that are relatively separate from the man living space of the residents, while other types of activity spaces are closer to the living spaces of the residents. The advantage of this layout is that the different activity spaces are clearly divided, so that residents who want to participate in different activities are not confused in the same area, and that some of the residents′ daily activities can be carried out in the activity space closet to their room without having to travel long distance. The disadvantage is that such a layout rends to result in residents being scattered in different areas of the home, which is not conducive to unified management, and also requires more space in the nursing home. The layout of shared type is the opposite of that of separate type, which is also relatively common in nursing homes. The different activity spaces in this layout are integrated together and share one space. This layout allows the residents′ activities to be effectively grouped together, which allows them to be better managed and saves a lot of space in the nursing home. But its disadvantages are also relatively apparent. In such a layout f a nursing home, the activities of the residents are often arranged in a uniform manner. The residents lack a specific area for some activities that are carried out spontaneously, and different activities have to be carried out in one space, which inevitably appears to be chaotic and unorganized. Therefore, in many nursing homes, different types of activity spaces are often arranged in a combination of shared type and separate type, with some activity spaces with similar or non-conflicting functions being arranged in a same space, and those closer to the residents′ usual life being placed in the residents′ living areas. This not only saves some space, but also enables residents to use the activity space more easily. However, the adjacent type where the different function spaces are placed in close proximity to each other is rarely used, as it is not only less space efficient than the layout of shared type, but also less convenient for the residents than the layout of separated type.

4.3. Spatial relationship between the entrance and the activity space

At the entrance floor, the entrance is the space that connects the interior to the exterior. On other floors, the entrance is stairwell or elevator that connects different floors. In a nursing home, the elderly must use the elevator, stair to get to other floor and must pass through the entrance to get outside. If the entrance is considered as a place with the least private and the activity space is considered as a place with semi-private, then the spatial relationship between the entrance and the activity space can help us to capture the privacy of the different spaces in a nursing home.

Table 4-2 The classification of spatial relationship between the entrance and the activity space (N=168, 1st Floor; N=158, other floor)

Type	a. Direct type	Usage Ratio	
Description	The entrance is directly connected to the activity space.	1st Floor	10.22%
Sketch map		Other Floors	21.03%
Type	b. Hall transition type	1st Floor	59.68%
Description	The entrance is connected to the activity space by a hall.		
Sketch map		Other Floors	42.92%
Type	c. Corridor transition type	1st Floor	30.11%
Description	The entrance is connected to the activity space by a corridor.		
Sketch map		Other Floors	36.05%

Of the 326 plans with activity spaces including 168 entrance floors and 158 other floors, there are three types of spatial relationships between the entrance and the activity space as shown in Table 2-8. The first type is the direct type, which means that the entrance is directly connected to the activity space, with no transition space between them. The second type is called the hall transition type, which means that the entrance is connected to the activity space through the hall. The last type is the corridor transition type, which means that the entrance is connected to the activity space by a corridor. Of the three types, the hall transition type is the most used both on the entrance floors and on other floors, and the usage rate of the hall transition type in entrance floors is about 20% higher than that in the other floors. The second is the corridor transition type which is used in more than 30% of the entrance floor and other floors. The direct type is the least used in all floors, but in comparison, the usage rate of the direct type in other floors is much higher than that in entrance floors.

Therefore, the activity space is arranged in a nursing home with privacy in mind. In addition to the privacy, the convenience for the elderly is also a factor to be considered. The corridor transition type provides the highest level of privacy, but the long corridors but the long corridors create a burden for the elderly to walk. The entrance on the entrance floor faces the outdoor and is used not only by residents, but also by visitors and employees, while the entrance on other floor is used mainly by residents, so entrances on the entrance floor are less private than entrances on other floors. Hence the elderly in the activity space of the direct type is more disturbed by others.

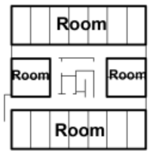
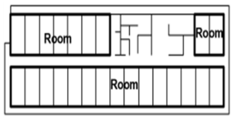
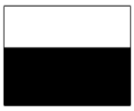
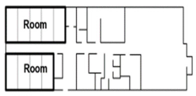
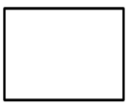
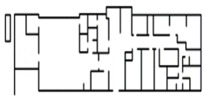
The activity space is one of the more open and free areas of the nursing home and is also used more frequently by residents. There is a degree of variation in the arrangement of the location of activity spaces in different nursing homes. On the ground of the home, the users of the activity space may involve staffs and visitors, in addition to the residents. In some nursing homes, the activity space is directly connected to the entrance or vestibule, and functions to a certain extent as a hall. In these homes, staffs, visitors, and residents can access the activity space directly from the entrance without any buffer space. This increases the utilization of the space, but takes away much of the privacy of the space. In such spaces, the residents' daily activities can easily be disturbed by visitors from outside. For this reason, such a layout of the activity space is relatively uncommon in nursing homes. The most common layout of activity spaces in nursing homes is the hall transition type. People enter the home from the outside and reach the activity space after passing through the hall. This layout of space largely prevents visitors from entering the residents' living space with the home, and most visitor-related business can be conducted in the hall without having to enter the home. The privacy of the residents' living space is largely maintained in this way. Even if some visitors have to enter the home, for example, to visit residents, the activity space is arranged close to the hall and provides a place for these activities without going deeper into the nursing home space. However, the activity space of the corridor transition type is embedded deep within the nursing home space, when people reach the activity space from the outside, they may have to cross not only the hall but also pass through the long corridor. The layout of this type of space, which is far removed from the outside world, provides a high degree of privacy for the residents. But if visitors need to visit the residents, they will have to go deeper into the nursing home, which will intrude to a large extent into the residents' living routs and deeper living areas, destroying the privacy of their living spaces. This layout is therefore less used in nursing homes than the hall transition. On the other floors of the nursing home, the users of the activity space are less likely to consider outside visitors, so the frequency of use of the activity space layout pattern has changed somewhat. A significant increase in the use of activity spaces directly connected to the entrance has been observed. Except on the ground, the activity space on other floors is often designed for use by the residents of that floor or the residents of the nursing home, so that the spaces can be embedded in the residents′ living areas for their convenience, and therefore the adoption of the corridor transition type of activity spaces is slightly increased. However, the gathering of residents in the space of this type of layout inevitably causes disturbance to other residents. When the floor plan is no longer an entrance floor, the buffering function of the hall is replaced by an elevator hall or a staircase hall, and its necessity is reduced, so that the adoption of the hall transition type of activity spaces decreases. But the activity spaces arranged close to these transitional spaces still have their own unique character. The elevator or staircase is a densely populated area in a nursing home, and the activity space is a relatively public living space. By placing these two relatively dynamic spaces together, the residents from different floors can come to this space to communicate without intruding into the more private living area of the floor. Hence, the layout of the activity space in the hall transition type and direct type can effectively contain the denser flow of people in one area of the floor and separate the dynamic and static spaces in the nursing home. Although there are variations in the adoption of the activity space layout on the other floors, in general, the transition type of activity spaces is still dominant, and the direct type of activity space still has the lowest adoption rate of the three. Therefore, these also show that the private and public nature of the activity space needs to be properly grasped when a nursing home is designed, and even more so to ensure the privacy of the residents′ main living space.

4.4. Spatial relationship between the rooms and the function spaces

The room is where the elderly spends most of their time in the nursing home, and in their daily lives they are constantly moving between it and other functional spaces. Therefore, in a sense than the spatial relationship between them can gives us a better understanding of the designer's intentions when laying out these spaces. There are four types of spatial relationships regarding the rooms and the functional spaces in the 524 plans of 168 nursing homes as shown in Table 2-8. The first is the enclosure type, which refers to that the functional space is enclosed by the room from all sides. This type is very rare in all nursing homes, with only 1.34% of the floor plans using this arrangement. The second type, called the embedded type, refers to that the functional spaces are set between the rooms in a plan. This type is widely used in the spatial layout of the floor plans of various nursing homes. However, this type is rarely used on the entrance floor, which is more suited to the spatial layout of other floors. The third is unilateral type, which means that the functional spaces and the rooms are on two sides of a plan. This type of spatial layout is used in 45% of the nursing home floor plans and it is commonly used on both the plans of entrance floor and the plans of other floors. The last type is the separated type, which means that the functional spaces and the rooms do not border each other or are on different floors. This type is used in only 10% of nursing home plans, the majority of which are the plans of entrance floor.

Rooms are private spaces and functional spaces are relatively public spaces. The rooms in the plan with the enclosure type or the embedded type are more closely connected to the functional

Table 4-3 The classification of spatial relationship between the rooms and the function spaces (N=524, 1st Floor=168, Other Floor=356)

			Ratio	
Type	a. Enclosure type (7units, 1.34%) 	Sketch map 	1st Floor	Other Floor
Description	The functional spaces are in the center of a plan and are enclosed by rooms.		0 unit 0%	7 units 1.34%
Type	b. Embedded type (220 units, 41.98%) 	Sketch map 	1st Floor	Other Floor
Description	The functional spaces in a plan are set between the rooms.		18 units 3.44%	202 units 38.55%
Type	c. Unilateral type (237units, 45.23%) 	Sketch map 	1st Floor	Other Floor
Description	The functional spaces and the rooms are on two sides of a plan.		100 units 19.08%	137 units 26.15%
Type	d. Separated type (60 units, 11.45%) 	Sketch map 	1st Floor	Other Floor
Description	The functional spaces and the rooms do not border each other or are on different floors.		50 units 9.54%	10 units 1.91%

■ Room □ Function space

spaces. It appears easier for the elderly to reach the functional space from the rooms, but it means that the functional spaces have a greater degree of interference with the rooms. Most of the functional spaces for receiving visitors and for staff are arranged on the plan of entrance floor, so that the functional spaces on the plan of entrance floor are more public and have a greater impact on the privacy of the occupants than the functional spaces on other floors. Therefore, the embedded type is more suited to the spatial layout on the other floors. The opposite of the embedded type is the separated type. In the plan with the separated type, the functional spaces are concentrated on one floor and the rooms are arranged on other floors. This ensures a high degree of privacy for the rooms, but the disadvantage of this is that the elderly have less access to the functional spaces. While the rooms in the plan with the unilateral type have more privacy than these in the plan with the embedded type, simultaneously the rooms are closer to the functional spaces than these in the plan with the separated type. Finally, each type of spatial layout has its advantages and disadvantages. On the entrance floor, there are more disturbances to the private space, designers will try to arrange as few or no rooms as possible, while on other floors, there are fewer disturbances to the private space, then the convenience of the rooms to the functional space is given more consideration. Therefore, designers often adopt a variety type of spatial layouts when designing a nursing home.

The resident's room is the main living space for residents and the place where they spend the most time every day. Several times a day residents move between their rooms and other space. It can be said that the most important path of movement for the inhabitants is from the room to the other function spaces. The position of the rooms in relation to other function spaces will therefore largely influence the movement routs of the inhabitants. In general, a greater variety of function spaces in addition to the rooms are equipped on the ground of the nursing home than on other floors. On the ground of the home, the flow of people is more intensive, and the variety of flow lines is more complex. So, while it may be easier for residents to reach the function spaces when residents live on the ground, the privacy of their living space is greatly compromised. Residents living on other floors are mostly concerned with dealing with their neighbors. But those living on the ground are not only dealing with their neighbors, but also with residents from other floors, and their living areas are more exposed to the movement routs of staffs and even the flow of visitors from outside. Therefore, in most of the entrance levels of nursing homes, rooms and other function spaces are usually laid out on both sides of the floor plan to ensure the privacy of the residents' living areas. Even in some nursing homes, there are no rooms at all on the entrance level, which is more effective in ensuring the privacy of the residents' living areas.

However, if the other function spaces are not large enough to fill the floor plan, this can lead to a waste of space. It is therefore easier to control and capture the use of space when a nursing home is designed by the layout of unilateral type. And this layout is the most common way that the spaces on the ground of nursing homes are arranged, followed by the separate type, while the other two layouts are very rare. On other floors, it is only necessary to consider the interface between residents, without the need to consider the intrusion of staff flow or visitors' flows on residents. Therefore, the spatial layout that the function spaces are embedded into the living space of the residents is often used in these floors. In this kind of the spatial layout, the function spaces can be located closer to the residents' rooms, which makes these spaces more accessible to the residents on that floor. However, such a spatial layout allows relatively public function spaces to intrude into the residents′ living area, thus reducing the privacy of the residents′ living space. So, the spatial layout of unilateral type, which enhances the privacy of the residents′ living space but reduces the degree of convenience of the residents′ use in that floor, is also adopted in many nursing homes. In conclusion, in terms of the layout between rooms and other function spaces, taking into account the convenience of the resident′s use and the privacy of the residents′ living area is an important consideration in the design of the nursing home. In addition, the layout of space of the enclosure type allows residents to access public spaces with great ease, but this layout breaks down the privacy of the living space. And the lack of light in the public areas also increases the consumption of electricity. So, it is rarely used to organize the space within the plan of the nursing home.

4.5. Corridor-based spatial layout of the interior space of the nursing home.

Spaces for movement form an integral part of any building organization, and the overall configuration of the circulation paths indirectly describes the spatial layout of a building. Within a nursing home, a corridor undertakes the circulation path and transition space between a series of individual rooms. Of 524 plans in the 168 nursing homes, there are 483 plans with at least one distinct long corridor per unit. One plane even consists of as many as 9 corridors. The spaces in the nursing home are joined together by corridors. Hence the number of corridors and the combined form of corridors are crucial factors in forming the spatial layout of the nursing home. Based on the survey of 168 Japanese nursing homes, four main spatial layouts are derived depending on the number of corridors the plan consists of. Table 2-9 shows the sketch maps of four spatial layouts and the usage rates of the four spatial layouts in the nursing homes. And the descriptions of four spatial layouts (a to d) are as follow:

a. Single-Corridor type. A series of individual rooms in a nursing home plan is organized by a single corridor.

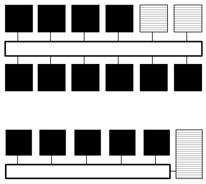
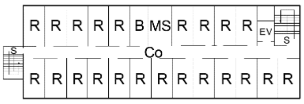
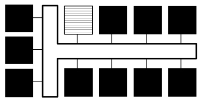
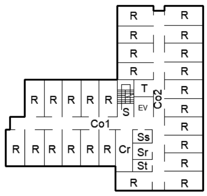
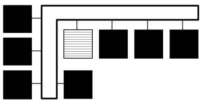
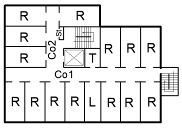
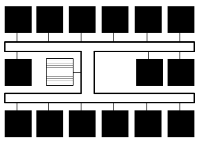
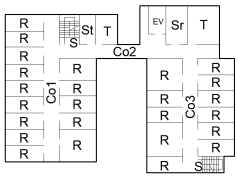
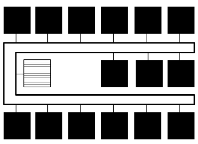
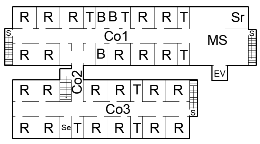
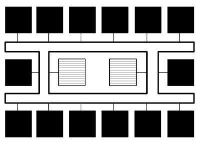
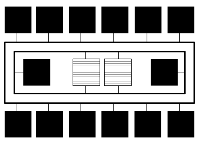
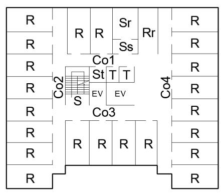
b. Dual-Corridor Type. Two corridors, which form in a T-shaped or L-shaped, organize a series of in-dividual rooms in a nursing home plan.

c. Tri-Corridor Type. A series of individual rooms within a nursing home plan is organized by three corridors which normally form in an H-shaped or C-shaped.

d. Ring-Corridor Type. A ring circulation path, which consists of more than three corridors, organizes a series of individual rooms in a nursing home plan.

The survey results show that 97% of 168 nursing homes adopt at least one of four spatial layouts as the organization of interior space. It is rare that a plan of the nursing home utilizes over four corridors. This indicates that designers have a certain constraint on the use of the number of corridors when organizing the interior spaces of nursing homes. In addition, the data reveals designers prefer the use of certain spatial layouts in their designs. Clearly, the highest usage rate is for the spatial layout of Single-Corridor type which is used in approximately two-thirds of nursing homes and in half of the plans. Subsequently, the spatial layout of Dual-Corridor Type appears in 44.26% of the nursing homes and in 33.21% of the plans. Nevertheless, the usage rate of the spatial layout of Tri-Corridor Type and Ring-Corridor Type is merely 11.9% and 2.97% of the nursing homes and 5.91% and 2.29% of the plans respectively. These data demonstrate that designers are more willing to utilize a spatial layout constituted by comparatively fewer corridors when designing

Table 4-4 The classification of corridor-based spatial layouts

Type	Sketch map	Case	Usage rate: Plan (524)	Usage rate: Nursing home (168)
a. Single-corridor type			49.81%	63.69%
		 (a-1) Homogenous type	261 units 49.81%	107 units 63.69%
b. Dual Corridor Type			33.21%	44.26%
		 (b-1) Homogenous type	162 units 31.30%	69 units 41.07%
		 (b-2) Non-homogeneous type	12 units 2.29%	5 units 2.97%
c. Tri-Corridor Type			5.91%	11.9%
		 (c-1) Homogenous type	29 units 5.53%	19 units 11.31%
		 (c-2) Non-homogeneous type	2 units 0.38%	1 units 0.59%
d. Ring-Corridor Type			2.29%	2.97%
		 (d-1) Homogenous type	12 units 2.29%	7 units 2.97%

■ Room ▢ Function space □ Corridor

Abbreviations of room labels are as follows:

B Bathroom Cr Communication room Co Corridor D Dining room EV Elevator

H Hall K Kitchen L Laundry Of Office R Room

S Stair Sr Staff room Ss Staff station St Store T Toilet a nursing home. Finally, in 91.23% of the plans the layouts of spaces adopt one of the four types. And in 17 plans the number of corridors is more than 3. The corridors are combined in a ring form in 12 plans, and in 10 plans the number of corridors is four. In the other five plans the combined form of corridors does not belong to any of four types.

Further investigation, based on four spatial layouts, reveals that the designers have similar solutions for the spatial distribution particular in the arrangement of the number of rooms. Firstly, around 94% of the plans with the spatial layouts of Dual-Corridor Type conform to a pattern of spatial distribution. The pattern, called homogenous type, exhibits that the number of rooms on corridor 1 is approximated by that on corridor 2 as shown in Table 2-9 (b-1). In contrast, the inhomogeneous type accounts for a very small proportion of the total. Secondly, Table 2-9 (c-1) depicts a dominant pattern (homogenous type) of spatial distribution within the spatial layouts of Tri-Corridor Type. This pattern illustrates that the number of rooms on corridor 1 and corridor 3 are similar, meanwhile they exceed the number of rooms on corridor 2. Likewise, an explicit pat-tern of spatial distribution exists in the spatial layouts of Ring-Corridor Type. It is consistent with that the number of rooms on the opposite side corridor approximates each other as shown in Table 2-9 (d-1). In short, these spatial distributions reflect the distribution characteristics of relative symmetry in morphology.

Transition spaces occupy a large part of the nursing home just second to rooms. Transition spaces connect the different function spaces, in the vertical direction, the elevator and the staircase link the different floors, and in the horizontal direction, corridors take on the role of connecting the different spaces on a floor plan. Hence, the elevator, the staircase and the corridor together form the most basic circulation path in a nursing home. In particular, the spatial distribution of the plan is significantly influenced by the number of corridors and the combined form of corridors. The spatial distribution of the single-corridor type has the highest adoption rate, both in terms of adoption in nursing homes and in terms of the organization of space within the floor plans. The plan where the spaces are connected by a single corridor, has a very simple spatial layout. In such a floor plan, the residents simply follow a corridor to arrive at their destinations from their rooms, without any diversions in the path. This layout of the spaces is friendly to residents with dementia, and residents don′t have to make choices at the fork in the road and get lost. However, this spatial layout also has the obvious disadvantages. In addition to the monotony of the layout, when the number of spaces in a plan is large, a long corridor is needed to connect these spaces, which can result in residents having to travel a long distance to get from one space to another, thus lacking good accessibility in the distance of the path. This disadvantage is exacerbated for elderly people who have difficulty with their legs. Therefore, this type of the layout is more suited to the floor plan of nursing homes with smaller scale. The high rate of adoption of this spatial layout in Japanese nursing homes also suggests that many nursing homes are relatively small in scale. As the floor plan of the nursing home increase in size, the spatial layout of single-corridor type becomes unsuitable and is replaced by the spatial layout of dual-corridor type consisting of two corridors forming ′T″-shaped. This spatial layout effectively solves the problem of long paths that form as the scale of space in the floor plan increases, although it does create a fork in the path that cause some obstruction to residents with dementia in their path. As a result, this spatial layout has a relatively high rate of adoption in both nursing homes and their floor plans. As the scale of the home increases, the number of corridors used in the floor plan increases. In the floor plans consisting of the spatial layout of tri-corridor type, the corridors are formed in a 'C'-shaped or 'H'-shaped. Although this kind of spatial layout alleviates the problem of long paths between spaces, the number of bifurcations in the path rises to two in the floor plan of this spatial layout. When the number of corridors reaches four, the ring-corridor type is the most common to be used in the spatial layout of floor plan. In such a floor plan consisting of this spatial layout, more bifurcations are created in the path, but the distance between spaces has a significant reduction. And in the plan of ring-corridor type, the corridors form a circular path, so that residents can return to their starting point from one space on the path, regardless of which direction they start from. This compensated to some extent for the weakness of the multiple bifurcations which are not friendly to residents with dementia. Hence, in almost all floor plans consisting of four corridors, the spaces are organized by the ring-corridor type. But, the plans with an excess of four corridors are rare, and even the plans consisting of three and four corridors are rarely used in the design of the nursing home. These seem to indicate that Japanese nursing homes with large scale are relatively rare, and that a simple spatial layout is preferred when a nursing home is designed. Furthermore, in those floor plans where the internal space is organized by more than one corridor, the spatial distribution tends to show a relative symmetry. This seem to suggest a preference for spatial design that is balanced in terms of spatial layout.

Therefore, we can infer that designers have a preference in using the number of corridors, the combined form of corridors, and spatial distribution when designing the nursing home. The preference indicates that these spatial layouts are considered by the designers to be relatively superior and reasonable compared to their homologous counterparts.

CHAPTER 5
CASE STUDIES ON THE CONFIGURATION ANALYSIS OF THE NURSING HOME

5. Case studies on the configuration analysis of the nursing home

In Chapter 2 we have learned that the modern residential nursing home in Japan is generally composed of 16 functional spaces, and examined these functional spaces in detail in terms of size, type, and ratio of space in the nursing home. In addition, we have discussed and summarized the spatial relationships between the internal spaces of the nursing home from a holistic and local perspective. However, the research in Chapter 2 is based on empiricism and typology. Much more is known about the structure and configuration of the nursing home through observation. We then know how large nursing homes accommodate the programmed and unprogrammed activities of organizations, and know what kind of activities should be held in this space in the nursing home. The research in Chapter 2 based on experience tells us what spaces should be available in a modern nursing home and how the spatial relationship between these spaces is.

In this Chapter, we will explore the rules of the spatial organization within nursing homes in terms of logic. The aim is to discover the design principles that designers follow when designing the nursing home within the theoretical framework of space syntax, seeking to contribute to a better understanding of nursing home morphology.

All buildings were then seen as selecting from the set of possible ʻstrangersʼ in the external universe, a sub-set of ʻvisitorsʼ who were defined as persons who may enter the building temporarily, but who do not control it. If the closed cell is the domain of an inhabitant, the open space is the locus of the ʻinterfaceʼ between inhabitant and visitor. Every building is therefore at least a domain of knowledge, in the sense that it is a spatial ordering of categories and at the same time a domain of control, in the sense that it is a certain ordering of boundaries, which together constitute a social interface between inhabitants and visitors.

A building may therefore be defined abstractly as a certain ordering of categories, to which is added a certain system of controls, the two conjointly constructing an interface between the inhabitants of the social knowledge embedded in the categories and the visitors whose relations with them are controlled by the building. All buildings, of whatever kind, have this abstract structure in common: a building type typically takes these fundamental relations and, by varying the syntactic parameters and the interface between them, bends the fundamental model in one direction or another, depending on the nature of categories and relations to be constructed by the ordering of space. [Hill]

5.1. Methodology

In order to compare buildings with one another and to interpret their sociological significance, we have to solve a prior problem, that of identifying the elements and relations which make up the space pattern. To compare spatial patterns, we have to know what a pattern is, and how to tell one configuration form another. Configuration, in this instance, means something quite precise. Spatial relations exist where there is any type of link between two spaces. Configuration exists when the relations which exist between two spaces are changed according to how we relate each to a third, or indeed to any number of spaces. Configurational descriptions therefore deal with the way in which a system of spaces is related together to form a pattern, rather than with the more localized properties of any particular space.

A simple graphic illustration may serve to explain. Figure 5-1(a-1) shows a simple, rectangular

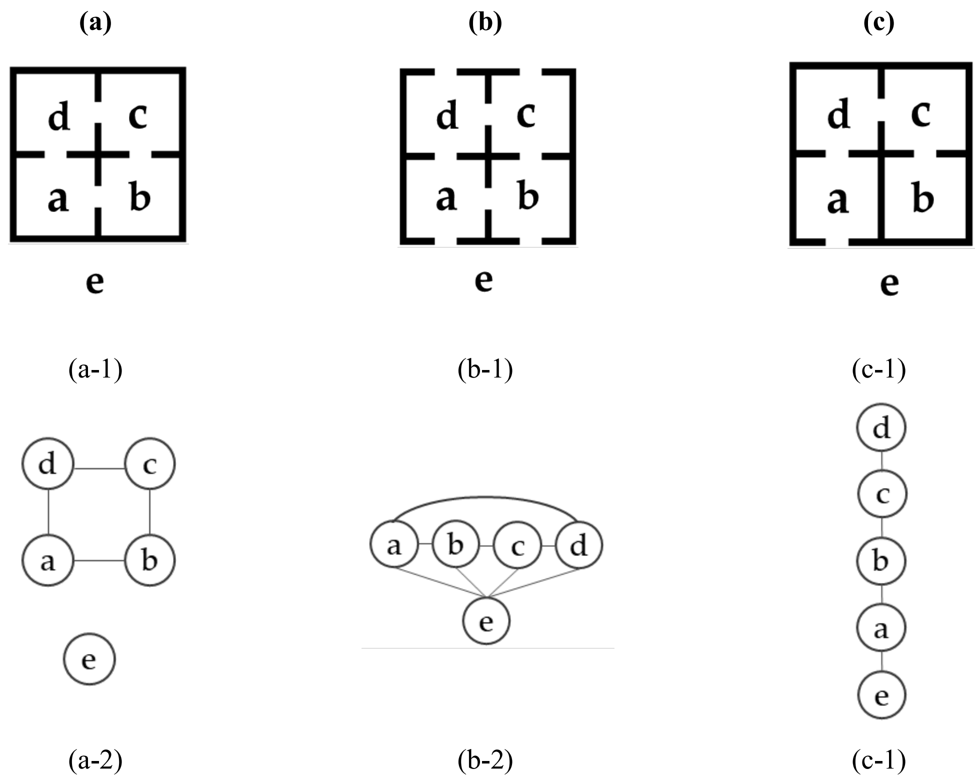


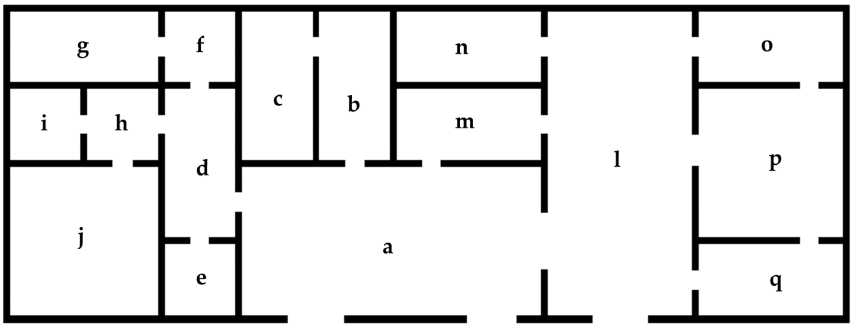
Figure 5-1 Basic configurational relationship

building divided by a partition into four, cell A, cell B, cell C and cell D, with a doorway creating a relation of permeability between them. It is clear that the relation is symmetrical in the algebraic sense, since A is to B, C, D as B is to A, C, D.

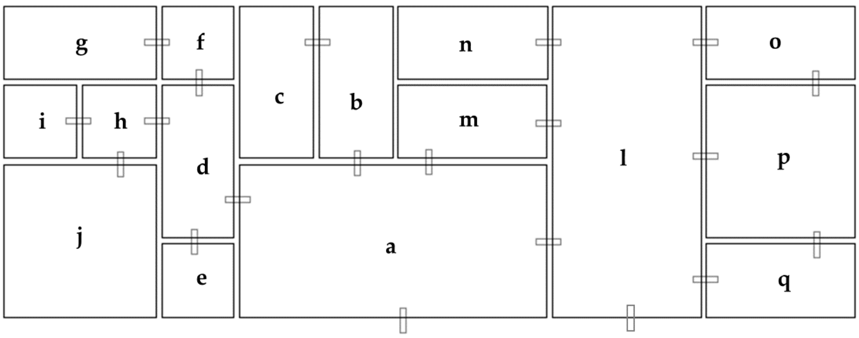
Now we add a fifth space E which is in fact the space outside of the rectangular building as shown in Figure 5-1(b-1, c-1). And space E is connected to cell A, cell B, cell C and cell D in two different ways, in b-1, cell A, cell B, cell C and cell D are directly permeable to space E, whereas, in c-1, only cell A is directly liked to space E. This means that in the latter case we must pass through cell A to get from cell B, C and D to space E, while in the former we can go either way. In c-1, cell A, cell B, cell C and cell D are different with respect to space E. The relation has become asymmetrical. Hence, there is a configurational difference between the two cases, and between the cells which make up the illustration in Figure 5-1.

A simple graphic way, which is called a 'justified' access graph (see Figure5-1a-2, b-2, c-2), is useful to indicate configurational differences. In the graph, we imagine ourselves staying in one space (such as space E), and align a graph of all the other spaces in configuration up the page, according to how 'deep' or how far away each space is from where we are. The justified graphs show configurational differences between two cases in Figure 5-1 rather clearly. They capture significant properties of spatial configurations in an immediate, visual way.

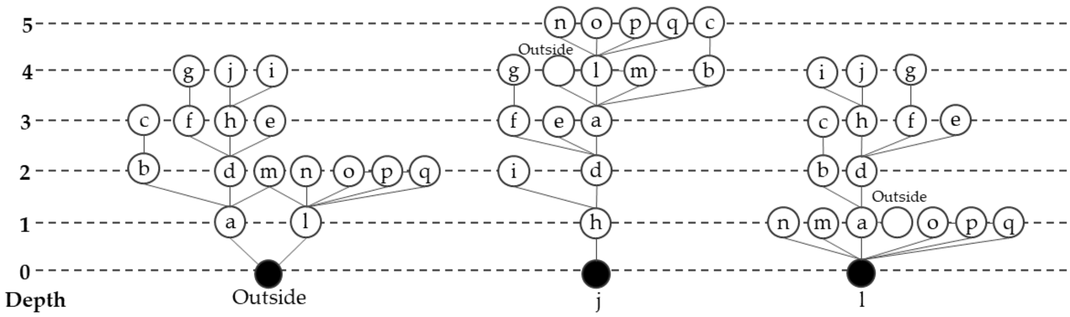
Now we utilize the justified graph to represent spatial configuration in a floor plan with more complex spatial elements. The process begins with drawing up a floor plan (Figure 5-2a). Then, space is divided into a number of convex spaces in which all points can completely see each other (Figure 5-2b). Finally, the connections of these convex spaces are transformed into a justified graph consisting of points and lines, where the points represent the convex spaces and the lines represent their connections, and Figure 5-2c-1 shows the



(a)



(b)



(c-1) (c-2) (c-3)

(c)

Total depth = 1*2+2*7+3*4+4*3=40
(outside)

Total depth = 1*1+2*2+3*3+4*5+5*5=59
(j)

Total depth = 1*6+2*3+3*4+4*3=36
(l)

Figure 5-2 a) Floor plan; (b) The space is divided into several convex spaces; (c) The justified graphs of three primary space (outside, 'j', and 'l').

justified graph of the case from the space outside.

However, the invention of the justified graph is more than a simple illustrative tool to clarify space configuration in buildings and settlements. So far as 'space syntax theory' is concerned, the variables 'depth' and 'rings' turn out to be fundamental properties of architectural space configurations. There can be no more depth from a point in a configuration than a sequence, nor less than a bush. A tree has the minimum number of connections to join the configuration up into a continuous space pattern. Rings add extra permeability, up to a theoretical maximum where every space is connected to every other. This enables us to measure the degree of depth and relative ringiness of a building, to capture in numbers the kinds of difference we find in building objects.

Justified graphs provide us with a quantitative analysis to understand the spatial configuration of a building. The justified graph which is drawn from different rooms in same case is different, in which the pattern of depth also changes as shown in Figure 5-2c. The depth or shallowness of the whole layout varied, often quite dramatically, depending on where you are positioned with it. 'a' space seems to draw the entire configuration towards the root, the furthest room from it being only 3 depth (see Figure 5-2 c-3). Whereas 'i' space and 'j' space seem to push most of the rest of rooms in the building deep, the deepest room being five depth away from it (see Figure 5-2 c-2).

We can express this variability mathematically, as the depth from each point compared with other in the same building, in a measure we call 'Total Depth' or 'Mean Depth'. Total Depth value (TD) or Mean Depth value (Md) is usually used to represent the sum or average of the minimum number of connection steps from a space to all other spaces, respectively. The smaller the total depth or mean depth value of a space, the shallower or more convenient (accessible) it is in that that building. The mathematics of the measure is:

$$MD_i = \frac{TD_i}{n-1} \qquad TD_i = \sum_{j=1}^{n} d_{ij} \tag{1}$$

where the numerator represents the Total Depth value of unit space i, dij represents the Depth of i to j (j , i), namely the minimum number of connection steps from i to j. The sum of the minimum number of connection steps from i to all other nodes is the Total Depth of i. n is the total number of nodes in the urban space, and (n − 1) indicates that at most (n − 1) nodes relate to i.

Table 5-1 shows the total depth value of each space in floor plan. The space of '*l*' is positioned by the main entrance (a) with direct accessibility from outside. In term of the depth conception, the space of '*j*' has the highest total depth than any other spaces, and can be considered to be in the most remote part of the plan. Therefore, the space of '*j*' is hard to reach by members of family, is away from most spaces in the floor plan. So the space can be served to receive people from outside, so that can effectively protect the privacy of the family members. In contrast, the space of '*a*' and '*l*' has the lower total depth, which indicates that the spaces are in the shallowest and most accessible position in the plan, and can be recognized as a central place, which is used most frequently by the family. Therefore, it indicates that the total depth can illustrate in a numeric way that where the spaces are located according to their functional properties, thus giving us a powerful way to understand the configurational properties of spaces and organize these spaces.

In addition to Total Depth and Mean Depth, integration is another important variable, which seems to capture the extent to which each spatial element contributes to drawing the whole

Table 5-1 Total depth of the space in floor plan

Name of space	a	b	c	d	e	f	g	h	i	j	l	m	n	o	p	q
Total Depth (TD)	30	43	58	33	48	46	61	44	59	59	36	40	50	49	48	49

configuration together into a more or less direct relationship. Integration degree Ii is the most commonly used and most effective syntax indicator, and it represents the degree of aggregation or dispersion between a unit space and all other spaces or parts of space within a few steps from it. The Integration degree and Mean Depth are greatly affected by the number of nodes in space. To eliminate the interference of redundant nodes, Space Syntax standardizes Mean Depth with relative asymmetric value (RAi) real relative asymmetric value (RRAi). The calculation formulas are:

$$RA_i = \frac{2(MD_i - 1)}{n - 2} \qquad RRA_i = \frac{RA_i}{D_n} \tag{2}$$

$$D_n = \frac{2\left\{n\left[log_2^{\left(\frac{n+2}{3}-1\right)} + 1\right]\right\}}{(n-1)(n-2)} \tag{3}$$

where MDi is the Mean Depth and n is the total number of nodes in the building spatial structure. The reciprocals RRAi are used to represent the Integration degree Ii of the unit space i, to conform to the conventional rule of "the larger the value, the greater the integration degree", namely:

$$I_i = \frac{1}{RRA_i} \tag{4}$$

The degree of Integration reflects the accessibility and convenience of the space unit and the ability to gather attractive flow and logistics, which in turn reflects the centrality of a unit space relative to the rest of the unit space. When the degree of Integration is greater than 1, and the value is larger, the accessibility and agglomeration of the space are stronger, and vice versa.

However, where the degree of difference between the integration values of any three (or more) spaces or functions is consistent for a sample of building plans, so that the most integrated space is shallow and pivotal and most segregated space is very secluded and private, we can infer that this has not occurred by accident. To measure this, we have developed an entropy-based measure called the 'difference factor', which quantifies the spread or degree of difference in configuration among integration values. The mathematics of the measure is:

$$H = -\left[\frac{a}{t} ln\left(\frac{a}{t}\right)\right] - \left[\frac{b}{t} ln\left(\frac{b}{t}\right)\right] - \left[\frac{c}{t} ln\left(\frac{c}{t}\right)\right] \quad (5)$$

$$H^* = \frac{H - ln\,2}{ln\,3 - ln\,2} \quad (6)$$

Where H^* is the difference factor of a building, and a is the minimum value of RRAi, b is the mean value of RRAi, and c is the maximum value of RRAi, finally t is the sum of the values of a,b,c. When the difference factor is closer to 0, the more differentiated and structured the buildings; Whereas it is closer to 1, the more homogenized the building. If the spaces in a building all have equal integration values and hence no configurational difference exist between them.

Eventually, justified graphs serve to better understand the different characteristics of the individual spaces that the layout of each building consists of. Overall, the configurations of a building can be made up of four broad topological space-types. The first type is called terminal space, which is end point in the justified graph and is connected to other spaces by only one entrance, such as the space of 'gs' in Figure 3-2. Such space can only accommodate movement to and from itself, and so in terms of its nature, it is intended mainly for static occupation, either by people or things. The second type of space is part of a larger tree-like justified graph. Such space, regarded as a thoroughfare like the space of 's', cannot be as dead end, but it is on the way to or from terminal spaces, hence by the nature, any movement through the space is highly directed. Third, the space like 'co' has more than one link and so can be traversed. In the justified graph, such space lies in as single ring so that it is possible to enter at one entrance on the ring and leave at another. Finally, such space in the justified graph has more than two links to other spaces and is an intersection of more than one ring, such as the space of 'sc' or 'outside' in Figure 3-2. Movement through these spaces generates choice as to where to go in the building. And these four space types are labelled as a, b, c and d spaces.

5.2. Cases study

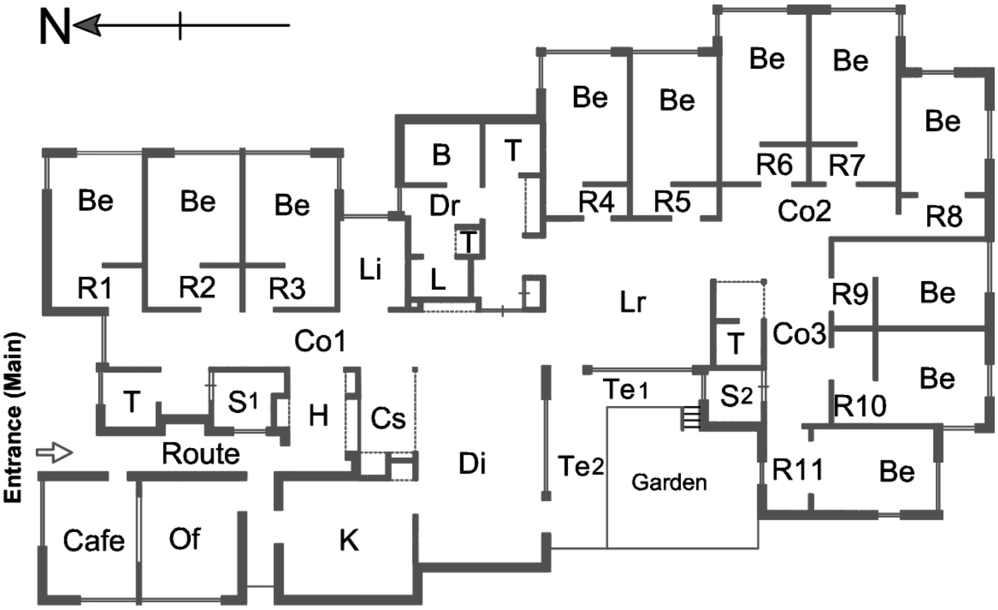
Six private nursing homes are selected from across Japan as case studies. The basic data relating to these six nursing homes is shown in Table 5-2, and the plans where the main spaces are labeled. These six homes come from six regions of Japan and were opened around 2010, varying in scale, height, and layout of spaces.

Table 5-2 The basic data of six nursing homes

Case	Location	Year	Scale (Area/Floor)	Main function spaces
A	Aichi	2009	382.99 m² 1F`	Rooms (11), Dining room, Living room, Communication area, Library, Common bathroom, Common toilet, Laundry, Hall, Kitchen, Office & nursing room, Café room
B	Tottori	2015	952.3 m² 2F	Rooms (27), Dining room & Communication area, Common bathroom, Common toilet, Laundry, Consultation room, Nursing room, Hall, Kitchen, Office, Staff room
C	Tokyo	2011	1625.95 m² 3F	Rooms (42), Dining room & rehabilitation area, Communication area, Common bathroom, Common toilet, Laundry, Consultation room, Nursing room, Reception room, Hall, Kitchen, Office, Staff room, Staff station
D	Osaka	2011	758.1m² 8F	Rooms (29), Multi-space, Common bathroom, Common toilet, Hall, Kitchen, Office & nursing room, Staff room
E	Hyogo	2012	1435.22m² 3F	Rooms (34), Dining room & rehabilitation area, Lobby, Communication area, Common bathroom, Common toilet, Laundry, Hall, Kitchen, Office & nursing room
F	Fukushima	2011	2248.27m² 2F	Rooms (58), Dining room, Rehabilitation area, Living room, Communication area, Common bathroom, common toilet, Laundry, Hall, Reception room, Kitchen, Office, Staff room, Staff station

5.2.1. The layout analysis of Case A ‘Hibiki’

Case A is a small, single-storey wooden nursing home called Hibiki, located in the suburb of Aichi, Japan, which was opened in 2009. The nursing home can accommodate 11 residents at a time and is mainly equipped with the dining room, the living room, the communication area, the common bathroom, the common toilet, the kitchen, the office, and a small library (See Figure 1).



Abbreviations of space labels are as follows:

B: Common bathroom	Ba: Balcony	Be: Bedroom	Co: Corridor
Cs: Communication space	Di: Dining room	Dr: Dressing room	H: Hall
K: Kitchen	L: Laundry	Li: Library	Lr: Living room
Of: Office	R: Room	S: Store	T: Common Toilet

Figure 5-3 The plan of the nursing home Case A

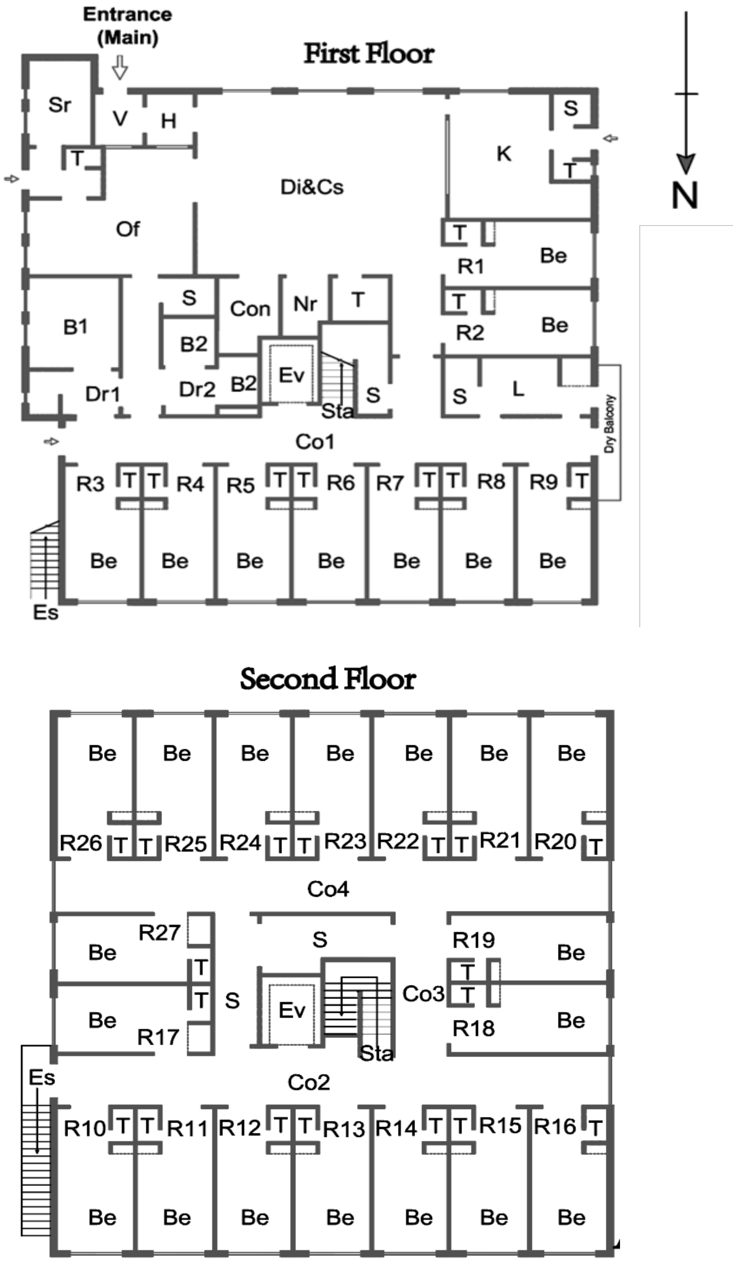
The nursing home is presented as a relative rectangle. The entrance is located on the north side and then a long passage leads into the hall of the nursing home. A café room is located near the entrance, which is connected to the long passage, and the office, which doubles as a nursing room, is on one side of the long passage. The first main indoor corridor can be reached across the hall, which connects three rooms and a common toilet to the left, and links the main activity spaces to the right. Adjacent to the hall is a small library for the residents to read in and a tatami-style communication area. The living room and the dining room are the most spacious spaces in the nursing home, where some specific group activities in addition to the dining take place, and outside of which there is a passable terrace and a garden. The living room and the dining room are separated from the outside by floor-to-ceiling windows, thus creating bright and spacious spaces for the residents. The living room and the dining room are important gathering spaces for the social interaction of the inhabitants and are also located in the centre of the plan. In the immediate vicinity of the living room and the dining room, the living service areas including bathrooms, toilets and washing rooms are arranged. The rest of the occupants' rooms are connected to the central activity area by two corridors. In general, the resident's rooms are distributed in three sides of the nursing home, and the common toilet is embedded into the immediate vicinity of the rooms since there are no individual toilets in the rooms. The kitchen is located on the north corner of the dining room and has a separate entrance with a connecting passage for the ingredients and staff. In the whole, the spatial distribution of the nursing home takes the form of an activity space-centred model.

In this nursing home, the living room and dining rooms which are the main indoor activity spaces are located at the centre of the plan and at the intersection of the three main corridors, serving as the most important interfaces for social interaction between the residents. It means that that the daily movement of the residents in the home revolves around these two spaces. The office is located outside the main building, but is close to the hall and is connected to the only passage between the interior and exterior of the home. So, although the office is located away from the centre, controls the circulation route to the outside and allows the movement of residents outside to be monitored. The café is a space for visitors and is a relatively public place where events take place, including the interface between residents, visitors, and staff. Hence， it can be inferred that the indoor movement routes of the occupants in this case are relativily separated from the movement routes of the staff and the outside world. Although the staff may intrude into the occupants' movement routes at certain times, the majority of the time the occupants' indoor movement routes are purely undisturbed. Therefore, it can be said that the daily interaction of the residents in this home is fundamentally a purely occupant-occupant interface centred around the common activity spaces and is less influenced by the outside world.

5.2.2. The layout analysis of Case B 'Healthcare Apartment Matsue'

Case B is a 2-storey steel nursing home called Healthcare Apartment Matsue in Tottori, Japan, which opened in 2015. The nursing home has a square shape and comprises 27 resident's rooms with toilets and is also equipped with some main functional spaces such as the dining room & rehabilitation area, the office, the common bathroom and the kitchen. (See Figure5-4).

The main entrance is located in the south-east corner of the nursing home, connects outwards to a large parking area and leads inwards to the vestibule and the hall. Through the vestibule and the hall, the dining room, which is the most spacious space of the nursing home, can be reached. The dining room is the only large activity space with a large glass façade on its south side in this home, which can be offered better light. Normally, the dining room in this room is not only used for meals, but also doubles as a place for rehabilitation, for communication and for festivals. Therefore, in the daily life, the residents can gather in the dining room and enjoy kinds of the activities, share a good sunshine indoor. A series of the function spaces are arranged surrounding the dining room, such as the kitchen with a toilet in the west, the office with a staff rest room and a toilet in the east, and the consultation room, the nursing room, and the common toilet in the north. While the office and the kitchen are equipped with separate entrances to the outside. This series of spaces is arranged centrally on the south side of the ground floor in the nursing home. On the



Abbreviations of space labels are as follows:

B: Common bathroom
Ba: Balcony
Be: Bedroom
Co: Corridor
Con: Consultation room
Cs: Communication space
Di: Dining room
Dr: Dressing room
Ev: Elevator
H: Hall
K: Kitchen
L: Laundry
Nr: Nursing room
Of: Office
R: Room
Re: Rehabilitation area
S: Store
Sr: Staff room
Sta: Staircase
T: Common Toilet
V: Vestibule

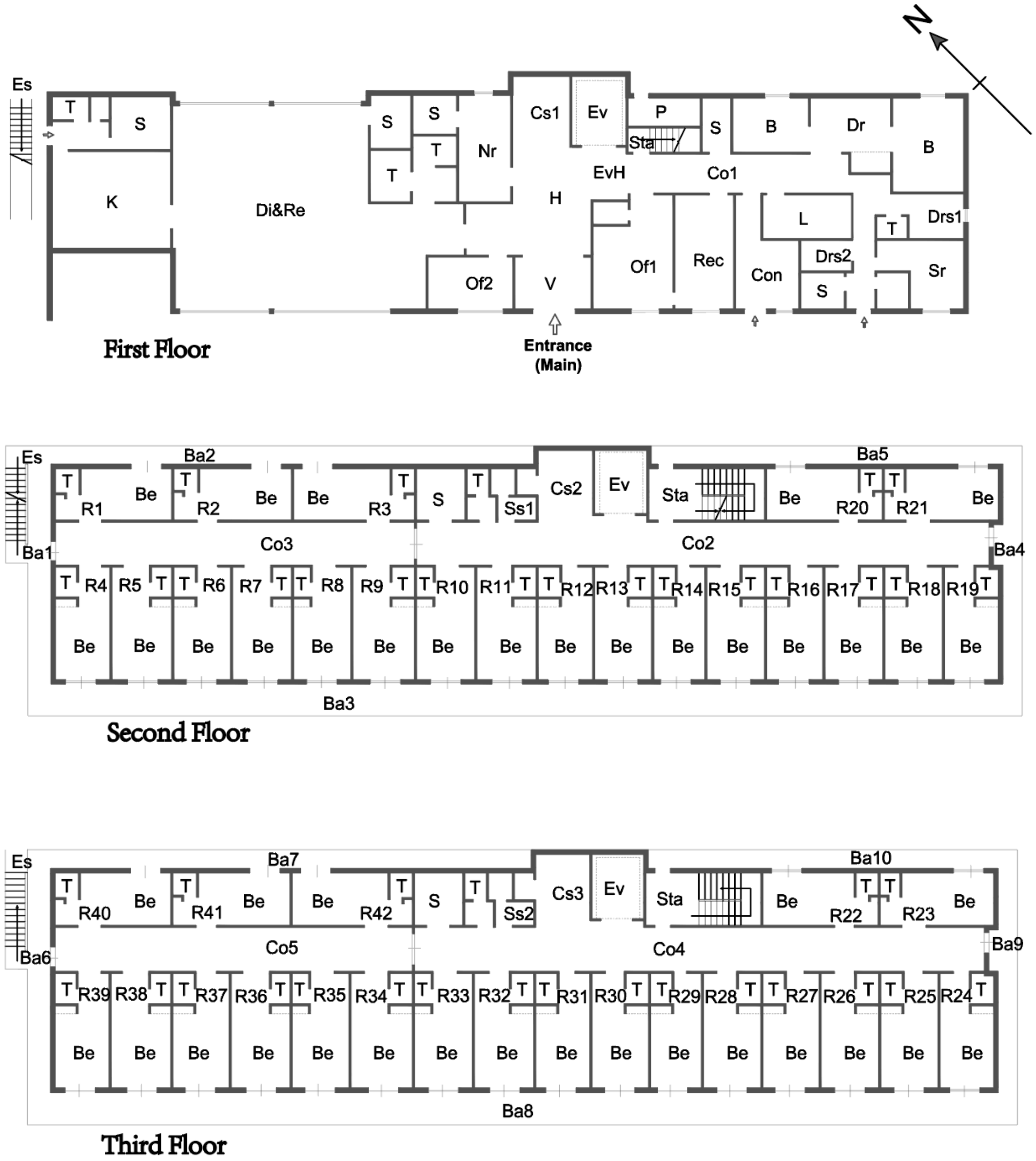
Figure 5-4 The plan of the nursing home Case B other side, the service spaces consisting of the common bathrooms, the laundry, and the rooms are distributed. Besides, there are an elevator and an interior staircase to the second floor. These spaces on the north side of the ground floor are linked by a corridor, and there is a separate entrance located at the eastern end of the corridor. Therefore, the occupants in this nursing home can leave the building without going through the hall so that they may enter and leave the home without being monitored by the office. Two passageways connect the north and south parts in the ground floor of the nursing home together. One on the east links the office to corridor, on either side of which the common bathrooms are arranged, so that residents who need assistance in the bath can be assisted by the staff in a timely manner. The other on the west connects the dining room to the corridor, on the side of which two resident's rooms are distributed. The second floor of the nursing home consists mainly of rooms, except for two stores, which are connected by three corridors and an outside staircase that connects to the outside and the ground floor.

In the spatial layout of Case B, the activity areas for the staff are controlled in the office and the kitchen. While the dining room assumes the interface between residents, staff and visitors, which is very different from the pattern of spatial layout in Case A. But the more private occupants' rooms and the closely related living spaces such as the bathroom, the laundry are concentrated on the other side and on the first floor, with a clear boundary between the staff space and the activity space, which seems to reflect the need to maintain the distancing of the interface between occupants - occupants and the staffs or visitors from outside. The distancing of the interface between the occupant and the staff and the outside world.

5.2.3. The layout analysis of Case C 'Good time nursing home Kokubunji'

Case C is a three-storey nursing home consisting of the steel structure, and which called 'Good time nursing home Kokubunji'. This nursing home was opened in 2011 in the centre of Fukuoka, Japan, and has a gross floor area of 1625.95 m². The rectangular shape of the nursing home can accommodate up to 42 residents.

The plan of the nursing home in which the key functional spaces labelled is shown in Figure 5-4, also which shows that the nursing home is made up of a very rich and comprehensive functional spaces. In this nursing home, the main activity spaces and the staff spaces are located on the ground floor, while all rooms are located on the second and third floors, completely separating the rooms from the entrance level. The pattern of spatial distribution is unlike that in the previous two cases. On the 2nd and 3rd floors, the rooms for the residents, equipped with a toilet and store, are connected by a long corridor which is cut into two parts by a door, and several other key functional spaces, including the staff station for the supervision of pedestrians, the communication area for the residents stay and communicate, the common toilet, are embedded. On the ground floor, the main functional spaces for the activity, service and staff spaces are arranged. The main entrance is located in the middle of the south-east side of the ground floor. Entering the home, the hall is the firstly reached, on the left and right side of which, a small and a large office are arranged respectively, and a nursing home, a communication area for residents to talk with visitors, and a hall of Elevator linked to the elevator which leads to level floors are distributed at the front of hall. Through from the left side of the hall, the dining room with two big glass facade, the largest and most important activity spaces of the home, which can also be used as a rehabilitation area as well as for festivals



Abbreviations of space labels are as follows:

B: Common bathroom	Ba: Balcony	Be: Bedroom	Co: Corridor
Con: Consultation room	Cs: Communication space	Di: Dingin room	Dr: Dressing room
Drs: Dressing room (staff)	Ev: Elevator	H: Hall	K: Kitchen
L: Laundry	Nr: Nursing room	Of: Office	R: Room
Re: Rehabilitation area	S: Store	Sr: Staff room	Sta: Staircase
Ss: Staff station	T: Common Toilet	V: Vestibule	

Figure 5-5 The plan of the nursing home Case C

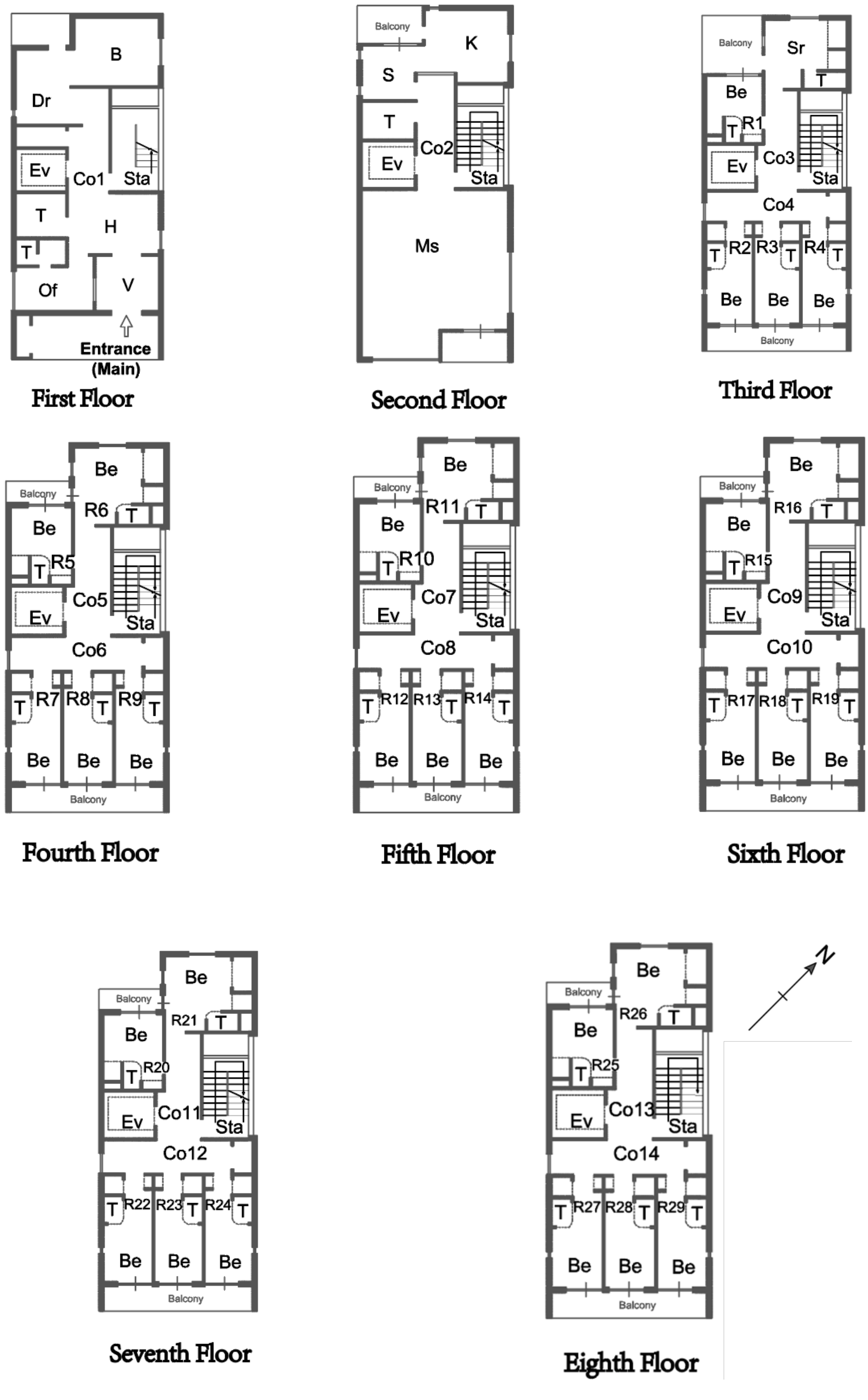
and other events, is arrived. The group of common toilets is arranged near the entrance to the dining room. The kitchen which is on the left of the dining room, is located away from the center of the floor plan and has a separate entrance and a separate toilet. To the right of the hall of elevator, a long corridor connects a series of functional spaces, such as the staircase which leads to other floors, the reception room for visitors which links to the office, the consultation room for residents to talk with the staff which has a separate entrance, the office, the common bathroom, and the laundry.
The staff rest room, the staff dressing room and the staff toilet are distributed at the right end of the corridor adjacent to the common bathroom, which are located away from the centre in an opposite position to the kitchen, and linked by a short corridor with a separate entrance. A special point to mention is that the spaces on the second and third floors are surrounded by connected balconies outside, which can be accessed by all occupants from their rooms and can be used for wandering, walking, etc. The balconies form a circular circulation path with the corridors. Finally, on the left side of the nursing home there is an outdoor staircase that circulates outside and can be reached through the corridor or the balcony.

In Case C, the resident has to pass through the hall to reach the main activity space from the living space (i.e. the resident has to go from the occupant-occupant interface to the resident-visitor-staff interface and then to the occupant-occupant interface). Such an occupant movement inevitably intersects with external movement or staff movement. However, the rooms are arranged in different floors with the activity spaces and the staff spaces. This seems to deliberately divide the intersection between the occupants and the outside world or the employee's movement, and the pattern of spatial distribution is similar to that in Case B.

5.2.4. The layout analysis of Case D 'Life Partner Isoji'

Case D is a high-rise nursing home with a smaller footprint near the Osaka Minato Ward City Hall called 'Life Partner Isoji'. The nursing home which has eight-stories and is made of reinforced concrete and steel, resembles a high-rise flat and can accommodate up to 29 residents. The resident's room which is equipped with accessible personal toilets are located from the third to the eighth floor. The nursing home has only one entrance which leads to the hall through the vestibule. The hall is located in the ground floor, which aims to receive visitors and acts as a buffer. The office with a separate toilet and with a window looking to the vestibule, and the common toilet are linked to the hall. Through the hall, there is a corridor connecting the common bathroom, and the elevator and staircase which leads to upper floors. The main activity space is located on the front side of the second floor, which hosts the nursing home's activities, entertainment, living, communication, and dining functions for the residents and is the only public space for the residents to gather for long periods of time. And a common toilet and a kitchen which are also arranged in the same floor, is linked with the vertical traffic spaces and activity spaces by a corridor. On 3rd to 8th floor, the rooms conclude the resident's rooms and a staff rest room on 3rd floor are connected by the 'T' shaped corridor with camera on each floor, and the adjacent rooms share a balcony.

Although the layered arrangement of activity and living spaces in Case D follows a similar pattern to that in Case C, the residents in this home experience a change from the private space to the occupant-occupant interface without the interference from the outside world when they arrive



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K: Kitchen	Of: Office	R: Room	S: Store
Sr: Staff room	Sta: Staircase	Ss: Staff station	T: Common Toilet
V: Vestibule			

Figure 5-6 The plan of the nursing home Case D

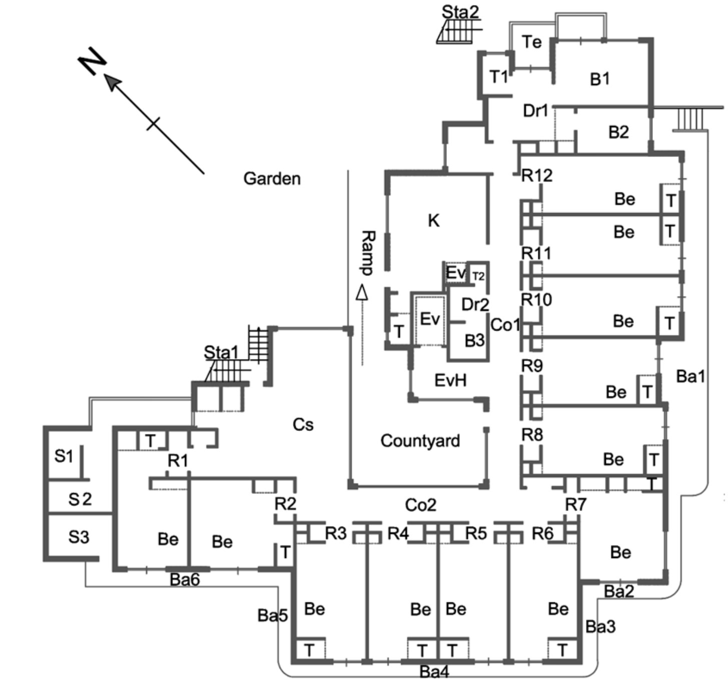
at the activity space from the room. The change is similar to that in Case A. The main interface between residents and staff or visitors in the home, is controlled on the ground floor in the hall. The staff can observe the movement of the residents mainly through the surveillance cameras in the corridors, thus effectively keeping the outside world out of the residents' way, even if the residents need to go to the ground floor for a bath, they can reach it without going through the hall.

5.2.5. The layout analysis of Case E 'Long Life Korakuen Ashiya Bettei'

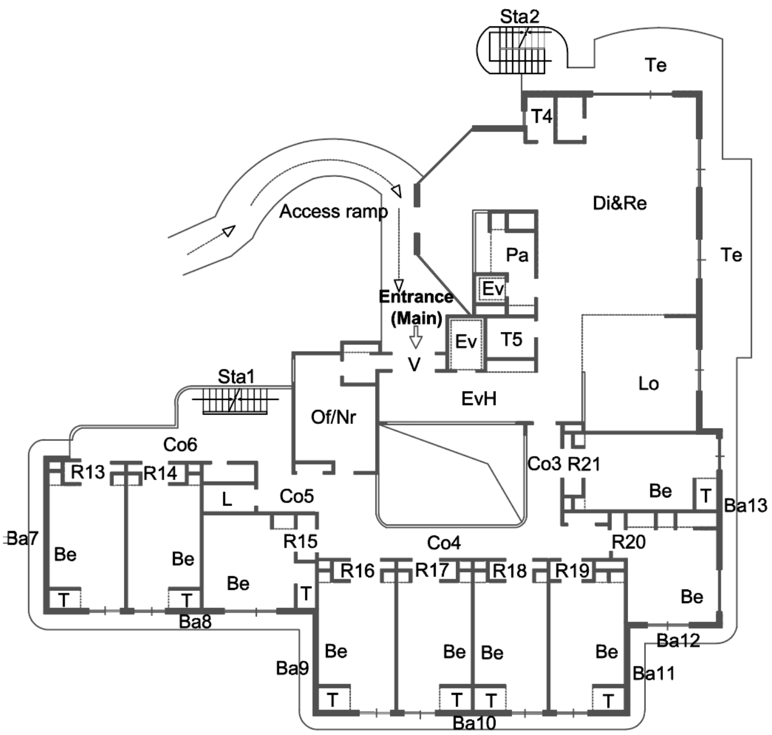
Long Life Korakuen Ashiya Bettei, the fifth case, is a three-storey high-class nursing home located on a hill near the port of Kobe in Hyogo. Total 35 rooms are accommodated in this home, each room is equipped with a personal toilet, in addition, each room on the third floor is also equipped with a personal bathroom, of which is even equipped with a kitchen.

The nursing home is set in a small garden and is shaped in a general L-shaped structure with a central courtyard that can be accessed from the ground floor. The home can be accessed from the garden by a total of seven entrances, allowing the residents maximum access to the garden. The main entrance of the home is located on the second floor and is connected to the interior, the garden by a curved ramp from the outside world. Two entrances which lead to the exterior staircases are respectively on the left side and uppermost side of the nursing home. The left one can lead to the communication space on the ground floor by a short stair and climb to the second floor. The upper one can give access to the terrace outside the dining room on the second floor by the staircase. Three entrances respectively lead to the courtyard by a ramp, the dining room, and the kitchen. The last one is on the upper right-hand corner of the ground floor plan, and can give access to the long balcony on the ground floor.

The office which doubles the nursing home is located to the left of the vestibule on the second floor. Through the vestibule, there is the hall of elevator connecting the elevator which lead to the first floor or the third floor. The lobby is located at the end of the elevator hall and is used mainly as an interface for residents to communicate with each other or visitors, on the opposite of which, a common toilet is located. The dining room, which is the biggest activity space with wide glass façade in this nursing home, is close to the lobby and is equipped with a separate common toilet. The dining room is primarily used to provide a good environment for meals, in other times, it also can offer a place for other activities such as rehabilitation. In addition, the dining room is equipped with a food pantry which links to the kitchen on the first floor by an elevator in its center. Two large terraces are configurated on the outside of the dining room and lobby and connected to a continuous balcony and an outdoor staircase, where the residents can enjoy the view outside and sunshine. The resident's room is distributed on the south-east side of the second-floor plan, connected by four corridors. These rooms appear to form a relatively independent group, which can be reached only by an entrance at the intersection of Corridor 1 and the elevator hall from the public areas.

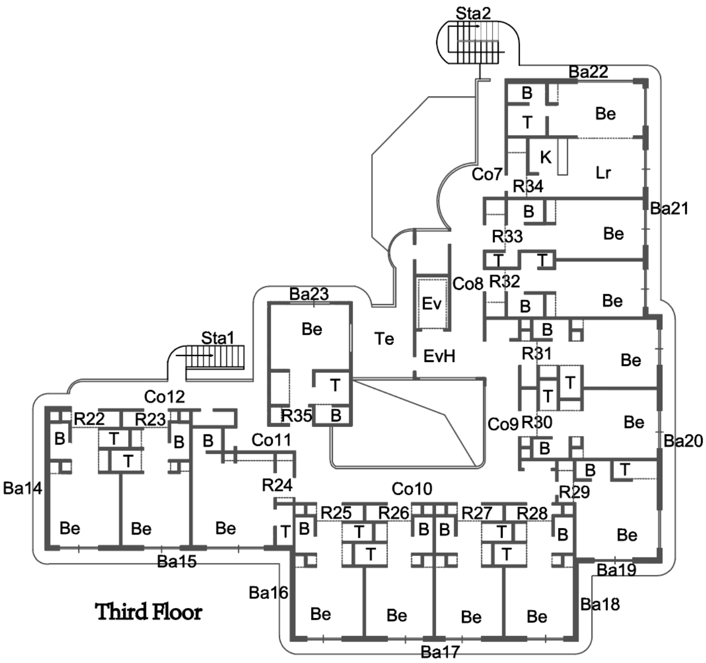


First Floor



Second Floor

Connect to third floor in page 118



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L: Laundry	Nr: Nursing room	Of: Office	R: Room
Re: Rehabilitation area	S: Store	Sr: Staff room	Sta: Staircase
Ss: Staff station	T: Common Toilet	Te: Terrace	V: Vestibule

Figure 5-7 The plan of the nursing home Case E

On the north-east side of the ground floor, the kitchen with a separate toilet is located, where the food cook and a small elevator is equipped to solver the food to the pantry on the second floor. The common bathrooms are located in two areas adjacent to the kitchen, a unit bathroom with a separate toilet is located near the elevator hall, a bath group consisting of a spring bathroom and a special bathroom is located at the end of corridor 1, on the north-west corner of the floor plan. A big communication space is embedded into the north-east corner of the ground floor plan, which is surrounded by the resident's rooms. The communication space appears to be situated in a relatively opposite direction of the activity space on the second floor, meaning that it can provide a sociable space for occupants away from the main activity space. Some stores are distributed to the far left of the ground floor, which are accessible via an outside balcony, away from the central area of the nursing home. The resident's rooms in the ground floor are connected internally mainly by two corridors and are distributed around the courtyard. The third floor of the home is mainly made up of the resident's rooms, these rooms are linked by 6 short corridors.

In addition, the spaces on each floor are connected by continuous corridors indoor and by continuous balconies outdoor. Especially on the second floor and the third floor, the interior continuous corridors and the exterior continuous balconies form a huge circulation path connecting all the main rooms, which allows the occupants can reach any spaces without backtracking from any point. This is beneficial for the residents' walks. This path is similar in the ground floor, except that the corridors and the balconies form a circulation path that requires passing through the garden.

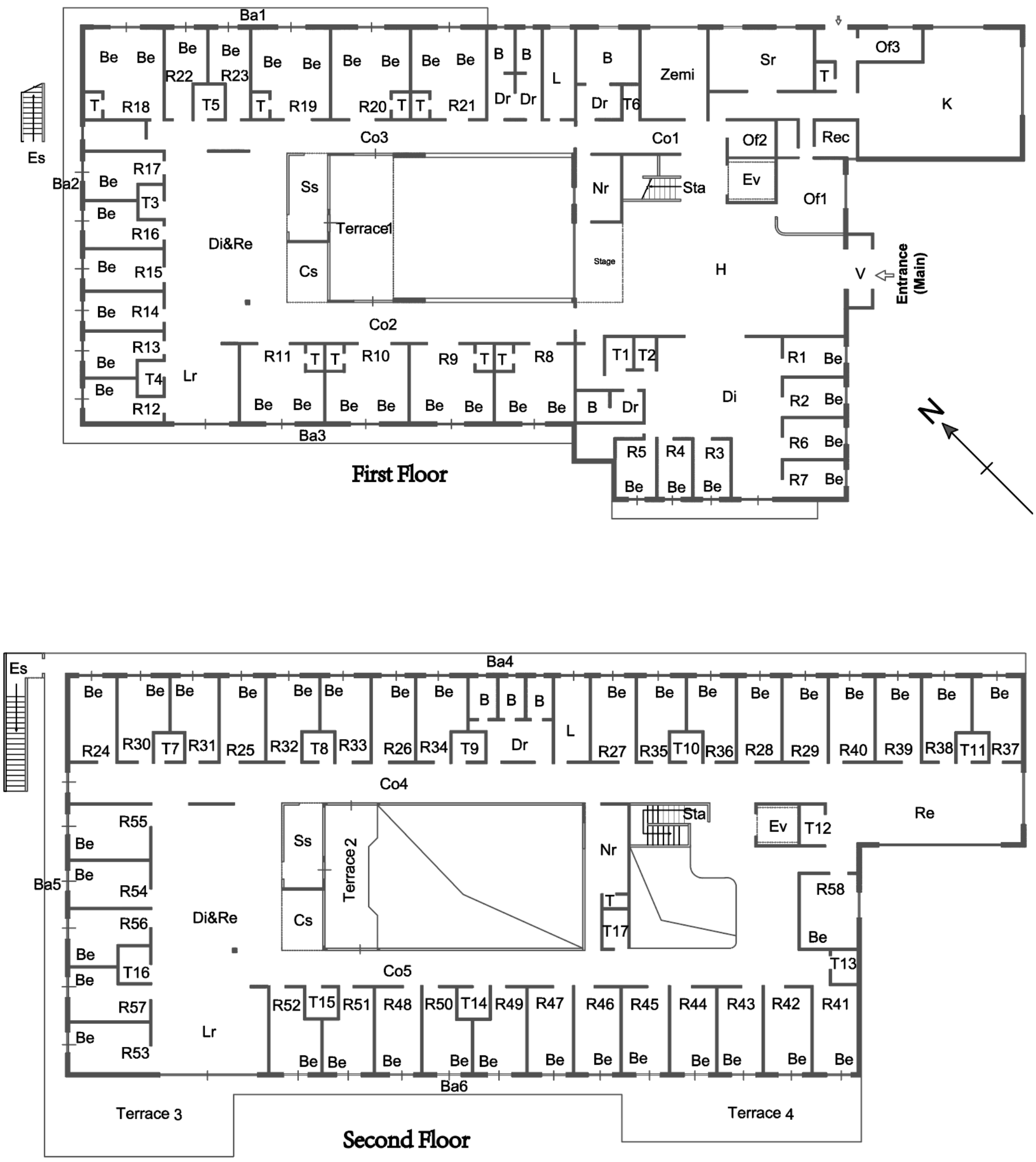
In Case E, the communication space on the ground floor, the dining room and lobby on the second floor are the two main activity areas of the home which can attract the residents to gather. Especially the dining room and lobby serves as the main interface between the residents, staff, and visitors, which are relatively public areas. In this nursing home, residents have more diverse and free movement paths. There are only two spaces for the staff in the entire home, one is the office fixed at the main entrance and the other is the kitchen. The kitchen staff flow has a separate elevator, which avoids the need to share the elevator with the residents and prevents the staff of kitchen from socializing with the residents. Visitors also stay mainly in the lobby on the second floor, which is strictly monitored by the office. The layout of the resident's rooms is also as distant as possible from the public areas. All the above would seem to indicate the spatial distribution in this home attempts to distance the private space from the public activity space, minimizing the intersection of the occupant flow with the staff flow or the visitor flow.

5.2.6. The layout analysis of Case E 'Esprit'

Case F is a large 2-storey home of 2,200 square metres in the suburbs of Aizu-Wakamatsu, Fukushima Prefecture, called Comprehensive Welfare Spiritual Village Residential Paid Home for the Elderly – 'Esprit'. The nursing home has 58 rooms for the elderly, 7 of which are short-term rent rooms, 8 of which are double rooms with separate toilets and the rest of which are single rooms.

The home is shaped as a rectangular, where the spaces are arranged around a courtyard in the center. There are three entrances, one of which is the main entrance on the right side of the ground floor plan, a staff entrance on the north-east corner of the plan and finally an entrance to the outdoor staircase on the left side of the plan leading to the balcony on the second floor.

The spaces on the ground floor are divided into left and right parts connected by two corridors on the upper and lower direction. In the centre of the right part, the huge hall with a stage for shows on the left, which is directly connected to the main entrance, is located. To the south -west of the hall, the short-term living group is located, where a dining room serves as the activity space and is surrounded by the resident's rooms, the common bathroom, and the common toilet. The main staff space and the indoor vertical traffic can be accessed from the north-eastern side of the hall. The hall of elevator is located on the upper side of the hall and provides access to the elevator and staircase to the second floor. The hall of elevator leads to a corridor to the left connecting the special bathroom, the meeting room, and the nursing room, to the right leading to the staff area. There are three offices, one of which is the main office, located near the main entrance, one of which is located at the staff entrance near the kitchen, the last one is located at the end of corridor 1 near the elevator, monitoring the flow of people. Three offices control access to the staff area, with office 1 and 2 controlling



Abbreviations of space labels are as follows:

B: Common bathroom	Ba: Balcony	Be: Bedroom	Co: Corridor
Con: Consultation room	Cs: Communication space	Di: Dingin room	Dr: Dressing room
Drs: Dressing room (staff)	Ev: Elevator	H: Hall	K: Kitchen
L: Laundry	Nr: Nursing room	Of: Office	R: Room
Re: Rehabilitation area	S: Store	Sr: Staff room	Sta: Staircase
Ss: Staff station	T: Common Toilet	Te: Terrace	V: Vestibule

Figure 5-8 The plan of the nursing home Case F

access to the staff area from inside and office 3 controlling access to the staff area from outside. In addition to the office, the staff area consists of a meeting room and a staff rest room near the office 2, a reception room at the back of office 1, a staff toilet on the road to staff entrance and a kitchen near office 3. In particular, the kitchen in this home is located away from the dining room, which is unique from the other five cases.

There are two long-term living groups in this nursing home. The one is located on the left part of the ground floor which can be reached through the two corridors on the upper and lower direction from the hall, where double rooms and single rooms are equipped. Another one is located on the second floor can be reached by the vertical traffics from the hall on the ground floor, where only single rooms are equipped. The spaces in the long-term living groups are arranged around the activity space and the courtyard with terraces. The activity space consists of the dining room used for meals or for rehabilitation sometimes connecting to two corridors, the living room below the dining room connecting to a corridor and terrace outside, and a communication space to the right connecting directly to the dining room and a corridor. Besides, a staff station is embedded into the activity space, which can assist the residents in time and surveillance the resident′s movement. On the second floor, a rehabilitation area with a big glass facade is set on the upper right-hand corner of the plan, away from the main activity space. This appears to provide additional activity space for residents who live away from the main activity space. In addition, since the single rooms aren′t equipped with toilets, a lot of the common toilets are embedded into the long-term living groups. And other living support spaces such as the common bathroom, the laundry and the nursing room are also offered to the living groups.

The spaces in each long-term living group are linked by two corridors inside, and are linked by continuous balconies outside. Especially, the indoor corridors and the outdoor balconies with two terraces embedded from a relativity circulation path through the living room, which can be possible to provide residents with more freedom and choice of wayfinding. This organization of the space has similarities to that in Case E.

In Case F, the hall, which is biggest activity space, is the intersection of different people′s flows in the home, and acts as the interface between the resident, the staff, and the visitor from outside. So, it can be said that the hall is most public area in the home. The three main activity spaces centred on the dining room assume the intersection of the pedestrian flow lines within their respective groups and are primarily the interface between the occupants. The staff's movement lines are mainly controlled in the north-east corner area of the ground floor plan. In the case, it also seems to be possible to keep the intersection of the occupants from being disturbed by the staff flow as well as by the visitors' flow. However, the major difference with the other cases is that in this case the kitchen is not located near the dining room, which would result in the staff's delivery routes intruding into the occupants' movement during meal times. Therefore, the occupants' flow would be disturbed by the staff during meal times. And there are staff station in both activity spaces, which, although providing supervision and timely care for the occupants, making the residents' flow to be disrupted to a certain extent. Overall, the paths in the plan belongs to the circular structure, thus reducing the number of dead ends and allowing residents to return to their starting point from one area without having to backtrack, which is friendly for the elderly with dementia. In addition, the continuous balconies outdoor provides an alternative circulation path for residents to take a walk while enjoying the view outside.

5.2.7. Summary of layout analysis

The six nursing homes with different size and level are near-modern homes from different cities in Japan. Overall, these nursing homes are equipped with a certain similar type of functional spaces. For instance, in addition to the necessary resident's rooms, generally, the nursing home is equipped with at least one main activity space with the main function being the dining room, besides, some function spaces such as the office, the common bathroom and the common toilet also are indispensable. In term of the organization of spaces, these nursing homes attempt to bring residents together in the main activity space for intensive care when some group activities are held. However, there is a desire to keep the private space of the residents at a distance from the public space. There are free and rigid circulation routes in these nursing homes, and there seem to be some differences in the organisation of the flow. These differences and similarities seem to reflect the main architectural differences and similarities such as paths, destinations, trajectories and locations, mobility and stationary or expected and arrived. These ideas can be compared in more detail by layouts

5.3. The configuration analysis of the plans

If we look at the six nursing homes as pure space configuration, then a comparison of the justified permeability graphs of the spatial layouts is already instructive. (see Figure 5-9). Then the graphs are drawn from the space of outside. The main spaces are keyed into the graphs, which also differentiate the transitions that are shown in black from the function spaces which are indicated by a circle. In the graph the rooms have been suitably simplified using replica models to be more clearly observed, depending on the large number of rooms and their similar spatial configuration. In addition, the elevator in the justified graph is regarded as a convex space. The relevant numerical data for each nursing home are shown in Figure (5-9). The graph representation and the numerical data show that Case A, Case B, and Case D can be considered as relatively small nursing homes from the point of view of the number of spaces in the plan, whilst the other three cases are considerably larger. The number of function spaces in each case suggests that Case A, Case B, Case C, and Case F are simply less elaborate than Case D and Case E, which has three to four times higher than the amount of accommodation. It seems to imply that the spatial layout with less transitions is more superior when the nursing homes were designed. However, despite the size and internal complexity of Case D, Case D is still a relatively shallow nursing home with 8 depths, similar to several other cases. The other four cases have similar, relatively few transitional spaces, possessing a lower ratio of functional to transitional spaces, having a depth of between six and eight. These suggest that the nursing home spaces have a high degree of permeability to the outside.

Case A, Case B, Case C and Case F have a relatively small number of transitions, that is corridors, passageways, and stairs, presenting a low transition: functions ratio in each case. Case E has a high number of transitions, suggesting that the that the organization of the home's space is relatively complex and the residents' daily routing is likely to be more difficult. Although the number of transitions in Case D is relatively less, the it has a high transition: functions ratio, which is just less than the Case E has. In addition, the importance of corridor circulation system in Case E and Case F is demonstrated by their high number of transitions, and suggesting that the plan in Case E and Case F is more fragmented.

The number of entrances indicates to a certain extent the closeness of the interior and exterior. Both Case A and Case D have only one main entrance, where the occupant, the staff, and the visitor enter the nursing home through the same entrance. The residents in these two homes are clearly isolated from the outside world, but a courtyard is placed in Case A to compensate for the shortage of contacting with the outside. Case F has three entrances in the ground floor, one is the main entrance for the occupant and the visitor, one is staff entrance, from which the staff and the ingredient enter, the last one is the last one is the emergency entrance, connected to the emergency staircase leading to balcony on the 2nd floor. The two nursing homes, Case B and Case C, relate to their grounds in a rather similar way, with four entrances. In addition to the main entrance, the office area and the kitchen area in both nursing homes have a separate entrance, but in Case B, the resident's living space at the back of the nursing home on the ground floor has an emergency entrance, whilst in Case C, the reception room which is linked to the office has a separate entrance. In particular, Case E has a surprisingly high number of entrances for the nursing home. Two of which including the main entrance and an entrance connecting to the dining room are distributed on the second floor, while five of which are arranged on the first floor, one leads to the kitchen, two leads to the outdoor staircases, one leads to the courtyard, and the last one leads to the balconies which links the residents' rooms. All seven entrances are connected to the outdoor garden. Therefore, one of the aims of the design of Case D perhaps is to encourage the residents to take the initiative to go outside and enjoy the outdoor world. There is a large variation in the local rings of the six nursing homes. The larger the size of the nursing home that has a continuous balcony of a large number of local rings, the instant it is a small nursing home where partial rooms can share a balcony, it also gets many local rings, which seems to imply that continuous or partial shared balcony can give more alternative paths to the residents in the nursing home. And, it has to be noted, however, that many of the local rings in these nursing homes consist of room-corridor-room-balcony, and very often the room as an extremely private space is not used as a passable space, or even amounts to a terminal space. Hence the large number of local rings in these homes is an illusion. But there is no doubt that the continuous balconies do provide the residents in the homes with more alternative paths of movement. Even more striking is the difference in the number and type of purely local rings which are found in six nursing home, but these nursing homes have less global rings in the plan.

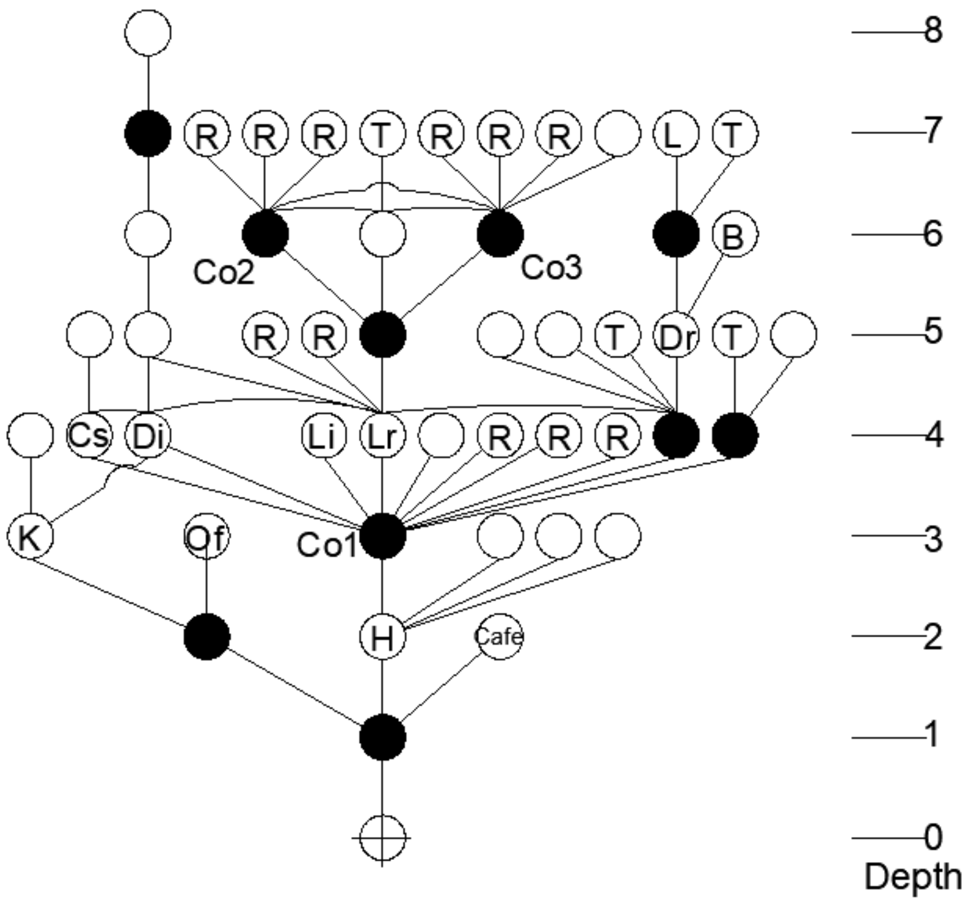


Figure 5-9 The justified permeability graphs of Case A

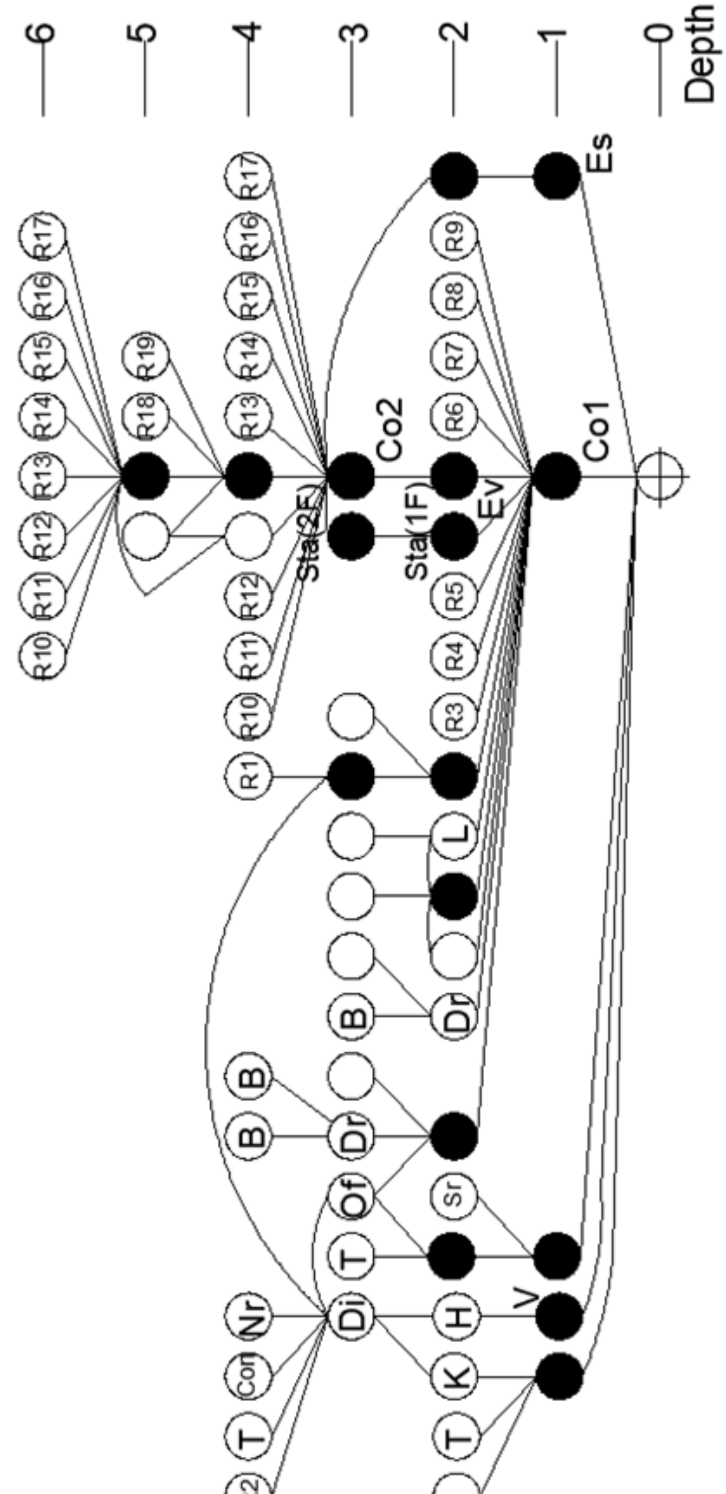


Figure 5-10 The justified permeability graphs of Case B

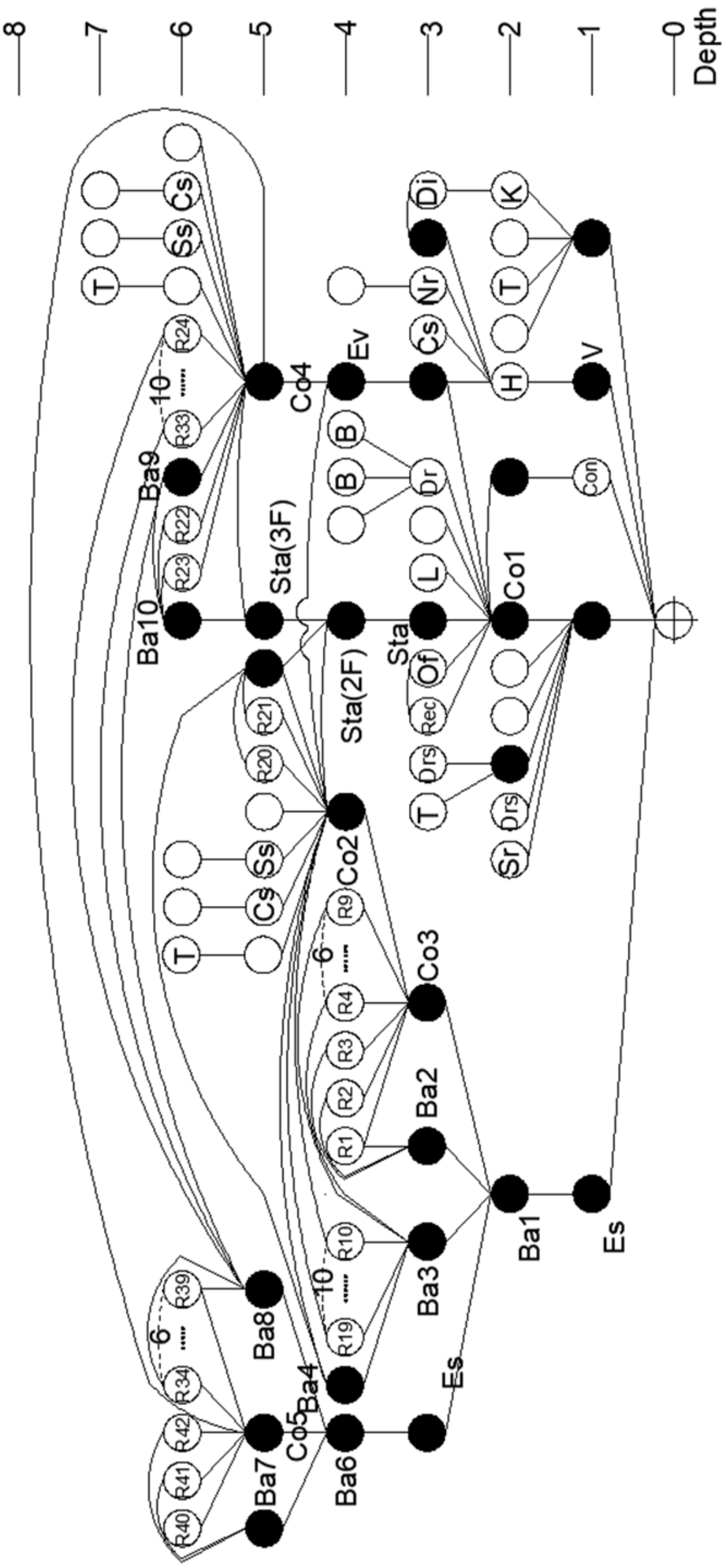


Figure 5-11The justified permeability graphs of Case C

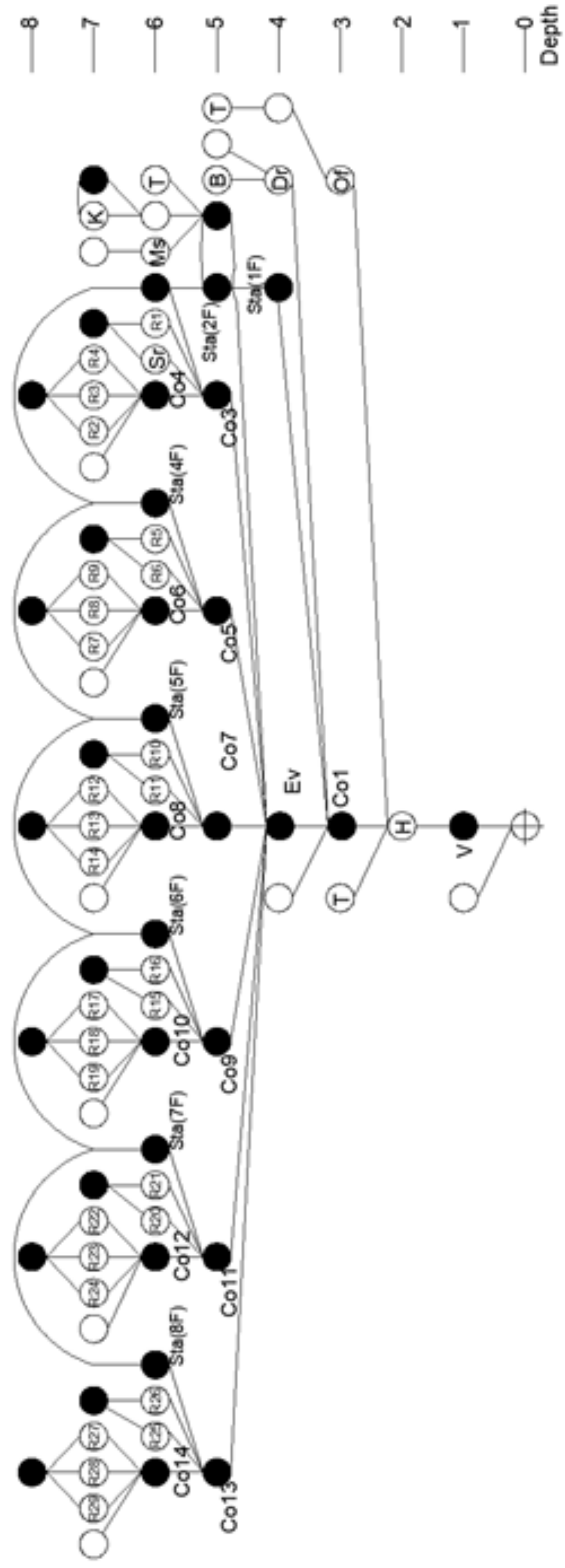


Figure 5-12 The justified permeability graphs of Case D

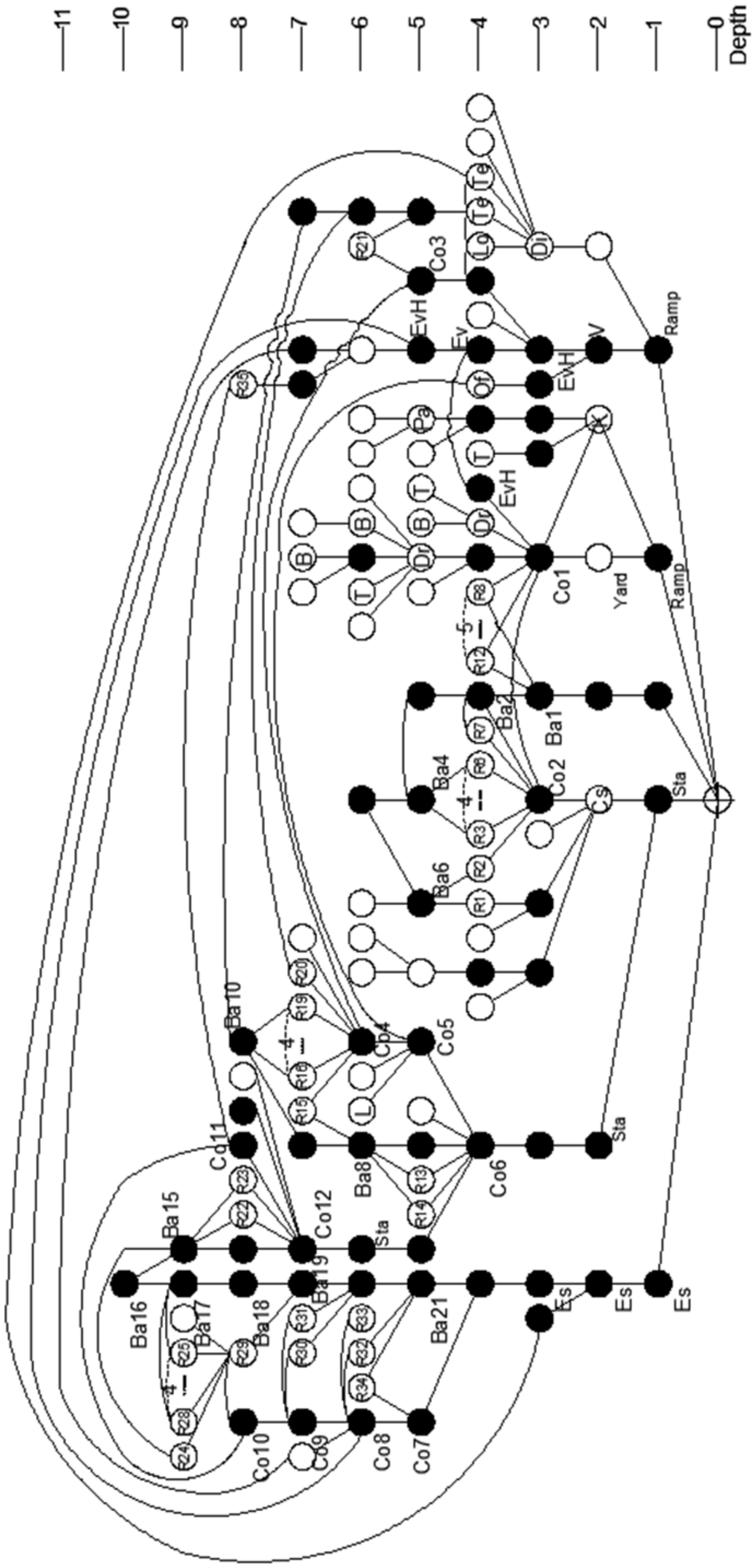


Figure 5-13 The justified permeability graphs of Case E

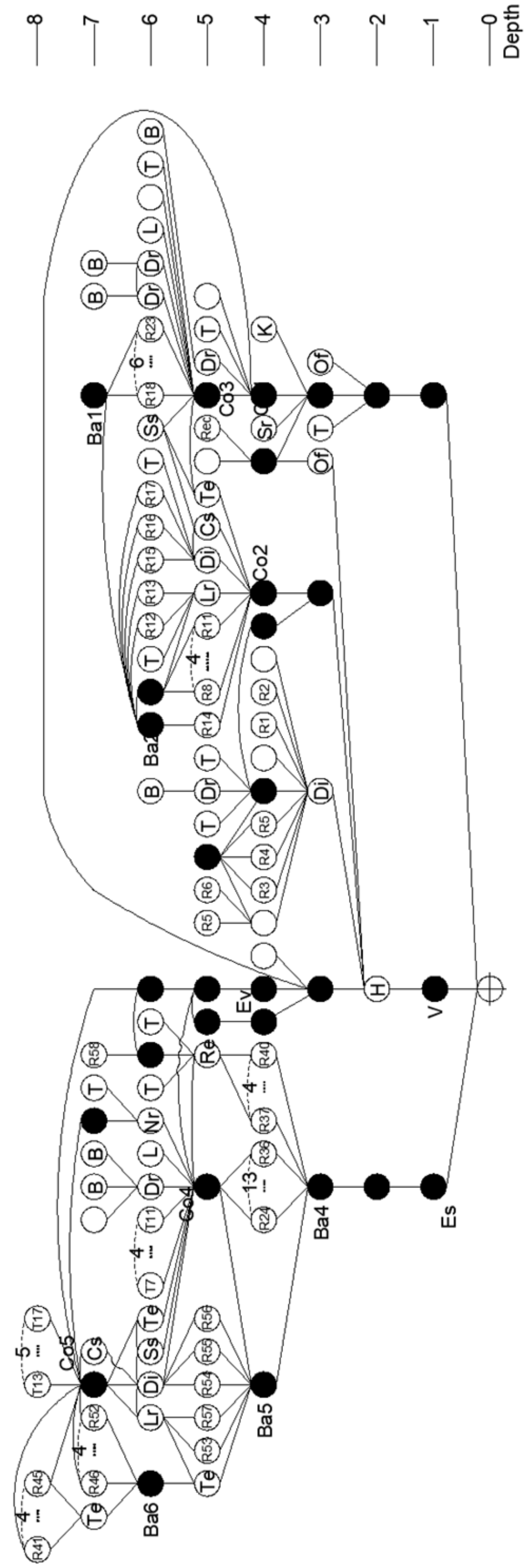


Figure 5-14 The justified permeability graphs of Case F

Table 5-3 Basic syntactic measures for the six nursing homes

Categories	Rings		Ent.	Functions	Transitions	Total	T::F
	glob.Int.	loc. R.		(F)	(T)	(F+T)	ratio
Case A	0	3	1	40	10	50	0.25
Case B	2	3	4	52	17	69	0.327
Case C	2	465	4	80	28	108	0.35
Case D	0	25	1	50	37	87	0.74
Case E	3	218	7	79	65	144	0.823
Case F	2	927	3	119	30	149	0.252

Categories	a space	b space	c space	d space	Distributedness (a+b)/(c+d)
Case A	31	5	7	7	2.57
	(62%)	(10%)	(14%)	(14%)	
Case B	42	1	17	9	1.65
	(60.87%)	(1.45%)	(24.64%)	(13.04%)	
Case C	24	9	54	21	0.44
	(22.22%)	(8.33%)	(50%)	(19.45%)	
Case D	14	6	42	25	0.298
	(16.09%)	(6.9%)	(48.28%)	(28.73%)	
Case E	28	10	62	44	0.358
	(19.44%)	(6.94%)	(43.06%)	(30.56%)	
Case F	43	3	72	31	0.446
	(28.86%)	(2.01%)	(48.32%)	(20.81%)	

It may be useful to describe the different characteristics of the individual spaces which make up the layout of each nursing home. Locally, configurations can be made up of four broad topological space-type. First, there are terminal spaces, which are end points in the justified graph and are linked to the rest of the complex by only one entrance. Such spaces can only accommodate movement to and from themselves, and so it is in their nature that they are intended mainly for static occupation, either by people or things. The influence of these spaces is local, and eliminating any one space from the complex by unlinking it would make very little difference to the rest of the layout. Second, there are spaces which are themselves thoroughfares, but which are part of a larger tree-like complex. Such spaces cannot be dead ends, but they are on the way to or from a dead end so, by implication, any movement through the space is still highly directed. Third, there are spaces which have more than one link and so can be traversed, but which also lie on a single ring so that it is possible to enter at one point on the ring and leave at another. Finally, there are spaces with more than two links and which form the intersection of more than one ring. Movement through these spaces generates choice as to where to go within whole sub-complexes of spaces within the overall configuration. Hiller has termed these four space-types, type a, b, c and d spaces.

The dominant space-type of Case A is ‘a’ space, or terminal space, of which there are thirtyone altogether scattered through the house, amounting to 62% of the total spaces. Seven, or 14%, are type ‘c’ or type ‘d’, which are linked together into a single deep ring, or which are at the intersection f the deep circulation rings. Only 5 spaces, 10%, are the ‘b’ type spaces which feature on unilinear sequences. Most ‘a’ type spaces consists of the resident’s rooms and service spaces including the common bathroom, the common toilet and laundry. Most ‘d’ type spaces contain important functions, including the passageway, the living room, the dining room, and the communication spaces. And the hall, some transitions without functions make up the ‘b’ type spaces and ‘c’ type spaces.

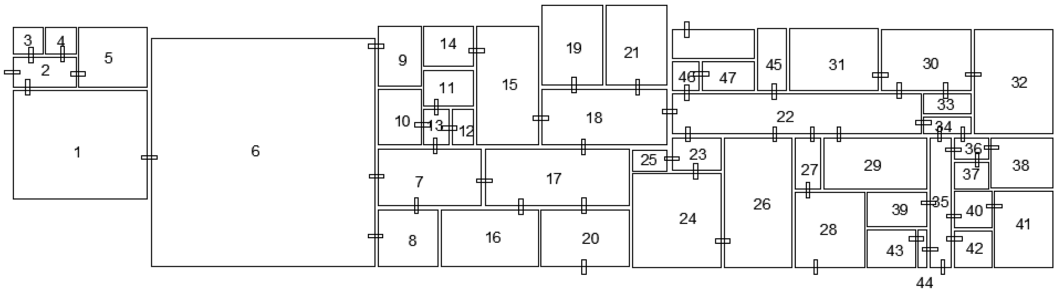
Case B also has a high proportion of terminal spaces forming 60.87% of the total. Here, ‘a’ type spaces are found everywhere, not just in the resident’s living spaces. But in Case B, 24.64% are ‘c” type is more than the ‘d’ type with 13.04%, that is, spaces which are linked together into a single deep ring are more than the spaces are brought into the intersection of the deep circulation rings. Specially, there is only one ‘b’ type spaces in Case B.

The rest cases have a similar proportion distribution of four type spaces. In Case C, Case D, Case E, and Case F, the most are ‘c’ type space, which are linked together into a single deep ring. Then the ‘d’ type spaces have a high proportion, in particular, 28.73%, and 30.56% are the ‘d’ type spaces just less than the ‘c’ type space in Case D and Case E. While just 16.09% and 19.44% are the ‘a’ type space in Case D and Case E. And the ‘a’ type space and ‘d’ type spaces occupy similar proportion with abound 20% in Case C and Case F. It should be noted that all cases have a lowest proportion of ‘b’ type spaces.

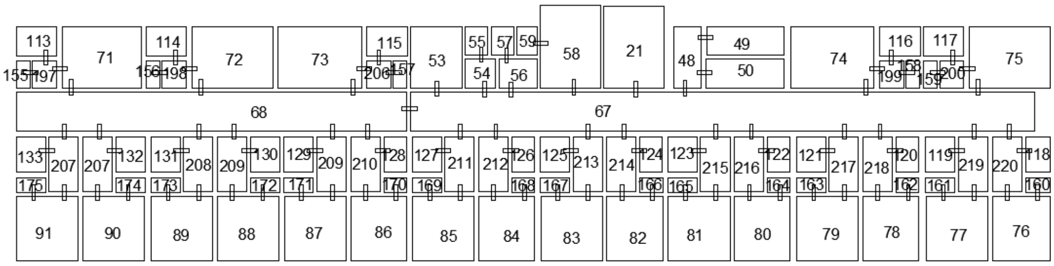
The order of the proportion of four type spaces in six cases as follow: Case A: a >c=d>b; Case B: a >c>d>b; Case C: c >a>d>b; Case D: c >d>a>b; Case E: c >d>a>b; Case F: c >a>d>b. Despite the architectural interest in ‘d’ space or intersection space with several ways through, this seems never to have played a major role in the space planning of the nursing home. In principle the private rooms in which residents live should be classified as terminal spaces, but the type of space in the six nursing homes shows that more of the residents’ rooms in the homes prefer to be designed as ‘c’ type spaces, with better permeability, although this makes for less privacy.

The spatial effects can be further explored in that ‘a’ and ‘b’ space-types emphasize tree-like configurational properties whereas ‘c’ and ‘d’ space-type are conducive to ranginess. Sociologically speaking, tree-like plans offer no route choice to their occupants whereas ringy plans can be used to give people choice in how they navigate and explore the building interior, as in the case of museums and galleries, or to differentially embed the circulation patterns of different groups of occupants such as residents, staffs, and visitors. Put another way, in a tree-like or non-distributed layout the building strongly frames the activity of its occupants whereas a distributed building is more permissive.

The distributedness or non-distributedness of the layout (spaces on rings or spaces within trees)



First Floor



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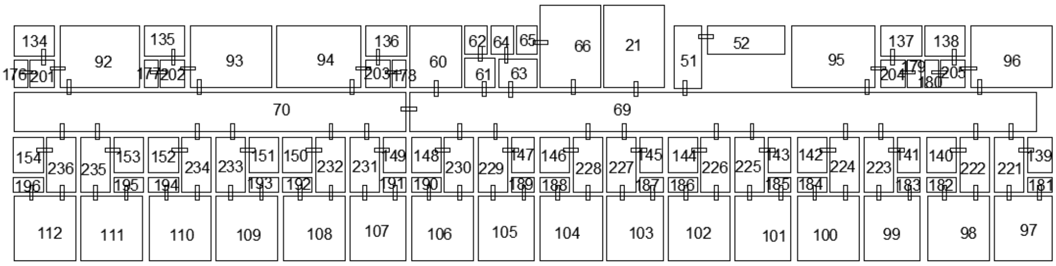


Third Floor

Main spaces of code labels are as follows:

1	Kitchen	26	Reception room
3,37	Toilet (staff)	28	Consultation
5	Food store	29	Laundry
6,7,8	Dining room or rehabilatation area	30	Dressing room (bath)
9,14,45,59.65	Store	31,32	Common bathroom
10,11, 55,62	Common toilet	38,39	Dressing room (staff)
15	Nursing room	41	Rest room (staff)
16,24	Office	43,53,60	Linen room
17	Entrance hall	46~52	Stairs
18	Elavator hall	56,63	Staff station
19,58,66	Communication space	57,64	Sewerage room
20	Vestibule	71~112	Bedroom (resident)
21	Elevator	113~154	Toilet (resident)
22,35,67~70	Main corridor	155~196	Store (resident)
25	Office acceptance		

Figure 5-15 Covex map of Case C

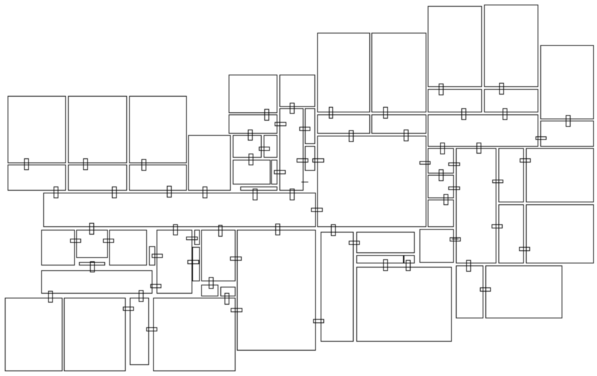
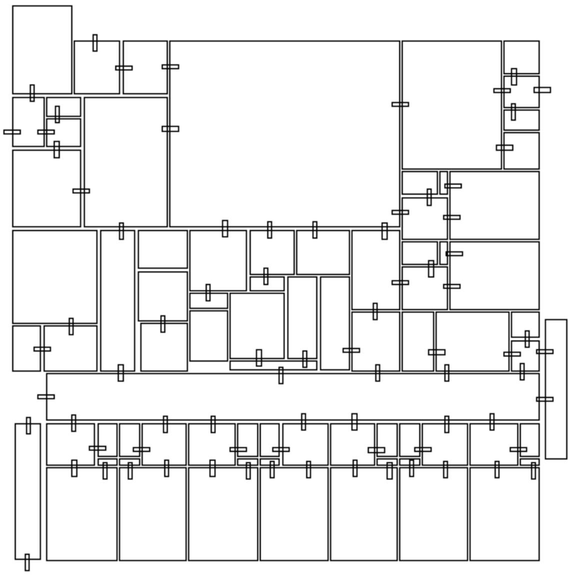


Figure 5-16 Covex map of Case A



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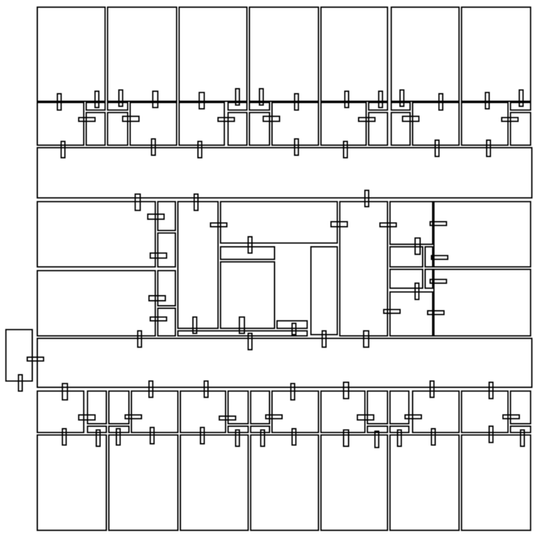

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Figure 5-17 Covex map of Case B

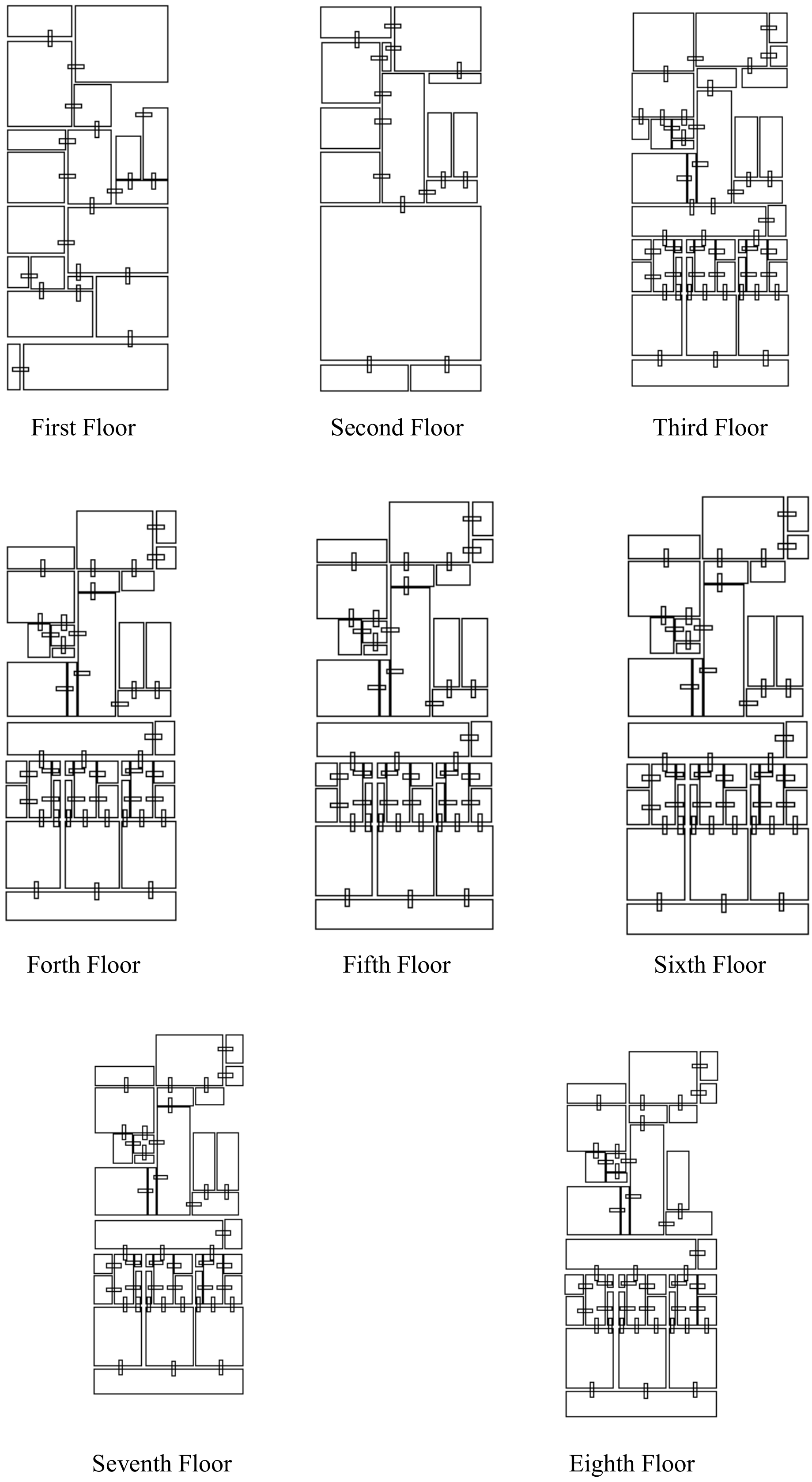
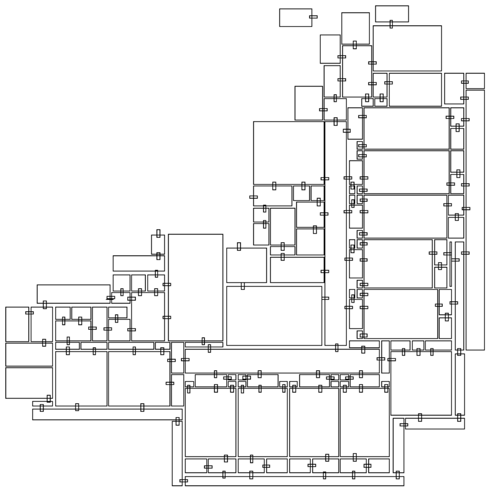


Figure 5-18 Covex map of Case D



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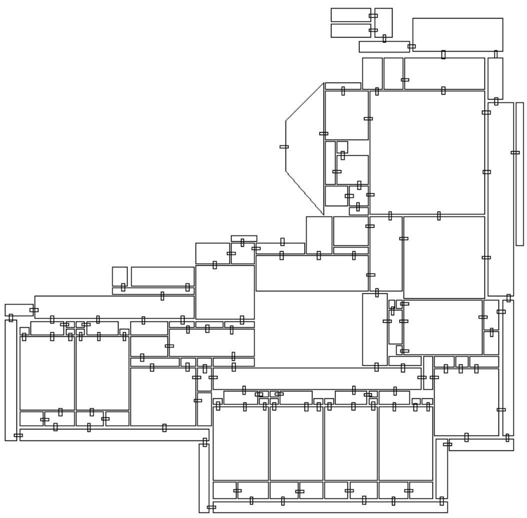
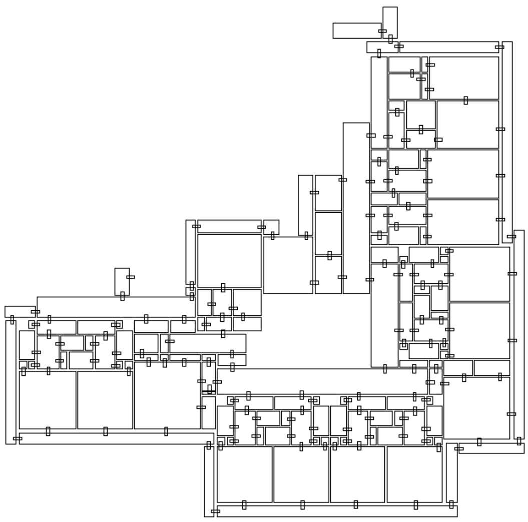


Second Floor



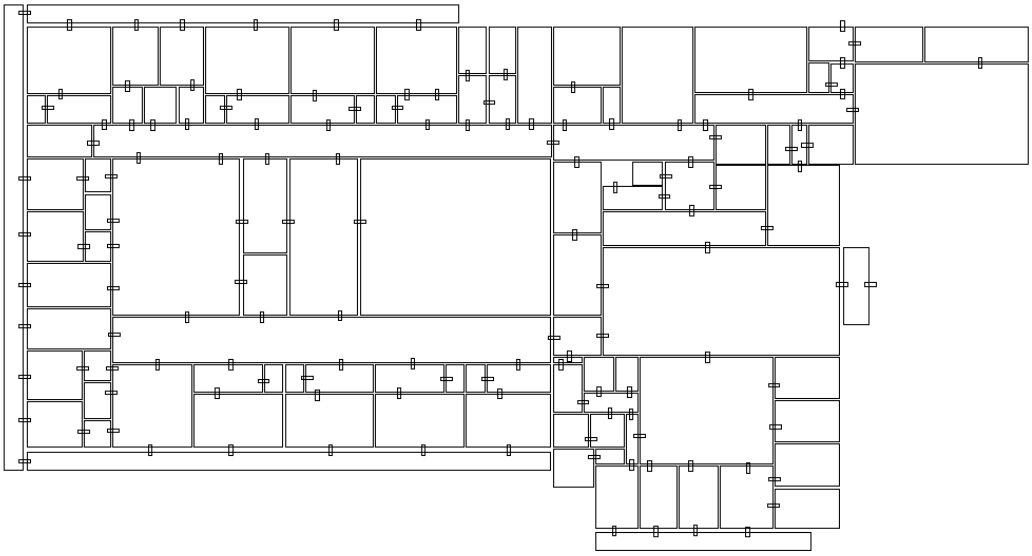
Third Floor

Figure 5-19 Covex map of Case E

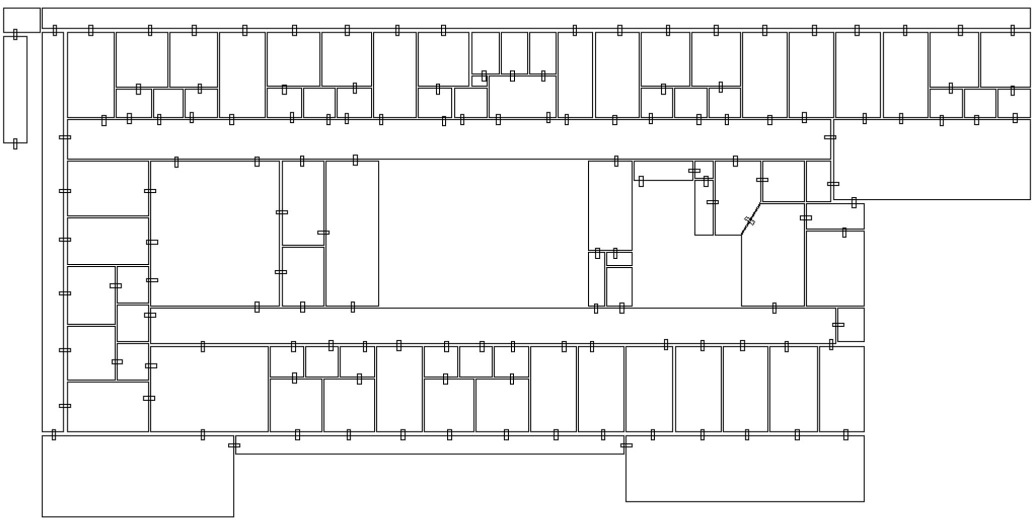
can be calculated by the formula (a+b)/ (c+d) = distributedness, where a low value is distributed and a high value is non-distributed. This gives a rank order for six nursing homes of Case A > Case B > Case F > Case C > Case E > Case D, suggesting that route choice at Case D is weakly-framed. In the remaining nursing homes, routes become increasingly constrained over time functionally to separate out the circulation patterns of different categories of occupants, both staffs and visitors. Although, the Case C, Case E and Case F has higher distributednesses than the Case D, the value of the distributedness is still very low, whilst the Case A and Case B have high distributednesses about more than 4 times than the others. As a result, the spatial organisation patterns of nursing homes seem to form two distinct frameworks. And the reason for this seems to be the presence of continuous balconies. Spatial organisation may arise from the mere addition or deletion of one element, and its structure may be dramatically different. This also tells us that we can flexibly change the organisation of space by controlling changes to one element. It can also be seen that although the movement of the elderly in a nursing home seems to be monitored in real time and in principle a strong frame is preferred, the fact that a weak frame offers more choice and freedom of movement for the residents is more often used by designers, suggesting that a more relaxed and free-living environment seems to be preferable.

Previous studies of residential care environments have focused on the difference between circulation paths and spaces designed for activities to occurrence. These distinctions also exist in nursing home spaces, the difference between spaces that are explicitly used to support activities and functions and those that are used for circulation is, certainly, itself a form of spatial ambiguity. In studies utilizing space syntax, there is a tendency to view transitions as mere circulation, aimed at providing efficient access and egress, or more speculatively, reducing unwanted contact by segregating activities and functions from each other. The presence of transition spaces has the effect of insulating spaces from one another as effectively as building walls, ensures that the boundaries of the spaces aren′t intruded upon and keep the social distance, provides appropriate environmental conditions. In addition, the ratio of transitions to function space can depict the characteristics of the organization of a nursing home space. For instance, among the six nursing homes, Case D, which is a small and has many storeys, and Case E, where the spatial layout is relatively complex, have a large number of transition spaces, close to the number of function spaces. In these two nursing homes, the layout of space is more dispersed, and the spaces are more insulated from each other. While in the other four homes, the number of transitions is much lower than the number of function spaces. In these nursing homes, the spaces are laid out more closely and the distances between spaces seem to be more integrated.

When we further categories the types of space within the nursing home for deeper exploration according to four broad topological space-types. The spatial layout of the nursing home seems to present two distinctly different frame structures. Case A and Case B exemplify a very strong framework structure, in which the spatial classification is more clearly defined, and routs are more easily dictated so as to people′s movements are more easily constrained and monitored. In other four nursing homes, the spatial layouts reflect a weakly-frame structure, in which the spatial classification is also relatively weak. The choice of routes is varied and difficult to controlled and predicted in these nursing home, and people also have a variety of alternatives for their routs of movement and their movements are more difficult to be monitored and restricted. The main reason for the two completely different frame structures between the nursing homes is that in Case A and Case B, the terminal spaces are dominant in all spaces, while in the other nursing homes, ʻcʼ type spaces occupy the most. A further key element is the change in the type of space on the room. In the first two nursing homes, the rooms belong to the terminal spaces, people moved between their rooms and other spaces only through interior transition spaces, and their paths of movement are relatively homogeneous and restricted. But in the last four nursing homes, the spaces are connected by outside continuous balconies in addition to by indoor corridors, the properties of the room become ʻcʼ type space.   People have alternative paths between their rooms and other spaces in these nursing homes, instead of having to go through indoor transition spaces, so that people seem to have more fun in choosing their paths. However, it has to be mentioned that in the spatial layout of a strongly framed



First Floor



Second Floor

Figure 5-20 Covex map of Case F

structure, the movement of the residents is easier for staffs to catch, and residents are more likely to be taken care of in time when accidents occur during their movement. Also, relatively simple, or single route seems to be more friendly for residents with dementia and less likely to get lost. Conversely, the spatial layout of the weakly-frame structure provides residents with more options of routes, which makes it difficult for staffs determine the route of movement of residents, and where it is more difficult for residents to get help in the shortest possible time when they are in trouble. In addition, this kind of spatial layout will also create more factors for residents with dementia to cause them to be lost.

5.4. The integration analysis of the plans

Before obtaining a map of the distribution of integration values, it is first necessary to convert the planar map into a convex spatial map. As shown in the diagram, the Case C floor plan was translated into a floor plan consisting of 236 convex spaces, and the other nursing home convex space diagrams are shown in the diagram. The convex space map is then translated into a distribution of integration values using depthmapx software. The relevant numerical data for each nursing home are shown in Figure ().

Firstly, it is in a comparison of the maximum, minimum, mean integration values and different factors for six nursing homes, give in Figure 2. The most obvious difference is in the difference between the maximum integration and the minimum integration, where the six cases seem to split into two subgroups. In cases A, C and D, the most aggregated space has an integration degree of over 2 and a difference of around 1.4. In the other group, cases B, E and F, the integration of the most aggregated space is less than 1.5 and the difference in aggregation is under 0.9. The most aggregated spaces in Case C are all larger and have the smallest aggregates while the opposite is true in Case E. Although the difference between them is 1.008 higher, the difference between them is only 0.241. In terms of average integration, the average integration of Case C has the highest average integration, at 1.167, even surpassing the integration of the most aggregated space of Case D. Case D has the smallest mean integration compared to the other cases at 0.714. The other cases have a similar mean integration between 0.923 and 1.036. Also in terms of DF, the overall structural hierarchy of the nursing home space is of a more homogeneous spatial distribution or a lower level of different types of equipment. However, it is surprising that the DF values for cases A, C and D in the first subgroup are in the range of 0.729 to 0.774 less than those for the other subgroup, which are in the range of 0.842 to 0.878. These seem to suggest that the design of nursing homes follows two design approaches (genotypes) in essence: one that separates the social interface from other spaces, as in cases A, C and D, and the other that integrates the social interface with other spaces in proximity, as in cases B, E and F.

Rank Order of Integration Value

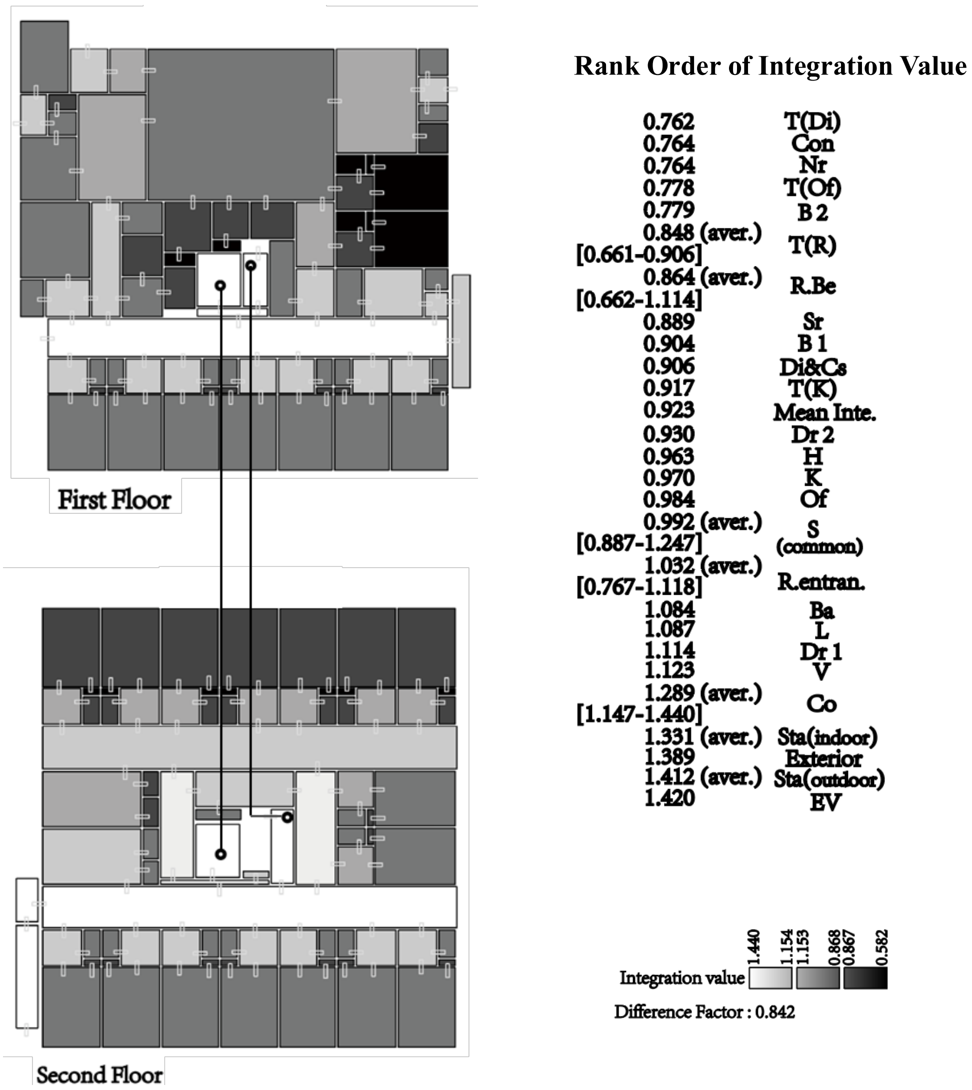
0.667	Garden
0.682	L
0.683	T2
0.726	Of&Nr
0.823 (aver.) [0.717-0.959]	R.Be
0.829	B
0.841	Cafe
0.841	Exterior
0.932 (aver.) [0.896-0.967]	S (common)
0.950 (aver.) [0.682-1.116]	T (common)
0.967	T1
1.027	Te2
1.036	T3
1.036	Mean Inte.
1.072 (aver.) [0.893-1.304]	R.entran.
1.075	Dr
1.095	Route
1.106	K
1.116	T4
1.290	Li
1.381	Te1
1.382	Cs
1.433	H
1.451	Di
1.455 (aver.) [1.191-2.001]	Co
1.872	Lr

Abbreviations of space labels are as follows:

B: Common bathroom	Ba: Balcony	Be: Bedroom	Co: Corridor
Cs: Communication space	Di: Dining room	Dr: Dressing	H: Hall
K: Kitchen	L: Laundry	Li: Library	Lr: Living room
Of: Office	R: Room	S: Store	T: Common Toilet

Figure 5-21 The distribution of integration at Case A "Hibiki"

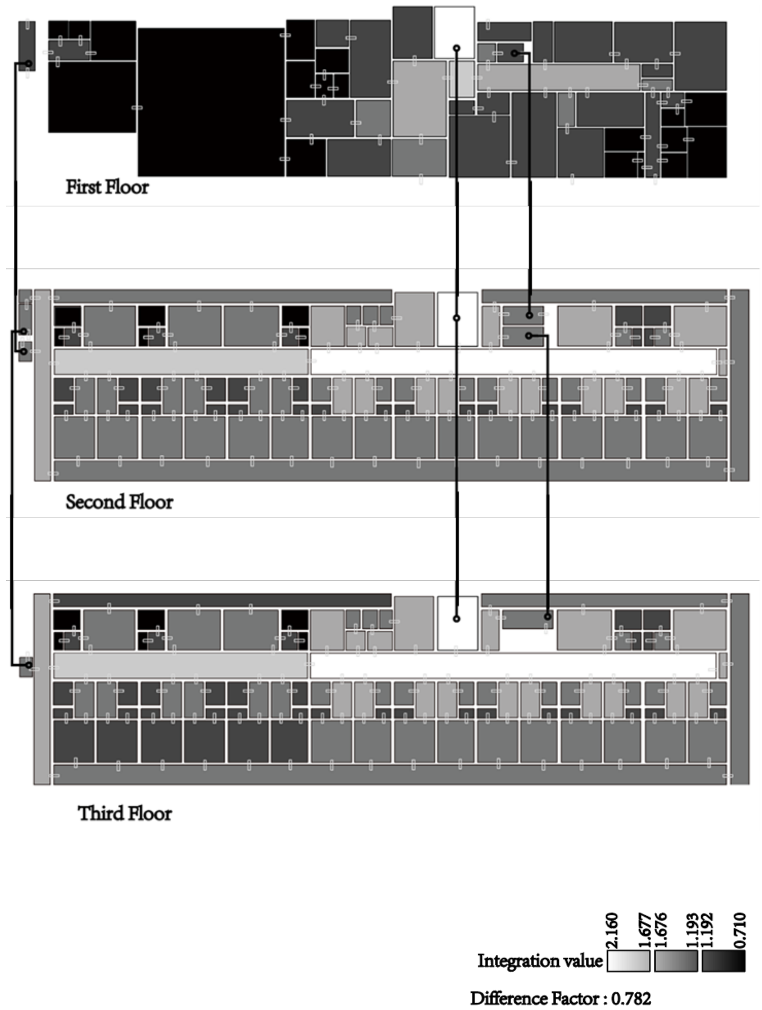
When focusing on the distribution of aggregation in each case. Similarities and similarities can be well observed. In case A, the integration shows a stepped distribution, with integration concentrated in corridor 1 and the living room, and decreasing in the spaces away from these two spaces, the canteen, the lobby, the lobby of the living area, the communication area and the balcony connecting the living room and the canteen are in the second rung of the aggregation, with an integration value close to 1.4. The third terrace has an integration value of around 1.2. Further out, the bedrooms of the rooms close to the central area, the entrances to the other rooms, the kitchen, the three remaining toilets, the dressing room and the outdoor roust, are at around 1.0, while the spaces further away include the service room, the cafeteria, the bathrooms, the outdoor bedrooms and the remaining rooms, and the most separated spaces are the garden, the washing room and the toilets2. From these descriptions The activity spaces such as the living and dining rooms are the main interface between the residents and the staff, and are the main spaces for



Abbreviations of space labels are as follows:

B: Common bathroom	Ba: Balcony	Be: Bedroom	Co: Corridor
Con: Consultation room	Cs: Communication space	Di: Dining room	Dr: Dressing room
Ev: Elevator	H: Hall	K: Kitchen	L: Laundry
Nr: Nursing room	Of: Office	R: Room	Re: Rehabilitation area
S: Store	Sr: Staff room	Sta: Staircase	T: Common Toilet
V: Vestibule			

Figure 5-22 The distribution of integration at Case B “Healthcare Apartment Matsue”



Rank Order of Integration Value

0.708	T(Di&Re)
0.761	Sr
0.799	T(K)
0.809	K
0.834	Drs 1
0.834	T (Drs 1)
0.842	Di&Re
0.883	Drs 2
0.930	Of 2
0.930	B
0.935	Of 1
1.038	Con
1.058 (aver.) [0.730-1.467]	S (common)
1.078 (aver.) [0.862-1.185]	T (R)
1.107	Exterior
1.109	Cs 1
1.111	Nr
1.115	L
1.116	Mean Inte.
1.117	Rec
1.120	Dr
1.159	T(3rd floor)
1.167	T(2nd floor)
1.168	V
1.212 (aver.)	Sta(outdoor)
1.265 (aver.) [1.116-1.495]	R.Be
1.270 (aver.) [1.102-1.458]	Ba
1.291 (aver.)	Sta(indoor)
1.390	H
1.410 (aver.) [1.252-1.511]	R.entra.
1.470	Cs 3
1.470	Ss 2
1.482	Cs 2
1.482	Ss 1
1.742 (aver.) [1.400-2.203]	Co
1.737	EvH
2.160	EV

Abbreviations of space labels are as follows:

B: Common bathroom	Ba: Balcony	Be: Bedroom	Co: Corridor
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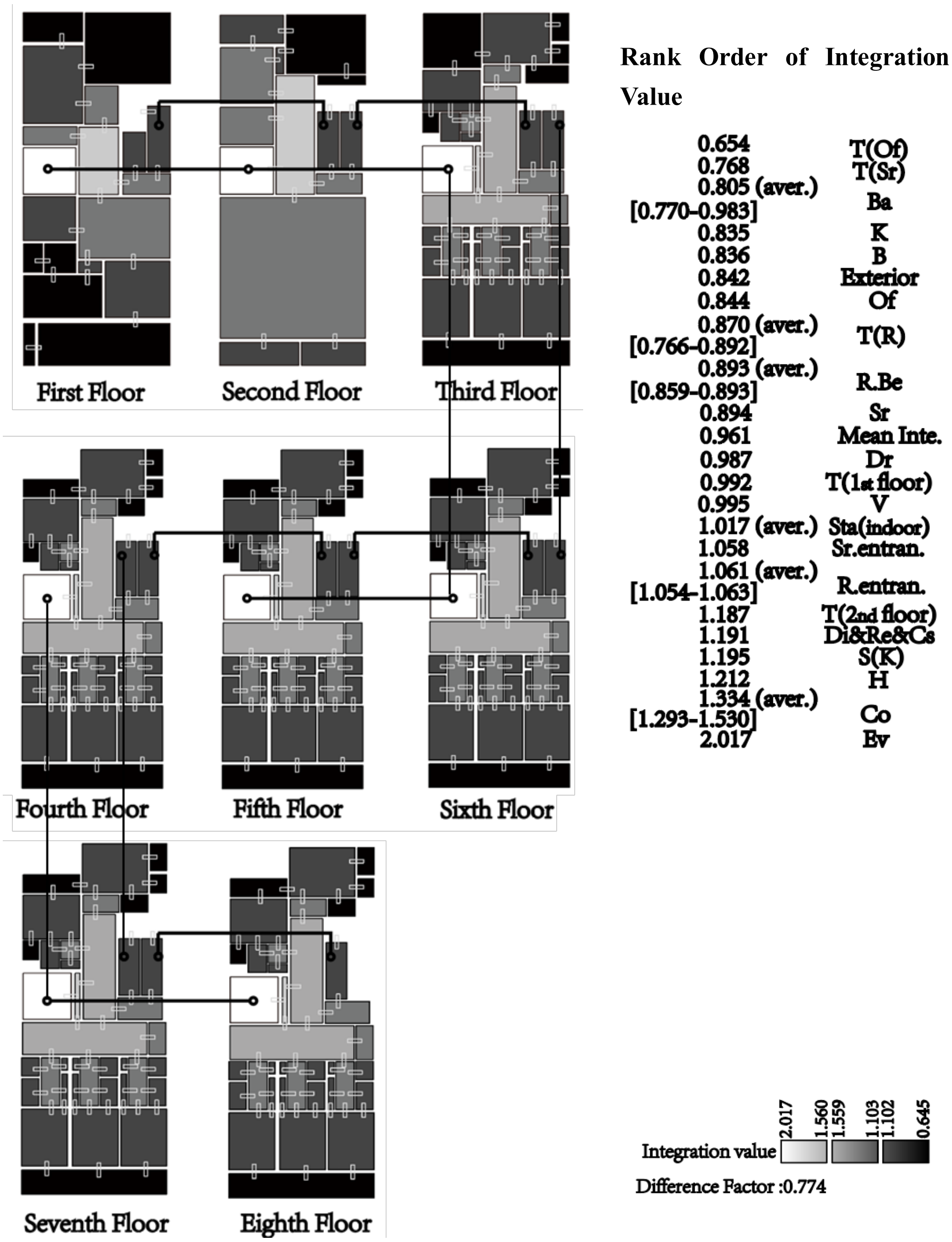
Drs: Dressing room (staff)	Ev: Elevator	H: Hall	K: Kitchen
L: Laundry	Nr: Nursing room	Of: Office	R: Room
Re: Rehabilitation area	S: Store	Sr: Staff room	Sta: Staircase
Ss: Staff station	T: Common Toilet	V: Vestibule	

Figure 5-23 The distribution of integration at Case C “Good time nursing home Kokubunji”

activity, being in the relative concentration of spaces in the home. This is followed by transitional spaces such as corridors and halls leading to other spaces. The room space concentrates the interface at the entrance and the bedroom section is in a relatively private position. The assisted living spaces are also in a relatively separate location. The staff living areas and the visitors' areas are more separated. The home therefore follows a pattern of separation between the main resident interface and the outside world, with the internal resident interface following a public to private pattern. If the integration of these main spaces is ranked, the order is as follows: Lr (1.872) > Di > Co (Average) > Hall > Cs > K > Entrance. R (average) > T (average, 0.95) > Bedroom. R(average)> B > Of > L. The home's spatial distribution appears to be centred on the central activity space and then receding in all directions.

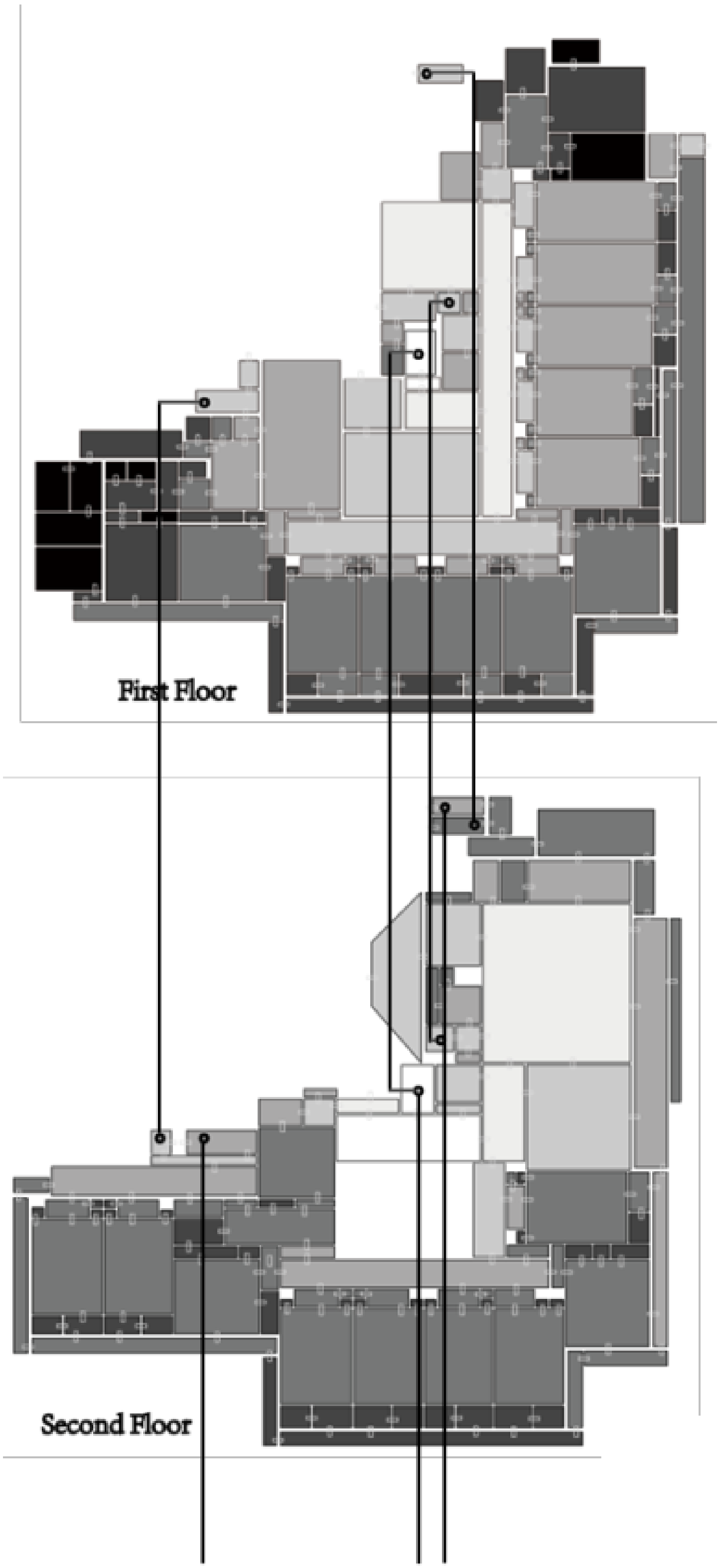
In Case B, the degree of integration is concentrated in transitional spaces such as lifts, stairs, corridors and outdoors (>1.3), in contrast to the main activity space, the canteen, which is in a relatively separated position (0.85). This suggests that the frequent interactions of the residents in this home occur in the transitional spaces, a situation that differs significantly from Case A. And despite that high level of aggregation in the outdoor space, the difference is small when comparing the average integration (when indoor-outdoor), which suggests that the nursing home is still part of the resident-to-resident intercourse pattern. The outdoor space does not have a significant impact on the circulation paths of the residents. In this nursing home, although staff are involved in helping the elderly with bathing time, OF is connected to the main living space by a corridor, it remains low and below average in terms of integration. The following is the ranking order: Co (Average,1.2886) > L (1.084) > Entrance. R (average, 1.032) > Dr (average 1.022) > Of (0.984) > K (0.97) > Hall (0.963) > Di (0.906) > Bedroom. R (average, 0.864) > B (0.821). This ranking shows that the resident's space and auxiliary spaces are separated from the public and staff spaces, and that the spatial configuration of the home follows the separation of the staff interface from the resident interface, and the configuration of the rooms on the outside follows the change from public to private. The act of arriving at the home's activity spaces is more subject to the arrangements of the home than to the conscious actions of the residents.



Abbreviations of space labels are as follows:

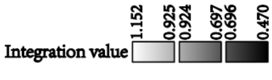
B: Common bathroom	Ba: Balcony	Be: Bedroom	Co: Corridor
Di: Dingin room	Dr: Dressing room	Ev: Elevator	H: Hall
K: Kitchen	Of: Office	R: Room	S: Store
Sr: Staff room	Sta: Staircase	Ss: Staff station	T: Common Toilet
V: Vestibule			

Figure 5-24 The distribution of integration at Case C “Life Partner Isoji”



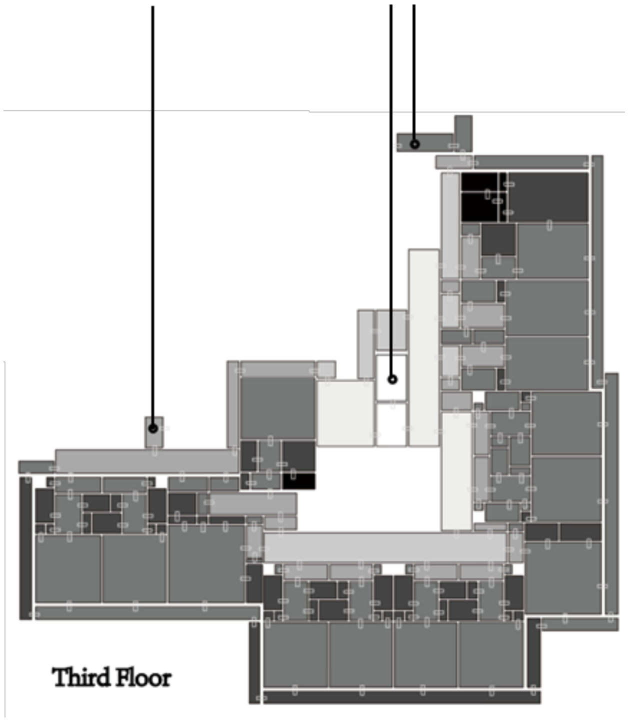
Rank Order of Integration Value

0.511	S 1
0.511	S 2
0.546	S 3
0.561	B 2
0.599 (aver.) [0.505-0.701]	T (R)
0.617	T (Dr2)
0.618	B 1
0.634 (aver.) [0.467-0.701]	B (R)
0.662	L
0.687	Dr 2
0.688 (aver.) [0.613-0.805]	Ba
0.703 (aver.) [0.605-0.773]	R.Be
0.714	Mean Inte.
0.719	T (K)
0.752	Of&Nr
0.760 (aver.)	Sta 2
0.762	B 3
0.762	T (Dr1)
0.788	Pa
0.798 (aver.) [0.622-0.894]	R. entra.
0.817	Cs
0.828	T (Di)
0.861	T (Lo)
0.863 (aver.)	Sta 1
0.871	Dr 1
0.879	Ev (k)
0.888 (aver.) [0.742-1.037]	Co
0.903	Lo
0.923	Countyard
0.959	Di
0.961	K
1.016	Exterior
1.020	V
1.027	Ev.H (1F)
1.095	Ev.H (2F)
1.103	Ev.H (3F)
1.152	Ev



Difference Factor :0.845

Connect to third floor in page 146

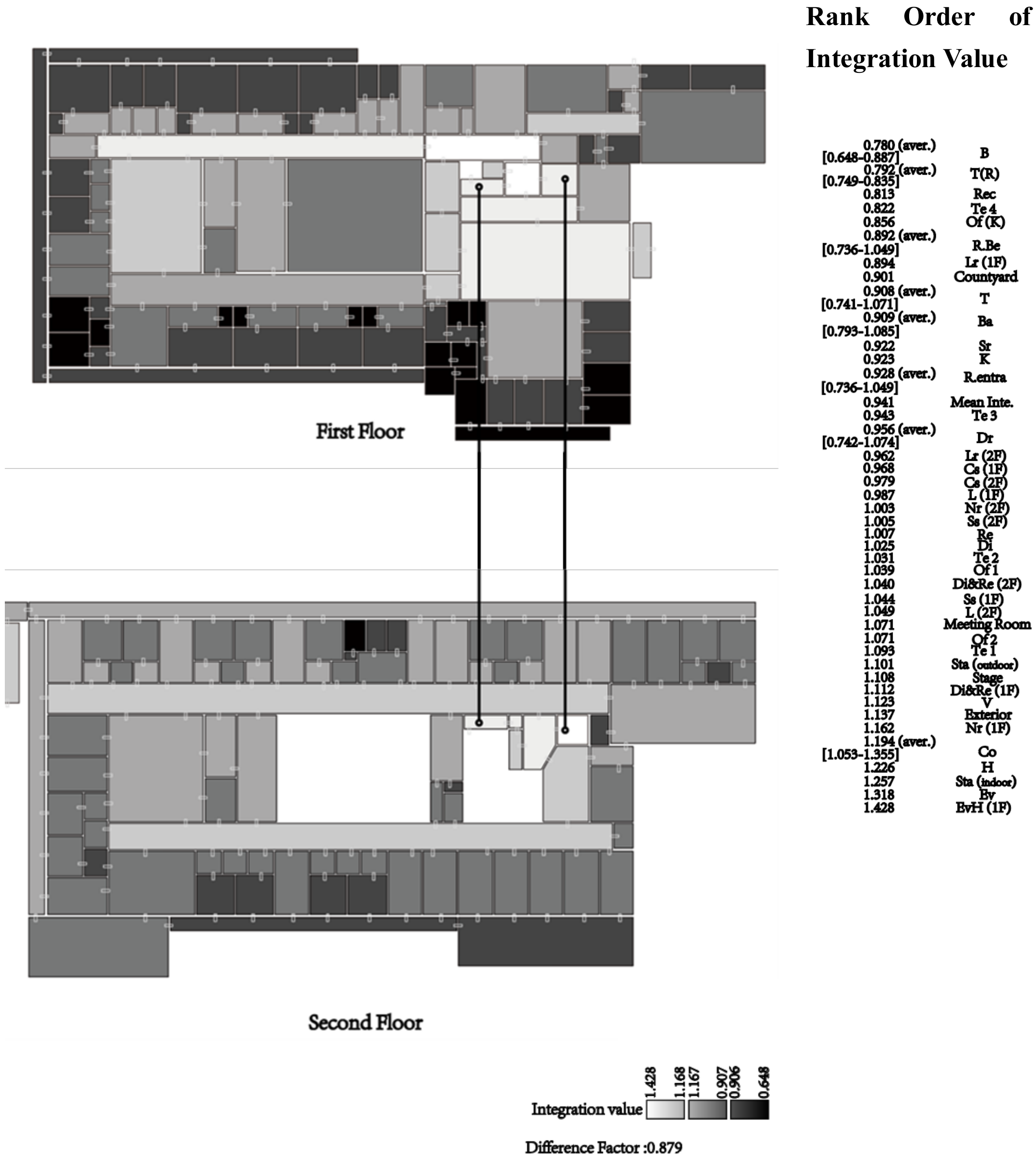


Abbreviations of space labels are as follows:

B: Common bathroom	Ba: Balcony	Be: Bedroom	Co: Corridor
Con: Consultation room	Cs: Communication space	Di: Dingin room	Dr: Dressing room
Drs: Dressing room (staff)	Ev: Elevator	H: Hall	K: Kitchen
L: Laundry	Nr: Nursing room	Of: Office	R: Room
Re: Rehabilitation area	S: Store	Sr: Staff room	Sta: Staircase
Ss: Staff station	T: Common Toilet	Te: Terrace	V: Vestibule

Figure 5-25 The distribution of integration at Case E "Long Life Korakuen Ashiya Bettei"

The distribution of integration in Case C is similar to that in Case B. Integration is concentrated in the transitional spaces, especially in the vertical traffic on the lifts and the flat traffic in the corridors. Overall, the degree of integration in the nursing home is divided, with the second and third floors having a higher degree of integration than the ground floor. The activity space of the canteen and the kitchen space connected to it, as well as the public toilets, are in a more separated position, while the same separated parts are the staff changing rooms and the rest rooms.



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Con: Consultation room	Cs: Communication space	Di: Dingin room	Dr: Dressing room
Drs: Dressing room (staff)	Ev: Elevator	H: Hall	K: Kitchen
L: Laundry	Nr: Nursing room	Of: Office	R: Room
Re: Rehabilitation area	S: Store	Sr: Staff room	Sta: Staircase
Ss: Staff station	T: Common Toilet	Te: Terrace	V: Vestibule

Figure 5-26 The distribution of integration at Case F “Esprit”

On the ground floor, the lobby, which serves as the interface between visitors and residents, and corridor 1, which serves as the interface between residents and staff, are the main areas of integration and have a relatively high degree of integration. Service spaces such as medical and laundry rooms and bathrooms are therefore located around them. The service rooms where the employees work are located adjacent to the lobby, but are relatively separate in terms of integration. On the second and third floors, the degree of integration is concentrated in corridor 2 and corridor 4, which are connected by communication spaces, staff duty rooms, etc. The integration of the main spaces of the home is ranked as follows: Co (Average,1.742) > Ss (Average,1.476) > Entrance. Bedroom. R (average, 1.265)> Dr (1.12)> L (1.115)> Of (0.932)> Di (0.842)> K (0.809)> Sr (0.761). From this ranking, the integration of the living space part of the room increases, with a higher mean than average integration due to the presence of the external continuous corridor. The presence of continuous balconies, while giving the occupants more optional circulation routes, seems to reduce their privacy. The balconies may disperse some of the circulation routes, but the corridors still occupy the main degree of integration. Although there are some similarities between the functional spaces in Case C and Case B, in Case C the service spaces such as the laundry and bathrooms, which are closely linked to the daily lives of the residents, are in a more detached position and are below the average level of integration. In general, the residents' interface is concentrated on the second and third floors of the home, while the staff's interface is mainly confined to the ground floor, so the residents' interface follows a separate pattern from the staff's interface. However, the main activity space, which is the main social interface for the residents and staff of the large nursing home, is in a separate location, and the junction is such that the functionality of the space must drive the residents to this space, and it is conceivable that without the arrangement, the residents would not inadvertently go to this space to a large extent. So, it seems that the designers have designed with the deviation of that activity space in mind, and so have cut in additional communicative spaces on each level for the occupants to use for extended periods of intersection.

In Case D, it is most evident that the lift has the highest degree of integration, at 2.16, almost 0.6 higher than Corridor 1 (1.53) in second place and 1.372 higher than the most separated space. It can therefore be surmised that vertical traffic is almost the key junction space for the traffic space in this nursing home. On every other single level, the degree of integration is concentrated in the corridors. The distribution of degrees of integration in the home follows the space where the lifts are most clustered, then the second gradient is the corridor space on each floor, before spreading to the rest of the space. Due to the presence of the lifts, the spaces on each floor in the home appear to be a juxtaposition. The main spatial ordering of the home is: Co (Average,1.334) > Hall (1.212) > Di (1.191) > Entrance. r (average, 1.098) > Dr(L) (0.987) > Sr (Average,0.894) > Bedroom. r (average, 0.893) > K (0.835) > Ba (Average,0.805) > Of (0.0.844). From this ranking, it can be seen that the corridor spaces of the nursing home continue to dominate. The lobby and activity spaces are in relative sets, but are closer to the entrances to the rooms, more akin to the rooms being in relative juxtaposed sets. Thus, in this home, the activity space is relatively low in terms of aggregation, relying on the functionality of the space and the arrangement of activities to gather the residents for socialising. Although there are several rooms sharing a balcony in the home, the bedrooms are less integrated and have a higher degree of privacy. Similarly, the staff lounge, service room and canteen are all in relatively separate locations, below the average level of integration. This suggests that the spontaneous daily interactions between residents, staff and visitors to the home are fragmented, with residents' daily interactions likely to be confined to localised locations or in the corridors. Most of the time the clustered intersections are in the daily arrangements of the home, including the organisation of events, arrangements or meetings with visitors.

In Case E, the lifts that run through the three floors are the most congregated areas of the home, and the lift lobbies are also important interfacing spaces, especially on the entrance level where the lifts are used as lobbies, and are highly integrated as they serve as an interface for visitors, residents and staff. On the ground floor, the degree of integration is concentrated around the lift lobby and gradually spreads outwards. Similarly, on the third level, the level of integration is higher near the lift lobby and decreases away from it. However, on the second level, in addition to the lift and lift lobbies, the canteen and lobby have a higher degree of integration, highlighting the gathering function of this activity space, while the integration is lower away from these spaces. In addition, the outdoor garden of the home is an important feature, so the outdoor space is in a relatively shallow position and has an integration of 1.016, indicating that the residents can reach the space relatively easily. Despite this, there is little difference in average integration, suggesting that the home remains a space at the occupant-occupier interface. The main spatial rankings in this home are: Hall (1.095) > K (0.961) > Di (0.959) > Lobby (0.903) > Co (Average,0.887) > Cs (0.817) > Entrance. r (average, 0.798) > Dr (0.779) > Of/Nr (0.752) > Bedroom. R (average,0.703) > Ba (Average,0.688). In this home, the kitchen is in a shallow position, which is a major difference from the other cases. The main activity spaces are in relatively clustered spaces, highlighting the function of these spaces as clustered intersections. The service room in this home is in a deeper position, albeit close to the junction. Some of the corridors in the home have a high degree of integration and some are in a more discrete position. On average at the time, the corridors in the home as a whole performed a more aggregated function. There are also continuous balcony spaces in the home, which provide residents with more circulation options. Although the continuous balconies may reduce the privacy of the rooms. However, similarly, the entrance to the rooms is above average and the bedrooms are below average, highlighting the privacy gradient of the rooms in the nursing home. The continuous balcony is less integrated than the corridor space, so the corridor space continues to dominate the circulation paths of the residents in the home. Finally, the difference in the integration of the main spaces in the home does not create a huge difference, with the shallowest space differing from the deepest space by only 0.685 integration, the lowest of all cases. This suggests that in this home the spaces may have been designed with the intention of being gathering spaces, but in reality, they may not have worked as well as they could have, more because of the function of the spaces or the arrangement of the spaces, allowing the residents to socialise rather than circulate unconsciously. The junction of paths, this is somewhat similar to Case D.

In this home, the lift lobby on the ground floor provides access to the lobby, the interior staircase, the lift and to the staff areas and service spaces, achieving the highest degree of integration. Corridor 1, which provides a flow for the staff and connects to the living areas of the residents on the ground floor and is connected to the lift lobby, also achieves a high degree of integration. The lobby, which is adjacent to the entrance, is also the venue for larger events and serves as the interface between all residents, staff and visitors, thus achieving a high level of integration. In everyday life, several canteen spaces are the core activity spaces of the home, which serve as regional activity centres for the residents. Smaller activity spaces such as living rooms, communication rooms and rehabilitation spaces complement the activity function, but are less integrated than the canteens. In this home, the main spaces are ranked as follows: Hall (1.226) > Co (Average,1.194) > Di (Average,1.0589) > Of (1.024) > Re (0.994) > Dr (average, 0.986) > Cs (Average,0.974) > Lr (Average,0.928) &Entrance. R (average, 0.928) > K (0.923) > Ba (Average,0.909) > K (0.897) > Bedroom. R (average,0.892). In this home, the service room is in a shallow position due to its direct connection to the hall, which is somewhat different from the other cases, but the staff lounge and kitchen are in a deeper position. The corridors still dominate the circulation routes of the residents in this home, although the average degree of integration of the continuous balconies is higher in this home, compared to the other cases. Also the average integration of the entrances to the rooms in this home is the only case where the average integration is lower than the average integration, which seems to indicate that the intersections between the residents in this home are relatively fragmented or more independent. Finally, the overall distribution of integration in the home is relatively homogeneous, with the difference between the highest and lowest levels of integration being only slightly higher than in case E at 0.781. It can be argued that the home lacks a core of spontaneous intersections in terms of spontaneous spatial organisation. It is not conducive to the communication of the residents, and more communication may be in an arranged or purposeful manner rather than occurring naturally.

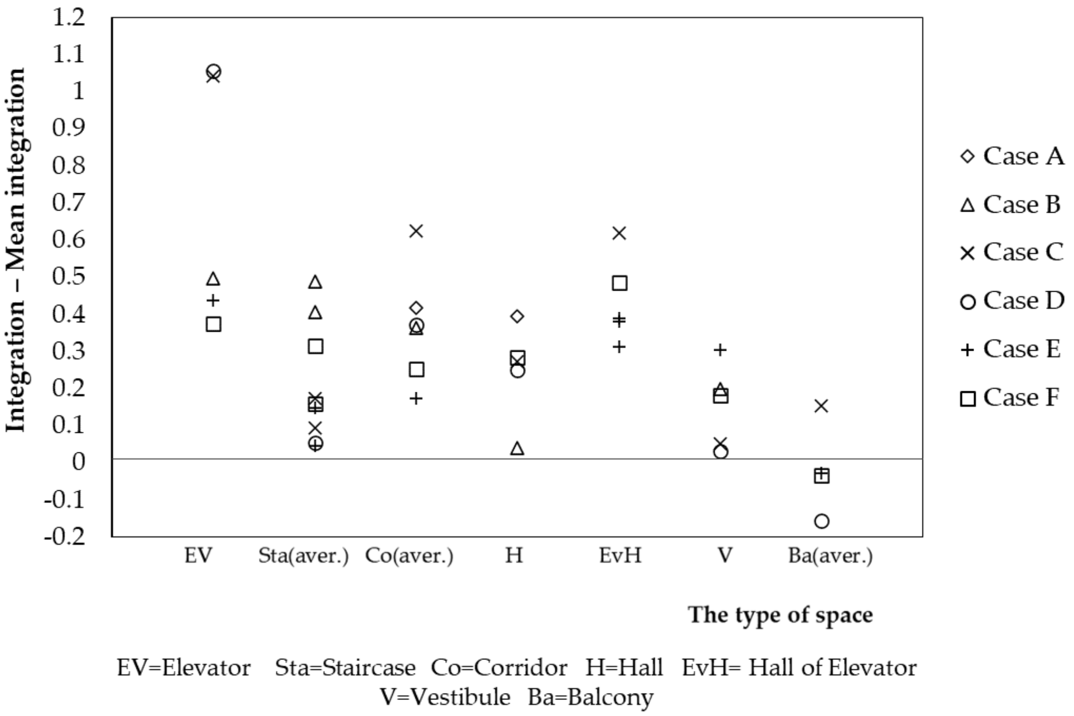


Figure 5-27 Distribution of integration values (Mean integration-integration) of the transition spaces

Transition spaces connect the different spaces in the home, and they govern the flow of movement of people like blood vessels in the human body. However, due to the function or location, these transition spaces differ in their ability to attract traffic. Although in some nursing homes, continuous balconies in the outside various rooms in the same way as corridors indoor, providing additional alternative paths for residents, indoor corridors are much more capable of attracting flow than continuous balconies in the plan, which continue to control the dynamic flow of residents. This seems to expose that the spatial layout of the weakly-frame structure in some nursing homes mentioned earlier is essentially superficial, even though the presence of continuous balconies provides additional paths of movements for residents, the corridors perhaps still be the routs that residents prefer to choose. Staffs can still control the movement of residents to a large extent by monitoring the corridors. Therefore, the spatial layouts of four nursing homes with the weakly-frame structure remain strong frame in nature. The hall and the vestibule are necessary spaces for residents, staffs, and visitors to enter and leave the nursing home, and serve as the buffers between the internal social interface of a nursing home and the external world. Empirically, it was thought that such spaces would be placed in more segregated locations, but it turns out that in most nursing homes, these two spaces are in shallow and easily accessible positions. The purpose of design may be intended to make it easier for residents to enter and exit the nursing home or to receive visitors.

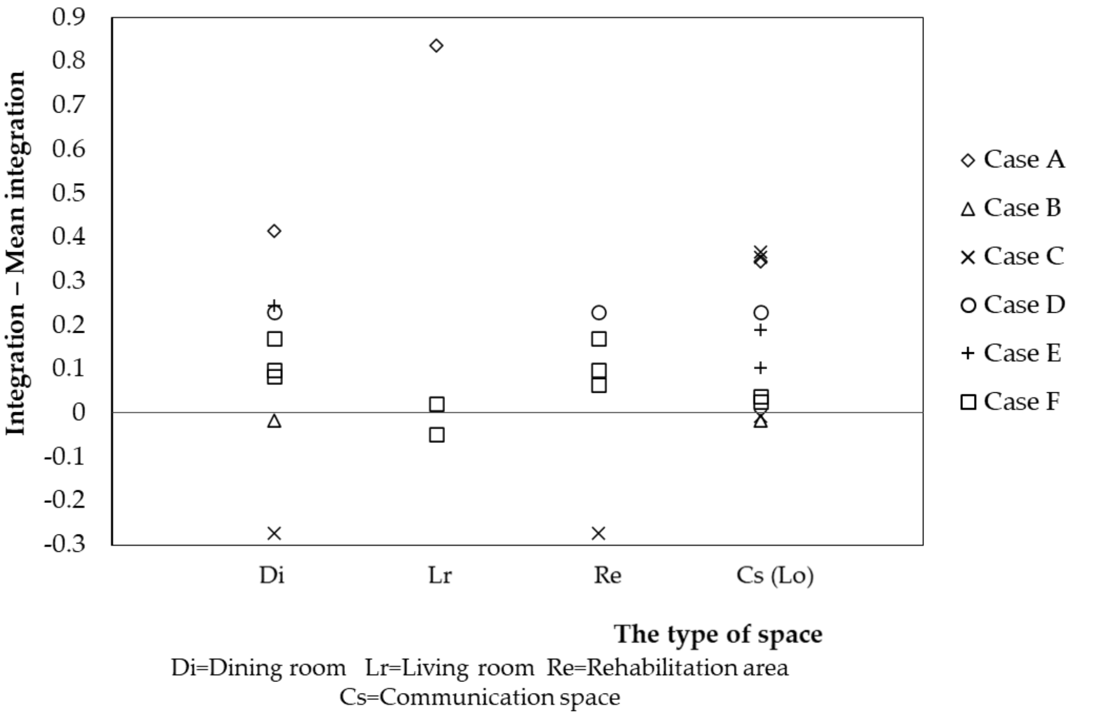


Figure 5-28 Distribution of integration values (Mean integration-integration) of the activity spaces

From Figure 5-30, the activity spaces including the dining room, the living room and the communication space have high integration values. Activity spaces are places where public activities take place and where residents socialize with each other. In a nursing home, sometimes the generation of the interaction between residents is mechanical. For instance, during daily and compulsory activities such as meals or rehabilitation arranged by the home, the residents are brought together and generate interaction with each other. But sometimes intercourse between residents arises naturally or spontaneously. The high integration value means the higher likelihood of naturalistic intersections between people arise in this space. Therefore, it suggests that the activity spaces of this nursing home provide the places for the both properties of interaction between residents. The form of layout of activity spaces in nursing homes is analogous to Durkheim's concept of organic solidary. The space of organic solidary is usually dense and nucleated in order to facilitate exchange and interaction. In addition, although hall and corridors have high integration value, they belong to the transitional spaces that can't provide for long stays and where people interact only temporarily. From Figure 5-30, the activity spaces including the dining room, the living room and the communication space have high integration values. Activity spaces are places where public activities take place and where residents socialize with each other. In a nursing home, sometimes the generation of the interaction between residents is mechanical. For instance, during daily and compulsory activities such as meals or rehabilitation arranged by the home, the residents are brought together and generate interaction with each other. But sometimes intercourse between residents arises naturally or spontaneously. The high integration value means the higher likelihood of naturalistic intersections between people arise in this space. Therefore, it suggests that the activity spaces of this nursing home provide the places for the both properties of interaction between residents. The form of layout of activity spaces in nursing homes is analogous to Durkheim's concept of organic solidary. The space of organic solidary is usually dense and nucleated in order to facilitate exchange and interaction. In addition, although hall and corridors have high integration value, they belong to the transitional spaces that can't provide for long stays and where people interact only temporarily. The layout of the activity spaces in the nursing home is also very different from previous guesses. In the assumptions based on experience, the activity space should be located in the central area of the nursing home plan, where people can conveniently gather together. The results of the study seem to emerge three different phenomena in the layout of the activity space. The first phenomenon is just like imagine, in which the activity space has a strong ability to attract traffic, and residents can naturally gather together in this space. The second phenomenon is diametrically opposed to the former, in which the activity space is placed in a deeper position with less accessibility in the nursing home. People usually don′t go to the space spontaneously, but are driven to the space passively by some kinds of regulations. The last one, which is between the former two phenomena, where the space is embedded into the living area of residents in the nursing home, and has a certain ability to attract traffic within a local area, while it is weaker to attract traffic for the entire nursing home. The activity space in a plan with such a spatial layout can provide better convenience for residents in the nearby local area, but it is very unfavorable for the nursing home to control the activities of the residents in a global manner.

As shown in Figure 5-31, the room is the most critical private space for residents in a nursing home. In order to maintain the privacy of the living space, the junction with the outside is controlled at the entrance or the gate of the room, maintaining the relatively good accessibility of the room, and making it more convenient for the occupants to travel between their rooms and other spaces. While the bedroom, the toilet, and the bathroom with more private in the room are in a deeper location in order to maintain a considerable level of privacy. Therefore, the rule of the spatial layout of the resident′s room follows a certain gradient of privacy.

Figure 5-29 Distribution of integration values (Mean integration-integration) of the privat spaces

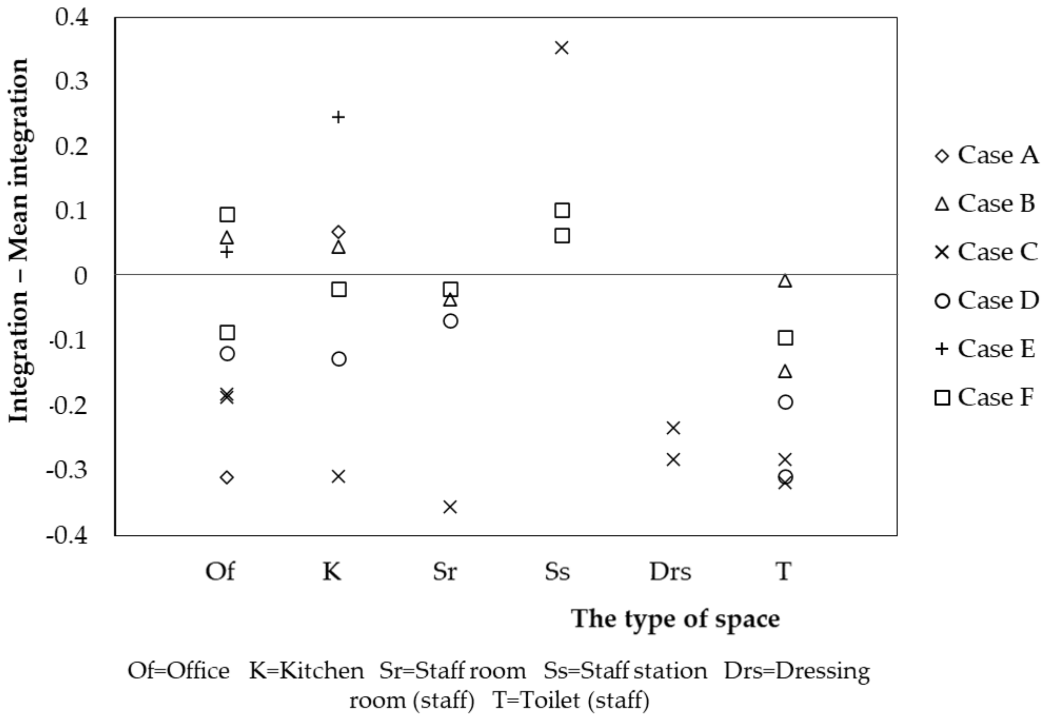


Figure 5-30 Distribution of integration values (Mean integration-integration) of the staff spaces

The layout of the staff spaces follows a certain variation of gradient. Staff space is divided into two main attributes, one is the space for external services and another one is the space used by employees themselves. There s a tendency for staff spaces that have nothing to do with residents to be in the deeper locations, such as staff duty stations that require constant monitoring of residents, so they are in shallower locations, while staff rest rooms that have almost nothing to do with residents, are in a deeper location. Therefore, the layout of the space is designed to minimize the intrusion of the employees′ flow into the residents′ flow, so as to keep the residents′ living space pure and independent.

In addition, most of spaces for assisted living of residents in these nursing homes are in relatively deep locations, and residents go to these spaces probably because of the function of these spaces. Of course, there are also some spaces for assisted living of residents that are in relatively shallow locations, but their better accessibility is only for residents who live in nearby local area rather than for residents who live in the entire nursing home.

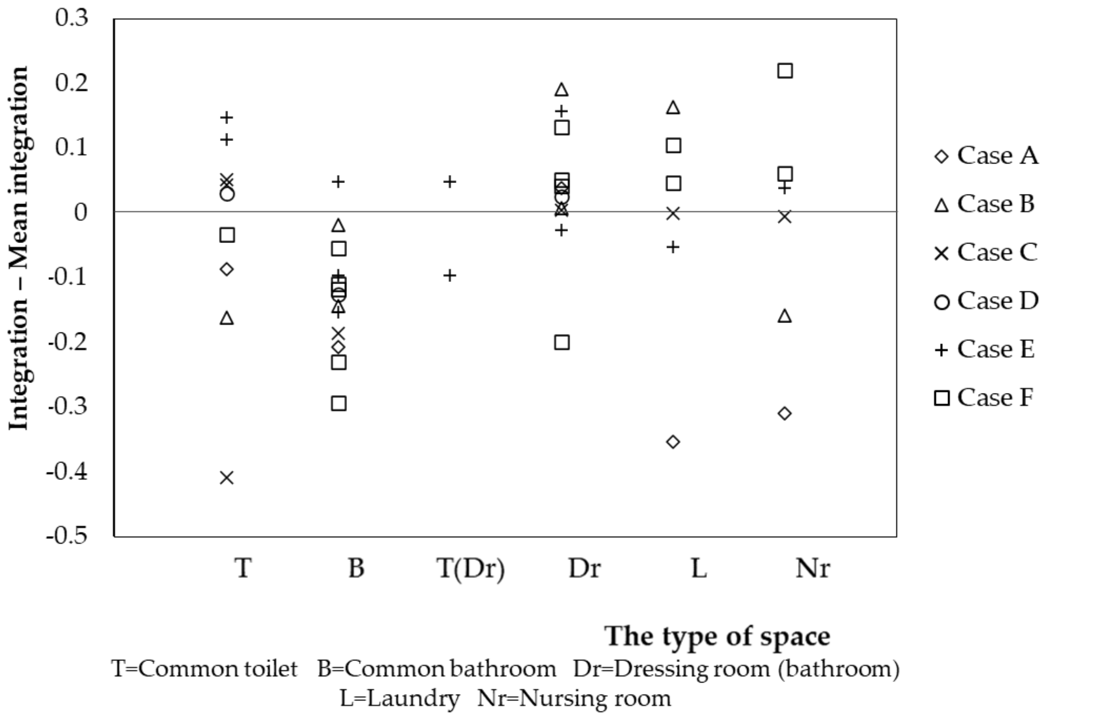


Figure 5-31 Distribution of integration values (Mean integration-integration) of the support spaces

5.5. Results

The nursing homes are not just assemblages of individual spaces but intricate patterns of organized space, governed by rules and conventions about the configuration of spaces. Which the activities go together, what kind of daily object are appropriated in each setting, how the residents relate to one another in different spaces, and how and where the visitors and the staffs should be received and worked in the nursing home. We have already seemed that even the most simple of plans can be considered by breaking up the interior in the way into its constituent elements and relations, for instance in this paper convex spaces are used. The viewpoint will yield insights into how the space of nursing home is organized for social purposes. The largest generation of computer techniques permits these different spatial representations to be overlaid directly upon one another so as to recapture a multi-layered spatial experience of the interior, and then to explore how the nursing home unfolds experientially to the moving observer in an animated ′walk-through′ of the interior. Once configured spaces are labelled to reflect the activities that take place in different spaces, the functions they serve, the conventions that govern which spaces different members of the nursing home occupy, and so on. This reintroduces the richness and diversity of life into a narrower morphological description and makes the interpretation of the arrangements of nursing home space easier. The nursing home experience is often related to different viewpoints among different people including resident-resident, resident-staff, resident-visitor, staff-staff, and staff-visitor. As research into the analogue use of nursing home space continues, a new and promising line of research is the relationship between the indoor activities and the patterns of daily routines that people engage in the nursing home. This has led to attempts to identify the choreography of people′s experience of space through the aesthetics of movement. Movement, gesture, and posture are reprogrammed so that the body is positioned and projected in space. Thus, although people′s actions, movements, gestures, and postures within the building are not determined by space, they may be related to the space either because they are exploratory improvisations in a free, unconstrained environment, or because they are the expression of traditional, even ritualized, social practices, or because they are involuntary acts cemented by habit.

So how are movements of people in a nursing home predicted? In this paper, we address this issue by embodying the ability of this space to attract traffic from the concept of the integration of the space in theory of space syntax. We still use the plans of the six nursing homes mentioned above as a basis to explore the possible trajectories of people′s movements in these nursing homes. A nursing home space will involve many different function spaces, how these spaces are placed on the homes, and how they attract people′s traffic? And the social relationship involved in a nursing home includes residents, staffs, and visitors. What are the circulation routes of these different groups of people in nursing home? Where are the intersections between these different groups of people placed when a nursing home space is laid out? And how to deal with the intersection of these different flow routes? Transition spaces connect the different spaces in the home, and they govern the flow of movement of people like blood vessels in the human body. However, due to the function or location, these transition spaces differ in their ability to attract traffic. Although in some nursing homes, continuous balconies in the outside various rooms in the same way as corridors indoor, providing additional alternative paths for residents, indoor corridors are much more capable of attracting flow than continuous balconies in the plan, which continue to control the dynamic flow of residents. This seems to expose that the spatial layout of the weakly-frame structure in some nursing homes mentioned earlier is essentially superficial, even though the presence of continuous balconies provides additional paths of movements for residents, the corridors perhaps still be the routs that residents prefer to choose. Staffs can still control the movement of residents to a large extent by monitoring the corridors. Therefore, the spatial layouts of four nursing homes with the weakly-frame structure remain strong frame in nature. The hall and the vestibule are necessary spaces for residents, staffs, and visitors to enter and leave the nursing home, and serve as the buffers between the internal social interface of a nursing home and the external world. Empirically, it was thought that such spaces would be placed in more segregated locations, but it turns out that in most nursing homes, these two spaces are in shallow and easily accessible positions. The purpose of design may be intended to make it easier for residents to enter and exit the nursing home or to receive visitors.

The layout of the activity spaces in the nursing home is also very different from previous guesses. In the assumptions based on experience, the activity space should be located in the central area of the nursing home plan, where people can conveniently gather together. The results of the study seem to emerge three different phenomena in the layout of the activity space. The first phenomenon is just like imagine, in which the activity space has a strong ability to attract traffic, and residents can naturally gather together in this space. The second phenomenon is diametrically opposed to the former, in which the activity space is placed in a deeper position with less accessibility in the nursing home. People usually don′t go to the space spontaneously, but are driven to the space passively by some kinds of regulations. The last one, which is between the former two phenomena, where the space is embedded into the living area of residents in the nursing home, and has a certain ability to attract traffic within a local area, while it is weaker to attract traffic for the entire nursing home. The activity space in a plan with such a spatial layout can provide better convenience for residents in the nearby local area, but it is very unfavorable for the nursing home to control the activities of the residents in a global manner.

In addition, most of spaces for assisted living of residents in these nursing homes are in relatively deep locations, and residents go to these spaces probably because of the function of these spaces. Of course, there are also some spaces for assisted living of residents that are in relatively shallow locations, but their better accessibility is only for residents who live in nearby local area rather than for residents who live in the entire nursing home.

The room is the most critical private space for residents in a nursing home. In order to maintain the privacy of the living space, the junction with the outside is controlled at the entrance or the gate of the room, maintaining the relatively good accessibility of the room, and making it more convenient for the occupants to travel between their rooms and other spaces. While the bedroom, the toilet, and the bathroom with more private in the room are in a deeper location in order to maintain a considerable level of privacy. Therefore, the rule of the spatial layout of the resident′s room follows a certain gradient of privacy.

Likely, the layout of the staff spaces follows a certain variation of gradient. Staff space is divided into two main attributes, one is the space for external services and another one is the space used by employees themselves. There s a tendency for staff spaces that have nothing to do with residents to be in the deeper locations, such as staff duty stations that require constant monitoring of residents, so they are in shallower locations, while staff rest rooms that have almost nothing to do with residents, are in a deeper location. Therefore, the layout of the space is designed to minimize the intrusion of the employees' flow into the residents' flow, so as to keep the residents' living space pure and independent.

In terms of space type, there are two main types of nursing home composition. One type is dominated by the exhaustive space, and such a nursing home usually reflects a stronger and more boring spatial framework. The other is the 'c' type of space, where the home has a weaker spatial framework and the residents have more freedom to find their way around. The main reason for this difference is the addition of a continuous shared balcony at the periphery of the building, which transforms the residents' individual rooms from end-to-end spaces into passable spaces. But despite the presence of balconies, the occupants have more possible route options. However, it is clear from the degree of integration that the interior corridor still has a greater ability to attract flow than the exterior balcony, and that the interior corridor remains the dominant planar transition space that dominates the internal flow of the nursing home. This helps to ensure that residents are more easily monitored during their daily movements by embedding staff stations or cameras in the corridors, thus reducing accidents and ensuring that most residents have a more convenient wayfinding experience within the home. experience.

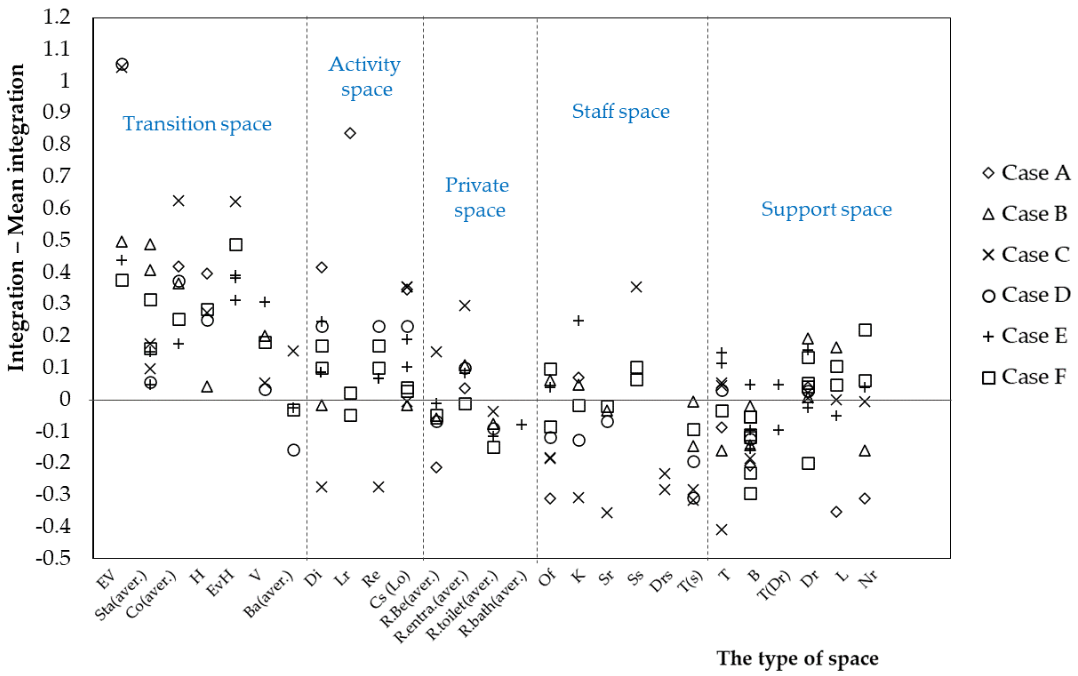


Figure 5-32 Distribution of integration values (Mean integration-integration) of the spaces within the nursing homes

Essentially, the interior space of a nursing home consists of two kinds of groups, a residential space with the residents as a group and a service space with the service providers as a group. The living space is an equal and repetitive, but also the most important space in a nursing home. It is also possible to assume that the nursing home is a structure where spatial differentiation is weak, but is reinforced by the presence of some service spaces, including staff spaces, in order to keep the staff spaces from interacting with the residential spaces as much as possible. Many spaces in nursing homes follow a social solidarity that is a mechanical solidarity, the mechanical solidarity that is mainly followed because of the function of the space that attracts the occupants to gather there, such as most of the service spaces, and even many of the activity spaces. The opposite of mechanical solidarity is organic solidarity. The space of organic solidarity is unsully dense and nucle0ated in order to facilitate exchange and interaction. Residents tend to gather naturally in such spaces, most typically in the canteen and living room in Case A.

Spatial organisation is often influenced by the character of the designer, local cultural policies and so on, but there are still many similarities in the spatial organisation of buildings of the same type. Architects are obliged and obliged to design a building by practice or by experiencing first-hand the way of life of the people who inhabit it.

CHAPTER 6
INTERPRETING THE CORRIDOR-BASED SPATIAL LAYOUT OF INTERIOR SPACES IN NURSING HOME

6. Interpreting the corridor-based spatial layout of interior spaces in nursing home

With the aging world, the quality of daily life for older people is gaining more attention. The older people′s health status and mobility decrease as they age. The elderly people are more willing to migrate to the nursing home with better accessible amenities from their own home environment. The built environment is the most primary, enveloping, the largest and the most socially significant artefact that humans create. In addition to the meaning of a physical shelter, a built environment is a meaningful formation of information that expresses the psychological need, social premise, and lifestyle of the inhabitant. The nursing home is a social welfare-built environment that specially provides comprehensive assistance in daily activities, complex care, and nursing needs for the elderly. Normally, in addition to providing living arrangements, nursing homes are equipped with some basic care facilities. Therefore, it is a topic worth exploring how to arrange the various functional spaces in a nursing home to provide a better living experience for the elderly.

Although the research to date on nursing homes has covered many disciplines, most has focused on care and social environment. In terms of the built environment, researchers have been working on the physical environment of nursing homes in the hope of improving the quality of life of residents. For instance, Burke et al. attempted a grounded theory approach to enabling articulation of new conceptual-spatial relationships between residents and physical environment of the nursing home based on residents′ lived experiences and aspirations; Davis et al. hoped to focus thinking for the design of the built environment from the perspective of the occupant's living experience to address and create a more occupant-friendly physical environment of the nursing home. Eijkelenbooma′s team researched the impact of architectural factors on the sense of home for elderly people living in nursing homes and developed design guidelines to improve the experience of nursing home residents; Burton et al. studied the effect of a particular spatial environment on the elderly; Rodiek et al. studied the preference of elderly residents for specific environmental characteristics of nursing homes; Parker, et, al. studied the individual space′s design objects such as security or privacy through the assessment of the physical environment; Shuang and Masataka's team studied the facility configurations of different types of Japanese nursing homes. However, research on the built environment of nursing homes mainly focused on the studies of individual spaces and the configuration of facilities, but little is known about the spatial layout of nursing homes.

The spatial layout is not only an important part in the architectural design process, but also a key attribute of the building's expression of its own function. More importantly, studies suggested that the spatial layout can predict people's wayfinding behaviour in the building, and can affect people work behaviour and productivity. So, how are the spaces laid out in the built environment of vulnerable people? This paper investigated the 168 existing commercial nursing homes in Japan to address this issue. The survey revealed a certain similarity among the spatial layouts of these nursing homes. In particular, some similar solutions regarding spatial layout, which include the number of corridors, the corridor combination, and spatial distribution, are widely used. Normally, the design of a building influenced by many factors, such as local requirements, client′s requests and preferences, building regs, designer′s personality. why did these spatial layouts end up being selected and widely used under a multitude of factors? Is it because these spatial layouts provide a

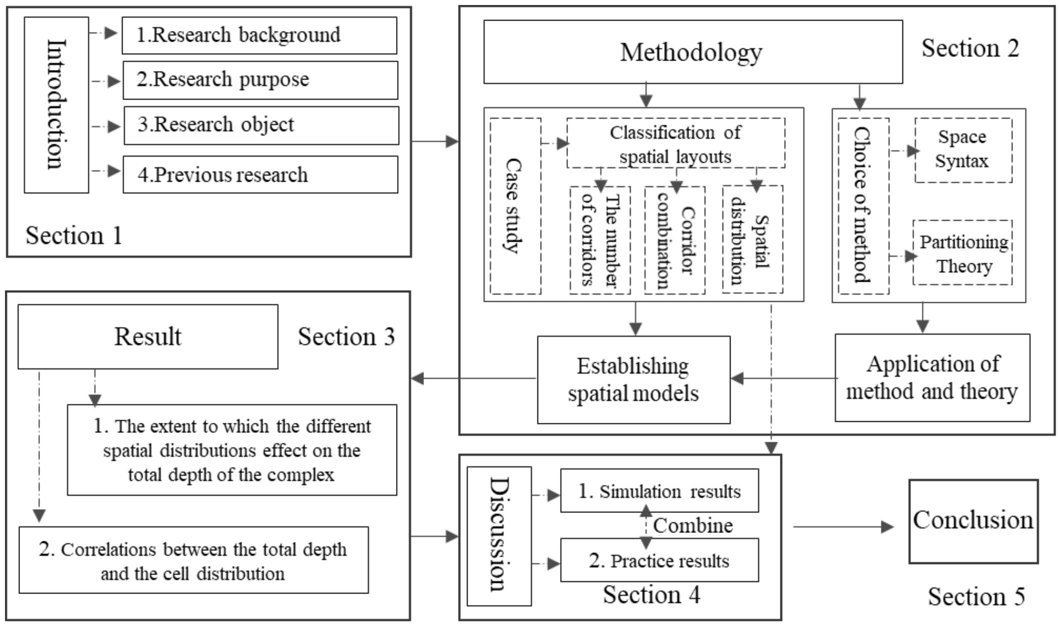


Figure 6-1Research framework

better living experience for the residents, such as better wayfinding? Or is the spatial distribution in them more rational? Regarding these questions, this paper attempts to explore these spatial layouts within a theoretical framework to seek a better understanding of the spatial layout of nursing homes. This combined framework is built through a series of case studies of the nursing home and seeks to develop a theoretical consensus based on experience. Finally, the paper examines the impact of the possible forms of different spatial layouts on their subjects in the light of the spatial models established by space syntax studies. The expectation is to discover the design principles that designers follow when laying out spaces for nursing homes, generating enlightening information and guidance for designing nursing homes. And the research framework is shown in Figure 1.

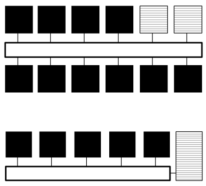
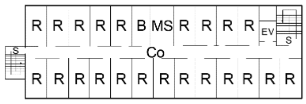
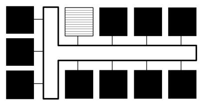
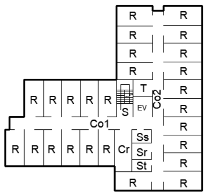
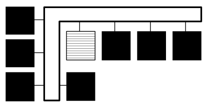
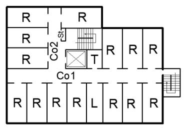
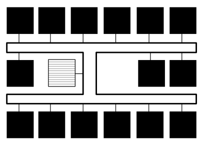
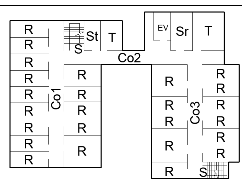
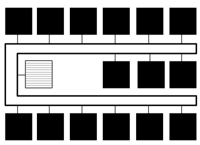
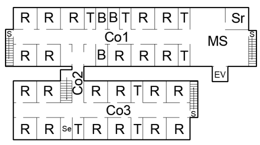
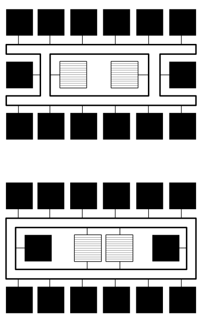
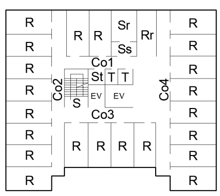
6.1. Classification and Description of The Main Spatial Layouts

Spaces for movement form an integral part of any building organization, and the overall configuration of the circulation paths indirectly describes the spatial layout of a building. Within a nursing home, a corridor undertakes the circulation path and transition space between a series of individual rooms. Of 524 plans in the 168 nursing homes, there are 483 plans with at least one distinct long corridor per unit. One plane even consists of as many as 9 corridors. The spaces in the nursing home are joined together by corridors. Hence the number of corridors and the combined form of corridors are crucial factors in forming the spatial layout of the nursing home. Based on the survey of 168 Japanese nursing homes, four main spatial layouts are derived depending on the number of corridors the plan consists of. Table 2-9 shows the sketch maps of four spatial layouts and the usage rates of the four spatial layouts in the nursing homes. And the descriptions of four spatial layouts (a to d) are as follow:

a. Single-Corridor type. A series of individual rooms in a nursing home plan is organized by a single corridor.

b. Dual-Corridor Type. Two corridors, which form in a T-shaped or L-shaped, organize a series of

Table 6-1 The classification of corridor-based spatial layouts

Type	Sketch map	Case	Usage rate: Plan (524)	Usage rate: Nursing home (168)
a. Single-corridor type		 (a-1) Homogenous type	49.81% 261 units 49.81%	63.69% 107 units 63.69%
b. Dual Corridor Type		 (b-1) Homogenous type	33.21% 162 units 31.30%	44.26% 69 units 41.07%
		 (b-2) Non-homogeneous type	12 units 2.29%	5 units 2.97%
c. Tri-Corridor Type		 (c-1) Homogenous type	5.91% 29 units 5.53%	11.9% 19 units 11.31%
		 (c-2) Non-homogeneous type	2 units 0.38%	1 units 0.59%
d. Ring-Corridor Type		 (d-1) Homogenous type	2.29% 12 units 2.29%	2.97% 7 units 2.97%

■ Room ▢ Function space ▭ Corridor

Abbreviations of room labels are as follows:
B Bathroom Cr Communication room Co Corridor D Dining room EV Elevator
H Hall K Kitchen L Laundry Of Office R Room
S Stair Sr Staff room Ss Staff station St Store T

c. Tri-Corridor Type. A series of individual rooms within a nursing home plan is organized by three corridors which normally form in an H-shaped or C-shaped.
d. Ring-Corridor Type. A ring circulation path, which consists of more than three corridors, organizes a series of individual rooms in a nursing home plan.

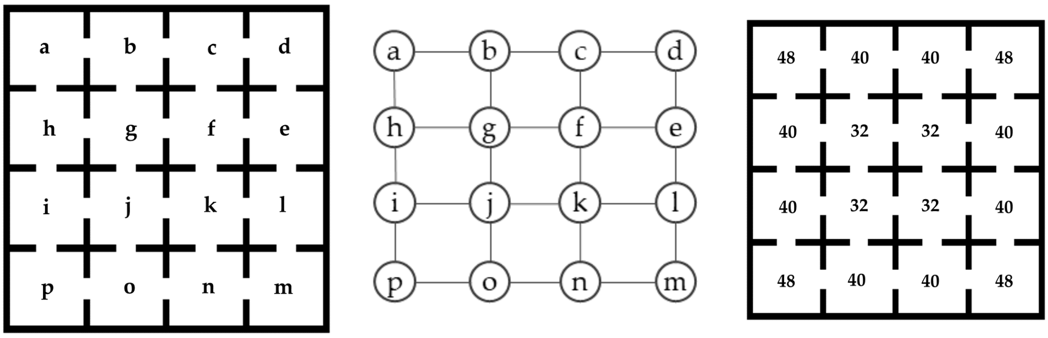
The survey results show that 97% of 168 nursing homes adopt at least one of four spatial layouts as the organization of interior space. It is rare that a plan of the nursing home utilizes over four corridors. This indicates that designers have a certain constraint on the use of the number of corridors when organizing the interior spaces of nursing homes. In addition, the data reveals designers prefer the use of certain spatial layouts in their designs. Clearly, the highest usage rate is for the spatial layout of Single-Corridor type which is used in approximately two-thirds of nursing homes and in half of the plans. Subsequently, the spatial layout of Dual-Corridor Type appears in 44.26% of the nursing homes and in 33.21% of the plans. Nevertheless, the usage rate of the spatial layout of Tri-Corridor Type and Ring-Corridor Type is merely 11.9% and 2.97% of the nursing homes and 5.91% and 2.29% of the plans respectively. These data demonstrate that designers are more willing to utilize a spatial layout constituted by comparatively fewer corridors when designing a nursing home. Finally, in 91.23% of the plans the layouts of spaces adopt one of the four types. And in 17 plans the number of corridors is more than 3. The corridors are combined in a ring form form of corridors does not belong to any of four types.

Further investigation, based on four spatial layouts, reveals that the designers have similar solutions for the spatial distribution particular in the arrangement of the number of rooms. Firstly, around 94% of the plans with the spatial layouts of Dual-Corridor Type conform to a pattern of spatial distribution. The pattern, called homogenous type, exhibits that the number of rooms on corridor 1 is approximated by that on corridor 2 as shown in Table 2-9 (b-1). In contrast, the inhomogeneous type accounts for a very small proportion of the total. Secondly, Table 2-9 (c-1) depicts a dominant pattern (homogenous type) of spatial distribution within the spatial layouts of Tri-Corridor Type. This pattern illustrates that the number of rooms on corridor 1 and corridor 3 are similar, meanwhile they exceed the number of rooms on corridor 2. Likewise, an explicit pat-tern of spatial distribution exists in the spatial layouts of Ring-Corridor Type. It is consistent with that the number of rooms on the opposite side corridor approximates each other as shown in Table 2-9 (d-1). In short, these spatial distributions reflect the distribution characteristics of relative symmetry in morphology.

Therefore, we can infer that designers have a preference in using the number of corridors, the combined form of corridors, and spatial distribution when designing the nursing home. The preference indicates that these spatial layouts are considered by the designers to be relatively superior and reasonable compared to their homologous counterparts.

6.2. Partitioning Theory: Gaining or Losing Total Depth

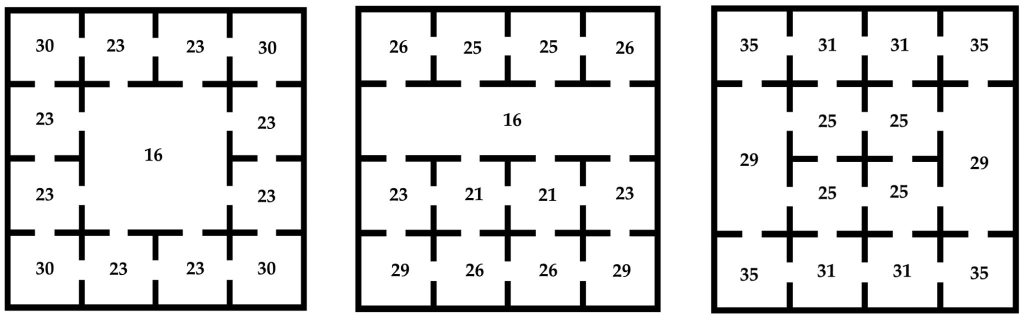
How the change in the spatial formation affects the depth of the space, or how it manifests itself in the gain or loss of depth. Regarding these questions, Hiller suggests partitioning theory. Depending on the partitioning theory, a 4 × 4 complex in which a total of 16 cells (a-p) are evenly



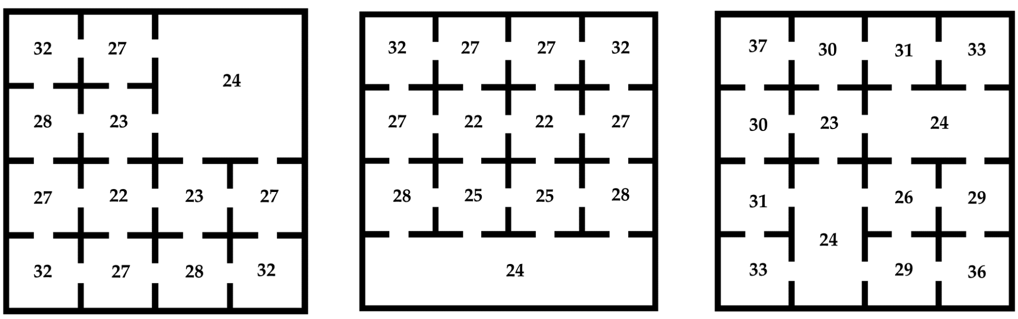
Layout of 4 x 4 cells (a) | Connectivity between cells (b) | Total Depth = 640 (c)

Figure 6-2 Spatial layout of 4 × 4 cells opens to each other; (b) Graph of connectivity between cells; (c) Total depth value of each cell from all the others

(a) (b) (c)



Total Depth = 320 (a-1) | Total Depth = 316 (b-1) | Total Depth = 422 (c-1)



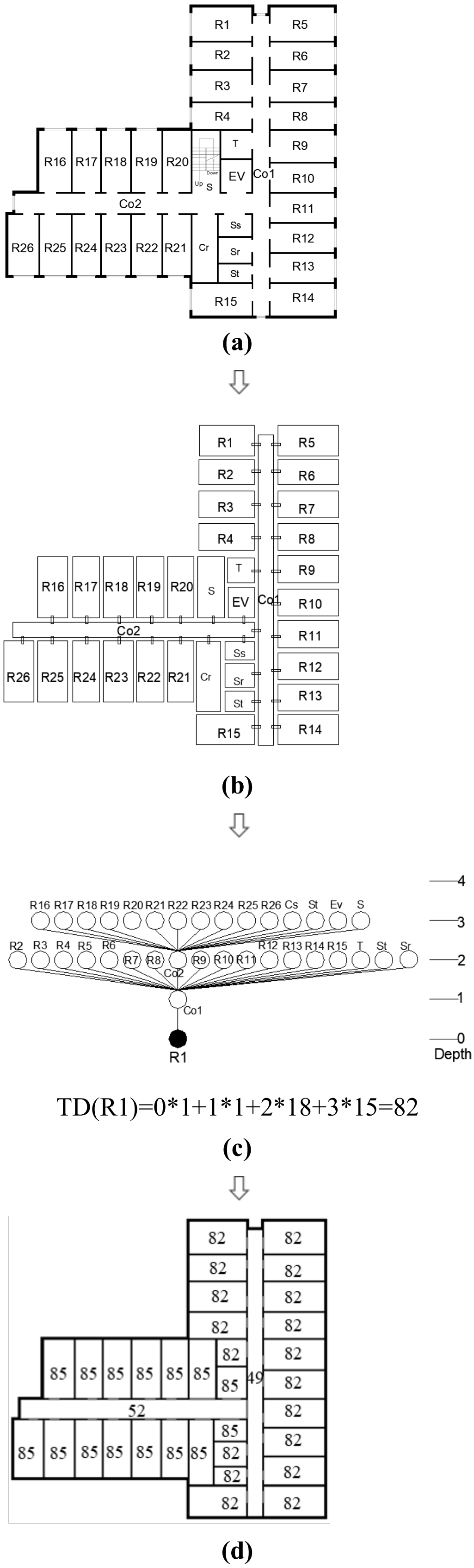
Total Depth = 352 (a-2) | Total Depth = 346 (b-2) | Total Depth = 416 (c-2)

Figure 6-3. The effect of larger space on the total depth in the complex; (a) Larger space with 2 × 2 cells; (b) Larger space with 1 × 4 cells; (c) Larger space with two 1 × 2 cells distributed within a square, and all cells are open to each other (Figure 6-2 (a)). And Figure 6-2 (b) shows the connections between all the cells in the complex. Then, the total depth values of each cell can be obtained by the formula of calculation. Finally, adding up the total depth values of all the cells, this complex has 640 depths as shown in Figure 6-2 (c). How depth gains or losses determine spatial formations. An explanation is creating a larger space in the complex resulting in a change in the total depth. For instance, in Figure 6-3 (a, b), larger spaces in the complexes are created by eliminating the existing two-thirds partitions in four adjacent cells. It can be noted that the larger spaces with different shapes and locations have implications for the total depth of the complex from the four complexes (Figure 6-3 (a, b)). And the total depth of the complex with a centrally placed open 'square' is 32 depths less than that of the complex with a peripherally placed open 'square' (Figure 6-3 (a-1), (a-2)). Figure 6-3 (a-1, b-1) shows that a linear larger space will result in the complex losing more depth than a compact one. In the two examples in Figure 6-3 (c), the larger space consisting of four open cells is divided into two two-cells spaces. By comparing c-complexes with a-complexes, b-complexes, a comparable number of discrete spaces create more depth for the complexes than continuously joined spaces.

6.3. Application of partitioning theory

How is a nursing home plan diagram translated into a depth diagram? An example based on a nursing home plan can help us to understand. Figure 5a shows a nursing home plan in an "L-shape". The plan is turned to a diagram of the connected relation between convex spaces or function spaces (see Figure 5b) (a convex space is defined as a space in which all points can completely see each other, and it is represented as a rectangle in the paper.). The convex space diagram is then transformed in a justified graph, and the total depth of each space is calculated according to equation 1. Figure 5c shows a justified graph drawn from space R1, and the process of calculating total depth of space R1. Finally, the total depth of the space is labelled into each convex space as shown in Figure 5d.

Within the partitioning theory, it has been clarified that the shape, location, and the number of larger spaces will affect the total depth of a complex. A corridor in a building plan acts like a large space in a complex of the partitioning theory. Similarly, it can be inferred that the number of corridors and the corridor combination have an impact on the total depth of a building plan. Then, the ideal models which resemble the grid complexes of the partitioning theory are created depending on the spatial layout within the nursing home. And these models are shown in detail as follows: Firstly, suppose that there are 10 individual cells, without a direct connection, linked by the corridors within a complex. Secondly, four models are conceived according to the number of corridors they consist of as shown in Figure 6(a-d). Another three models composed of identical number of corridors but with different combined forms of corridors are created as shown in Figure 6(d-f). Thirdly, different spatial distributions within each model are represented by altering the number of cells on the corridor, such as complex (b-1) to complex (b-4) in Figure 6. Finally, six groups of models are formed. Considering that the change in the number of corridors gives rise to the deviation in the total number of spaces within the complex. And the deviation will affect the gain or loss of the total depth of the complex. Therefore, here the sum of the total depths of the 10 cells are used to represent the total depth of the complex. Finally, the total depth of each cell is marked separately on each cell of each complex. And the total depth of each complex is shown below each complex



Abbreviations of space labels are as follows:

Cr: Communication Room

Co: Corridor

Ev: Elevator

R: Room

S: Stair

Sr: Staff room

Ss: Staff Station

St: Store

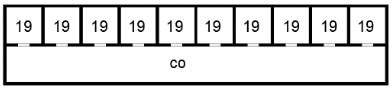
T: Common Toilet

Figure 6-4 (a) a 2nd floor plan of a nursing home; (b) The convex space diagram with labels; (c) The justified graph drawn from Space R1; (d) The depth diagram of the plan.

in Figure 6-4.

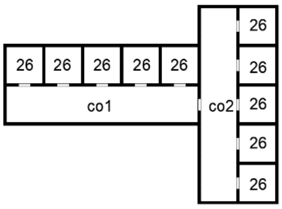
The first point can be drawn from Figure 6 is that the discrete corridors create more depth for a complex than a single corridor. This can be derived from the fact that the total depth of the complex (a-1) is less than that of any other complex in Figure 6. The second point can be obtained is that the complex tends to gain more depth as the greater the number of corridors it is composed of. Complex (a-1), (b-1), (c-1) and (d-1) are taken as examples. The total depth increases from 190 in the complex (a-1) to 360 in the complex (d-1) as the number of corridors rises from 1 to 4. This can also be seen by comparing the average total depths of the complex in different models. As the number of corridors within the complex increasing from 1 to 4, the average of total depth of the complex changes from 190 in Model (a) to 253 in Model (b), 325.75 in Model (c), and 355 in Model (d). The third point is that the gain or loss of the total depth of a complex is related to the cell distribution. In each model, each complex which represent a cell distribution has a unique total depth of the complex. Particularly in four complexes of Model (b), the number of cells on corridor 1 declines from 5 to 2, and that on corridor 2 increases from 5 to 8. The result follows a sequential reduction that the total depth of the complex reduces from 260 to 258, 252, and 242. The last point concerns that the total depth of a complex will be affected by the combined form of corridors the complex consists of. This can be evidently derived by comparing the complex (d-1), (e-3) and (f-1) in Figure 6. The cell distribution where each corridor carries 3, 2, 2, and 3 cells in sequence, is consistent among the complex (d-1), (e-3) and (f-1). But the three complexes have the total depth of 360,382 and 406 respectively. In addition, the average total depths of the complex in Model (d), (e) and (f) are different. Especially the average total depth in Model (d) which has 355 is lower than that with 398.5 in Model (e) and that with 395.5 in Model (f). Therefore, preliminary results suggest that the total depth of the complex will be affect by the number of corridors, the combined form of corridors and the cell distribution.

(**a**)



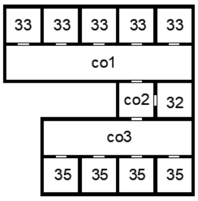
(**a-1**) Total depth=190

(**b**) (**c**) (**d**)



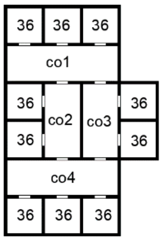
Total depth=260

(**b-1**)



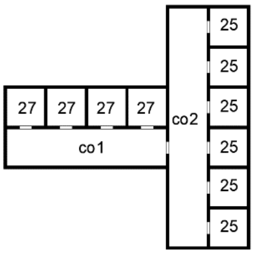
Total depth=337

(**c-1**)



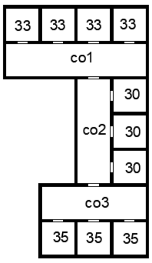
Total depth=360

(**d-1**)



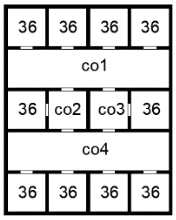
Total depth=258

(**b-2**)



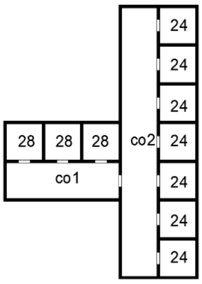
Total depth=327

(**c-2**)



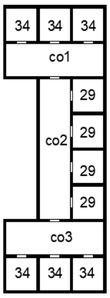
Total depth=360

(**d-2**)



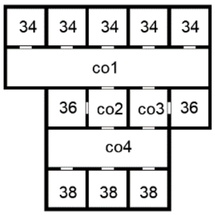
Total depth=252

(**b-3**)



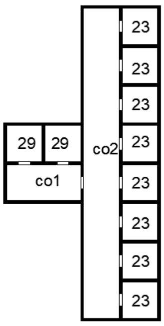
Total depth=320

(**c-3**)



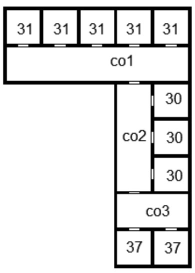
Total depth=356

(**d-3**)



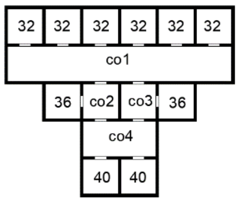
Total depth=242

(**b-4**)



Total depth=319

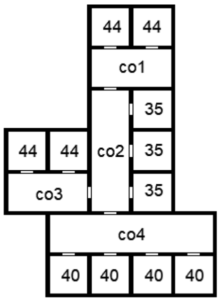
(**c-4**)



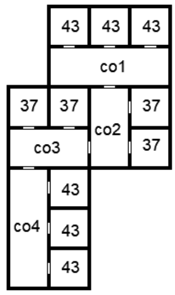
Total depth=344

(**d-4**)

(e)



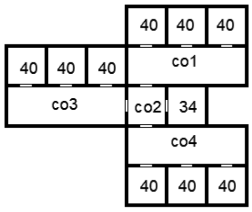
(f)



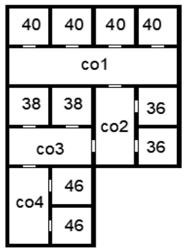
Total depth=441

Total depth=406

(e-1)



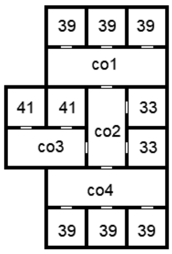
(f-1)



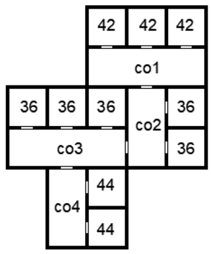
Total depth=394

Total depth=400

(e-2)



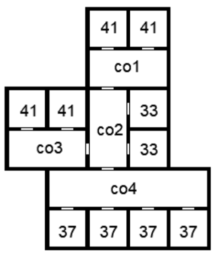
(f-2)



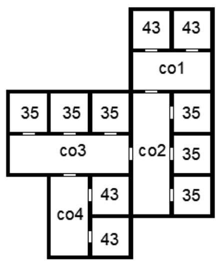
Total depth=382

Total depth=394

(e-3)



(f-3)



Total depth=378

Total depth=382

(e-4)

(f-4)

co=corridor

Figure 6-5 The total depth of each complex and the total depth of the cell in each complex within 6 models: (a) single corridor; (b) double corridors; (c) three corridors; (d)(e)(f) four corridors ((e)(f) serve as the control groups of (d)).

The further explorations will focus on two goals. The first one is to explore which factor has a greater impact on gain or loss of the total depth of the complex. For instance, the total depth increases 60 from the complex (b-1) to (c-3), while it gains 77 from the complex (b-1) to (c-1), an additional 17. The consequence is subject to two factors including the number of corridors and the cell distribution. But in the instance, which factor is dominant can't be determined intuitively. The second goal is to discover the correlation between the total depth and the cell distribution. When a complex is partitioned by the corridors, the total depth varies with the number of cells connected on the corridors. The first relatively apparent correlation is expressed between the total depth of the complex and the cell distribution in the complex. It can be elaborated as that the complex gradually loses the total depth as the cells are progressively clustering on a corridor. In other words, the complex has more potential to gain total depth when the cell distribution tends to be homogeneous. This correlation is clearly presented in the variation of the four complexes in Model (b). From the complex (b-1) to (b-4), the number of cells on corridor 1 decreases from 5 to 2, conversely, that on corridor 2 increases from 5 to 8, resulting in a decrease in the total depth of the complex from 260 to 242. This can be interpreted that as the difference between the number of cells on corridor 1 and 2 rises from 0 in complex (b-1) up to 6 in complex (b-4), which means the cell distribution tends to inhomogeneous, the total depth of the complex reduces 18. In addition, the variation between part of the complexes in Model (c) or (d) also reflects the correlation. For instance, the most cells with 5 on corridor 1 but the least with 2 on corridor 3, and the difference is 2 in the complex (c-4) with the total depth of 319. Yet in the complex (c-2) with the total depth of 327, the most cells with 4 on corridor 1, the least cells with 3 on corridor 2 or 3, a difference of 1. The cell distribution in the complex (c-4) is more inhomogeneous than that in the complex (c-2), the total depth of the complex in the former is less than that in the latter by 8. Similarly, the difference of the cells in the complex (d-4) is 4, and that in the complex (d-1) is 1, the complex (d-1) has 16 total depths of the complex more than the complex (d-4). Hence it suggests that the shifts between these two complexes in Model (c) and (d) are consistent with the first correlation.

The second relatively apparent correlation is related to the relation between the cell distribution and the total depth of the individual cell. In detail, the total depth of the cell on a corridor decreases as the number of cells on that corridor increases, and vice versa. That is, the greater the difference between the total depths the cells on the different corridors have as the cell distribution becomes more inhomogeneous. A clearly regularity about the correlation is presented in the complexes of Model (a). As the difference between the number of cells on corridor 1 and 2 increases from 0 in the complex (b-1) to 6 in the complex (b-4), the difference between the total depth of the cells on corridor 1 and on corridor 2 expands gradually from 0 to 2, 4, and 6. In the complex (c-4) with 3 differences of the number of cells, the cells on corridor 3 have the highest total depth with 37, but that on corridor 2 have the least total depth with 30, a difference of 7. In the complex (c-2) or (c-3) which has only 1 difference of the number of cells, the difference between the total depths of the cells is 5. So, it suggests that the change in cell distribution from the complex (c-4) to (c-2) or (c-3) tends towards homogeneous, with a reduction in the difference between the total depths of the cell. Similarly, as the homogeneity of the cell distribution increases sequentially from the complex (d-4) with 5 differences of the number of cells to the complex (d-3) with 4 differences, and the complex (d-1) with 1 difference, the difference between the total depths of the cell decreases gradually from

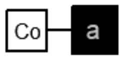
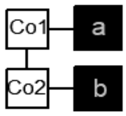
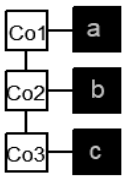
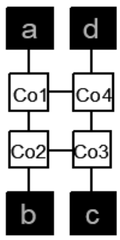
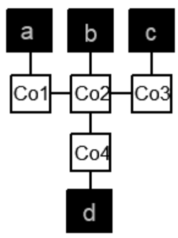
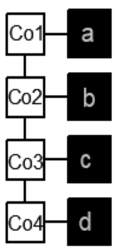
8 to 4, and 0.

A relatively clear pattern of variation between the complexes in Model (b) reflects the above two correlations. However, the two correlations seems to be reflected just in part of complexes of Model (c) and (d). For instance, the cell distribution in the complex (c-1) is more inhomogeneous compared to the other three complexes in Model (c). But the complex (c-1) gains the most total depth, meanwhile where the difference between the total depths of individual cells is minimal. This seems to embody the exact opposite character to the two correlations. In addition, despite the differences of the number of cells are identical in the complex (c-2) and (c-3), the complex (c-3) has 7 more total depth than the complex (c-2). Within the Model (d), the shifts between the complex (d-4) and (d-3) is fully consistent with the two correlations. Nevertheless, the shifts between the complex (d-2) and (d-1) exhibit a unique correlation. In detail, although the cell distributions are different in complex (d-2) and (d-1), the total depths of the complexes are identical as well the total depth of each cell. Therefore, these suggest that the shifts between the complexes in Model (c) and Model (d) are possibly influenced by other rules in addition to the two correlations. However, with only four complexes of each model, the exploration here is limited, the results may be full of chance and are lack of conviction. Hence, the next study will further refine these two goals, and validate and complement the findings here from a more comprehensive range of cases.

6.3.1. Acquisition of cases

Assuming that there are 'n' individual cells, without a direct connection, connected by the corridors within a complex, the number of cells on each corridor is labeled as a, b, c, and d, as shown in Table 2. And three cross-referenced experiments are designed, the total number of cells in each experiment is 10, 20, and 30, respectively. Each experiment consists of 6 sub-experiments (T1 to T6). The variables among the former four sub-experiments (T1 to T4) contain the number of corridors and the number of cells on each corridor. The latter two sub-experiments served as control groups for sub-experiment T4, where the variables include the combined form of corridors and the number of cells on each corridor. Then each complex within each sub-experiment represents a kind of cell distribution. Meanwhile, the total depth of each complex and the total depth of each cell need to be recorded. Finally, the number of complexes in Table 2 shows all possible cell distributions in each sub-experiment. And these numbers have excluded duplicated cell distribution due to symmetrical distribution.

Table 6-2 Information of the sub-experiments in three experiments.

Type	Sketch maps of the cell distribution		Number of complexes		
			n=10	n=20	n=30
T1		a=n	1	1	1
T2		a+b=n	5	10	15
T3		a+b+c=n	16	89	209
T4		a+b+c+d=n	16	146	507
T5		a+b+c+d=n	22	207	711
T6		a+b+c+d=n	40	498	1847

Co=Corridor, a, b, c, d=Number of cells, a, b, c, d >0

6.4. Results

6.4.1. The extent to which the number of corridors, the combined form of corridors and the cell distribution effect on the total depth of the complex

Normally, each complex within the identical sub-experiment obtains a unique total depth due to the different cell distribution. Thus, each sub-experiment generates a range about the total depth of the complex. Figure 6-6 (a-c) shows the maximum, minimum, and average total depths of the complex within each sub-experiment of three experiments. The maximum total depth means that within the identical sub-experiment the total depth of a complex is larger than that of any other complex. Whilst the definition of the minimum total depth is the opposite of the maximum total depth. The average total depth conveys the central tendency of the total depths of all the complexes in a sub-experiment. Finally, the range of total depth (maximum total depth – minimum total depth) describes the range and dispersion of the total depth of the complex. And the distribution of the range of the total depth for all sub-experiments is displayed in Figure 6-6 (d).

From Figure 6-6 (a-c), the first point can be noted that each sub-experiment possesses a unique range of total depth. It indicates that the variations of cell distribution generate different degrees of impact on the total depth of the complexes in different sub-experiments. Therefore, we cannot conclude which complex from the different sub-experiments obtained more total depth. But the average total depth within each experiment shows a clear upward trend from sub-experiment T1 to T4, or T5, or T6. The trend statistically reflects that the complex consisting of fewer corridors has a greater potential to gain less total depth. Particularly, the single corridor has the absolute advantage of keeping the complex with least total depth. In addition, the average total depth of sub-experiment T4 is apparently lower than the average total depth

of T5 or of T6. It illustrates that a ring-corridor brings less total depth to the complex than other forms which consist of the identical corridor with the former. Meanwhile the rising trend of the average total depth attenuates on sub-experiment T4. These means that the ring-corridor can effectively weaken the total depth of the complex brought by the increased number of corridors.

Figure 6-6 (d) shows the tendency of the range of the total depth among the different sub-experiments. First, vertically, the range of the total depth in each column noticeably expands as the number of cells in the complex rises from 10 to 30. Second, horizontally, the range of the total depth in each row tends to enlarge when the corridors within the complex increases from 1 to 4. Finally, the tendency of the range of the total depth is overall exhibited radially from the point of sub-experiment T1. However, an exception is that the trend drops off at the point of sub-experimental T4. The range of the total depth in sub-experimental T4 is narrower than that in sub- experimental T5 or T6, even smaller than that in sub-experimental T3. And this drop is greater as the number of cells in the complex increases. These trends statistically articulate that the variation of the total depth of the complex is less and more stable when the complex consists of fewer corridors, fewer cells, or a ring-corridor.

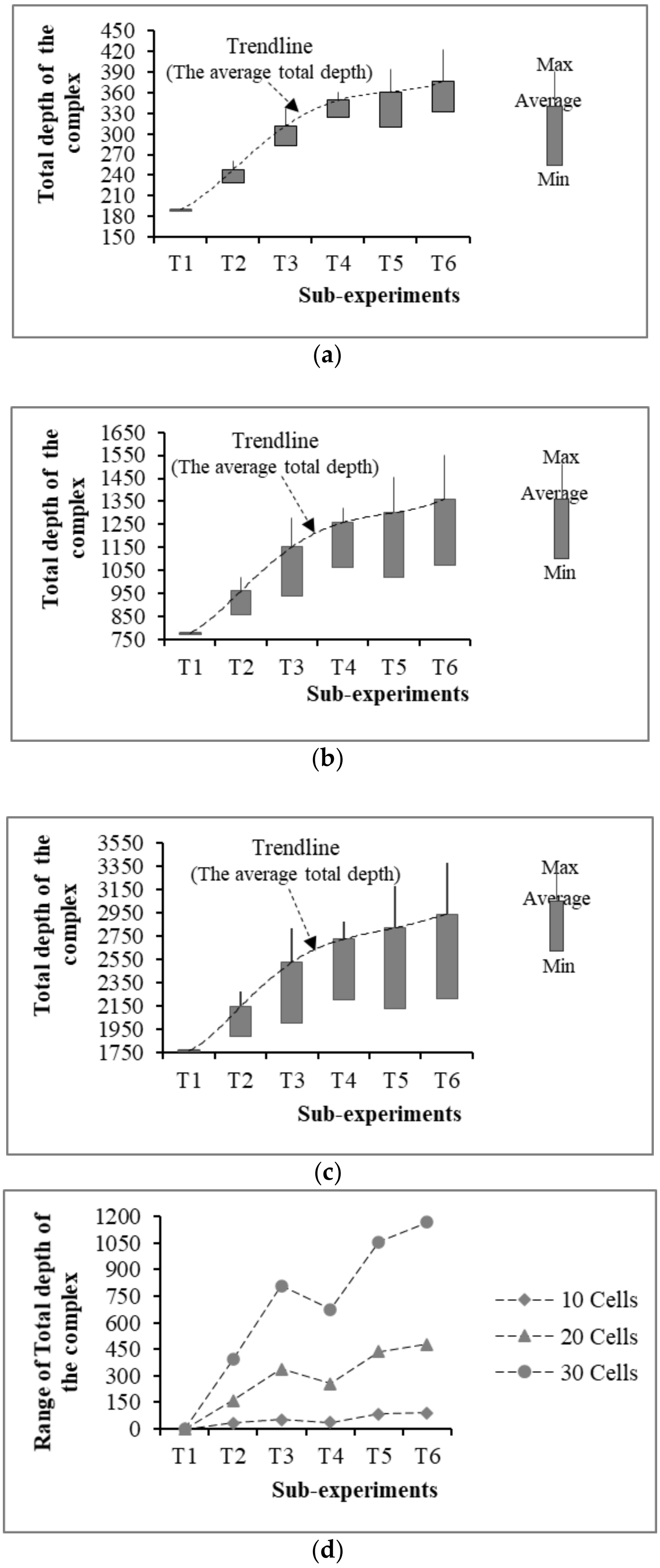


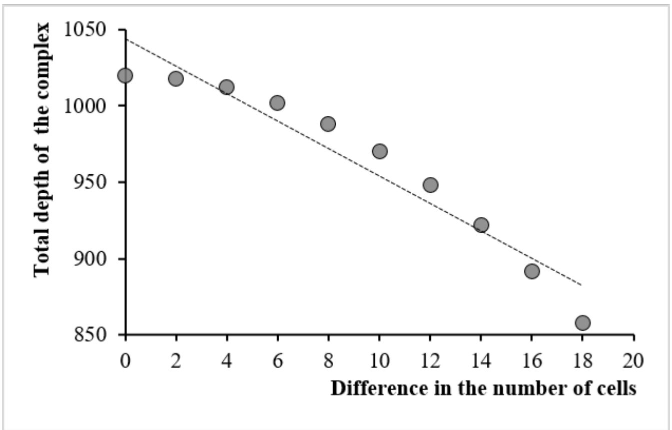
Figure 6-6 The maximum, minimum, and average total depths of the complex within each sub-experiment of three experiments.: (**a**) n=10, (**b**) n=20, (**c**) n=30; (d) The distribution of the range of the total depth for all sub-experiments.

6.4.2. Correlations between the total depth and the cell distribution

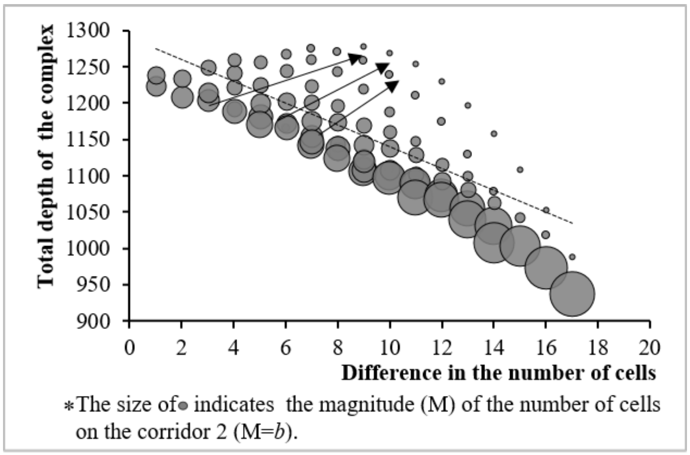
The complex of sub-experiment T1 consists of one corridor, where the cell distribution and total depth are constant. Hence the objects of the study focus on the complexes in sub-experiments T2, T3, and T4. And the experiment n=20 is selected as the case.

First, probing and verifying the regularity between the total depth of the complex and the cell distribution in the complex. Here the difference in the number of cells represents the degree of homogeneity of the cell distribution. The difference derives from that the number of cells on a corridor minus that on another corridor. For instance, in a complex consisting of three corridors and 20 cells, the number of cells on each corridor is 2, 5, and 13 respectively. Then 13 (max)-2(min)=11 represents the difference in the number of cells in this complex. When the difference is taken as the independent variable X, the total depth of the complex as the response variable Y, a graph of the relationship between them is obtained. The three graphs in Figure 8 represent the distribution of all the complexes in sub-experiments T2, T3, and T4, respectively. In Graph (a), the total depth of the complex shows a parabolic decrease as the difference in the number of cells becomes larger. Graph (b) and (c) overall show the trend like that in Graph (a). Partially, several exceptions which against the trend exist in Graph (b) and (c). The reason is that the trend is influenced by additional factors in sub-experiment T3 and T4. In sub-experiment the factor is that the variation in the number of cells on corridor 2 has a greater impact on the total depth than that on other corridors. As shown in Graph(b), the size of the dot indicates the magnitude of the number of cells on corridor 2, the bigger the dot, the more cells. Graph (b) shows that within the identical difference in the number of cells, the smaller the total depth of the complex as corridor 2 carries more cells. It suggests that when the cells are concentrated on corridor 2, the complex has more advantage in obtaining less total depth. That is, despite the difference in the number of cells increases, the total depth of the complex perhaps rises instead. Because the total depth the complex loses by the larger the difference in the number of cells is perhaps less than that gains by the decrease the cells on corridor 2. This is reflected in Graph (b). As shown by the arrow, as the difference in the number of cells expands, a few complexes gain more total depth. In sub-experiment T4, the factor is related to the difference between the number of cells the mutual opposite side corridor has. Specifically, the difference refers to the difference in the number of cells on corridors 1 and 3 or that on corridors 2 and 4. Graph (c) takes the sum of the two differences as another independent variable in addition to the difference in the number of cells. The size of the dot indicates the magnitude of the sum of the differences, the bigger the dot, the greater the sum. Clearly, the complex with smaller sum gains more total depth, when the sum is 0, the complex obtains the most total depth. Besides, within the identical difference in the number of cells, the complex loses the total depth as its sum increases. These lead to that the complex where the difference in the number of cells increases does not necessarily lose total depth but has a global trend in losing the total depth.

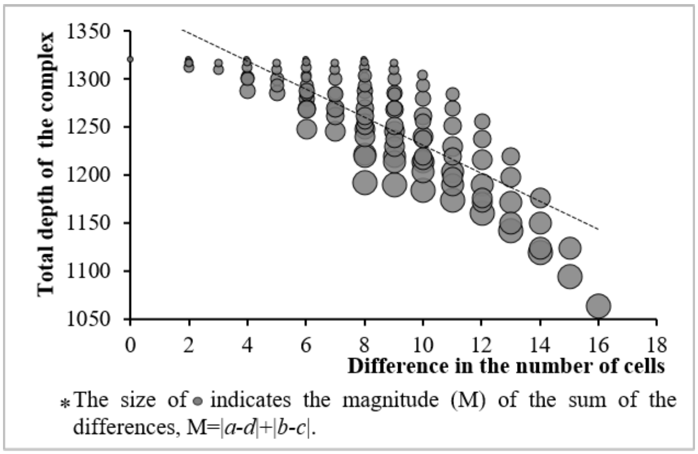
Second, the section will focus on discussing the regularities between the total depth of the individual cell and the cell distribution in the complex. Likewise, the difference in the number of cells is taken as the independent variable X, while the range in the total depth of cell as the



(a)

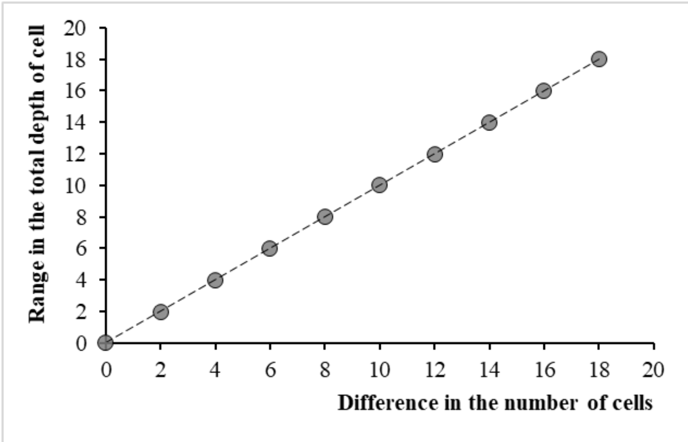


(b)

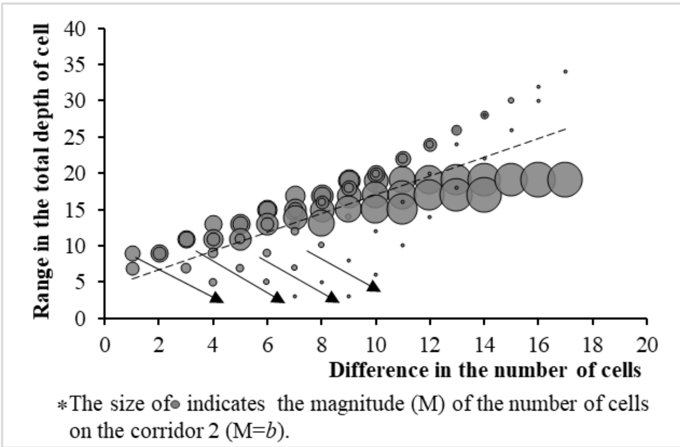


(c)

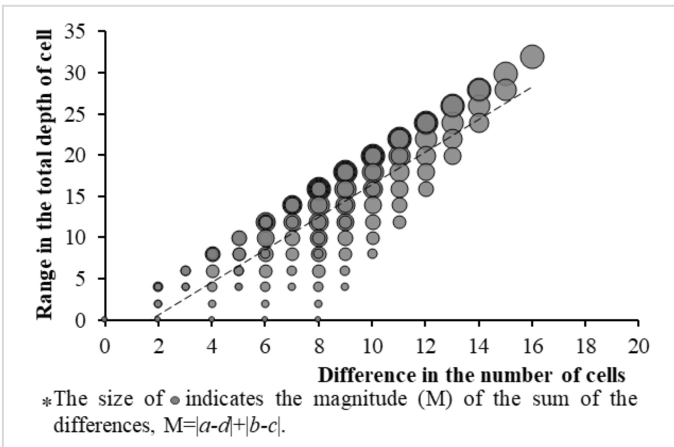
Figure 6-7 The relationship between the total depth of the complex and the difference in the number of cells in the n=20 experiment: (**a**) Sub-experiment T2, (**b**) Sub-experiment T3, (**c**) Sub-experiment T4.



(a)

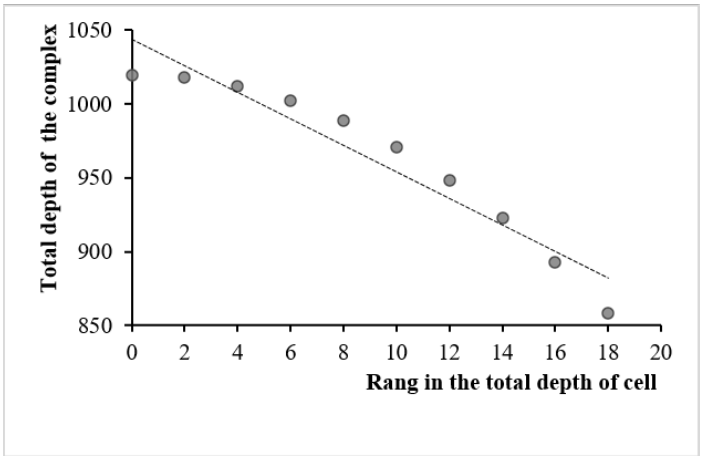


(b)

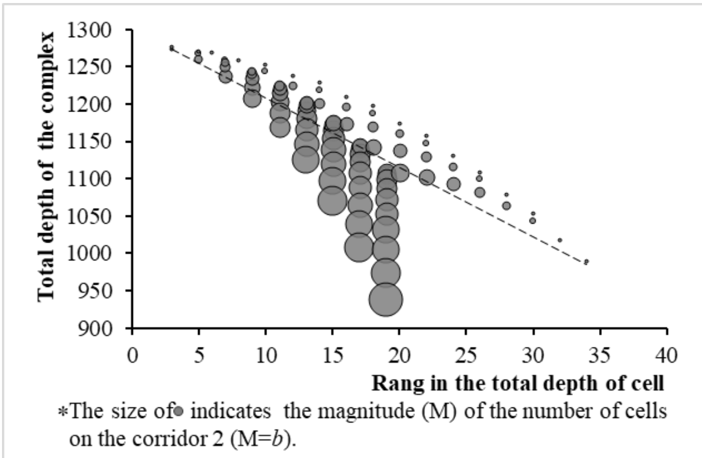


(c)

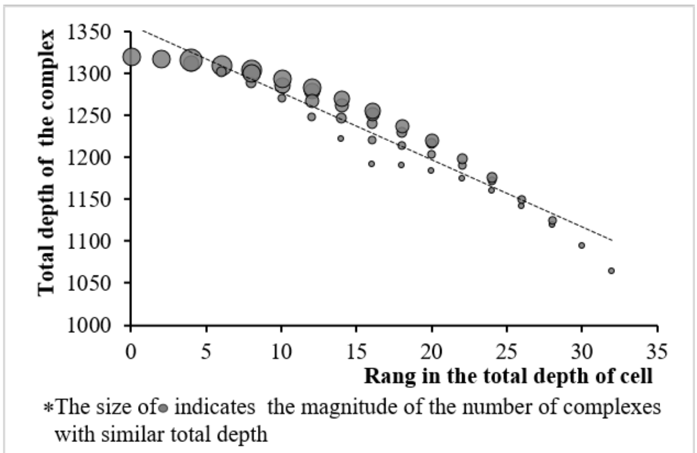
Figure 6-8 The relationship between the range in the total depth of cell and the difference in the number of cells in the n=20 experiment: (**a**) Sub-experiment T2, (**b**) Sub-experiment T3, (**c**) Sub-experiment T4.



(a)



(b)



(c)

Figure 6-9 The relationship between the total depth of the complex and the range in the total depth of cell in the n=20 experiment: (a) Sub-experiment T2, (b) Sub-experiment T3, (c) Sub-experiment T4.

response variable Y. The range in the total depth of cell represents the degree of homogeneity of the cell distribution in terms of the spatial depth conception. The range derives from the difference between the total depth a cell has most and that another cell has least within an identical complex. Graph (a), (b), and (c) in Figure 6-7 show the correlation between two variables in three sub-experiments. Graph (a) illustrates the standard positive correlation between the two variables. This means that within the complex of sub-experiment T2, the inhomogeneity of the cell distribution in the number directly determines the degree of inhomogeneity in depth. Whilst the correlation in Graph (b) appears relatively ambiguous, but is linear globally. Likewise, the size of the dot indicates the magnitude of the number of cells on corridor 2, the bigger the dot, the more cells. In general, the range in the total depth of cell expands with the increase of the difference in the number of cells in sub-experiment T3. However, the ranges in part of complexes declines as the difference rises within the region where the difference is less than 10. And the range is smaller as fewer cells on corridor 2, as shown by the arrows. It illustrates that when the cell distribution within the complex is relatively homogeneous, keeping the smaller cells on corridor 2 enables a more uniform cell distribution in depth. Conversely, when the cell distribution within the complex is extremely heterogeneous, the unevenness of cell distribution in depth can be reduced when the cells are concentrated on corridor 2. Graph (c) demonstrates the apparent correlation between the variables. In the graph, the size of the dot indicates the magnitude of the sum of the differences, the bigger the dot, the greater the sum. When the difference and the sum are smaller, the cell distribution in the complex is more homogeneous in depth. It means that the homogeneity of the cell number distribution in the complex of sub-experiment T4 is reflected by the difference and the sum.

Finally, the three graphs in Figure 6-9 are supplemented to illustrate the relationship between the total depth of the complex and the range in the total depth of cell. An anti-correlation is observed from the graphs that the range in the total depth of the cell is smaller, the total depth of the complex is larger. This implies that the cells within the complex are more homogeneously distributed in terms of depth, but most of the cells are instead at deeper locations.

6.4.3. Discussion and conclusion

This study objectively interprets the properties of the spatial layout being widely adopted in a quantitative and numerical way of thinking by using partitioning theory. The architecture educators, particularly those who are interested in the design of nursing homes, may benefit from this study. The design of a nursing home should be based on a human-centred philosophy, and aim to provide the best possible living experience for the residents. However, the design process of a building is certainly influenced by many factors such as local regulations, the requests and preferences of the residents, investors′ requirements, building regulations, etc. The final building that is presented to us is created by the architects after balancing all these factors. Therefore, the design solutions that are currently widely used, including spatial layout, are to some extent relatively more rational and superior than others. There are many factors that affect the quality of life of the elderly in a nursing home, such as the care environment, the adequacy of facilities and the built environment. Wayfinding behaviour is inevitable in the daily life of elderly people in nursing homes. A good spatial layout can facilitate the wayfinding behaviour of elderly people with relatively fragile physical conditions. The total depth in the space syntax is a variable that measures the degree of spatial accessibility in a building, and in this paper is used to assesses the overall accessibility of planes with different spatial layouts.

The results show that a complex consisting of fewer corridors has more potential to gain less total depth, leaving the space within the complex at a shallower position globally. Particularly, the spatial layout of a single corridor brings the least total depth to the complex, resulting in the spaces with a high degree of accessibility in the complex. It means that residents can find their destinations more easily in the plan consisting of fewer corridors. In practice, in the commercial market of nursing homes in Japan, the nursing home in which the spaces in the plan are organized by one or two corridors is also dominant. It is even rare that a nursing home plan consists of over four corridors. In terms of corridor combinations, the ring-corridor can effectively reduce the total depth of the complex brought by the increased number of corridors, thus increasing the accessibility of the interior space of the complex. In fact, when the number of corridors forming the nursing home plan increases, especially when there are more than three, the use of ring-corridors occupies a dominant position compared to the other corridor combinations. But in shape, the ring-corridor forms a closed circular route in a plan thus reducing the number of dead ends, and residents within that plan can find their destination from any point on the corridor. In this respect, the spatial layout of the ring-corridor seems to be more friendly to the movement of elderly people with dementia. However, the nursing home in which the plan is organized by the ring-corridor occupies only a relatively small part of the market. Therefore, these suggests that the design solution that provides better convenience and accessibility for residents is a very important consideration in the design of nursing homes.

In terms of spatial distribution, these spatial layouts that are widely adopted in practice have the similar characteristic of being relatively symmetrical in form and relatively homogeneous in depth. That is, the spaces in these spatial layouts are at locations with similar spatial depths and have relatively equal accessibility and convenience. It suggests that in the plans consisting of these spatial layouts, the spatial distribution is more balanced, avoiding some spaces being located far away from the subject. But these spatial layouts bring the complexes more total depth. This means that in the plans consisting of these spatial layouts, the space is generally at a relatively deeper location with relatively poor accessibility, and it is more difficult for residents to arrival their destinations. The principle of adopting a spatial distribution seems to be the opposite to that of adopting the number of corridors and the corridor combinations. So, in spatial distribution, the design solution seems to focus more on maintaining a balanced spatial distribution.

In addition, the results also shows that the number of corridors and the corridor combinations have a greater potential impact on gain and loss of total depth in the complex than the spatial distribution. This implies that changing the number of corridor or corridor combination of corridor has a greater impact on wayfinding of the residents in the plan than changing the spatial distribution. Therefore, it can be inferred that a design principle for the nursing home is to improve accessibility of the spaces by minimizing the use of corridors within the plan or using ring-corridor when the corridors increase and then to maintain an even plan design by adjusting the spatial distribution.

6.5. Conclusion

This paper analyses the impact of different spatial layouts on the accessibility of spaces from the perspective of people′s movement in the plan through the spatial models established by using partitioning theory. The results show that changing the number of corridor or corridor combination of corridor has a greater impact on wayfinding of the residents in the plan than changing the spatial distribution. Therefore, in terms of the number of corridors and the corridor combinations, the spatial layout which facilitates the residents' wayfinding is adopt in more nursing home plans, but in terms of spatial distribution, the plan layout of nursing homes is more focused on a balanced design and less on the convenience and accessibility of spaces. This shows that it is often necessary to consider a combination of possible factors, rather than focusing on one indicator when a building is designed.

In The Ten Books on Architecture, Vitruvius (15 B.C./1914) suggested that knowledge in architecture is the product of both theory and practice. The spatial models in this paper are built up through a series of case studies of the nursing home and provide an empirical explanation of the different spatial layouts based on a theoretical approach. Through a combination of theoretical and practical data, this paper demonstrates that the spatial layout determined in practice by a series of possible factors (such as user requirements, rule constraints, design experience, and common sense, etc.) can also be shown to be relatively reasonable and superior in a theoretical approach.

In conclusion, it should be noted that the spatial model is proposed as a way of thinking based on the study of space syntax to reading the spatial layout of the nursing home. In that sense, it might be suggested that the method could be a valuable contribution to the design of the nursing home. As it provides designers with a better understanding of principles and some knowledge of the systemic consequences of strategic design decisions. In terms of the accessibility of spaces, designers can use this method to simulate and analyze the spatial layout of the building before designing a building, as well as to assess the spatial layout of existing building. More importantly perhaps, it can also inform the application of new ideas, and encourage new ways of approaching the relationships between spaces.

However, the approach in this study is deficient in some aspects. Space syntax is helpful in predicting people's wayfinding as it focuses more on people's movement through building when it is used to study architectural space. But space syntax is based on relatively pure spatial topological relationships and studies architecture from a perspective of more rational and dialectical thinking, thus lacking consideration of the subjective consciousness and will of the residents. This perhaps leads to the research results being biased towards idealization. In addition, the analysis in this study is based on simplified models built up from summaries of practical cases. The individual cells in these models are all identified as one type of space, which ignores the distinction between spatial types in the nursing home plan and lacks consideration of the differences in the size of space. Finally, wayfinding is just one factor that may affect the living experience of the elderly in a nursing home. The overall improvement of the quality of life of elderly people in nursing homes requires exploration and breakthroughs in a variety of areas. Regarding these shortcomings, further improvements are needed in future research, in the hope that a more comprehensive exploration and better study methods can help us to better understand the spatial layout of nursing homes and improve the quality of life of the elderly in nursing homes.

CHAPTER 7
DISCUSSION AND CONCLUSION

7. Discussion and Conclusion

7.1. Discussion

With regard to the composition and configuration of architectural spaces, the understanding of the significance of space in structuring social relations has been greatly increased by empirical research. Much more is now known about the effects which the physical form and structure of the urban grid have on observed patterns of human co-presence and movement, and about how large building complexes accommodate the programmed and unprogrammed activities of organizations. One aim of our research is to confirmed that the spatial measure of how integrated or segregated a particular space is within a building or a settlement is a powerful predictor of how busy or quite it is likely to be.

Integration is the key by which we can understand the social content of architecture and show how buildings and places function at a collective level. This is not a native 'architectural determinism' which says that buildings and places compel people to behave in particular ways. The effects which we have identified are from spatial patterns to patterns of movement among collections of people, which arise from everyone going about their business in a very ordinary way.

In parallel to the more public programme of research at the urban scale and into the building for work, welfare and leisure which shape most people's experience of architecture, systematic investigation has continued over the past two decades into the ways in which people's dwellings embody and express cultural and lifestyle preferences. The dwelling is the original building historically, and a universal building type today. Nearly everyone has some kind of a place to live, so everyone feels entitled to a view on what counts as good design in housing and what as bad. Nowhere is the relationship between architecture and life so passionately debated as in the association between architecture form and culture.

The nursing home as a place to provide a residential environment for the elderly, everywhere serve the relatively same basic needs of living, eating, entertaining, bathing, sleeping, storage and the like, but a glance at the architectural record reveals an astonishing variety in the ways in which these activities are accommodated in different nursing homes. The important thing about a nursing home is not that it is a list of activities or rooms but that it is a pattern of space, governed by intricate conventions about what spaces there are, how they are connected together and sequenced, which activities go together and which are separated out, even what kinds of the functional space should be arranged in the different parts of the nursing home. If there are principles to be learned form studying the design of homes, they do not yield easily to a superficial analysis of 'basic human needs'.

This study examines the spaces of a nursing home in terms of both directions including the composition of space and configuration of space, based on existing Japanese nursing homes. The architecture educators, particularly those who are interested in the design of nursing homes, may benefit from this study. The design of a nursing home should be based on a human-centred philosophy, and aim to provide the best possible living experience for the residents. However, the design process of a building is certainly influenced by many factors such as local regulations, the requests and preference of the residents, investors' requirements, building regulations, etc. The final building that is presented to us is created by the architects after balancing all these factors. Therefore, the design solutions that are currently widely used, including spatial layouts, are to some extent relatively more rational and superior than others. There are many factors that affect the quality of life of the elderly in a nursing home, such as the care environment, the adequacy of facilities and the built environment.

Although 950 samples in this study is relatively small for a study of thousands of nursing homes in Japan, these samples including a variety of civil nursing homes were collected from various regions of Japan, by all kinds of ways including the internet, e-mail and relevant books and journals, So, these samples are relatively reliable and representative. This study in chapter 2 begins with a global analysis of the 950 initial sample in terms of the rent fee, the ratio of the number of staffs to the number of residents, the year of opening, the structure, the number of floors, the scale of building including the gross floor area of the building and the number of resident's rooms the nursing home equipped, and the type and size of the rooms, to gain a preliminary understanding of the current policy, fees the elderly spend, the speed of development of nursing homes and level of care for nursing homes in Japan now. From the 950 samples, 168 nursing home with detailed information were then screened. These nursing homes were provided with the full floor plans where the detailed functional spaces were labelled, and with a variety of basic information about the nursing home, for the rest of study.

What spaces are the interior of a nursing home made up of, how big functional spaces are available to meet the living needs of the residents in the nursing home, and how are these spaces placed in relation to each other? Does the spatial distribution within the nursing home follow certain rules or patterns? And why are these patterns so widely adopted? In Chapters 3 and 4, this paper analyzes and summaries typologically and empirically the composition of the types and dimensions of the functional spaces in the nursing homes, and the relationship between the position of these functional spaces, based on detailed plans of 168 nursing homes. In Chapters 5 and 6, the article explores the rules of spatial distribution within the six nursing homes by using the theory of space syntax, and interprets the choice of corridor-based spatial layout.

7.1.1. What spaces are interior of a nursing home made up of?

The nursing home as an alternative place of residence that specially provides comprehensive assistance in daily activities, complex care, and nursing needs for the elderly, which is equipped with a variety of functional spaces like a mini-community dedicated to the elderly. While overall, the nursing home consist of four types of spaces, in addition to the private space consisting of the resident's room that is necessary for the elderly in a nursing home, a type of space is called common space which can be shared to be used by all the residents in the nursing home. The common space is made up two types of spaces, one is activity space where the residents can enjoy eating, entertaining, doing some rehabilitation and communicating, such as the dining room, the rehabilitation area, the communication space, and the living room. The other one is supporting space that can provide residents with some functional spaces, may not be equipped in the room, for assisted living, such as the common toilet, the common bathroom, and the laundry. A type of space named service space, which is not as public as the common space. This type of space is mainly available to residents, employees, or visitors at specific times or for specific events. For instance, the nursing home where the caregivers work and offer services for the residents who need medical help, such as daily health check. The last type of space called staff space, is a place where the staff deal with all matters relating to the nursing home, such as the office, the kitchen, and the staff rest room.

Furthermore, the room, as the main space in a nursing home, although its function is to provide living space for the residents, in different nursing homes or even within a nursing home, different types of rooms are equipped to meet the needs of the residents. Firstly, the vast majority of rooms equipped in the nursing homes belong to the single room which provides separate living space for only one resident. But there are also a number of nursing homes that provide rooms for more than one person, most of which belong to the couple room which can provide a place for couples to live, and very few nursing homes are equipped with the room for more than two people. This seems to indicate that the approach of sharing living space with someone but a partner is unpopular and perhaps even difficult to be accepted by Japanese elderly people, even though it can reduce the rent payment. Therefore, it suggests that maintaining the independence and privacy of the living space is a relatively dominant consideration when a Japanese nursing home is designed. Secondly, the room can be classified into 14 categories, depending on seven functional spaces (consisting of living space (bedroom), storage, toilet, dresser, kitchen, bathroom and living room) the room are equipped with. In addition to the living space (bedroom), the majority of rooms have the dresser and the toilet, around half have the storage, and a few are equipped with the kitchen, the bathroom and the living room. Beside, the room type (living space + toilet + dresser) and room type (living space + toilet + dresser + storage) occupy a dominant position in all room types. This suggests that in addition to the bed, the toilet and the dresser are essential spaces to facilitate the daily living of the elderly, although in many nursing homes, the common toilet with the dresser is provided. Conversely, the bathroom, also a very private space, should be equipped in the room in principle, but seems to be less indispensable perhaps as the bathroom is used relatively infrequently and the elderly people need more assistance when they use the bathroom, in contrast, the elderly people can be better assisted in the common bathroom. The reason why the number of rooms with the storage isn't probably related to the fact that the storage can be replaced by some furniture without having to make space for it during the design. In addition, most of the nursing homes can deliver meals for the residents in a uniform manner, so naturally the kitchen in the room isn't as important. The size of room would increase due to the configuration of the living room, so that the price of the room would be higher, which can result in a higher cost for the elderly or their children or the government.

With regard to the common space, in general, there are 19 types of function spaces, the most common of which are the activity space, the common toilet, the common bathroom and the laundry, depending on the composition of the different nursing homes. Firstly, each nursing home is equipped with at least one, an average of 2.21 activity spaces for the residents. It suggests that the activity space for residents to stay for long periods of time or to hold activities are essential spaces for nursing homes. The activity space is mainly made up five types of space consisting of the dining room, rehabilitation area, communication space, multi-function space and living room depending on the function. But in many nursing homes, an activity space normally takes on more than one function, and the activity space can be classified into 12 types of space based on the functions it can provide. However, the dining room is the main function to be provided in most activity spaces and even each nursing home perhaps is quipped with 1.26 dining room in average. Therefore, this indicates that it is a higher priority to provide a place for residents to have their meals when designing a nursing home. Apart from the dining room, Although the activity space may appear to be used for relatively few other functions, in essential, the activity space is a space that can be used flexibly in a nursing home. In some nursing homes, the space is only marked as the dining room on the floor plan, but it can also used as a communication space where the residents can talk with each other before or after dinner, and can even be used as a place for doing some rehabilitation or holding some festive activity by switching or moving the equipment or furniture within the space.

Secondly, the number of common toilets in a nursing home is closely related to the scale of the nursing home and whether the resident′s rooms are equipped with private toilet. If a nursing home is large and equipped with more activity space, or if the rooms in the nursing home aren′t equipped with private toilets, the home will accordingly increase the number of common toilets to meet the needs of the residents. The nursing home is generally equipped with three types of common toilet including ordinary toilet, wheelchair used toilet and multi-function toilet, to facilitate the different needs of residents. Of which the majority of common toilets are of the wheelchair used toilet, while the other two are relatively few in number and most of the nursing home are equipped with the common toilet can be available for wheelchair. It means that barrier-free design is an important consideration for the common toilet, as well as an essential design criterion for nursing home. Although the ordinary toilet with simpler equipment requires less floor space and is more economical, it has an obvious limitation which can only be used by those who are relatively healthy residents, so it is less commonly used in the nursing home. Conversely, the multi-functional toilet, although very well equipped with equipment, is also less used in nursing homes. This is due to the fact that this kind of common toilet takes up more space, and are more expensive and less cost effective.

Thirdly, only a small number of resident′s rooms are equipped with private bathrooms, so in most nursing homes residents bathe in common bathrooms. Four types of bathrooms, including the unit bathroom, the special bathroom, the common bathroom and the spring bathroom, are frequently used as the common space in the nursing home, of which the unit bathroom with good privacy and simple support facilities and the special bathroom with full assistive devices are the most common in the nursing home. The common bathroom and the spring bathroom with the hot spring, which can be used by more than one person at a time, are relatively uncommon. In terms of number, there are also many more unit bathrooms and special bathrooms than the other two, in particular, the unit bathroom account for over 60% of the total. These can indicate two points, the first point is that privacy is an important design element in the design of common bathrooms, as most healthy elderly people prefer to enjoy bathing alone, the second point is that the accessibility is still an important principle in the design of common bathroom and that the special bathroom can assist residents with reduced mobility to complete their baths. While the common bathroom and the spring bathroom, which lack privacy, are less indispensable, even the spring bathroom offers the hot spring with wellness benefits. Based on the result that a nursing home is equipped with about three common bathrooms in average, the pattern, that the common bathroom the nursing home is equipped with, can be inferred is that a special bathroom with a number of unit bathroom is equipped in a nursing home to meet the bathing needs of the residents. Furthermore, it is common in nursing homes for different types of common bathrooms to share a dressing room, especially between the other three types of common bathrooms in addition to the unit bathroom, proving once again the importance of independence and privacy for the common bathroom.

Fourth, most nursing home have a dedicated laundry room for residents, but many of these are not paired with a dedicated drying room, which seems to feeds into the fact that most resident's rooms in nursing homes do not require individual laundry machines and that residents often need to take their dirty clothes to a special laundry room for washing. It also suggest that many of the laundry rooms are equipped with dryers so that residents can dry their washed clothes without having to dry them in the drying room, or residents can dry their washed clothes in their own rooms, which would have the advantage of avoiding mixing up residents' clothes while maintaining their privacy.

In terms of the service space, the nursing home generally involve four types of functional space, such as the consultation room, the nursing room, the reception room, and the beauty salon, of which the consultation room and the nursing room are the most common. The consultation room can be used as a place with multi-purpose services, to receive the visitor, or as a relatively private place for the resident to talk with each other or to communicate with the staff and the visitor. To some extent, therefore, the function of the consultation room is duplicated by that of the reception room, which is probably one of the reasons why most nursing homes aren't equipped with a reception room. Although Japanese nursing homes have regular cooperation with nearby hospitals, most are equipped with a dedicated space for caregivers with professional qualifications to stay for long periods of time, even some have several nursing rooms in different locations. In some nursing homes, the nursing room is integrated with the space of office. The function of the nursing room is to provide the residents of the nursing home with the basic daily medical needs. For a group of people with relatively fragile health, a stationary medical station in the nursing home not only provides a stable place to monitor the health of the residents, but also to cope with any unexpected situations. The nursing room is therefore an important design element of Japanese nursing homes.

Dedicated staffs are indispensable to maintain the normal day-to-day operations of the nursing home, as well as providing appropriate services to the residents. The office is the most basic staff space equipped in a nursing home and is the primary space provided for the staff to work. Some offices can also be used as nursing rooms. In a few homes there are more than two offices, one for staffs to work on external matters such as advice from outside and visits, and the other for staffs to work on internal matters such as assisting residents and consulting with them. The kitchen is another important staff space, usually accompanying the dining room, in which staffs can prepare meals for the residents. Although in some nursing homes, the kitchen is open for residents to use freely, so that they can participate in the preparation of meals and feel more at home, the kitchens with some dangerous appliances are still unsafe places and require good hygiene conditions, where residents are more likely to be injured and where it is more difficult for residents to control the hygiene conditions and make the food more vulnerable to contamination. This is why most kitchens in nursing homes are clearly demarcated from the outside and don't allow access to residents. Finally, in many nursing homes, a number of auxiliary spaces specifically for staff use are equipped in, such as the staff rest room, which provide a place for staff to rest and in which they can take a short break or spend the night, and then the dressing room where staffs can change their clothing when they come to work or at the end of the day. The two types of staff service spaces are placed in the same space or integrated in the office in some nursing homes. The staff station, a third type of staff service space which is more common in nursing homes, seems to be an extension of the function of the office. This type of space is generally embedded in the residents′ living area in homes. The presence of the staff station allows the staff to intrude into the residents′ living area, seemingly breaking the relative independence of the residents′ living area, but serving to monitor the residents′ daily activities and to be able to provide for their needs in a timely manner. This seems to indicate that the design of a nursing home has always given priority to the idea of providing quick assistance to the residents.

7.1.2. How big functional spaces are available to meet the living needs of the residents in the nursing home?

Let′s start with the room in the private space, which are the most dominant space in a nursing home, but the percentage of total space occupied varies greatly, for a maximum of 85.6% to a minimum of 6.5%. However, overall, the total space of the room account for 47.6% of the nursing home in average, suggesting that room space is the most important component of a nursing home. Although the size of individual rooms is as varied as the type of rooms, the majority of rooms are concentrated between 9.1 m² and 20 m², in particular, the number of rooms of around 18 m² has a dominated position in all rooms. This indicates that a room with around 18 m² is the most appropriate choice in Japanese nursing homes today, both in terms of economy and in terms of the living experience of the residents.

Apart from the rooms, the activity space in the common spaces is the largest functional space in a nursing home. Although it varies in different nursing homes, on average it occupies approximately 11.6% of the total space. On a per capita basis, each resident has approximately 3.38 m² of activity space. It means that it is currently reasonable to design nursing homes with around 10% of space, and with 3 m² per person, for residents to carry out their activities. The common toilet occupies a very small part of the nursing home, on average about 1.36% of the total space, although in some nursing homes with more common toilets, the space can occupy up to 4.32% of all space. The size of the different common toilets varies according to the number of facilities they are equipped with, but in general the size of the three types of common toilets is close to 2.34 m² for the ordinary common toilet with the most simplified facilities, 4.04 m² for the wheelchair accessible toilets with simple support facilities, and 5.3 m² which is the largest for the multi-purpose toilets with the most complete facilities. When designing a nursing home, it is relatively reasonable to allocate around 3.55% of the total space and 3.064 m² per person to the common bathroom. The unit bathroom in general has the smallest area, and the other three common bathrooms have a relatively larger area, but there is no fixed standard and it is still dependent on the designer′s overall control in the design. The size of the laundry room usually depends on the scale of the nursing home. However, on average, the laundry room generally takes up around 1.19% of the area of a nursing home, with most of them averaging around 9 m² each. Overall the majority of conversation rooms are concentrated between 5 m² and 14.9 m², with an average of 11.51 m², occupying approximately 0.89% of the area of the nursing home. The plan for the allocation of space to the nursing room in the nursing home is similar to that of the laundry room and the conversation room, with an average of around 11.97 m² each, taking up around 1.13% of the total area.

The office, which is the most important part of the staff space and one of the most vital functional spaces in a nursing home, accounts for a very small part of the nursing home, with an average of only 2.35% of the total space, and an average of 23.55 m² each. In terms of floor space ratio, the space allocated to the kitchen is relatively similar to that allocated to the office, at around 2.7% which is only slightly higher that the ratio of space allocated to the office. However, in term of area, each kitchen has an average of 34.56 m², which is over 10 m² more than the average area of each office. This suggests that the allocation of functional spaces, such as offices and kitchens, varies considerably from different nursing homes, and is influenced by uncertainties such as the designer's preference. This is also evidenced by the area ration of the other spaces in the staff space. Due to the distribution of these spaces in nursing home is relatively complex, in this paper their areas are integrated in such a way that, on average, these space account for about 2% of the space with more than 30 m² in each nursing home.

Finally, totally, the rooms occupy 47.6% of the total space in the nursing home, followed by the common space which occupy roughly 16.5%, the staff space which occupy roughly 7%, the service space which occupy about 2%, and finally the remaining around 26% of the space is used as transitional space. Almost all the spaces in the nursing home are set up around the residents' lives. The most important form of resident life is rest and activity, so the rooms and activity spaces closest to the residents' lives form the main space, and then some secondary space for living are distributed along with this main body, the spaces furthest away from the residents' lives are the staff spaces. The connection between these spaces cannot be made without the existence of transitional spaces. In terms of area distribution, the average area of transitional spaces is second only to the area of rooms. This indicates that the size of the transitional space is also an important point to note when designing a nursing home, even though it does not function as a function space and seems to be a rather wasteful space, but sufficient space has to be left for it. At last, the reference ratio of area zoning within the nursing home tends to be closer to 24:13:8.5:3.5:1 (Private space: transition space: common space: staff space: service space).

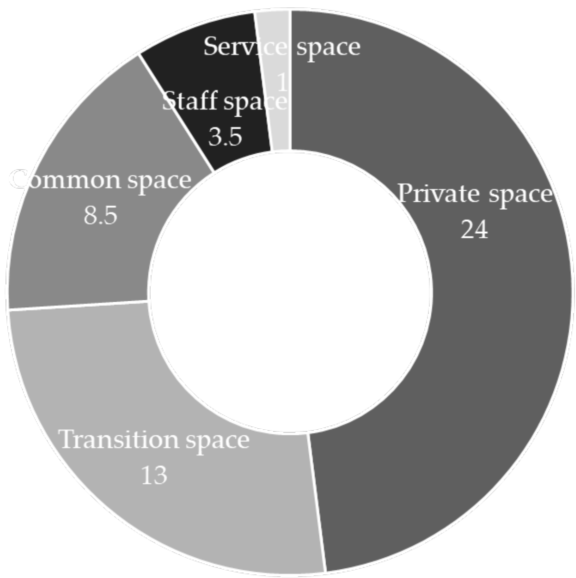


Figure 7-1 The ratio of area the spaces occupy the nursing home

7.1.3. How are these spaces placed in relation to each other?

How is the layout of the space convenient for the residents in the nursing home? The activity space is one of the more open and free areas of the nursing home and is also used more frequently by residents. There is a degree of variation in the arrangement of the location of activity spaces in different nursing homes. On the ground of the home, the users of the activity space may involve staffs and visitors, in addition to the residents. In some nursing homes, the activity space is directly connected to the entrance or vestibule, and functions to a certain extent as a hall. In these homes, staffs, visitors, and residents can access the activity space directly from the entrance without any buffer space. This increases the utilization of the space, but takes away much of the privacy of the space. In such spaces, the residents' daily activities can easily be disturbed by visitors from outside. For this reason, such a layout of the activity space is relatively uncommon in nursing homes.

The most common layout of activity spaces in nursing homes is the hall transition type. People enter the home from the outside and reach the activity space after passing through the hall. This layout of space largely prevents visitors from entering the residents' living space with the home, and most visitor-related business can be conducted in the hall without having to enter the home. The privacy of the residents' living space is largely maintained in this way. Even if some visitors have to enter the home, for example, to visit residents, the activity space is arranged close to the hall and provides a place for these activities without going deeper into the nursing home space. However, the activity space of the corridor transition type is embedded deep within the nursing home space, when people reach the activity space from the outside, they may have to cross not only the hall but also pass through the long corridor. The layout of this type of space, which is far removed from the outside world, provides a high degree of privacy for the residents. But if visitors need to visit the residents, they will have to go deeper into the nursing home, which will intrude to a large extent into the residents' living routs and deeper living areas, destroying the privacy of their living spaces. This layout is therefore less used in nursing homes than the hall transition.

On the other floors of the nursing home, the users of the activity space are less likely to consider outside visitors, so the frequency of use of the activity space layout pattern has changed somewhat. A significant increase in the use of activity spaces directly connected to the entrance has been observed. Except on the ground, the activity space on other floors is often designed for use by the residents of that floor or the residents of the nursing home, so that the spaces can be embedded in the residents' living areas for their convenience, and therefore the adoption of the corridor transition type of activity spaces is slightly increased. However, the gathering of residents in the space of this type of layout inevitably causes disturbance to other residents. When the floor plan is no longer an entrance floor, the buffering function of the hall is replaced by an elevator hall or a staircase hall, and its necessity is reduced, so that the adoption of the hall transition type of activity spaces decreases. But the activity spaces arranged close to these transitional spaces still have their own unique character. The elevator or staircase is a densely populated area in a nursing home, and the activity space is a relatively public living space. By placing these two relatively dynamic spaces together, the residents from different floors can come to this space to communicate without intruding into the more private living area of the floor. Hence, the layout of the activity space in the hall transition type and direct type can effectively contain the denser flow of people in one area of the floor and separate the dynamic and static spaces in the nursing home.

Although there are variations in the adoption of the activity space layout on the other floors, in general, the transition type of activity spaces is still dominant, and the direct type of activity space still has the lowest adoption rate of the three. Therefore, these also show that the private and public nature of the activity space needs to be properly grasped when a nursing home is designed, and even more so to ensure the privacy of the residents' main living space.

The functions of the different types of activity spaces vary, the most common and important activity space in a nursing home is the dining room. Moving around the different activity spaces within a nursing home is one of the important routs of movement for residents. It is therefore highly likely that the relationship between the location of the different activity spaces will have an impact on the movement of residents within the nursing home. When a nursing home is equipped with more than one type of activity space, the most common layout is to distribute them in different areas and keep a distance between them. In this layout, the dining rooms are generally arranged in areas that are relatively separate from the man living space of the residents, while other types of activity spaces are closer to the living spaces of the residents. The advantage of this layout is that the different activity spaces are clearly divided, so that residents who want to participate in different activities are not confused in the same area, and that some of the residents' daily activities can be carried out in the activity space closet to their room without having to travel long distance. The disadvantage is that such a layout rends to result in residents being scattered in different areas of the home, which is not conducive to unified management, and also requires more space in the nursing home. The layout of shared type is the opposite of that of separate type, which is also relatively common in nursing homes. The different activity spaces in this layout are integrated together and share one space. This layout allows the residents' activities to be effectively grouped together, which allows them to be better managed and saves a lot of space in the nursing home. But its disadvantages are also relatively apparent. In such a layout f a nursing home, the activities of the residents are often arranged in a uniform manner. The residents lack a specific area for some activities that are carried out spontaneously, and different activities have to be carried out in one space, which inevitably appears to be chaotic and unorganized. Therefore, in many nursing homes, different types of activity spaces are often arranged in a combination of shared type and separate type, with some activity spaces with similar or non-conflicting functions being arranged in a same space, and those closer to the residents' usual life being placed in the residents' living areas. This not only saves some space, but also enables residents to use the activity space more easily. However, the adjacent type where the different function spaces are placed in close proximity to each other is rarely used, as it is not only less space efficient than the layout of shared type, but also less convenient for the residents than the layout of separated type.

The resident's room is the main living space for residents and the place where they spend the most time every day. Several times a day residents move between their rooms and other space. It can be said that the most important path of movement for the inhabitants is from the room to the other function spaces. The position of the rooms in relation to other function spaces will therefore largely influence the movement routs of the inhabitants. In general, a greater variety of function spaces in addition to the rooms are equipped on the ground of the nursing home than on other floors. On the ground of the home, the flow of people is more intensive, and the variety of flow lines is more complex. So, while it may be easier for residents to reach the function spaces when residents live on the ground, the privacy of their living space is greatly compromised. Residents living on other floors are mostly concerned with dealing with their neighbors. But those living on the ground are not only dealing with their neighbors, but also with residents from other floors, and their living areas are more exposed to the movement routs of staffs and even the flow of visitors from outside. Therefore, in most of the entrance levels of nursing homes, rooms and other function spaces are usually laid out on both sides of the floor plan to ensure the privacy of the residents' living areas. Even in some nursing homes, there are no rooms at all on the entrance level, which is more effective in ensuring the privacy of the residents' living areas. However, if the other function spaces are not large enough to fill the floor plan, this can lead to a waste of space. It is therefore easier to control and capture the use of space when a nursing home is designed by the layout of unilateral type. And this layout is the most common way that the spaces on the ground of nursing homes are arranged, followed by the separate type, while the other two layouts are very rare.

On other floors, it is only necessary to consider the interface between residents, without the need to consider the intrusion of staff flow or visitors' flows on residents. Therefore, the spatial layout that the function spaces are embedded into the living space of the residents is often used in these floors. In this kind of the spatial layout, the function spaces can be located closer to the residents' rooms, which makes these spaces more accessible to the residents on that floor. However, such a spatial layout allows relatively public function spaces to intrude into the residents' living area, thus reducing the privacy of the residents' living space. So, the spatial layout of unilateral type, which enhances the privacy of the residents' living space but reduces the degree of convenience of the residents' use in that floor, is also adopted in many nursing homes.

In conclusion, in terms of the layout between rooms and other function spaces, taking into account the convenience of the resident's use and the privacy of the residents' living area is an important consideration in the design of the nursing home. In addition, the layout of space of the enclosure type allows residents to access public spaces with great ease, but this layout breaks down the privacy of the living space. And the lack of light in the public areas also increases the consumption of electricity. So, it is rarely used to organize the space within the plan of the nursing home.

Transition spaces occupy a large part of the nursing home just second to rooms. Transition spaces connect the different function spaces, in the vertical direction, the elevator and the staircase link the different floors, and in the horizontal direction, corridors take on the role of connecting the different spaces on a floor plan. Hence, the elevator, the staircase and the corridor together form the most basic circulation path in a nursing home. In particular, the spatial distribution of the plan is significantly influenced by the number of corridors and the combined form of corridors. The spatial distribution of the single-corridor type has the highest adoption rate, both in terms of adoption in nursing homes and in terms of the organization of space within the floor plans. The plan where the spaces are connected by a single corridor, has a very simple spatial layout. In such a floor plan, the residents simply follow a corridor to arrive at their destinations from their rooms, without any diversions in the path. This layout of the spaces is friendly to residents with dementia, and residents don't have to make choices at the fork in the road and get lost. However, this spatial layout also has the obvious disadvantages. In addition to the monotony of the layout, when the number of spaces in a plan is large, a long corridor is needed to connect these spaces, which can result in residents having to travel a long distance to get from one space to another, thus lacking good accessibility in the distance of the path. This disadvantage is exacerbated for elderly people who have difficulty with their legs. Therefore, this type of the layout is more suited to the floor plan of nursing homes with smaller scale. The high rate of adoption of this spatial layout in Japanese nursing homes also suggests that many nursing homes are relatively small in scale.

As the floor plan of the nursing home increase in size, the spatial layout of single-corridor type becomes unsuitable and is replaced by the spatial layout of dual-corridor type consisting of two corridors forming ′T″-shaped. This spatial layout effectively solves the problem of long paths that form as the scale of space in the floor plan increases, although it does create a fork in the path that cause some obstruction to residents with dementia in their path. As a result, this spatial layout has a relatively high rate of adoption in both nursing homes and their floor plans. As the scale of the home increases, the number of corridors used in the floor plan increases. In the floor plans consisting of the spatial layout of tri-corridor type, the corridors are formed in a ′C′-shaped or ′H′-shaped. Although this kind of spatial layout alleviates the problem of long paths between spaces, the number of bifurcations in the path rises to two in the floor plan of this spatial layout. When the number of corridors reaches four, the ring-corridor type is the most common to be used in the spatial layout of floor plan. In such a floor plan consisting of this spatial layout, more bifurcations are created in the path, but the distance between spaces has a significant reduction. And in the plan of ring-corridor type, the corridors form a circular path, so that residents can return to their starting point from one space on the path, regardless of which direction they start from. This compensated to some extent for the weakness of the multiple bifurcations which are not friendly to residents with dementia. Hence, in almost all floor plans consisting of four corridors, the spaces are organized by the ring-corridor type. But, the plans with an excess of four corridors are rare, and even the plans consisting of three and four corridors are rarely used in the design of the nursing home. These seem to indicate that Japanese nursing homes with large scale are relatively rare, and that a simple spatial layout is preferred when a nursing home is designed. Furthermore, in those floor plans where the internal space is organized by more than one corridor, the spatial distribution tends to show a relative symmetry. This seem to suggest a preference for spatial design that is balanced in terms of spatial layout.

7.1.4. Does the spatial distribution within the nursing home follow certain rules or patterns?

The nursing homes are not just assemblages of individual spaces but intricate patterns of organized space, governed by rules and conventions about the configuration of spaces. Which the activities go together, what kind of daily object are appropriated in each setting, how the residents relate to one another in different spaces, and how and where the visitors and the staffs should be received and worked in the nursing home. We have already seemed that even the most simple of plans can be considered by breaking up the interior in the way into its constituent elements and relations, for instance in this paper convex spaces are used. The viewpoint will yield insights into how the space of nursing home is organized for social purposes. The largest generation of computer techniques permits these different spatial representations to be overlaid directly upon one another so as to recapture a multi-layered spatial experience of the interior, and then to explore how the nursing home unfolds experientially to the moving observer in an animated ʻwalk-throughʼ of the interior.

We have seen that the configurational patterns which result from partitioning space are themselves lawful. Crudely, space is lawful because it is not possible for two entities to occupy the same space at the same time. Spaces can be assembled together into a larger continuous entity only by placing them next to one another or by putting them inside on another. Most of the time, people who use space do so ʻwith their feet on the groundʼ which means that its two-dimensional extent has a more immediate impact on human activity than does the experience of volumetric space. More importantly, the spatial property of depth, whether from the outside or the generalized depth of each space in the nursing home from all others, which is another way of conceptualizing integration, is lawful in its operations. Depth from the outside and integration within the interior are the two dimensions of the layout of a home which usually turn to have significant social connotations. The way these underlying dimensions are configured spatially constructs an interface among the houseʼs inhabitants and relates them to visitors to the home.

All other things being equal, integrations are strongest in the center of a compact, regular plan or in the middle room in a chain of spaces which are connected together in a sequence, and partitioning rules can be derived to show precisely how integration is constructed in simple, functionless room arrangements. However, in the forms of nursing home space arrangements that we normally encounter in different parts of the world integration and depth from the outside are usually manipulated, so that those spaces which draw the nursing home together and are shallowest in relation to every other space in the nursing home also contain activities which draw people together in activities. Depth from the outside may be organized so as to open the heart of the nursing home to outside influence or to curtail and control the penetration of visitors into the nursing home. Likewise, the constituent space-types which make up the nursing home locally usually exploit the logical potential of terminal space, bi-permeable spaces in sequence, bi-permeable spaces on a ring, or intersection spaces to act as the locus for occupation or movement about the nursing home interior.

In Chapter 5 of the article, based on the plans of the six nursing homes, we explored the rules of the organization of the nursing home space in terms of the spatial configuration and spatial integration within the plans by using the theory of space syntax. Previous studies of residential care environments have focused on the difference between circulation paths and spaces designed for activities to occurrence. These distinctions also exist in nursing home spaces, the difference between spaces that are explicitly used to support activities and functions and those that are used for circulation is, certainly, itself a form of spatial ambiguity. In studies utilizing space syntax, there is a tendency to view transitions as mere circulation, aimed at providing efficient access and egress, or more speculatively, reducing unwanted contact by segregating activities and functions from each other. The presence of transition spaces has the effect of insulating spaces from one another as effectively as building walls, ensures that the boundaries of the spaces arenʼt intruded upon and keep the social distance, provides appropriate environmental conditions. In addition, the ratio of transitions to function space can depict the characteristics of the organization of a nursing home space. For instance, among the six nursing homes, Case D, which is a small and has many storeys, and Case E, where the spatial layout is relatively complex, have a large number of transition spaces, close to the number of function spaces. In these two nursing homes, the layout of space is more dispersed, and the spaces are more insulated from each other. While in the other four homes, the number of transitions is much lower than the number of function spaces. In these nursing homes, the spaces are laid out more closely and the distances between spaces seem to be more integrated.

When we further categories the types of space within the nursing home for deeper exploration according to four broad topological space-types. The spatial layout of the nursing home seems to present two distinctly different frame structures. Case A and Case B exemplify a very strong framework structure, in which the spatial classification is more clearly defined, and routs are more easily dictated so as to people′s movements are more easily constrained and monitored. In other four nursing homes, the spatial layouts reflect a weakly-frame structure, in which the spatial classification is also relatively weak. The choice of routes is varied and difficult to controlled and predicted in these nursing home, and people also have a variety of alternatives for their routs of movement and their movements are more difficult to be monitored and restricted. The main reason for the two completely different frame structures between the nursing homes is that in Case A and Case B, the terminal spaces are dominant in all spaces, while in the other nursing homes, ′c′ type spaces occupy the most. A further key element is the change in the type of space on the room. In the first two nursing homes, the rooms belong to the terminal spaces, people moved between their rooms and other spaces only through interior transition spaces, and their paths of movement are relatively homogeneous and restricted. But in the last four nursing homes, the spaces are connected by outside continuous balconies in addition to by indoor corridors, the properties of the room become ′c′ type space. People have alternative paths between their rooms and other spaces in these nursing homes, instead of having to go through indoor transition spaces, so that people seem to have more fun in choosing their paths. However, it has to be mentioned that in the spatial layout of a strongly framed structure, the movement of the residents is easier for staffs to catch, and residents are more likely to be taken care of in time when accidents occur during their movement. Also, relatively simple, or single route seems to be more friendly for residents with dementia and less likely to get lost. Conversely, the spatial layout of the weakly-frame structure provides residents with more options of routes, which makes it difficult for staffs determine the route of movement of residents, and where it is more difficult for residents to get help in the shortest possible time when they are in trouble. In addition, this kind of spatial layout will also create more factors for residents with dementia to cause them to be lost.

Once configured spaces are labelled to reflect the activities that take place in different spaces, the functions they serve, the conventions that govern which spaces different members of the nursing home occupy, and so on. This reintroduces the richness and diversity of life into a narrower morphological description and makes the interpretation of the arrangements of nursing home space easier. The nursing home experience is often related to different viewpoints among different people including resident-resident, resident-staff, resident-visitor, staff-staff, and staff-visitor. As research into the analogue use of nursing home space continues, a new and promising line of research is the relationship between the indoor activities and the patterns of daily routines that people engage in the nursing home. This has led to attempts to identify the choreography of people′s experience of space through the aesthetics of movement. Movement, gesture, and posture are reprogrammed so that the body is positioned and projected in space. Thus, although people′s actions, movements, gestures, and postures within the building are not determined by space, they maybe related to the space either because they are exploratory improvisations in a free, unconstrained environment, or because they are the expression of traditional, even ritualized, social practices, or because they are involuntary acts cemented by habit.

So how are movements of people in a nursing home predicted? In this paper, we address this issue by embodying the ability of this space to attract traffic from the concept of the integration of the space in theory of space syntax. We still use the plans of the six nursing homes mentioned above as a basis to explore the possible trajectories of people′s movements in these nursing homes. A nursing home space will involve many different function spaces, how these spaces are placed on the homes, and how they attract people′s traffic? And the social relationship involved in a nursing home includes residents, staffs, and visitors. What are the circulation routes of these different groups of people in nursing home? Where are the intersections between these different groups of people placed when a nursing home space is laid out? And how to deal with the intersection of these different flow routes?

Transition spaces connect the different spaces in the home, and they govern the flow of movement of people like blood vessels in the human body. However, due to the function or location, these transition spaces differ in their ability to attract traffic. Although in some nursing homes, continuous balconies in the outside various rooms in the same way as corridors indoor, providing additional alternative paths for residents, indoor corridors are much more capable of attracting flow than continuous balconies in the plan, which continue to control the dynamic flow of residents. This seems to expose that the spatial layout of the weakly-frame structure in some nursing homes mentioned earlier is essentially superficial, even though the presence of continuous balconies provides additional paths of movements for residents, the corridors perhaps still be the routs that residents prefer to choose. Staffs can still control the movement of residents to a large extent by monitoring the corridors. Therefore, the spatial layouts of four nursing homes with the weakly-frame structure remain strong frame in nature. The hall and the vestibule are necessary spaces for residents, staffs, and visitors to enter and leave the nursing home, and serve as the buffers between the internal social interface of a nursing home and the external world. Empirically, it was thought that such spaces would be placed in more segregated locations, but it turns out that in most nursing homes, these two spaces are in shallow and easily accessible positions. The purpose of design may be intended to make it easier for residents to enter and exit the nursing home or to receive visitors.

The layout of the activity spaces in the nursing home is also very different from previous guesses. In the assumptions based on experience, the activity space should be located in the central area of the nursing home plan, where people can conveniently gather together. The results of the study seem to emerge three different phenomena in the layout of the activity space. The first phenomenon is just like imagine, in which the activity space has a strong ability to attract traffic, and residents can naturally gather together in this space. The second phenomenon is diametrically opposed to the former, in which the activity space is placed in a deeper position with less accessibility in the nursing home. People usually don′t go to the space spontaneously, but are driven to the space passively by some kinds of regulations. The last one, which is between the former two phenomena, where the space is embedded into the living area of residents in the nursing home, and has a certain ability to attract traffic within a local area, while it is weaker to attract traffic for the entire nursing home. The activity space in a plan with such a spatial layout can provide better convenience for residents in the nearby local area, but it is very unfavorable for the nursing home to control the activities of the residents in a global manner.

In addition, most of spaces for assisted living of residents in these nursing homes are in relatively deep locations, and residents go to these spaces probably because of the function of these spaces. Of course, there are also some spaces for assisted living of residents that are in relatively shallow locations, but their better accessibility is only for residents who live in nearby local area rather than for residents who live in the entire nursing home.

The room is the most critical private space for residents in a nursing home. In order to maintain the privacy of the living space, the junction with the outside is controlled at the entrance or the gate of the room, maintaining the relatively good accessibility of the room, and making it more convenient for the occupants to travel between their rooms and other spaces. While the bedroom, the toilet, and the bathroom with more private in the room are in a deeper location in order to maintain a considerable level of privacy. Therefore, the rule of the spatial layout of the resident′s room follows a certain gradient of privacy.

Similarly, the layout of the staff spaces follows a certain variation of gradient. Staff space is divided into two main attributes, one is the space for external services and another one is the space used by employees themselves. There s a tendency for staff spaces that have nothing to do with residents to be in the deeper locations, such as staff duty stations that require constant monitoring of residents, so they are in shallower locations, while staff rest rooms that have almost nothing to do with residents, are in a deeper location. Therefore, the layout of the space is designed to minimize the intrusion of the employees′ flow into the residents′ flow, so as to keep the residents′ living space pure and independent.

7.1.5. why are these spatial layouts more widely adopted in nursing homes?

The spatial layout of a nursing home can be divided into many kinds from different perspectives. Transition spaces connect the different spaces in the home, and they govern the flow of movement of people like blood vessels in the human body. Therefore, the spatial layout based on the transition space is the most relevant and comprehensive for the circulation paths of the residents in the nursing home. We have summarized four corridor-based spatial layouts in Chapter 3. There is a huge difference in the adoption rate of these types of spatial layouts in nursing home, so why is there such a phenomenon? In Chapter 7, the article explores the characteristics of these spatial layouts from the perspective of people′s wayfinding behavior by using the partitioning theory in space syntax.

A complex consisting of fewer corridors has more potential to gain less total depth, leaving the space within the complex at a shallower position globally. Particularly, the spatial layout of a single corridor brings the least total depth to the complex, resulting in the spaces with a high degree of accessibility in the complex. It means that residents can find their destinations more easily in the plan consisting of fewer corridors. In practice, in the commercial market of nursing homes in Japan, the nursing home in which the spaces in the plan are organized by one or two corridors is also dominant. It is even rare that a nursing home plan consists of over four corridors. In terms of corridor combinations, the ring-corridor can effectively reduce the total depth of the complex brought by the increased number of corridors, thus increasing the accessibility of the interior space of the complex. In fact, when the number of corridors forming the nursing home plan increases, especially when there are more than three, the use of ring-corridors occupies a dominant position compared to the other corridor combinations. But in shape, the ring-corridor forms a closed circular route in a plan thus reducing the number of dead ends, and residents within that plan can find their destination from any point on the corridor. In this respect, the spatial layout of the ring-corridor seems to be more friendly to the movement of elderly people with dementia. However, the nursing home in which the plan is organized by the ring-corridor occupies only a relatively small part of the market. Therefore, these suggests that the design solution that provides better convenience and accessibility for residents is a very important consideration in the design of nursing homes.

In terms of spatial distribution, these spatial layouts that are widely adopted in practice have the similar characteristic of being relatively symmetrical in form and relatively homogeneous in depth. That is, the spaces in these spatial layouts are at locations with similar spatial depths and have relatively equal accessibility and convenience. It suggests that in the plans consisting of these spatial layouts, the spatial distribution is more balanced, avoiding some spaces being located far away from the subject. But these spatial layouts bring the complexes more total depth. This means that in the plans consisting of these spatial layouts, the space is generally at a relatively deeper location with relatively poor accessibility, and it is more difficult for residents to arrival their destinations. The principle of adopting a spatial distribution seems to be the opposite to that of adopting the number of corridors and the corridor combinations. So, in spatial distribution, the design solution seems to focus more on maintaining a balanced spatial distribution.

In addition, the results also shows that the number of corridors and the corridor combinations have a greater potential impact on gain and loss of total depth in the complex than the spatial distribution. This implies that changing the number of corridor or corridor combination of corridor has a greater impact on wayfinding of the residents in the plan than changing the spatial distribution. Therefore, it can be inferred that a design principle for the nursing home is to improve accessibility of the spaces by minimizing the use of corridors within the plan or using ring-corridor when the corridors increase and then to maintain an even plan design by adjusting the spatial distribution.

The design solutions that are currently widely used, including spatial layout, are to some extent relatively more rational and superior than others. There are many factors that affect the quality of life of the elderly in a nursing home, such as the care environment, the adequacy of facilities and the built environment. Wayfinding behaviour is inevitable in the daily life of elderly people in nursing homes. A good spatial layout can facilitate the wayfinding behaviour of elderly people with relatively fragile physical conditions.

7.1.6. What are the novelty points of the article?

Although the researches to date on nursing homes have focus on care and social environment, most have focused on care and social environment. In terms of the built environment, researcher have been working on the physical environment of nursing homes in the hope of improving the quality of life of residents. Most of these studies, however, are based on the living experiences and aspirations of the residents, or on the security and privacy of the residents′ living environment. These studies are closely related to the psychological environment of the residents and seem to have a strong relevance to the field of psychology. Or they may study the physical space of nursing homes from a purely morphological point of view in terms of individual spaces and the composition of facilities. But little is known about the spatial layout of nursing homes. The spatial layout is not only an important part in the architectural design process, but also a key attribute of the building′s expression of its own function. More importantly, studies suggested that the spatial layout can predict people′s wayfinding behavior in the building, and can affect people work behavior and productivity. So, how are spaces laid out in the built environment of vulnerable people?

The methods used for the study of physical environment of buildings are diverse. However, most research tools involve questionnaires and interviews to assess the environment of the nursing home from a more psychological, sociological, behavioral, and medical perspective. Space syntax techniques for the analysis of spatial layouts were the first to demonstrate, in numerical way, clear and systematic relations between spatial design and observed functioning across a range of building and urban types. Space syntax attempts to constitute a configurational theory in architecture by generating a theoretical understanding of how people make and use spatial configurations. In the study of the built physical environment, spatial syntax is often used to study people's activity and movement in space, to predict people′s wayfinding behavior in buildings.

A building can be influenced by many factors in the design process, such as local requirement, client′s requests, and preference, building regs, designer′s personality. The design solutions that are currently widely used, are to some extent relatively more rational and superior than others. This article begins with an analysis and summary of the individual spaces and the composition of facilities within existing Japanese nursing home. This provides a detailed understanding on the condition of the composition of nursing home spaces from the conventional approach-the purely morphology. Secondly, this paper attempts to explore how these spaces are arranged in nursing homes and to interpret why some spatial layouts are widely used within a theoretical framework based on space syntax, seeking a better understanding of the organization of nursing home spaces.

Therefore, we think that the architecture educators, particularly those who are interested in the design of nursing home, may benefit from this study. This paper empirically provides some reference standards for designers on the composition and configuration of Japanese nursing home spaces, and provides designers with a better understanding of principles and some knowledges of the systemic consequences of strategic design decisions. Particularly in terms of the accessibility of spaces, designers can use this method of space syntax to simulate and analyze the spatial layout of the building before designing a building, as well as to assess the spatial layout of existing building.

7.2. Conclusion

Nursing homes are not just assemblages of individual rooms but intricate patterns of organized space, governed by rules and conventions not only about the size and composition of rooms, what function spaces are necessary to meet the needs of residents, how large a function space is appropriate, and what relationships between spaces are reasonable, but also about the organization of spaces, where the occupants gather together and entertain, how the members of nursing home related to one another in different spaces, what the circulation routes of these different groups of people are in nursing home, where the intersections between these different groups of people are placed when a nursing home space is laid out. Regarding these questions, this paper explores the condition of composition of nursing home spaces from a purely morphological point of view, and explores how these spaces are arranged in nursing homes and to interpret why some spatial layouts are widely used within a theoretical framework based on space syntax.

Firstly, the results regarding the composition of the nursing home spaces are as follow. (1). A complete nursing home is made up of four types of spaces consisting of the private space, the common space, the service space, and the staff space, in addition to the transition space. Specifically, the room, the activity space, the common toilet, the common bathroom, and the office are essential components of a nursing home. Besides, the laundry, the nursing room, the consultation room, and the kitchen may be added as a matter of priority. (2). Single rooms of around 18 m^2 with better independence and privacy, which are equipped with private toilets and dressers, tend to be more frequently used in the design of Japanese nursing homes. (3). The space that can provides the dining environment for the residents is the most important component of the activity space in a nursing home. (4). Common toilets and common bathrooms in nursing homes should be designed for barrier-free access, and unit with a good degree of privacy are welcome. (5). The provision of good medical care is also a key point to consider when a nursing home is designed. (6). In average, the room occupy around 47.6% of the total nursing home space, followed by the common space which occupies roughly 16.5%, the staff space which occupies about 7%, the service space which occupies the most with about 2%, and the remaining around 26% of the space is used as the transition space. At last, the reference ratio of area zoning within the nursing home tends to be closer to 24:13:8.5:3.5:1 (Private space: Transition space: Common space: Staff space: Service space).

Secondly, the conclusions on spatial position relationship within the nursing home are as follows. Simple spatial layouts with good privacy and convenience are popular to be adopted in the design of the nursing home. The private and public nature of the activity space needs to be properly grasped when a nursing home is designed, and even more so to ensure the privacy of the residents′ main living space, Therefore, the shared type, the separated type, and the hall transition type about the layout of the activity spaces are the most widely used in the nursing home. And the embedded type and the unilateral type of the layout of the room are more common in the spatial layouts of the nursing homes. Designers are more willing to utilize a spatial layout constituted by comparatively fewer corridor when designing a nursing home.

Thirdly, the spatial distribution within the nursing home follows some rules. The spatial layouts of nursing homes are by nature strongly framed structures in which the route of residents become increasingly constrained. However, the differentiation of space within the nursing home is relatively weak. Many spaces in nursing homes follow a social solidarity that is a mechanical solidarity, the mechanical solidarity that is mainly followed because of the function of the space that attracts the occupants to gather there, such as most of the service spaces, and even many of the activity spaces. The opposite of mechanical solidarity is organic solidarity. The space of organic solidarity is unsully dense and nucle0ated in order to facilitate exchange and interaction. Residents tend to gather naturally in such spaces, most typically in the canteen and living room in Case A.

Finally, this paper analyses the impact of different spatial layouts on the accessibility of spaces from the perspective of people′s movement in the plan through the spatial models established by using partitioning theory. The results show that changing the number of corridor or corridor combination of corridor has a greater impact on wayfinding of the residents in the plan than changing the spatial distribution, the residents can find their destinations more easily in the plan consisting of fewer corridors. Therefore, in terms of the number of corridors and the corridor combinations, the spatial layout which facilitates the residents' wayfinding is adopt in more nursing home plans, but in terms of spatial distribution, the plan layout of nursing homes is more focused on a balanced design and less on the convenience and accessibility of spaces. This shows that it is often necessary to consider a combination of possible factors, rather than focusing on one indicator when a building is designed.

The built environment is initially understood as a structure that protects the privacy of its occupants and has physical boundaries. The experience of a nursing home is often associated with a sense of security and comfort. The design of a nursing home in itself is a very complex task. In addition to the many external factors (such as rule constraints, design experience, common sense, etc.) that must be taken into account, there are also the many feelings of the main users inside the home. In The Ten Books on Architecture, Vitruvius suggests that knowledge in architecture is the product of both theory and practice. This paper analyses and summaries the composition of spaces based on existing nursing homes, and explores the regularity of the choreography of space in nursing homes from the perspective of kinesthetic aesthetics by using the theory of space syntax. The space syntax provides designers with a better understanding of principles and some knowledge of the systemic consequences of strategic design decisions. Designers can use space syntax to simulate and analyze the spatial layout of the building before designing a building, as well as to assess the spatial layout of existing building on the accessibility of spaces. More importantly perhaps, it can also inform the application of new ideas, and encourage new ways of approaching the relationships between spaces.

7.3. Limitation and outlook

The paper in this study is deficient in some aspects. Firstly, with regard to the choice of objects to be studied, the plans provided by the nursing home aren′t very detailed. These plans need to be redrawn, the dimensions of them need to be recalculated to the extent that there are deviations in accuracy. And some of spaces within the plans are labelled with functional attributes but without clear boundaries, so there is inevitably some error in aggregating the areas of these spaces. In addition, the sample of the main research objects in this paper is somewhat small and may not be fully representative of Japanese nursing homes. Moreover, in Chapter 5, only six nursing homes are selected as cases for the study, which is indeed a small sample to draw global conclusions, so it is hoped that in future studies, more nursing homes will be picked as a sample to draw more representative results. Methodologically, Space syntax is helpful in predicting people's wayfinding as it focuses more on people's movement through building when it is used to study architectural space. But space syntax is based on relatively pure spatial topological relationships and studies architecture from a perspective of more rational and dialectical thinking, thus lacking consideration of the subjective consciousness and will of the residents. This perhaps leads to the research results being biased towards idealization. Finally, wayfinding is just one factor that may affect the living experience of the elderly in a nursing home. The overall improvement of the quality of life of elderly people in nursing homes requires exploration and breakthroughs in a variety of areas. Regarding these shortcomings, further improvements are needed in future research, in the hope that a more comprehensive exploration and better study methods can help us to better understand the spatial layout of nursing homes and improve the quality of life of the elderly in nursing homes.

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9. Reference

1) Byun, N. (2015) Genetic Characteristics Found in Spatial Structure of the Korean Apartment Complexes and Unit Plans, Doctoral Dissertation, Seoul National University.

2) Choi, J. (1990) From Courtyard to Living Room, *Housing City*, no. 51, Korea Housing Corporation, pp.52-64.

3) Choi, J. (1996a) A Diachronic Analysis of the Unit Plan Changes in the Context of Space Syntax Model for the 4LDK Apartment Unit Plans in Metropolitan Seoul Area, *Journal of Architectural Institute of Korea,* vol. 12, no. 7, pp.15-28.

4) Choi, J. (1996b) Changes in Residential Lifestyles in the Contemporary Korean Society in the Context of the Changes in the 3LDK Apartment Unit Plans in the Metropolitan Seoul Area, *Journal of Architectural Institute of Korea,* vol. 12, no. 9, pp.3-13.

5) Choi, J., Kim, Y., Kang, J. and Choi, Y. (2014) Comparative Analysis of the Spatial Structure of Apartment Unit Plans in Asia: Apartment in Korea, Vietnam and Kazakhstan, *Journal of Asian Architecture and Building Engineering*, vol. 13, no. 3, pp.563-569.

6) Choi, J., Lee, Y., Kang, H., and Byun. N. (2009) Schematic Development on the Extension Remodeling Types of Public Rental Housing, *Journal of Architectural Institute of Korea,* vol. 25, no. 3, pp.3-10.

7) Hanson, J. (1998) *Decoding Homes and Houses*, Cambridge University Press, 23-25, pp.80-108.

8) Hillier, B. and Hanson, J. (1984) *The Social Logic of Space*, Cambridge University Press.

9) Jeon, B. and Kwon, Y. (2008) A Diachronic Study of the Archetypal Spatial Elements in the Korean House Plan, *Journal of Architectural Institute of Korea,* vol. 24, no. 7, pp.181-192.

10) Kang, B., Kang, I., Park, K., Park, I., Park, C., and Baek, H. (1999) *History of Planning for Korean Apartment Housing*, Sejinsa, Seoul, pp.340-342.

11) Kang, B. & Choi, J. (2004) Economic Logic of Apartment Unit Designs, *Journal of Asian Architecture and Building Engineering*, vol. 3, no. 1, pp.125-132.

12) Kim, S., Lee, H., Seo, B. (1992) Inflexible Patterns of Apartment Unit Plan: Focused on the Private Sector Apartment, *Journal of Architectural Institute of Korea,* vol. 8, no. 4, pp.3-11.

13) Rapoport, A. (2001) Theory, Culture, and housing, *Housing, Theory and Society*, vol. 17, no. 4, pp.145-165.

14) Seo, K. (2003) Topological Paths in Housing Evolution, Proceedings of the 3rd International Space Syntax Symposium, London.

15) Seo, K. (2006) The Law of Conservation of Activities in Domestic Space, *Journal of Asian Architecture and Building Engineering*, vol. 5, no. 1, pp.21-28.

16)Ali Al-Hesabi, M., Hosseini, S. B., & Nasbi, F. (2012). Analysis of visual quality of residential space according to the capabil- ity and visibility of a case study: Bushehr old texture houses. *Iranian Architecture, and Urban Planning*, *4*, 83–69.

17)Alitajer, S., & Nojoumi, G. M. (2016). Privacy at home: Analysis of behavioral patterns in the spatial configuration of tradi- tional and modern houses in the city of Hamedan based on the notion of space syntax. *Frontiers of Architectural Research*, *5*(3), 341–352. https://doi.org/10.1016/j.foar.2016.02.003

18)Asefi, M., & Imani, E. (2016). Redefining design patterns of Is- lamic desirable contemporary housing through qualitative evaluation of traditional homes. *Iran University of Science* & *Technology*, *4*(2), 56–73.

19)Bazai, M., Ghasemi Sijani, M., & Shojaei, A. (2020). Continuity reading and change in spatial configuration of Shiraz native houses (Zandieh and Qajar) using quantitative data of UCL Depth Map software. *Islamic Art*, *37*, 67–47.

20)Chegeni, F., Didehban, M., & Hessari, P. (2020). Space configura- tion cognition in contemporary and traditional housing using space syntax technique (case study: Borujerd Sufian Neigh- borhood). *Journal of Architectural Thought*, *5*(9).

21)Emo, B. (2015). Exploring isovists: The egocentric perspective. In

Proceedings of the 10th International Space Syntax Symposium

22) (Vol. 121, pp. 1–8). Space Syntax Laboratory.
Estaji, H. (2014). Flexible spatial configuration in traditional houses, the case of Sabzevar. *International Journal of Contem-*

23)*porary Architecture "The New Arch"*, *1*(1), 26–35.
Fisher, B. S., & Nasar, J. L. (1992). Fear in relation to three site features: Prospect, refuge and escape. *Environment and Behav- ior*, *24*(1), 35–62. https://doi.org/10.1177/0013916592241002
Goodarzi, A., & Jalili, M. (2014). *Investigating the process of for- mation and physical expansion of Boroujerd city* [Conference presentation]. 2nd National Conference on Architecture,

24)Civil Engineering, and Urban Environment, Hamedan. Habitat. (2003). *The Habitat Agenda goals and principles, com- mitments and the global plan of action*. https://www.un.org/

en/events/pastevents/pdfs/habitat_agenda.pdf

25)Hajian, M., Alitajer, S., & Mahdavinejad, M. J. (2020). The in- fluence of courtyard on the formation of Iranian traditional houses configuration in Kashan. *Armanshahr Magazine*, *30*, 55–63.

26)Heidari, A. A., Peyvasteh gar, Y., Mohebi nejad, S., & Kiaee, M. (2018). Evaluation the methods of confidentiality in three Peymoon of large, small and breack in the articulation of Iranian-Islamic housing using space syntax techniques. *Maremat* & *Me'mari-e Iran*, *1*(16), 51–68.

27)Heidari, A., & Peyvastegar, Y. (2018). Check the quality of the se- curity permeability edge of space (case study: spatial analysis Timcheh structure in traditional Bazar). *Honar-Ha-Ye-Ziba: Memary Va Shahrsazi*, *23*(1), 41–54.

28)Hillier, B. (2007). *Space is the machine* (Electronic ed.). Press Syndicate of the University of Cambrige.

29Hillier, B., Honson, J., & Peponis, J. (1984). What do we mean by building function? In J. A. Powell, I. Cooper, & S. Lera (Eds.), *Designing for building utilisation* (pp. 61–72). E & F. N. Spon Ltd.

30)Jeong, S., Lee, T., & Ban, Y. (2015). Characteristics of spatial con- figurations in Pyongyang, North Korea. *Journal of Habitat In- ternational*, *47*, 148–157. https://doi.org/10.1016/j.habitatint.2015.01.010

31)Kamalipour, H., Memarian, G. H., Faizi, M., & Mousavian, S. M. F. (2012). Formal classification and spatial configuration in

32)vernacular housing: a comparative study on the zoning of the reception area in traditional houses of Kerman province. *Journal of Housing and Rural Environment*, *31*(138), 3–16.

33)Klarqvist, B. (1993). A space syntax glossary. *Nordisk Arkitektur- forskning*, *12*, 8–19.

34)Madahi, S. M., & Memarian, G. H. (2019). Reading the link of spatial organization of house and lifestyle in vernacular ar- chitecture (case study: Boshrooyeh). *Journal of Housing and Rural Environment*, *37*(164), 69–84.

35)Manum, B. (2009). A-graph complementary software for axial- line Analysis. In *Proceedings of the 7th International Space Syntax Symposium* (pp. 1–7), Stockholm, Sweden.

36)Mohareb, N. I. (2009). Street morphology and its effect on pe- destrian movement in historical Cairo. *Cognitive Processing*, *10*(2), 253–256. https://doi.org/10.1007/s10339-009-0283-x

37)Mollazadeh, A., Barani Pesian, V., & Khosrozadeh, M. (2012). The application of the space syntax of the Valiasr St Basht city. *Urban Management Journal*, *10*(29), 81–90.

38)Momeni, K., Attarian, K., & Mohebian, M. (2020). Recognition of the identity of Islamic culture in the architecture of input faces (case study: Dezful house of old texture). *Journal of Architectural Thought*, *7*, 14–28.

39)Montello, D. R. (2007). The contribution of space syntax to a comprehensive theory of environmental psychology. In *Pro- ceedings of the 6th International Space Syntax Symposium* (pp. 1–12), Istanbul.

40)Mozaffar, F., Hosseini, S. B., & Abdemojiri, A. (2012). Culture in architectural researches. *Journal of Human Rights and the Environment*, *31*(138), 29–38.

41)Mustafa, F. A., Hassan, A. S., & Baper, S. Y. (2010). Using space syntax analysis in detecting privacy: a comparative study of traditional and modern house layouts in Erbil city, Iraq. *Asian Social Science*, *6*(8), 157–166. https://doi.org/10.5539/ass.v6n8p157

42)Nasr, T. (2015). The position of the "Housing architecture" para- digm in today's image of the Islamic Iranian city. *Islamic Ira- nian City*, *2*, 67–78.

43)Ostwald, M. J. (2011). A Justified Plan Graph analysis of the early houses (1975-1985) of Glem Murcutt. *Nexus Network Journal*, *13*(3), 737–762. https://doi.org/10.1007/s00004-011-0089-x

44)Penone, C., Machon, N., Julliard, R., & Le Viol, I. (2012). Do railway edges provide functional connectivity for plant com- munities in an urban context? *Biological Conservation*, *148*(1), 126–133. https://doi.org/10.1016/j.biocon.2012.01.041

45)Perugia, I., Pietra, P., & Russo, A. (2016). A plane wave virtual element method for the Helmholtz problem. *ESAIM: Math- ematical Modelling and Numerical Analysis*, *50*(3), 783–808. https://doi.org/10.1051/m2an/2015066

46)Pinelo, J., & Turner, A. (2010, September 10). *Introduction to UCL Depthmap* (version 10.08.00r). UCL.

47)Rajaei, A., Keramataleh, Z., & Abbasi Fallah, V. (2018). Evalua- tion of the pattern of theft crimes based on spatial configura- tion (case study: Varamin city). *Journal of Law Enforcement Knowledge Research*, 66–34.

48)Rodriguez, C., Lima Sakr, F., Griffiths, S., & Hillier, B. (2012). The relationship of spatial configuration and socio-economic conditions in São Paulo, Brazil. In *Proceedings of the Eighth International Space Syntax Symposium* (pp. 1–24), Santiago de Chile.

49)Sa'adati Waqar, P., Zarghami, E., & Qanbaran, A. A. (2020). Analysis of the interaction between the formal types of tra- ditional houses and spatial configurations using space syntax case study: traditional houses of Kashan. *Journal of Iranian Architecture Studies*, *8*(16), 153–179.

50)Sajjadzadeh, H., Izadi, M. S., & Haghi, M. R. (2017). Recreating urban slums on spatial configuration analysis (study sample: Hamadan). *Environmental Studies*, *43*, 1–15

51)Siadatian, S., & Pourjafar, M. (2015). Testing the application of "Justified Plan Graph" (JPG) in Iranian-Islamic architec- ture (case studies: Rasoolian House in Yazd and a House in Masooleh). *Naqshejahan-Basic Studies and New Technologies of Architecture and Planning*, *4*(3), 27–39.

52)Statistics Center of Iran. (2016). *General population and housing census*. Statistics Center of Iran, Tehran.

53)Tabatabae Malazi, F., & Sabernejad, J. (2016). The space syntax analytical approach in understanding the configuration of Qeshm vernacular housing (case study: Laft village). *Journal of Housing and Rural Environment*, *35*(154), 75–88

54)Turner, A. (2004). *SalaScript manual* (Depthmap version 7.09.00r).

55)Vannes, A. (2011). The One_ and Two_Dimensional Isovist analyses in space syntax. *Research in Urbanism*, (2), 167–170. Weisman, J. (1981). Evaluating architectural legibility: way-find- ing in in the built. *Environment and Behavior*, *13*(2), 189–204.

https://doi.org/10.1177/0013916581132004

56)Zolfagharzadeh, H., & Hessari, P. (2014). Ecological view to the architecture of habitats. *Journal of Housing and Rural Envi- ronment*, *33*(145), 29–44.

57)Abbaszadegan, M., 2002. Space syntax method in urban design process, with an overview on Yazd city. Urban Manag. 9, 35–43. Alalhesabi, M., Korrani, N., 2013. The factors affecting housing evolution from the past to the future. Hous. Rural Environ. 141, 19–36.
Altman, I., 1975. The Environment and Social Behavior. In: Nama-

58)ziyan., A. (Ed.), Shahid Beheshti University Press, Tehran. Baldwin, E., Tomita, S., 2007. Housing in Response to the Human Life Cycle. In: Proceedings of Paper presented at the 2nd International Conference on Technology and Aging (ICTA), Toronto.

59)BaniMasoud, A., 2009. Iranian Contemporary Architecture. Honar-e- Memari-e-Gharn Publication.

60)Bendikt, M., Burnham , C.A., 1985. Perceiving architectural space: from optic arrays to isovists. In: Warren, W.H., Shaw, R.E.

61)Dawson, P.C., 2002. Space syntax analysis of central inuit snow houses. J. Anthropol. Archaeol. 21 (4), 464–480.

62)Dunn, J.R., 2000. Housing and health inequalities: a review and prospects for research. Hous. Stud. 15 (3), 341–366.

63)Dursum, P, 2007. Space syntax in architectural design. In: Proceed- ings Space.

64)Fischer, C.T., 1971. Toward the structure of privacy: implications for psychological assessment. In: Giorgi, A., Fischer, W.G., Von Eckartsberg, R. (Eds.), Duquesne Studies in Phenomenological Psychology. Duquesne University Press, Pittsburgh, PA.

65)Forgas, J., 1985/1994. In: Beigi, K., Firouzbakht., M. (Eds.), Interpersonal Behaviour: The Psychology of Social Interaction. Abjad, Tehran.

66)Gibson, J.J., 1979. The Ecological Approach to Visual Perception. Psychology Press, Boston, London.

67)Haeri-Mazandarani, M.H., 2009. House, Culture, and Nature: A Study of the Architecture of Traditional and Modern Houses to develop Criteria for the Process of Building. The Research Center for Architecture and Urban Development, Tehran.

68)Hanson, J., 1998. Deconstructing architects-houses. Environ. Plan. 21, 675–705.

69)Hanson, M.G., 2008. The Private Sphere: An Emotional Territory and its Agent. Springer, New York.

70)Hillier, B., 2004. Designing safer streets: an evidence-based approach. Plan. Lond. 48, 45–49.

71)Hillier, B., 2007. Space is the Machine, A Configurational Theory of Architecture. Cambridge University Press, London.

72)Hoeven, F., Nes, A., 2014. Improving the design of urban under- ground space in metro stations using the space syntax metho- dology. Tunn. Undergr. Space Technol. 40, 64–74.

73)Hussin, N., Zawawi, M., 2012. Preventing criminal victimization through community education: an islamic formula. Procedia – Soc. Behav. Sci. 68, 855–864.

74)Jafari-Bahman, J., Khaniyan, M., 2012. Finding the problems of comprehensive plans from a behavioral approach and comparing them with the current state by means of space syntax theory: the case of Kababiyan quarter in Hamedan. Me'mari va Shahrsazi-ye Armanshahr 9, 289–299.

75)S. Alitajer, G. Molavi Nojoumi Jeong, S.K., Un Ban, Yong, 2014. The spatial configurations in South Korean apartments built between 1972 and 2000. Habitat Int. 42, 90–102.

77)Jiang, B., Claramunt, Ch, Klarqvist, B., 2000. Integration of space syntax into GIS for modeling urban space. JAG 2 (3), 161–171.

78)Kamalipour, H., Me'mariyan, G., Feizi, M., Mousaviyan, M., 2012. Formal composition and spatial configuration in native housing: a comparison of the division of parlor space in traditional houses in Kerman. Maskan va Mohit-e Roustaee 138, 3–16.

79)Kasemook, A., 2003. Spatial and functional differentiation: a symbiotic and systematic relationship. In: Proceedings of the 4th International Space Syntax Symposium. London.

80)Kelvin, P., 1973. Asocial psychological examination of privacy. Br. J. Soc. Clin. Psychol. 12 (3), 248–261.

81)Khalesian, M., Pahlavani, P., Delavar, M.R., 2009. A GIS-based traffic control strategy planning at urban intersections. IJCSNS 9 (1), 166.

82)Klarqvist, B., 1993. A space syntax glossary. Nord. Arkit. 2, 11–12. Laurence, G.A., Fried, Y., Slowik, L., H., 2013. "My space": a moderated mediation model of the effect of architectural and experienced privacy and workspace personalization on emotional exhaustion at work. J. Environ. Psychol. 36, 144–152. Lima, J.J., 2001. Socio-spatial segregation and urban form: belemat the end of the 1990s. Geoforum 32 (4), 493–507.

83)Margulis, S.T., 1977. Conceptions of privacy: current status and next steps. J. Soc. Issues 33 (3), 5–21.

84)Makri, M., Folkesson, C., 2000. Accessibility measures for analyzes of land use and traveling with geographical information systems. In: Proceedings of Proceedings of 2nd KFB-Research Conference. Paper presented at the Urban Transport Systems. Lund, Sweden.

85)Mellors, C., 1978. Governments and the Individual their Secrecy and his Privacy. Young, John B, New York.

86)Memarian, GHH., 2002. Space Syntax. Soffeh 35, 75–83.

87)Moein, M., 2010. Moein Dictionary. AmirkabirPub, Tehran. Mokhtarzadeh, S., Abbaszadegan, M., Rismanchian, Omid, 2012.

88)Analysis of the relation between spatial atructure and the sustainable development level. A case study from Mashhad/ Iran. In: Proceedings of the Eighth International Space Syntax Symposium, Santiago.

89)Montello, Daniel R., 2007. The contribution of space syntax to a comprehensive therory of enviromental psychology. In: Proceed- ings of the 6th International Space Syntax Symposium, Istanbul.

90)Mortada, H., 2003. Traditional Islamic Principles of Built Environ- ment. Routledge Curzon, New York.

91)Mustafa, F.A., Sanusi Hassan, A., 2013. Mosque layout design: an analytical study of mosque layouts in the early Ottoman period. Front. Archit. Res. 2 (4), 445–456.

92)Naghi Zadeh, M., 2008. City and Islamic Architecture. Mani publication, Tehran.

93)Nastaran, M., Ra'naee, A., 2010. An analysis of the concept of cooperation and group work in the projects of land preparation of Maskan-e Mehr. Armanshahr 4, 111–123.

94)Newell, P.B., 1994. A systems model of privacy. J. Environ. Psychol. 14 (1), 65–78.

95)Omer, S., 2011. Housing lessons from the life of prophet muhammad (pbuh): the subject of privacy. Retrieved April 23, 2012, from medina.net: 〈〈http://www.medinanet.org/home/10-housing/ 178-housing-lessons-from-the-life-of-prophet-muhammadp buh〉〉 - the-subject-of-p.

96)Penn, A., 2011. Space syntax and spatial cognition or, why the axial line? In: Proceedings of the 3rd International Space Syntax Symposium, Atlanta.

97)Pirnia, M.K., 2004. Stylistics of Iranian Architecture. Sorush Danesh, Tehran.

98)Pirnia, M.K., 2005. An Introduction to Islamic Architecture of Iran. Soroosh Danesh.

99)Rahim, Z. Abdul, Hashim, A. Hariza, 2012. Adapting to terrace housing living in Malaysia. Procedia – Soc. Behav. Sci. 36, 147–157.

100)Rapoport, A., El Sayegh, S., 2005. Culture Architecture and Design. Locke science publishing company, Chicago,USA.

101)Reis, A., 2003. Original and converted social housing: spatial configuration and residents' attitude. In: Proceedings of the Paper presented at the 4th International Space Syntax Symposium. London.

102)Rismanchiyan, O., Bell, S., 2011. A study over spatial segregation of deprived areas in spatial structure of Tehran by using space syntax technique. Bagh-I-Nazar 7, 69–80.

103)Rossler, Beate, Glasglow, Rupert, D.V., 2005. The Value of Privacy. Cambridge Eng, Malden, Mass, Polity.

104)Saruwono, Masran, 2012. Shouting in silence: expression of self in private homes a dwelling, house or home? Procedia – Soc. Behav. Sci. 42, 34–41.

105)Shin, Jung-hye, 2014. Making home in the age of globalization: a comparative analysis of elderly homes in the U.S. and Korea. J. Environ. Psychol. 37, 80–93.

106)Turner, A., Penn, A., 1999. Making Isovists Syntactic: Isovist Integration. Universided de berasilia.

107)Tuan, Y.F., 1977. Space and Place: The Perspective of Experience. University of Minnesota Press, United States.

108)Westin, A., 1970. Privacy and Freedom. New York, Ballantine. Wineman, J., Peponis, J., Conreoy Dalton, R., 2006. Exploring, engaging, understanding in museums. In: Holscher, Ch., Conroy Dalton, R., Turner, A. (Eds.), Space Syntax and Spatial Cognition

109)Proceedings of the Workshop held in Bremen, Germany. Yazdanfar, S.A., Mousavi, M., Zargar, H., 2008. Analysis of the spatial structure of Tabriz in Barrow with usage of space syntax

method. Road Struct. 67, 58–67.

110)Altman I, Wohlwall J (Eds.) (1978) *Children and the environment*. New York: Plenum Press. Amedeo D, York RA (1990) Indications of environmental schemata from thoughts about environ-

ments. *Journal of Environmental Psychology* 10:219-253.

111)Bloom D (1989) Locating the learning of reading and writing in classrooms: Beyond deficit, difference, and effectiveness models. In C Emihovich (Ed.), *Locating learning: Eth- nographic perspectives on classroom research*. Norwood, NJ: Ablex Publishing Cor- poration, pp. 87-114.

112)Charles CM, Senter GW, Barr KB (1996) *Building classroom discipline*. White Plains, NY: Longman Publishers.

113)Cheetham AH, Hazel JE (1969) Binary (presence-absence) similarity coefficients. *Journal of Paleon- tology* 43(5):1130-1136.

114)Delamont S (Ed.) (1984) *Readings on interactions in the classroom*. New York: Methuen. Denscombe M (1985) *Classroom control: A sociological perspective*. London: Allen, & Unwin (Pub-

lishers) Ltd.

115)Emihovich C (Ed.) (1989) *Locating learning: Ethnographic perspectives on classroom research*. Nor- wood, NJ: Ablex Publishing Corporation.

116)Evertson CM, Emmer ET, Clements BS, Sanford JP, Worsham ME (1994) *Classroom management for elementary teachers*. Boston: Allyn & Bacon.

117)Glass G, Cohen L, Smith M, Filby N (1982) *School class size: Research and policy*. Beverly Hills, CA: Sage Publications.

118)Gump PV (1987) School and classroom environments. In D Stokols and I Altman (Eds.), *Handbook of environmental psychology*, Vol. 1. New York: John Wiley & Sons.

119)Hamel J (with DuFour Dominic Fortin S) (1993) *Case study methods*. Newburg Park, CA: Sage Publications.

120)King J, Marans RW, *et al*. (1979) *The physical environment and the learning process: A survey of recent research*. Published jointly by Survey Research Center and College of Architec- ture and Planning, University of Michigan.

121)Montello D (1988) Classroom seating location and its effect on course achievement, participation, and attitudes. *Journal of Environmental Psychology* 8(2):149-157.

122Journal of Architectural and Planning Research 20:4 (Winter, 2003) 342

123)Moore D, Glynn T (1984) Variation in question rate as a function of position in the classroom. *Educational Psychiatry* 4:232-248.

124)Moore GT (1986) Effects of the spatial definition of behavior settings on children's behavior: A quasi-experimental field study. *Journal of Environmental Psychology* 6(3)(Septem- ber):205-231.

125)Rapoport A (1994) The need for (what) knowledge. In A Seidel (Ed.), *EDRA 25, Banking on Design. Proceedings of the Twenty-Fifth Annual Conference of the Environmental Design Re- search Association*. San Antonio, TX, pp. 10-15.

126)Rivlin LG, Rothenberg M (1976) The use of space in open classrooms. In HM Proshansky, WH Ittelson, and LG Rivlin (Eds.), *Environmental psychology: People and their physical settings*. New York: Holt, Rinehart and Winston, pp. 479-489.

127)Russell JS (1994) Can design schools survive the '90s? In A Seidel (Ed.), *EDRA 25, Banking on Design. Proceedings of the Twenty-Fifth Annual Conference of the Environmental Design Research Association*. San Antonio, TX, pp. 15-17.

128)Sanoff H (1994) *School design*. New York: Van Nostrand Reinhold.

129)Sanoff H, Sanoff J (1981) *Learning environments for children*. Atlanta: Humanics.

130)Sanoff H, Sanoff J, Hensley A (1972) *Learning environments for children*. Raleigh, NC: Distributed by Learning Environments.

131)Schwartz S, Pollishuke M (1991) *Creating the child-centered classroom*. Katonah, New York: Richard C. Owen Publishers, Inc.

132)Seidel A (Ed.) (1994) *EDRA 25, Banking on Design. Proceedings of the Twenty-fifth International Conference of the Environmental Design Research Association*. San Antonio, TX.

133)Smith LM, Keith P (1971) *Anatomy of educational innovation*. New York: John Wiley & Sons.
134)Smith LM, Keith P (1984) Kensington School: Unique physical features. In S Delamont (Ed.), *Readings on interaction in the classroom*. New York: Methuen & Co., pp. 58-80.

135)Sommer R, Olsen H (1980) The soft classroom. *Environment and Behavior* 12(1):3-16.

136)Spencer C, Blades M, Morsley K (1989) *The child in the physical environment: The development of spatial knowledge and cognition*. New York: John Wiley & Sons.

137)*SYSTAT 6.0 For Windows: Statistics* (1996) Chicago: SPSS.

138)Wineman J, Hillier B, Peponis J (1998) Letting buildings speak: The contributions of space syntax. In Jon Sanford (Ed.), *DRN Design Research News*. *Environmental Design Research Association* XXIX(3):4-5.

139)Wishart D (1969) *Fortran II programs for 8 methods of cluster analysis*. Computer Contribution 38, D Merriam (Ed.), Lawrence: State Geological Survey, University of Kansas.

Appendix: The plans of 168 nursing homes

Code Plans

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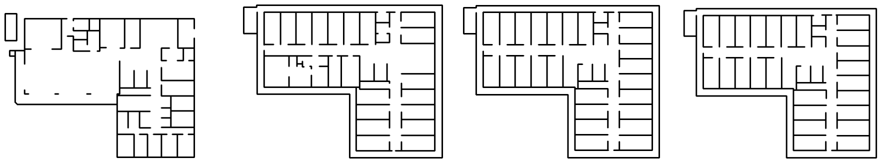

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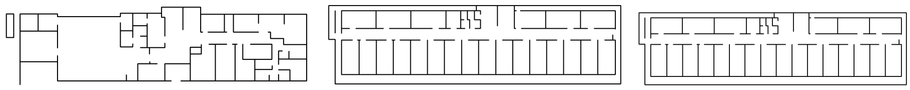

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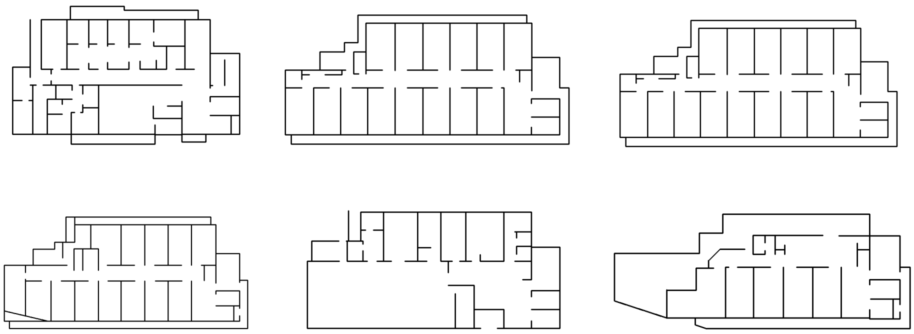

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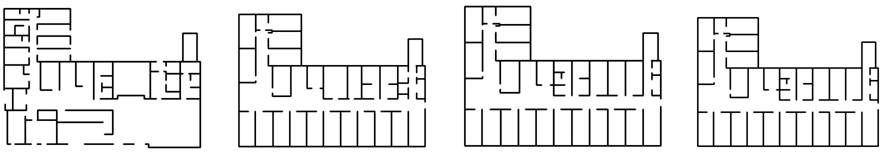

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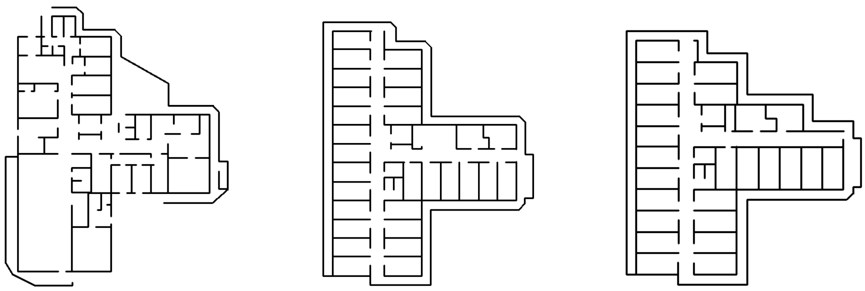

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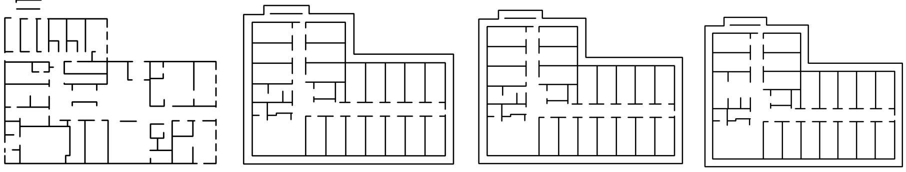

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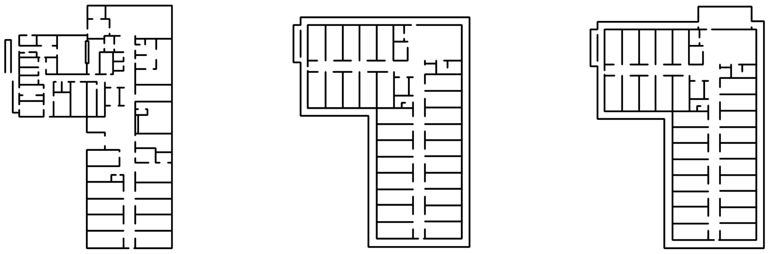

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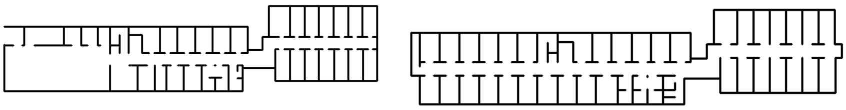

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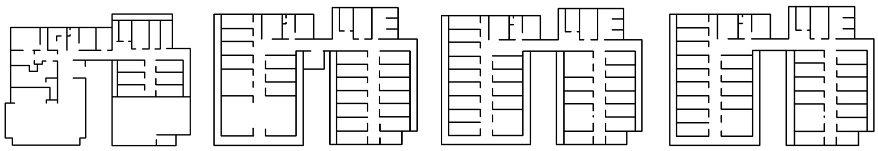

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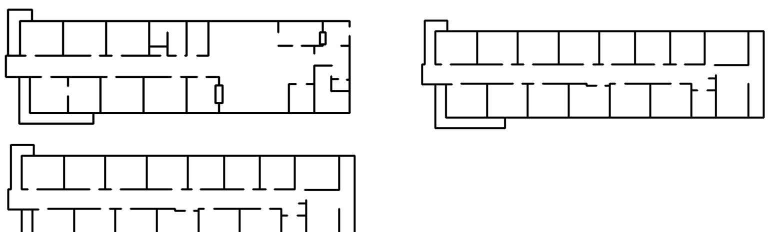

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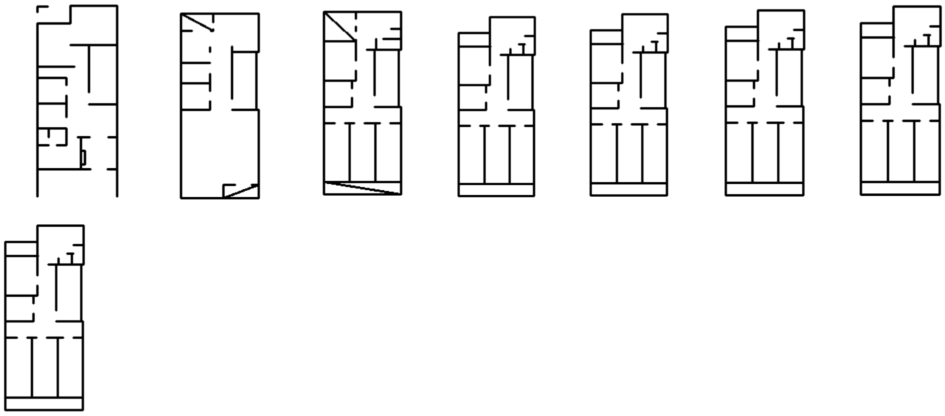

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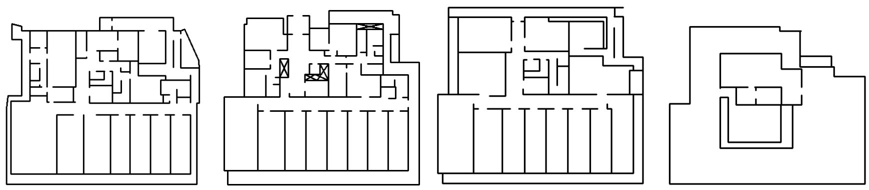

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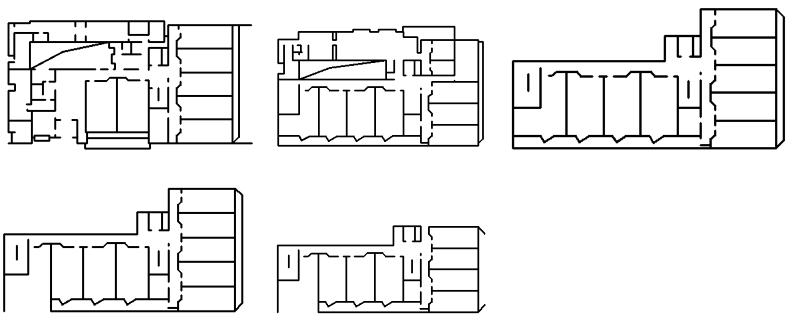

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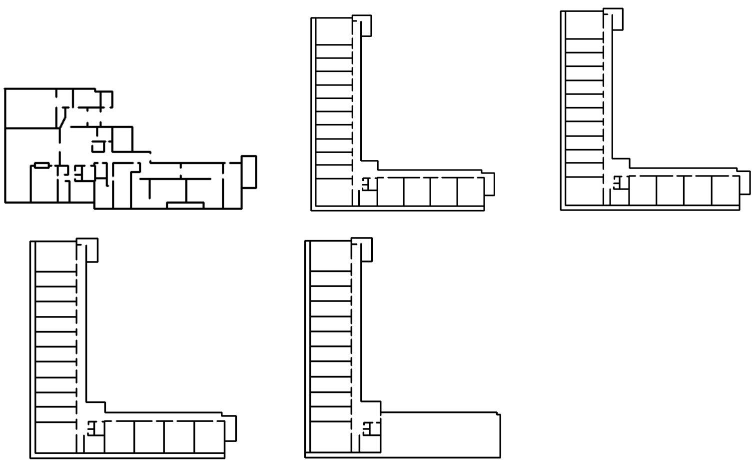

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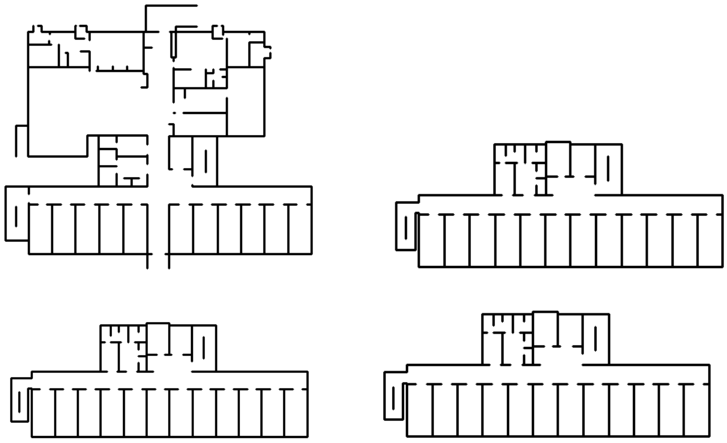

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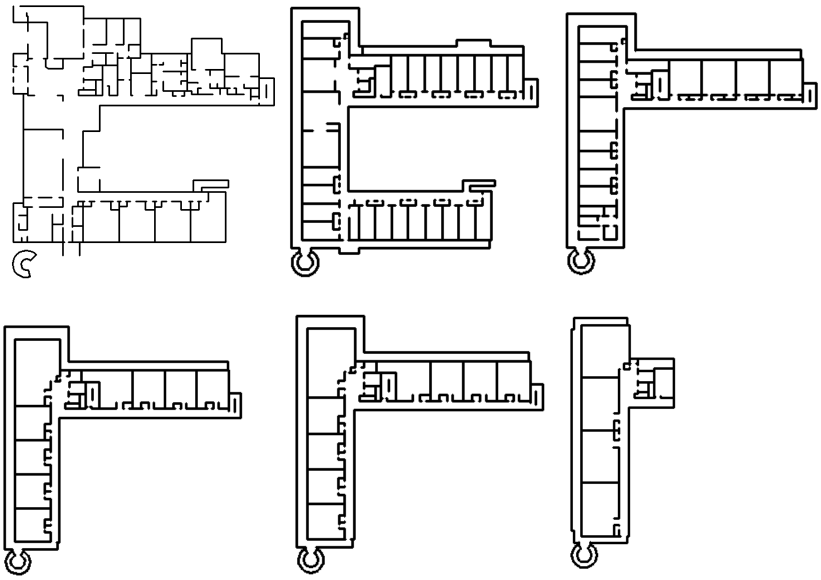

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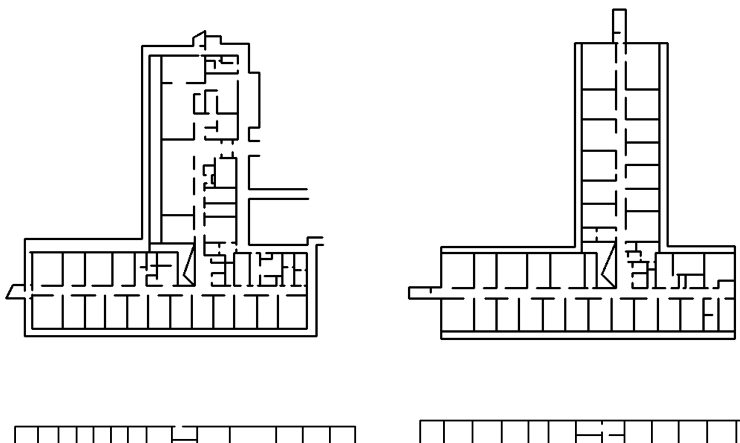

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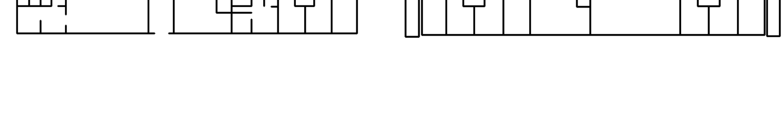

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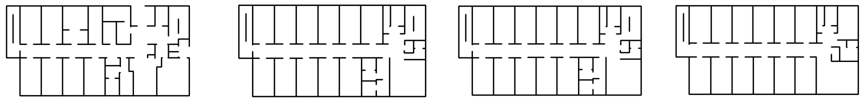

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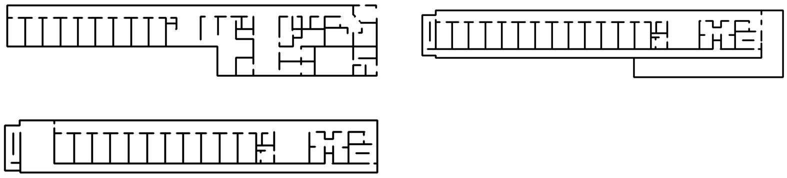

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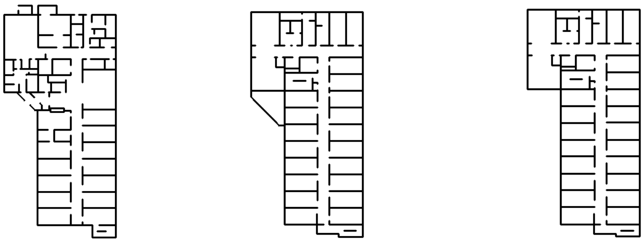

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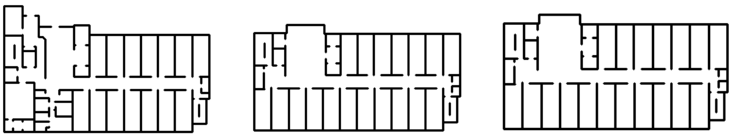

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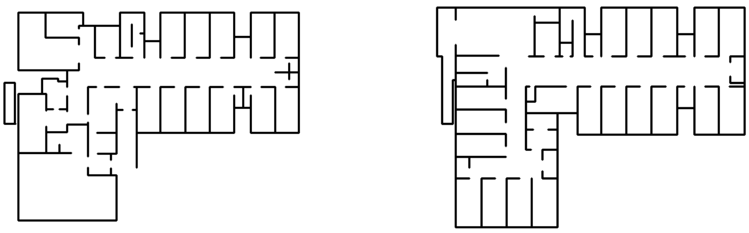

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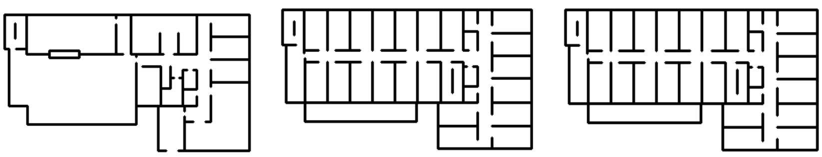

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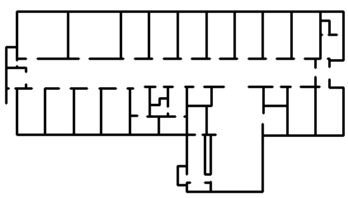

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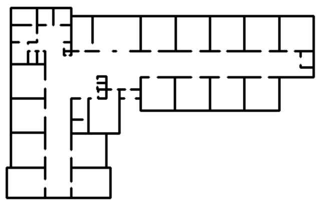

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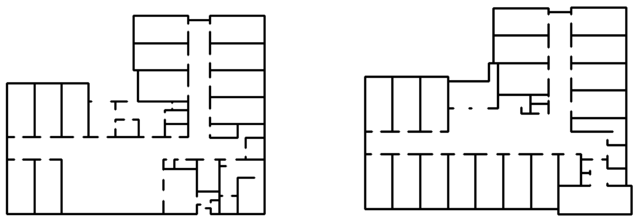

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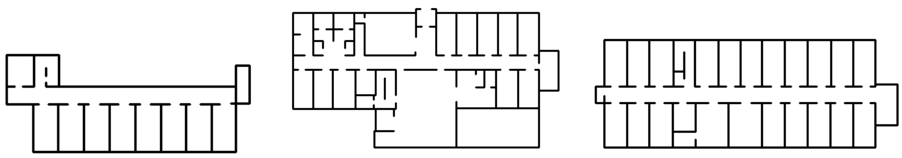

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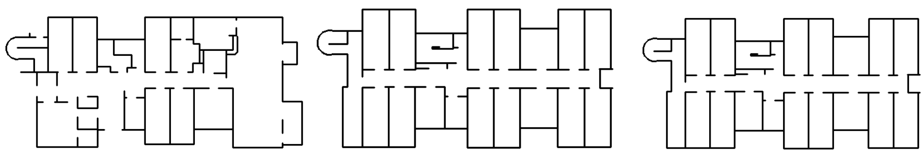

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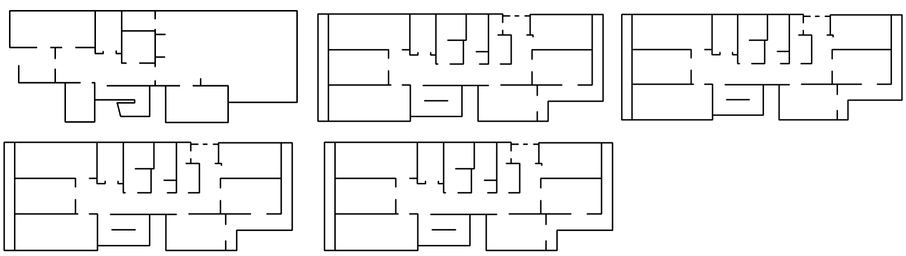

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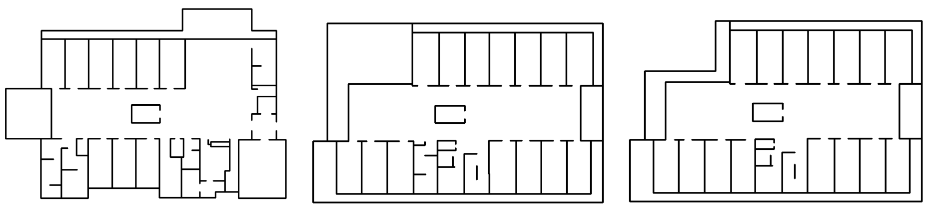

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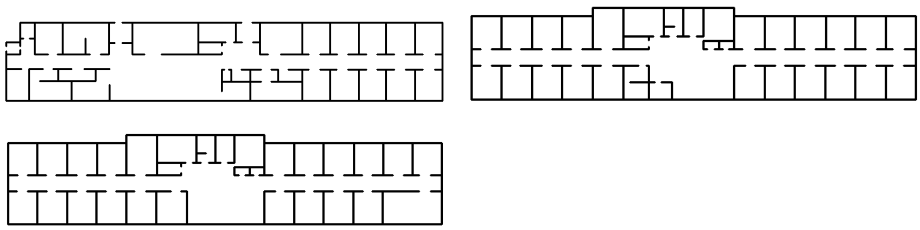

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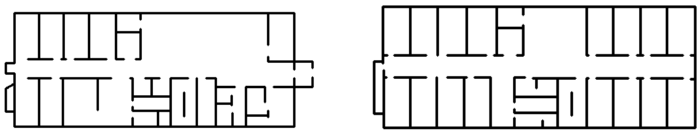

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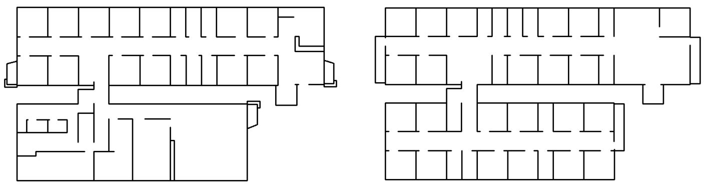

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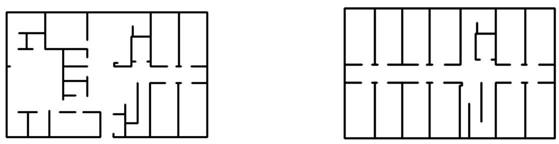

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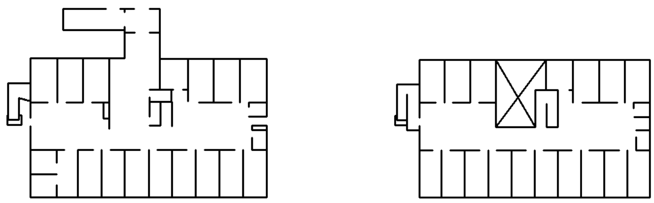

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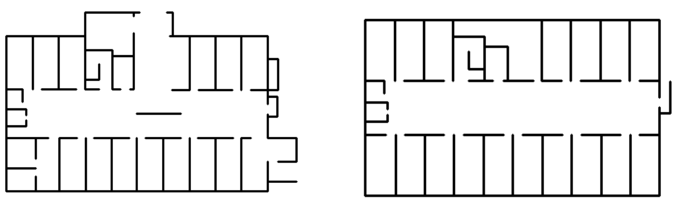

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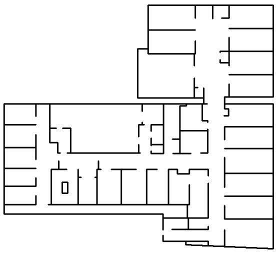

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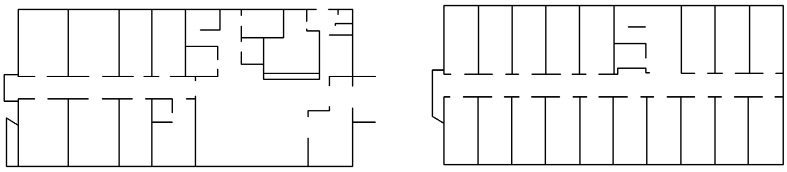

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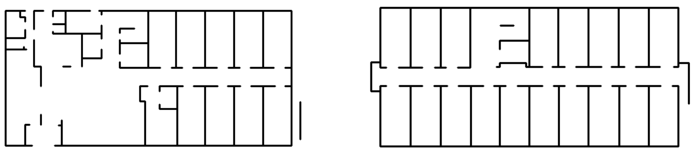

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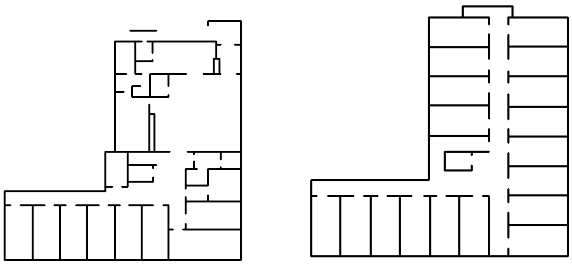

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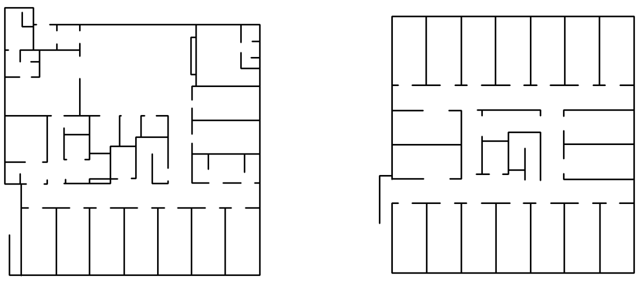

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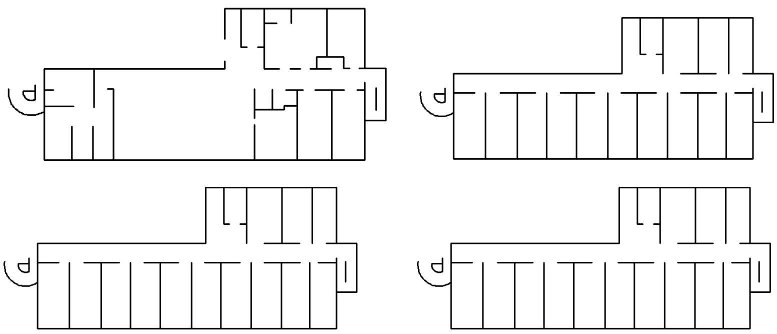

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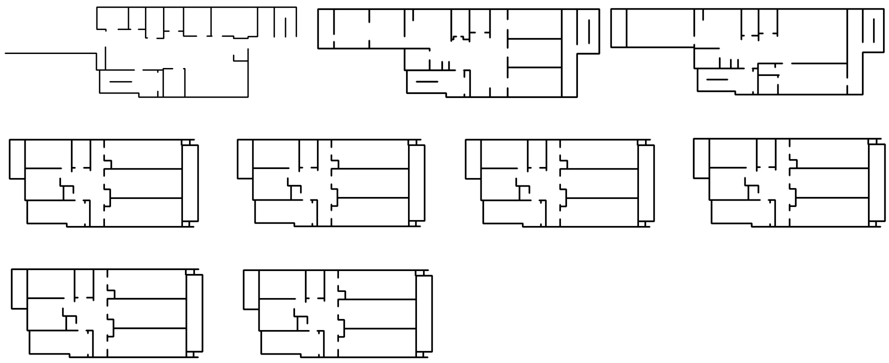

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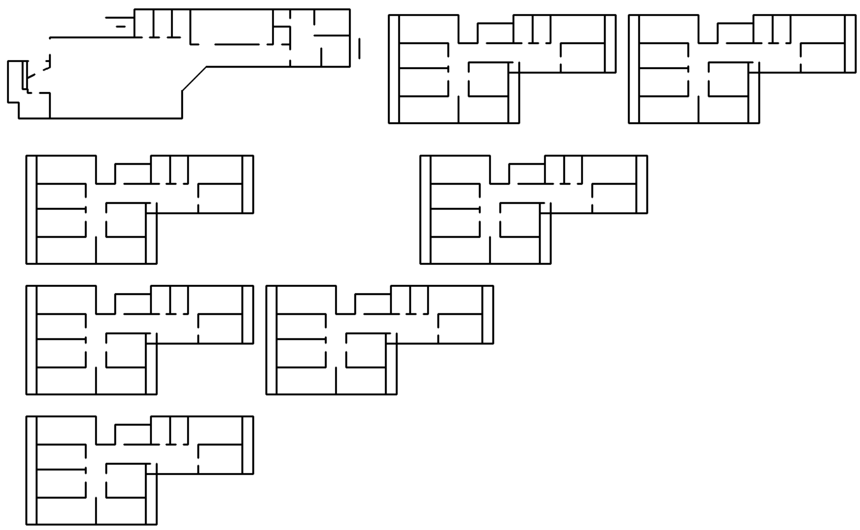

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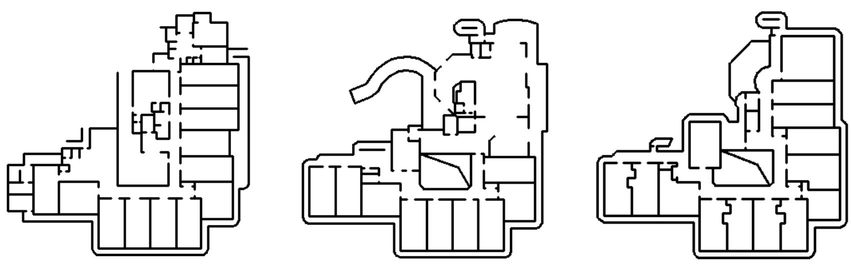

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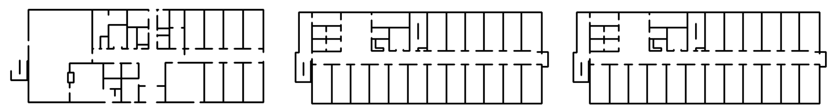

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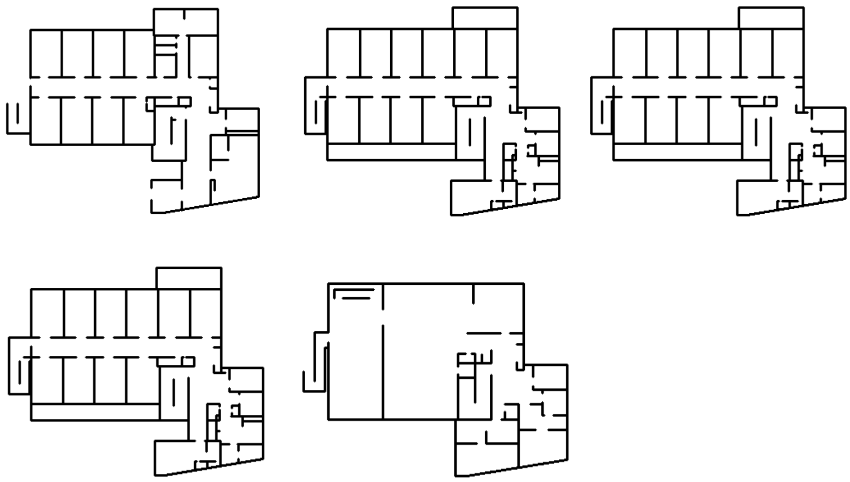

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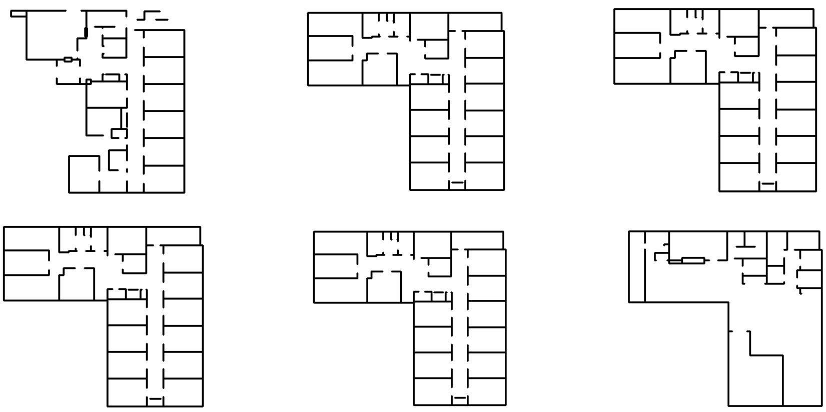

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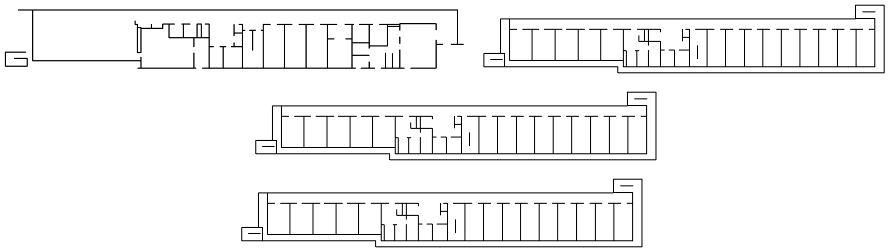

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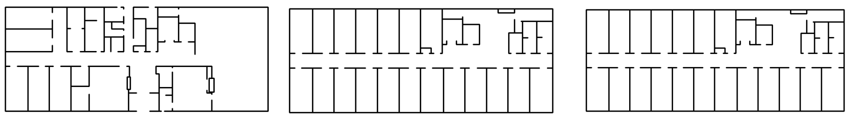

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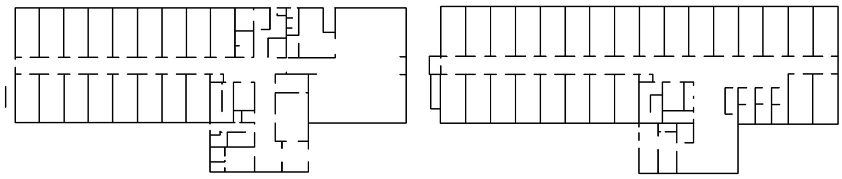

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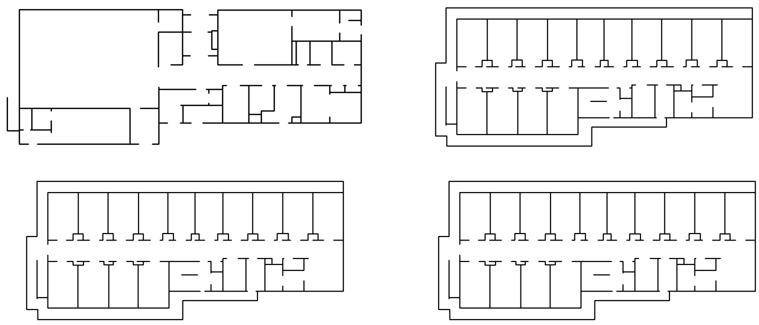

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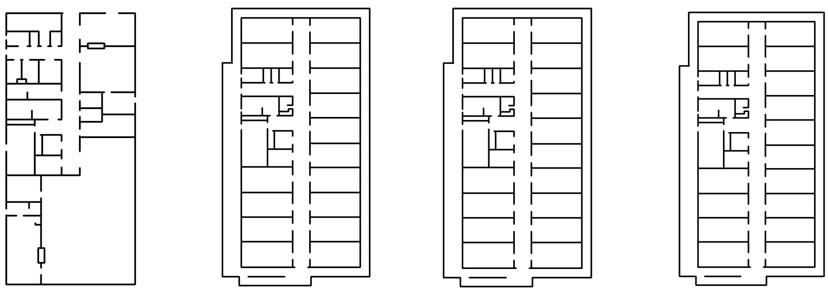

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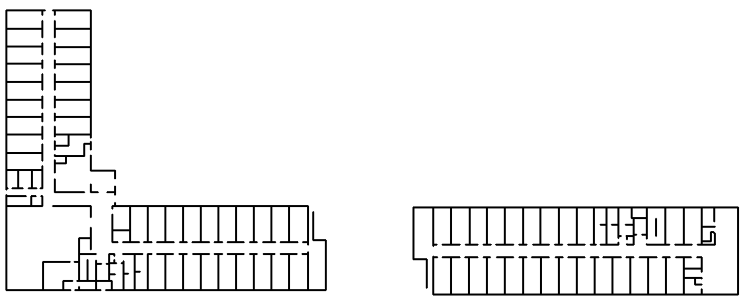

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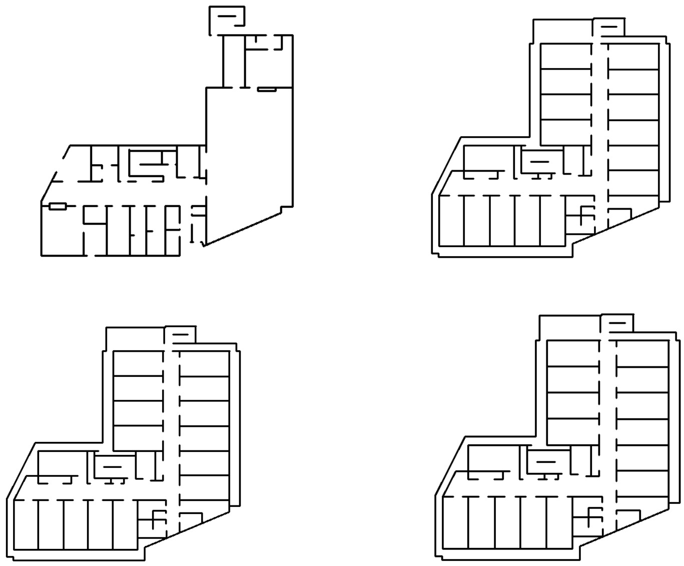

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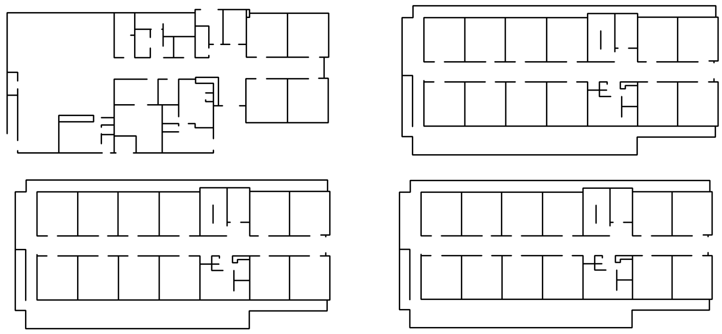

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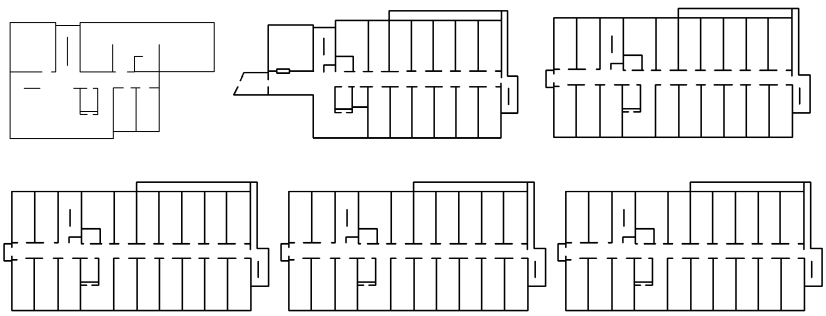

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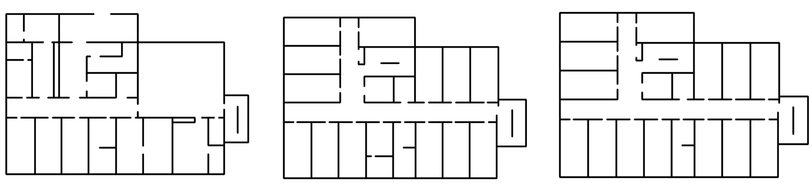

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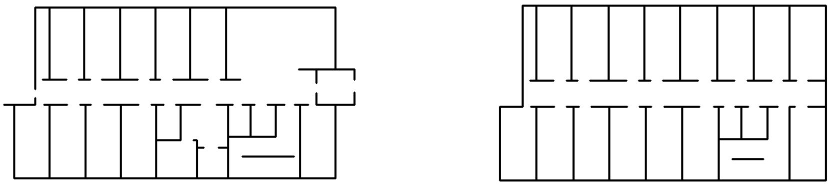

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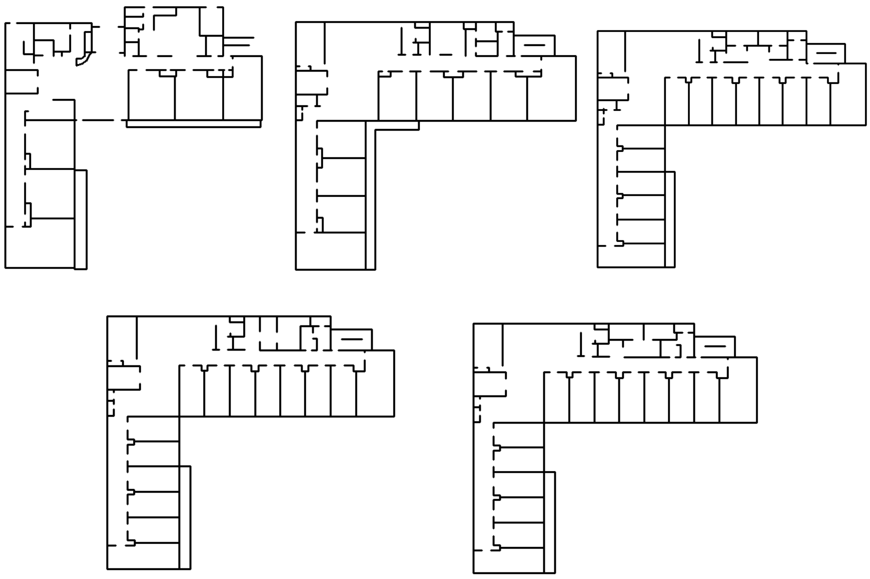

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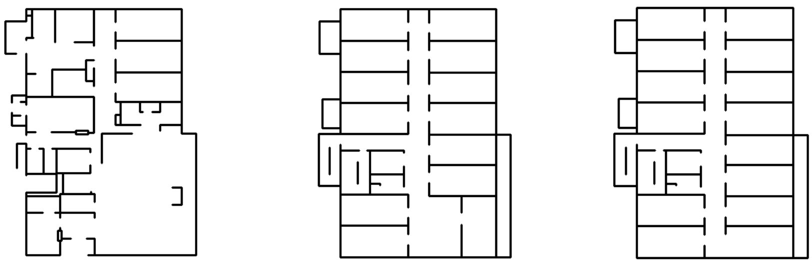

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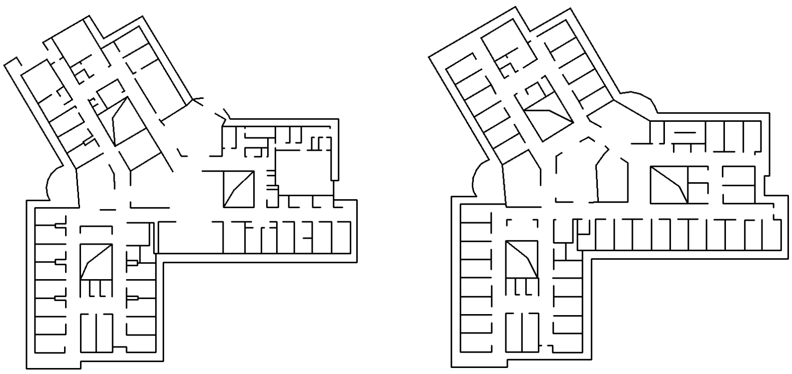

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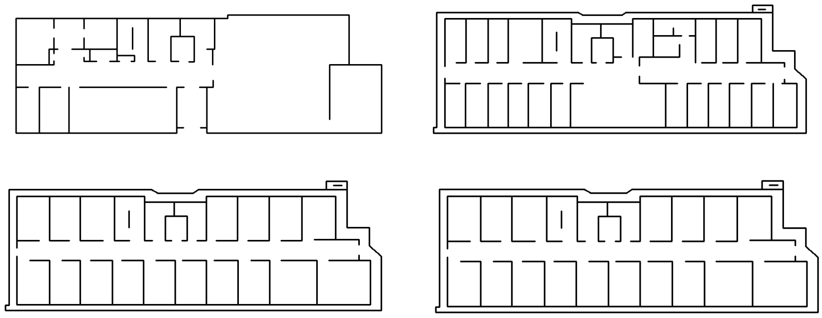

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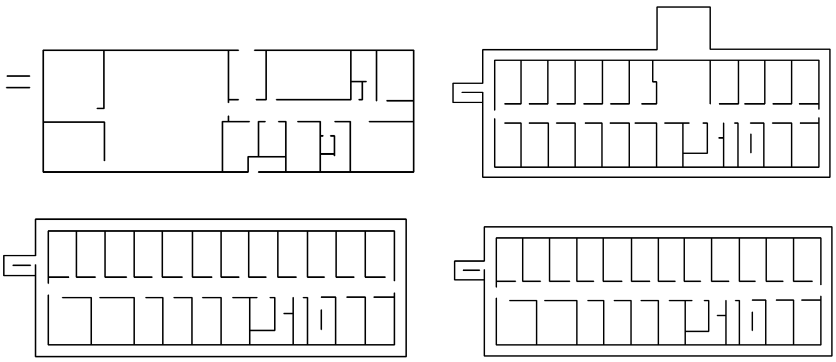

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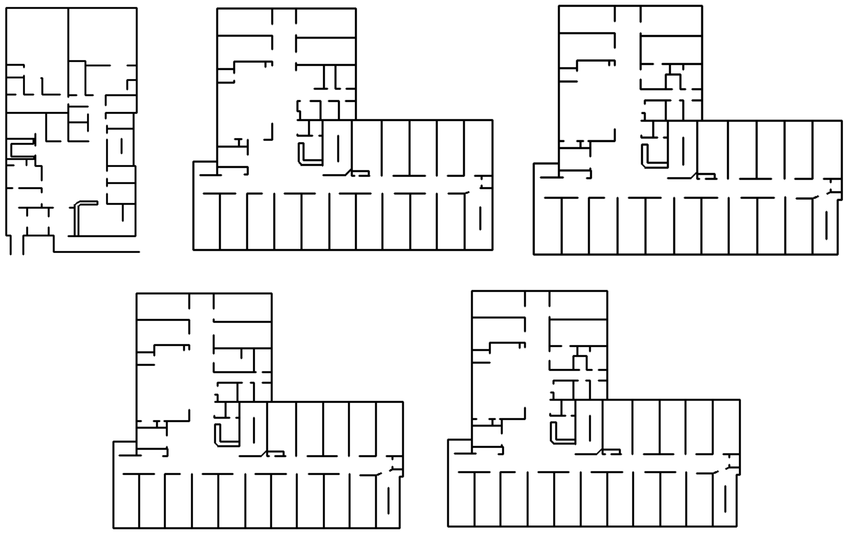

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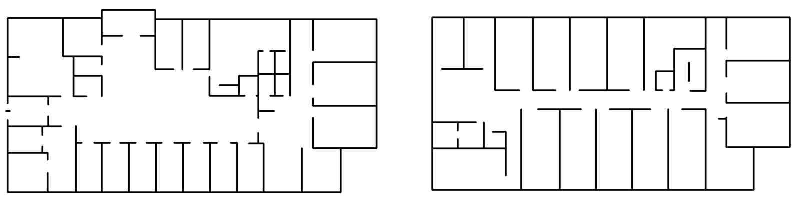

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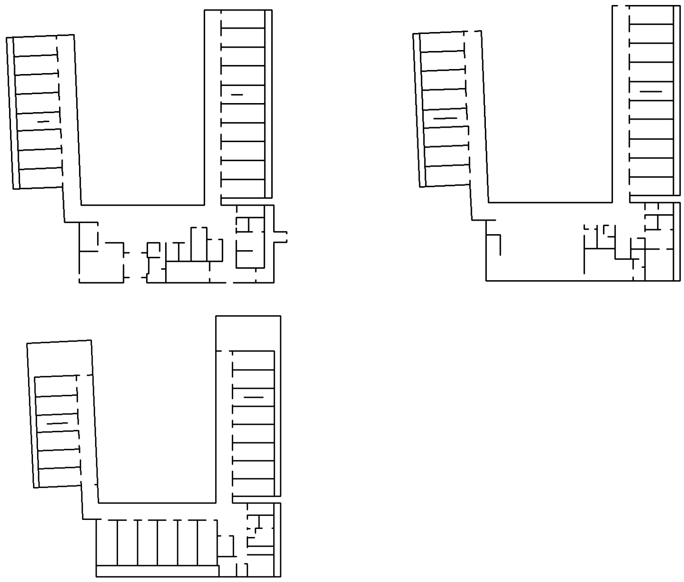

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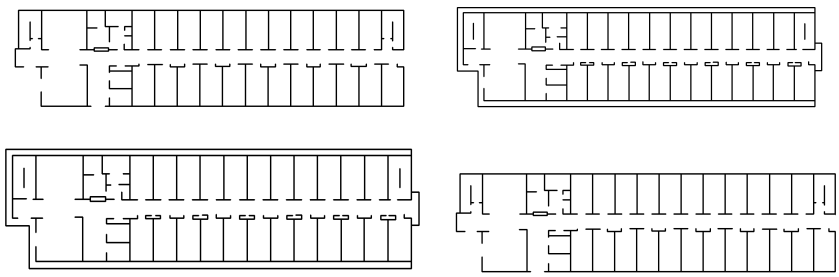

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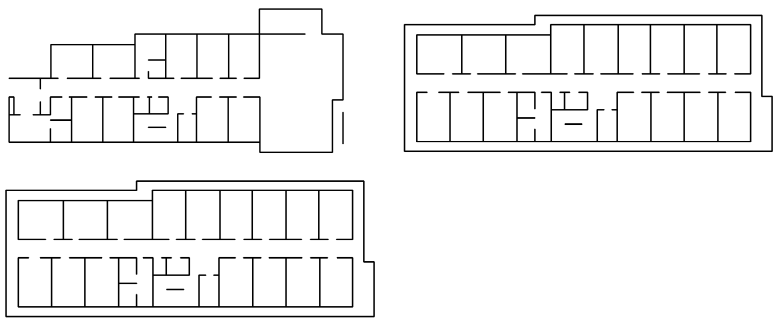

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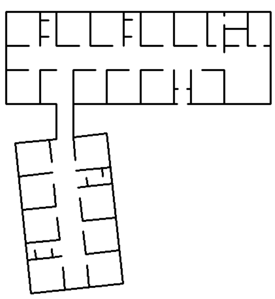

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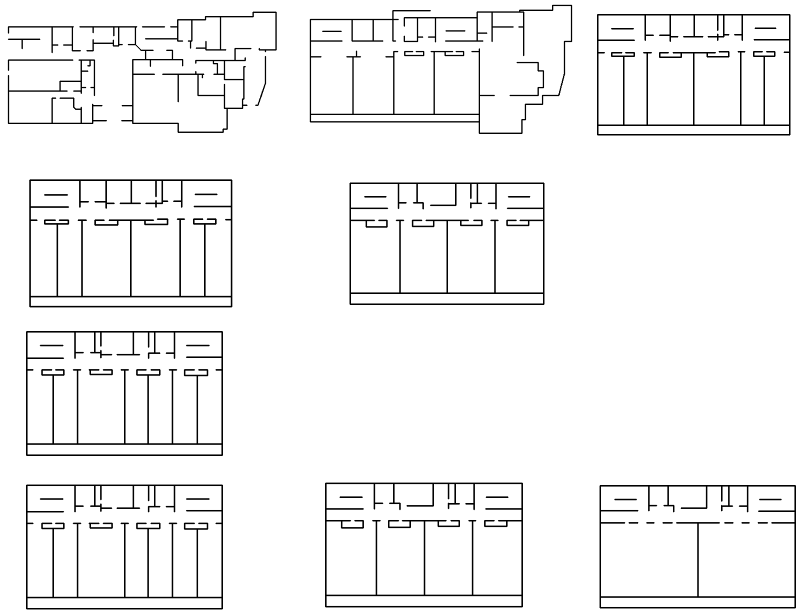

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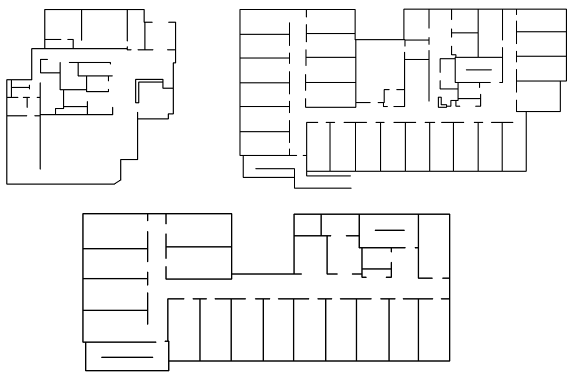

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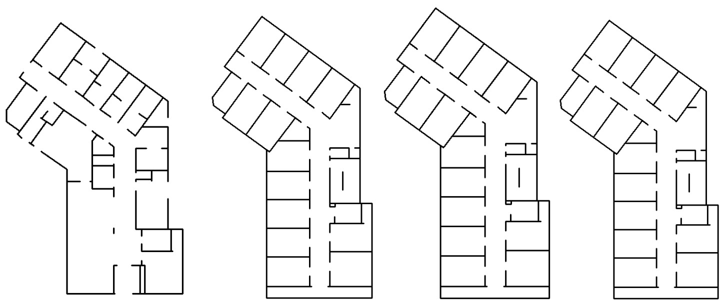

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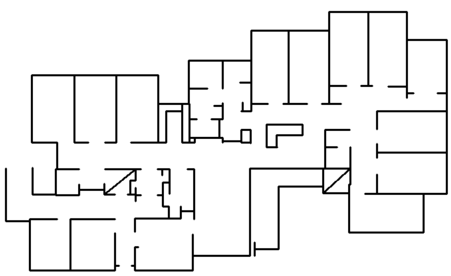

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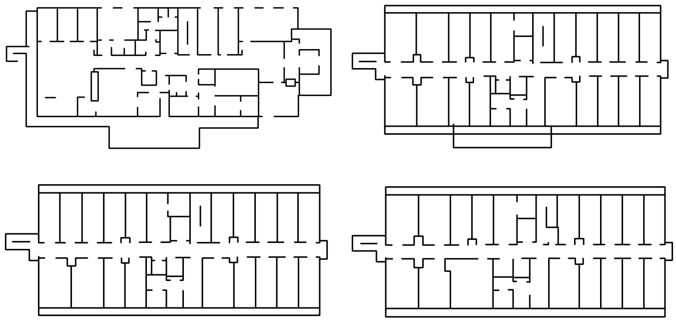

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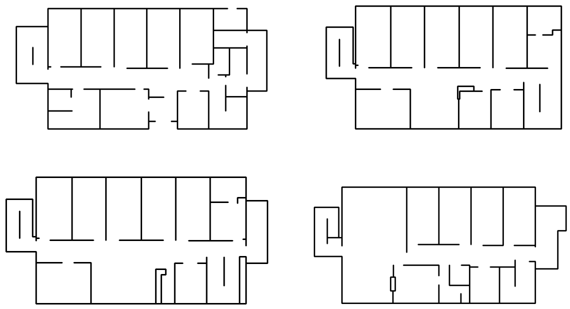

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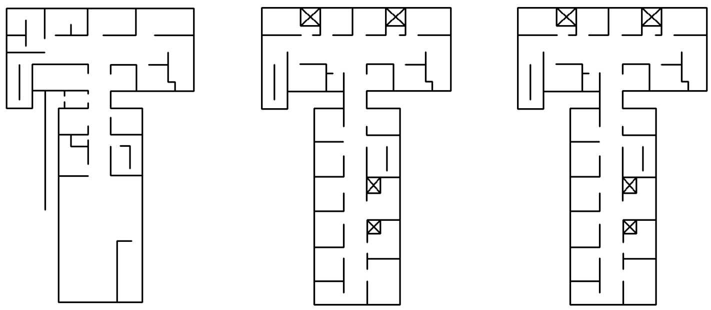

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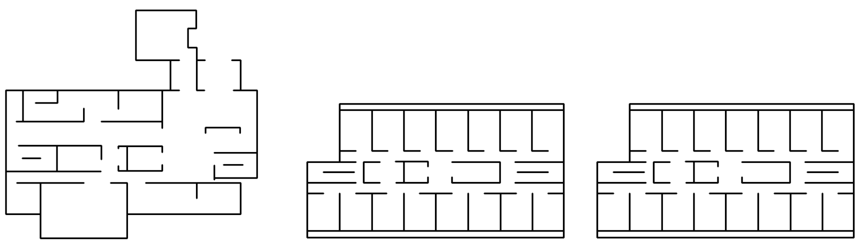

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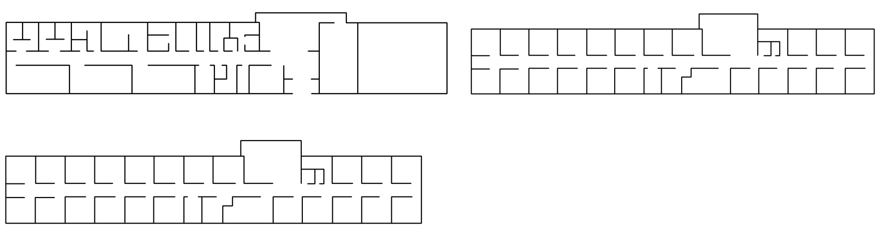

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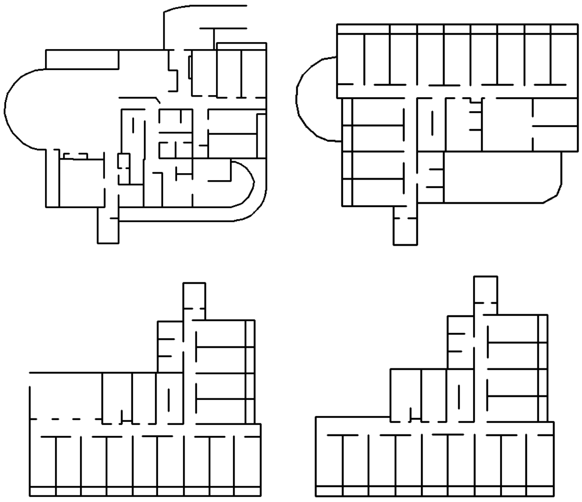

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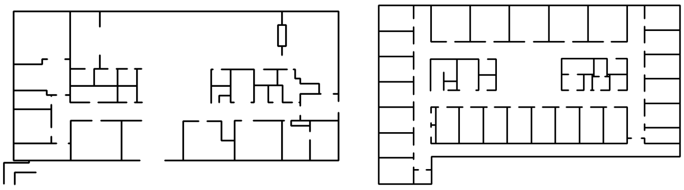

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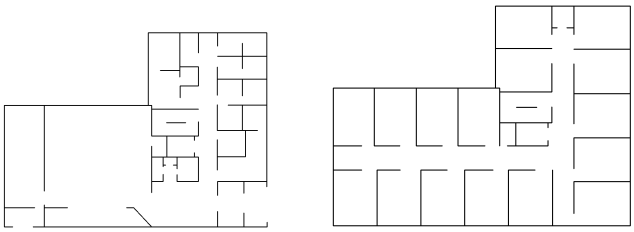

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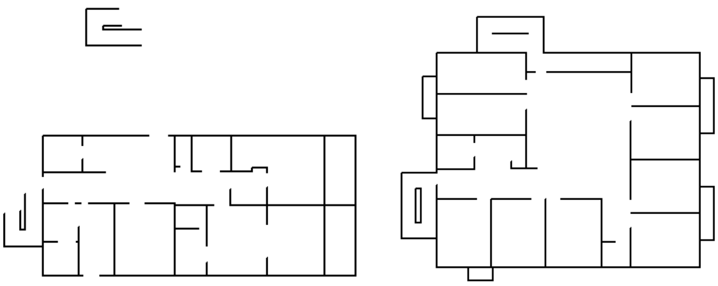

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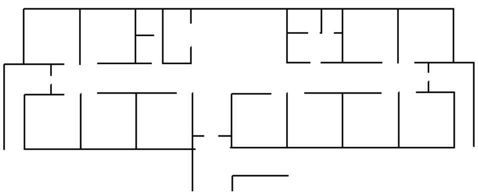

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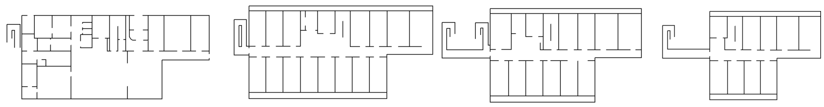

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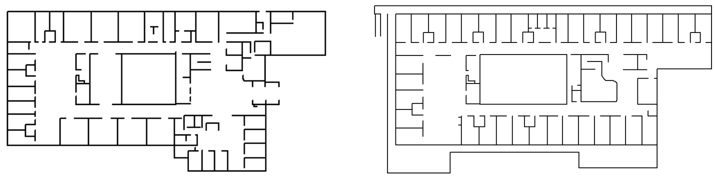

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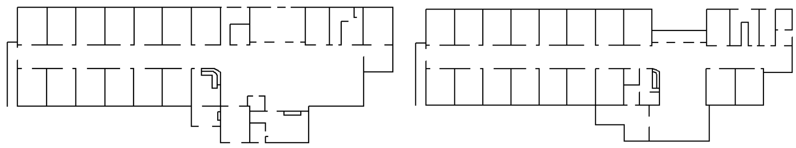

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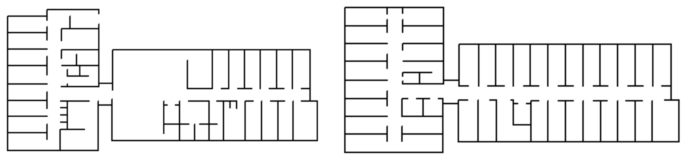

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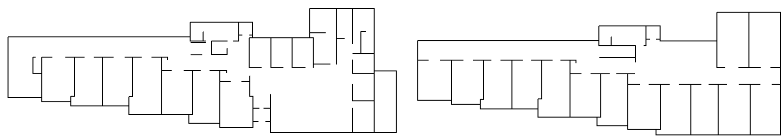

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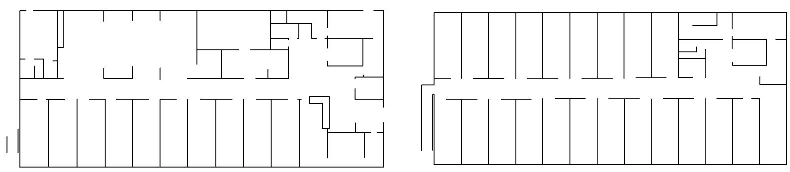

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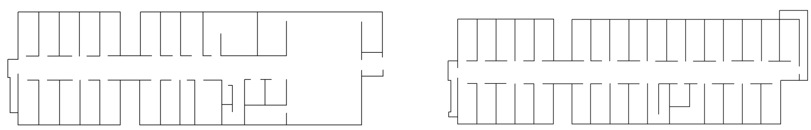

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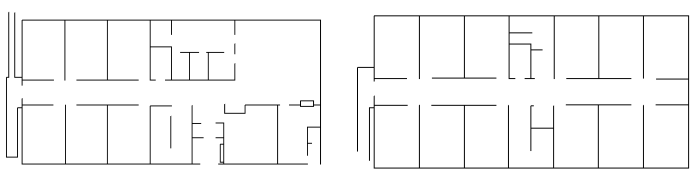

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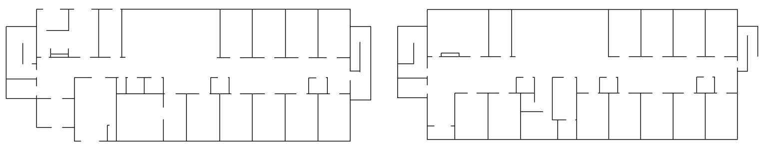

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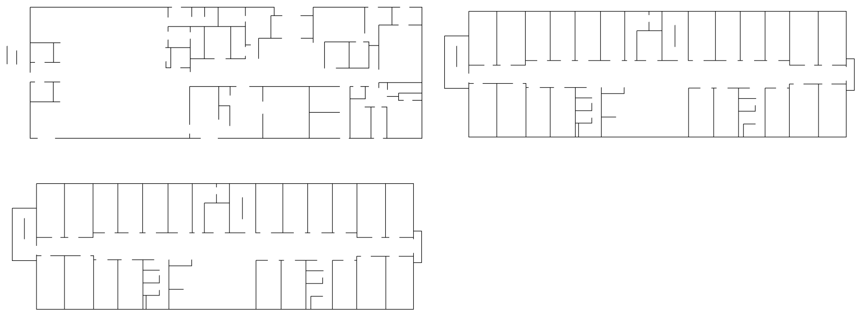

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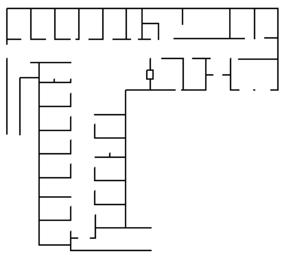

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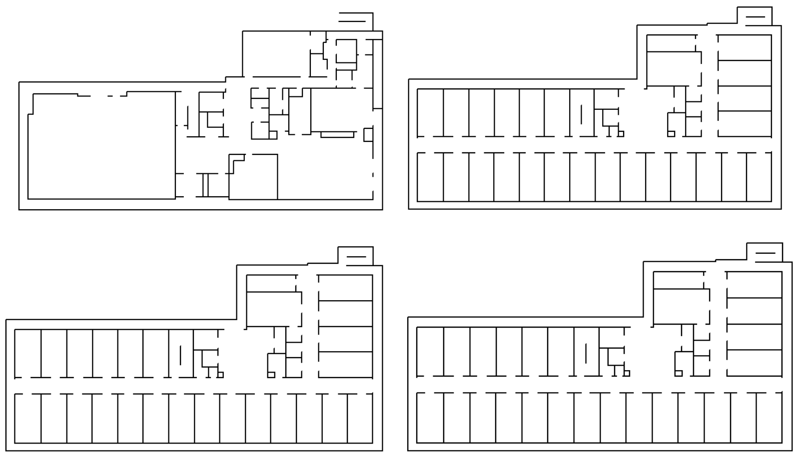

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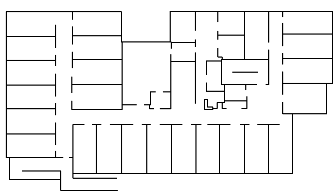

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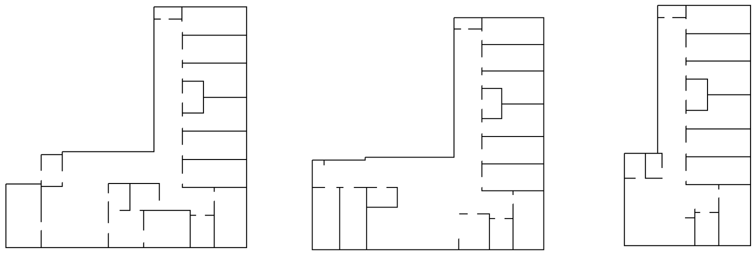

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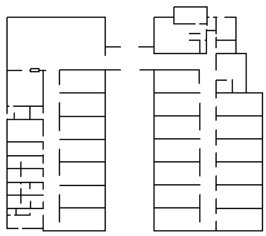

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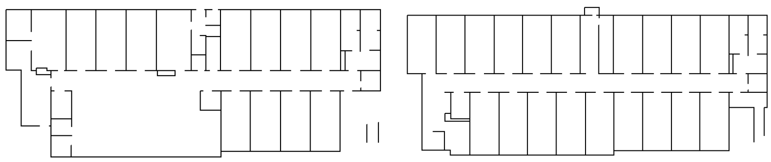

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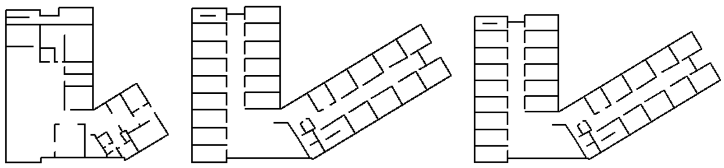

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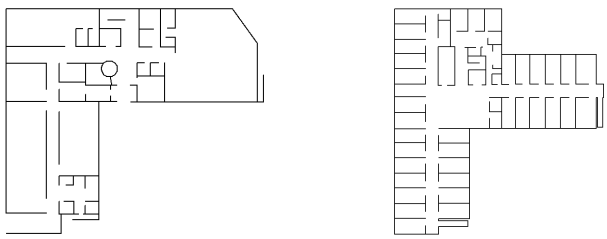

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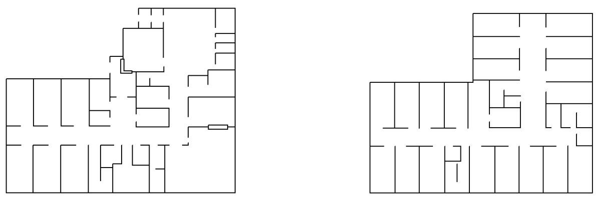

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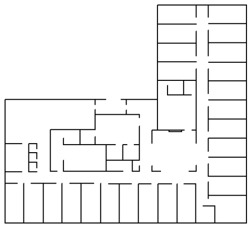

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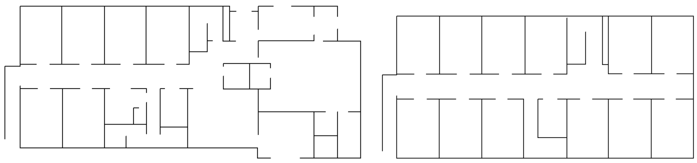

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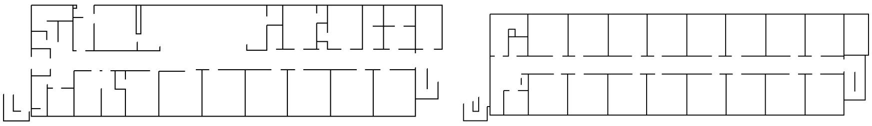

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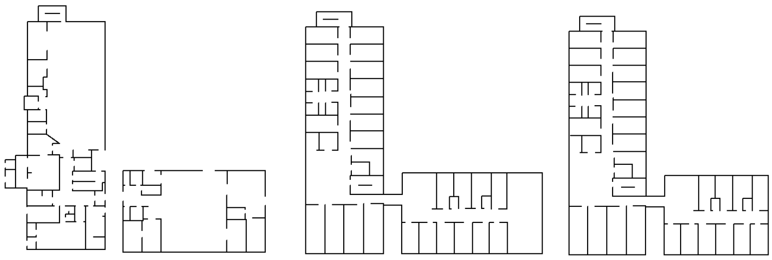

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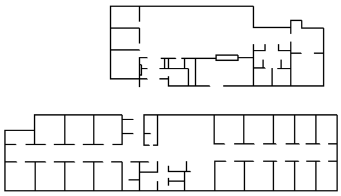

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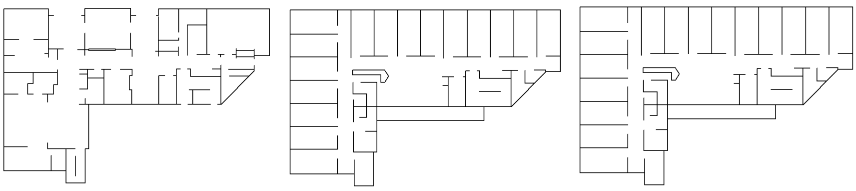

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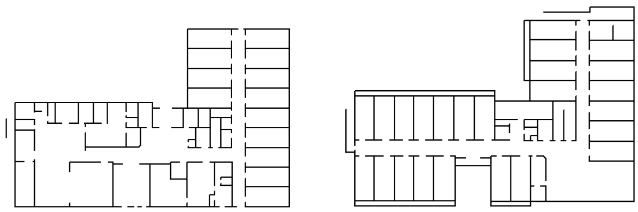

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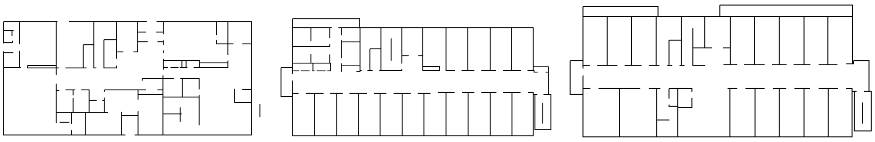

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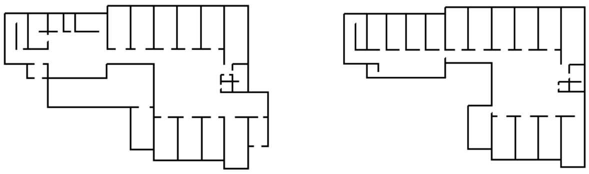

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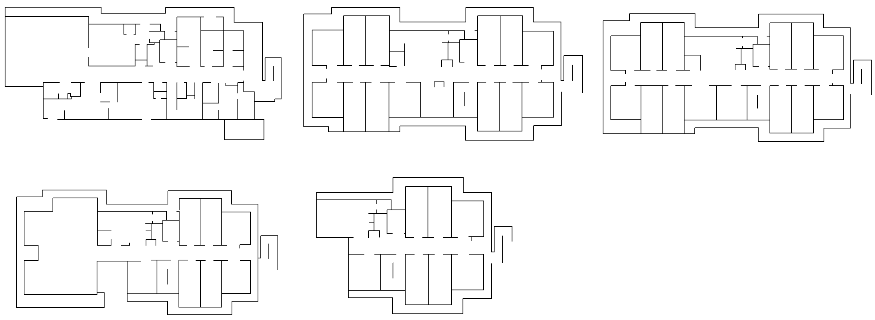

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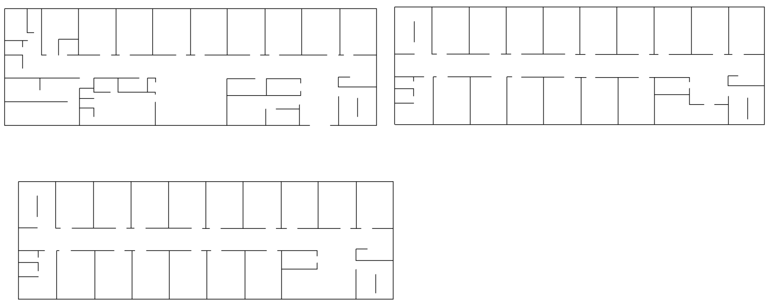

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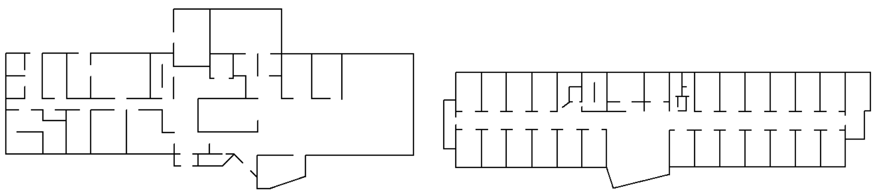

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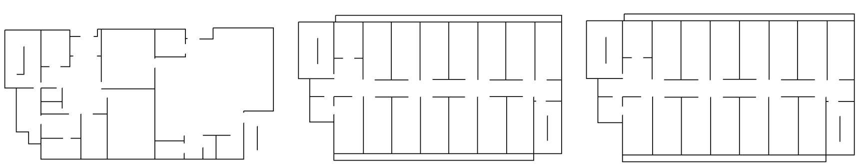

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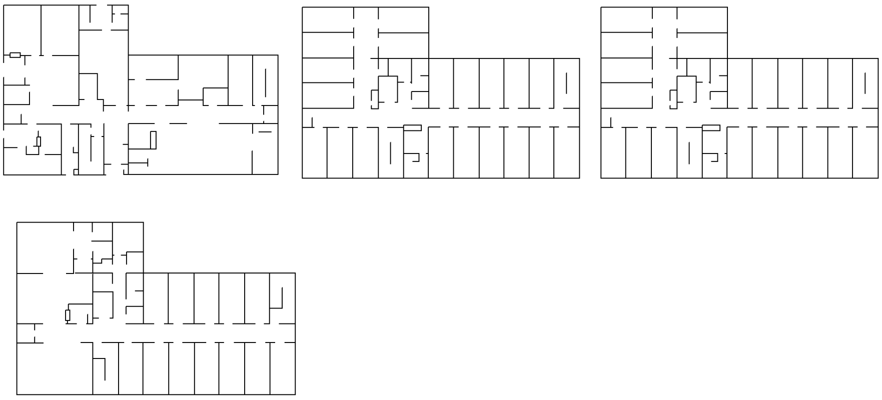

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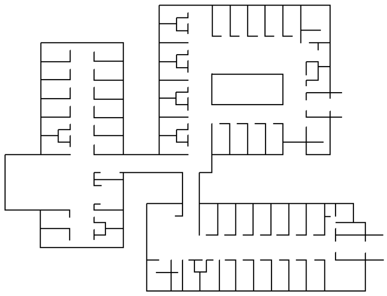

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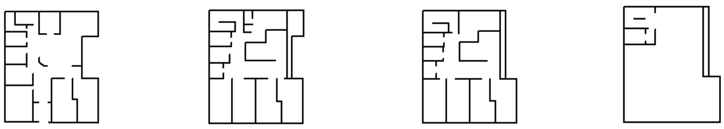

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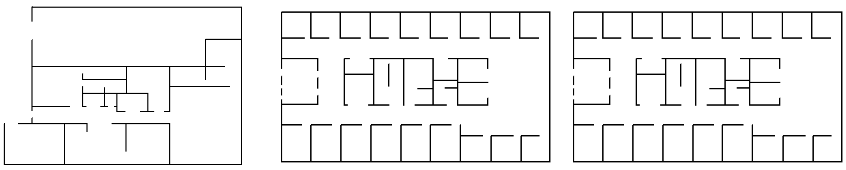

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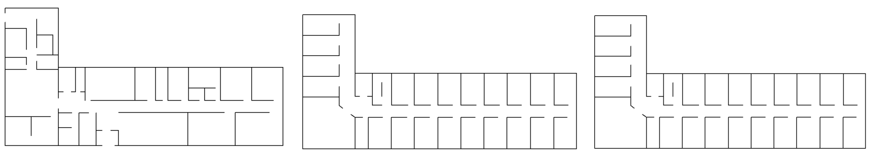

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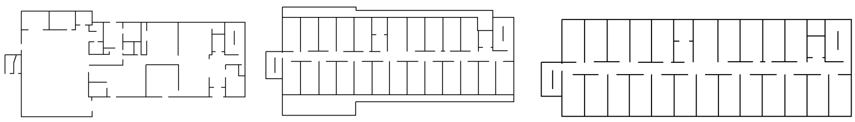

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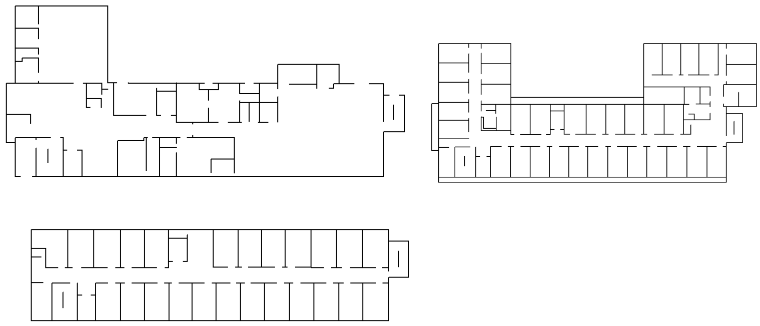

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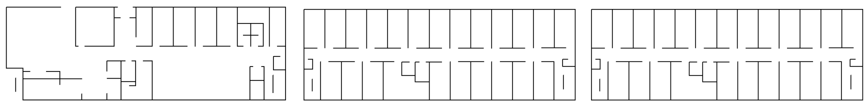

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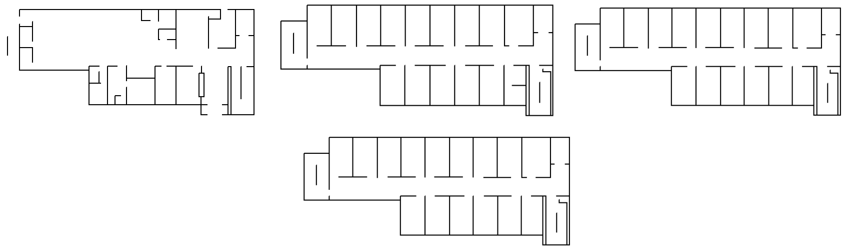

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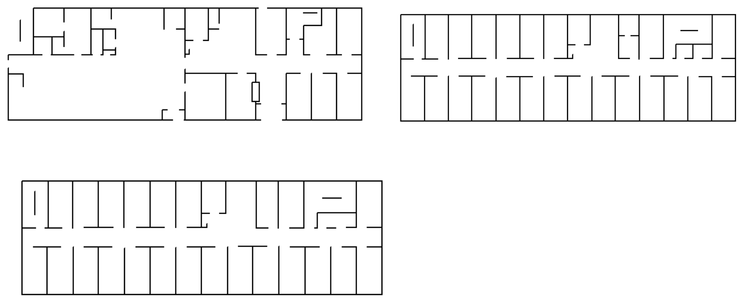

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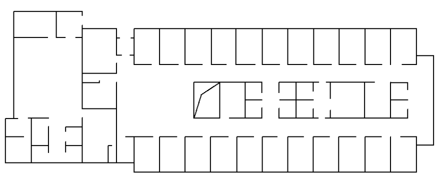

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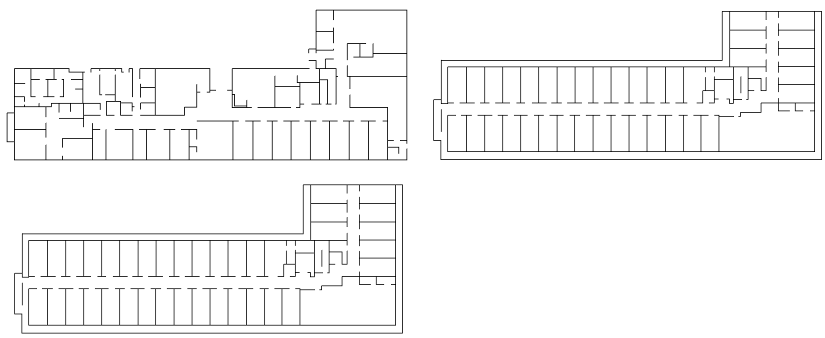

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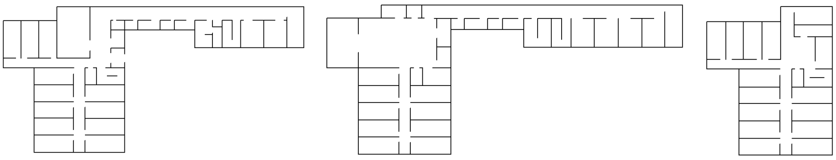

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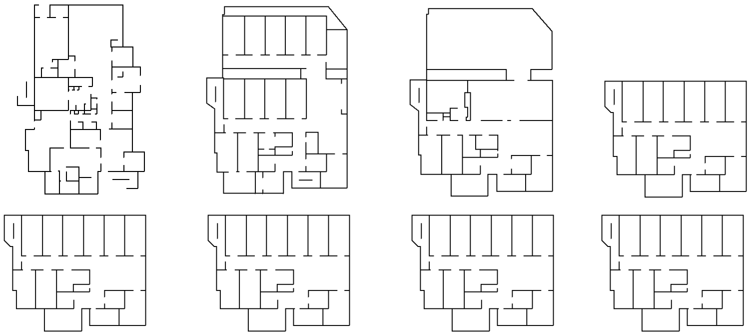

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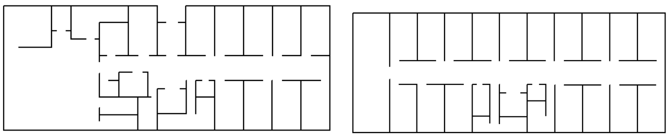

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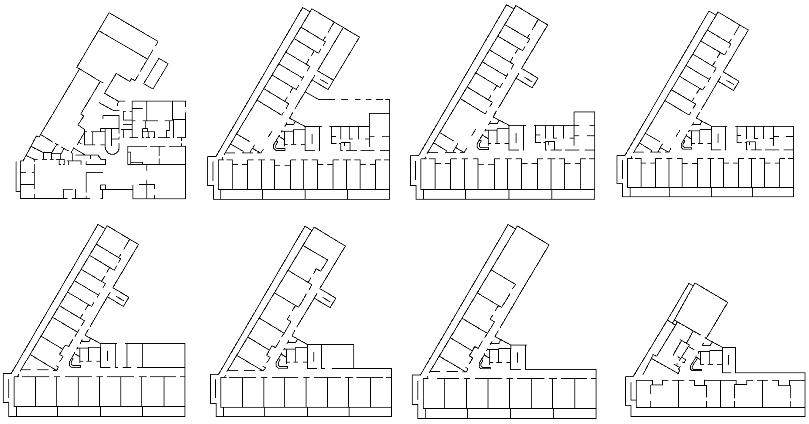

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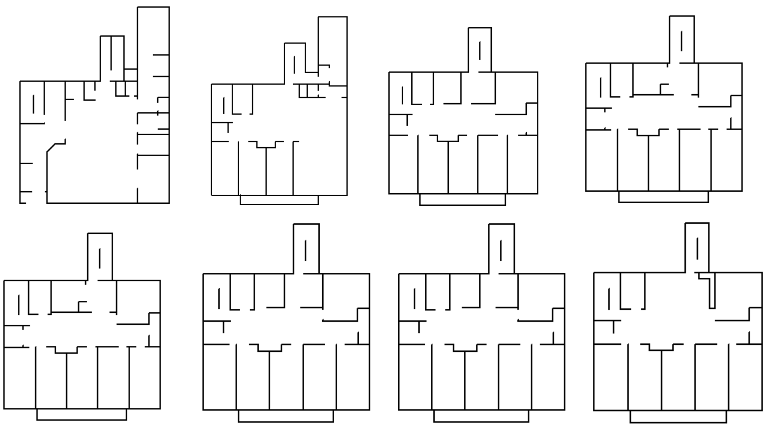

143
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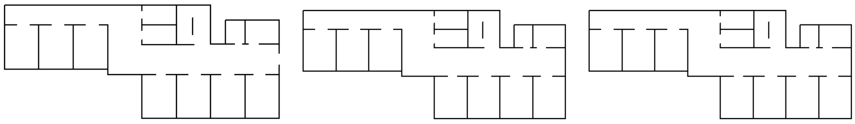

144
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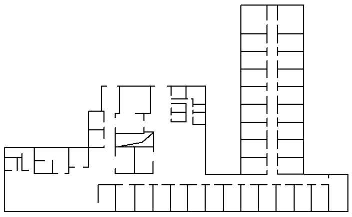

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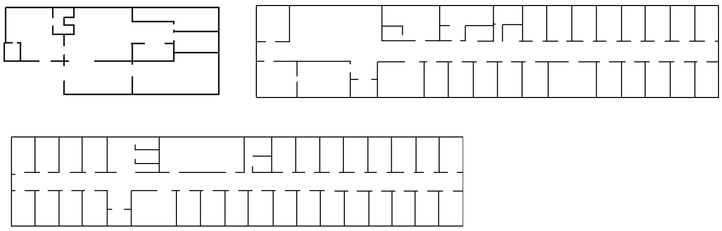

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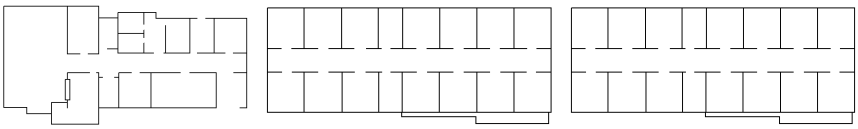

147
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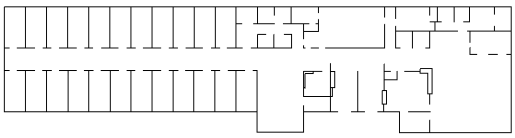

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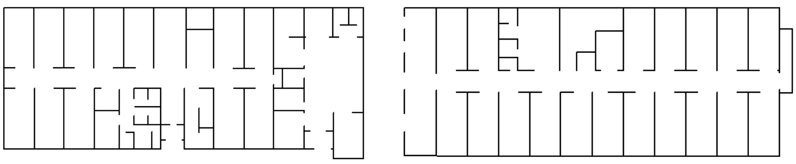

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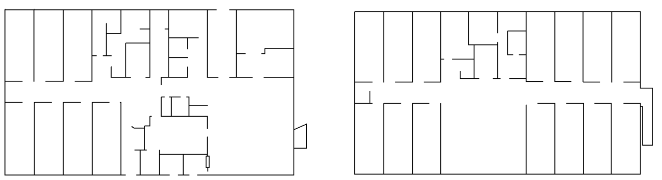

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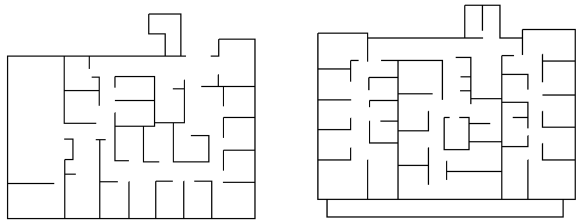

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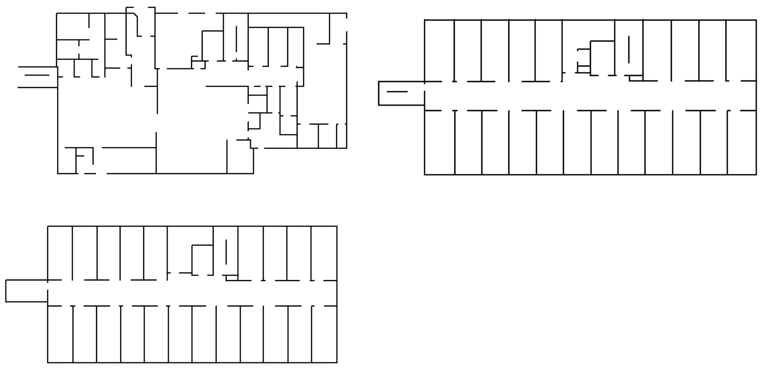

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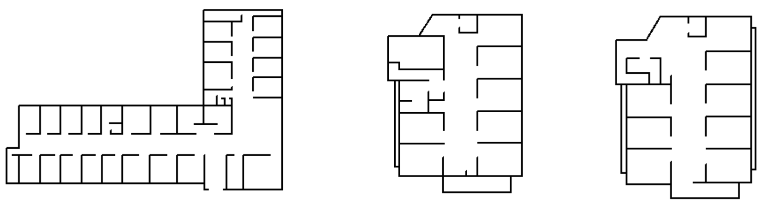

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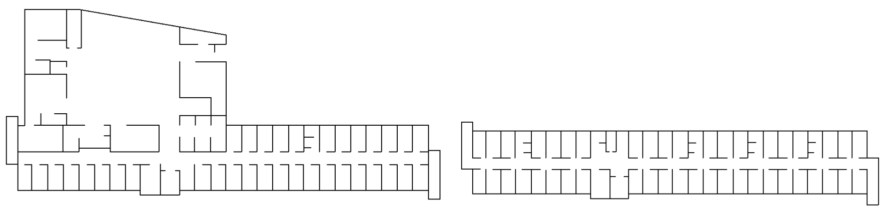

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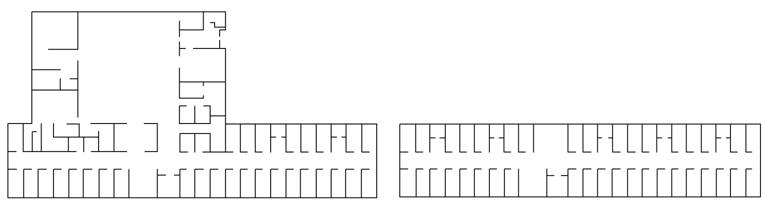

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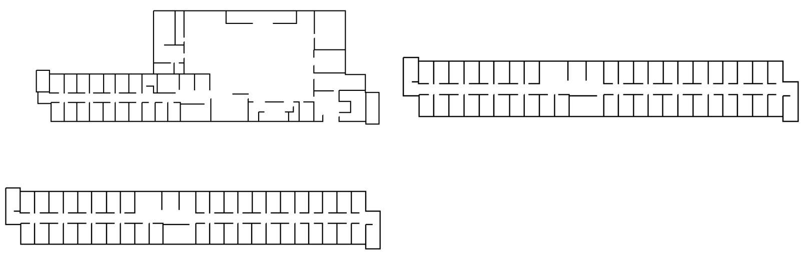

156
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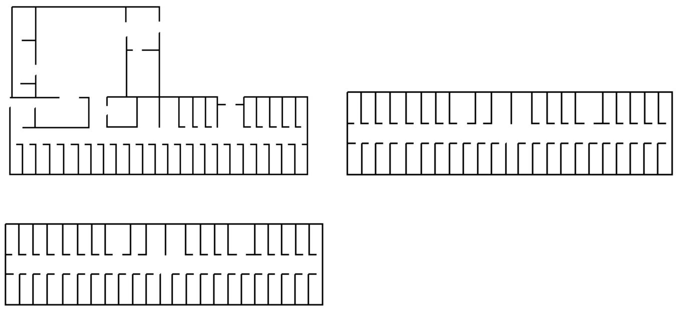

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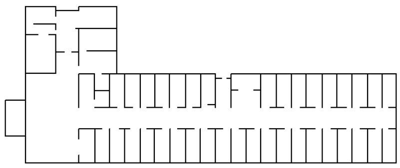

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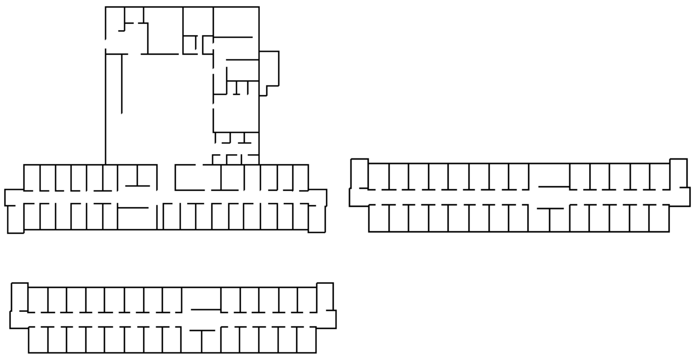

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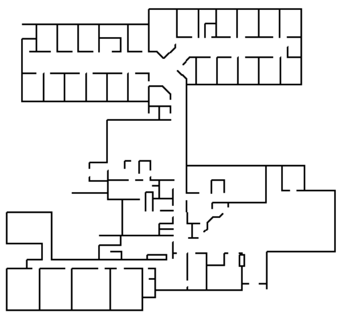

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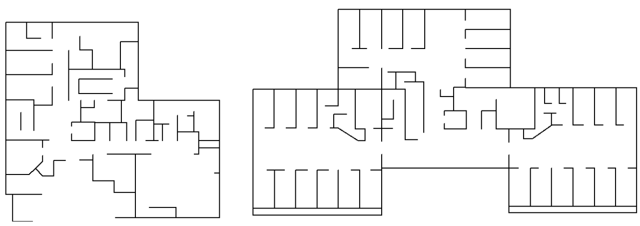

161
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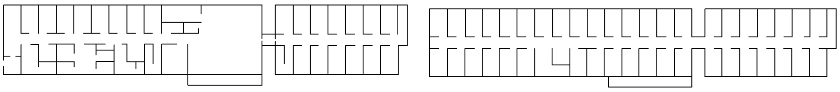

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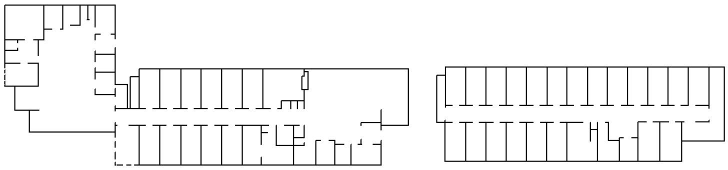

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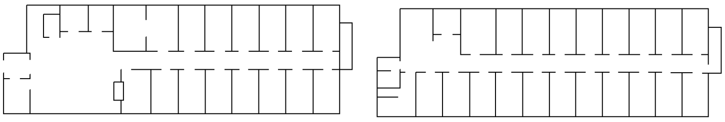

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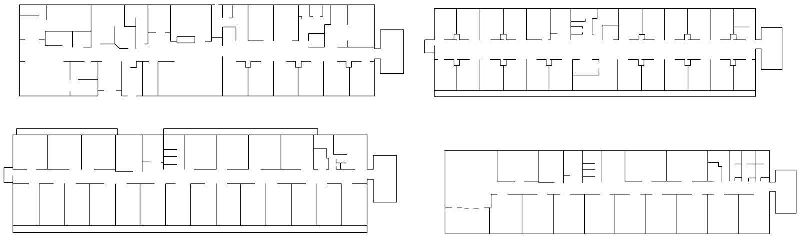

165
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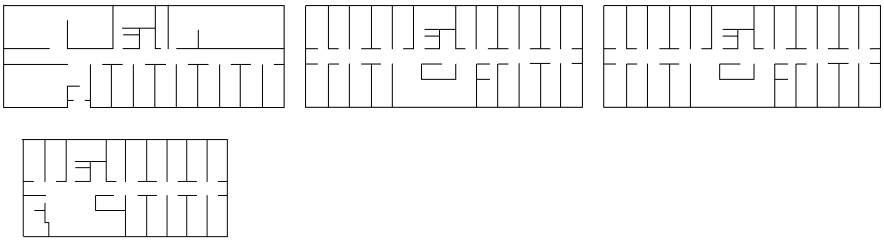

166
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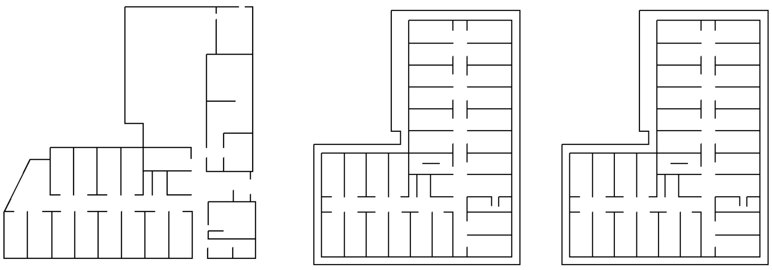

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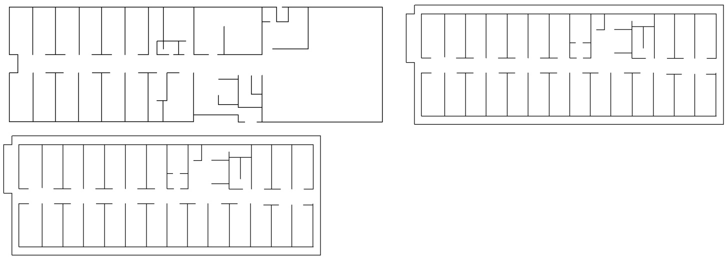

168
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