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EXPLORING THE USE OF FLEXIBLE AND ADAPTABLE SPACES IN STUDENT HOUSING DESIGN.

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Iloma Doris is currently a Post-Graduate Student at Rivers State University, Department of Architecture. Port-Harcourt. Nigeria. She is much more fascinated on how spaces can keep evolving as human needs are ever-changing. Her research works are evidence of her contributions in the field of research on how every building footprint, could be an advantage towards sustainability and energy efficiency of the future and innovative ways to end the housing problems the world is currently facing today.

Keywords
Adaptability, Flexibility, Spatial organization, Student Housing.

Abstract
Flexibility can be thought of as the concept of quality about 20 years ago. For decades now, flexibility has been a central theme in the design of dwellings; by incorporating adaptability, maintainability, accessibility and resilience into the concept, buildings of different scales and purpose, can be designed to ascertain certain high levels of sustainability. Flexible spaces are used as solutions in social housing at varying context i.e. lack of space, changing user needs, temporal structures, etc. this study attempts to research less focused concept on flexible housing that has the potential to be adopted into student design characterized by an interrelated spatial organization which contributes to placing of spaces according to their functions by creating multilateral relationships that respond to the user (students) ever-changing needs; while avoiding any major damages to the structure. This paper also reveals the potential of the student housing project in Nigeria as well as a historical background 0f adaptable architecture.

1.0. Introduction

Student housing design standards are growing more complex and demanding every year. Installing bunk beds and ergonomic desks in every room of a multi-storey residence hall isn't enough anymore. Today's students want housing that's not only comfortable to live in, but that also offers many more amenities. To address these growing needs, architects are constantly improving the way they design student housing. These spaces need to feel like a home away from home. They also have to strike the perfect balance between privacy and community. A well-designed residence hall can make all of the difference in the lives of students who are learning how to live on their own for the very first time. (HMC Architects, 2019)

The extent of flexibility can be determined in two ways: first, the in-built opportunity for adaptability, described as capable of various social uses; and second the opportunity for flexibility, described as capable of various physical arrangements. Then again, despite the numerous attempts, the tendency to design flexible buildings is usually anticipated for a short term where it relates to a particular type of dwelling for a while. Therefore, it is required to accept the necessity for long term dwelling reflecting on the uncertainty of future demand and occupation. (Till and Schneider, 2005, pg.157).

''The 20th century will be about staying in a place worth staying in.'' *(Kunstler J.H, 2019.)*

Learning how to live on our own for the first time is a completely overwhelming experience. Meeting new people and creating lasting friendship and memories that make living on campus an experience worth it. Student housing has evolved in response to social, academic and economic needs and changed simultaneously with the development of societal and campus culture.

The early dormitories comprise just of single or double bunk beds made of wood or iron, arranged in rows in an open space/hall. Bathrooms and toilets separated from sleeping areas with no major consideration to social spaces and growth. The need for social interaction and yet still social distancing due to transmittable virus such as Covid-19 has also influenced how student housing should be as a means of controlling possible spread of viruses or other communicable diseases. Flexible and adaptable spaces are the best-known design approach that can respond to major and minor changes of such in the society without much cost and labour input. The notion of adaptability and flexibility of space in student housing design is to prevent unnecessary changing of rooms or entire building reconstruction whenever any new circumstances in life occur, which could be due to finance, lifestyle, campus culture, population growth etc. and also having a hostel accommodation which encourages students to stay on campus rather than off-campus. The idea is the hostel itself must adapt to the changing needs of students and new educational needs, rather than the inhabitants changing their accommodation or reconstruction to meet their new requirements. Most students who stay off-campus plan to stay in student accommodation for the duration of their study period (4-5 years). For students who lodge the on-campus environment, either stays for the period of their programme or goes off-campus towards the end of their programme (3rd, 4th, or fifth year). It is also assumed that some students don't lodge on campus due to inadequacy of rooms, sanitation, and personal reasons. This paper I based on research that attempts to exhaustively examine the concept of flexibility and adaptability of space in architecture and propose flexible and adaptable models that respond to changing needs of students and of course meet the requirements of the educational sector as well as tenets of sustainability.

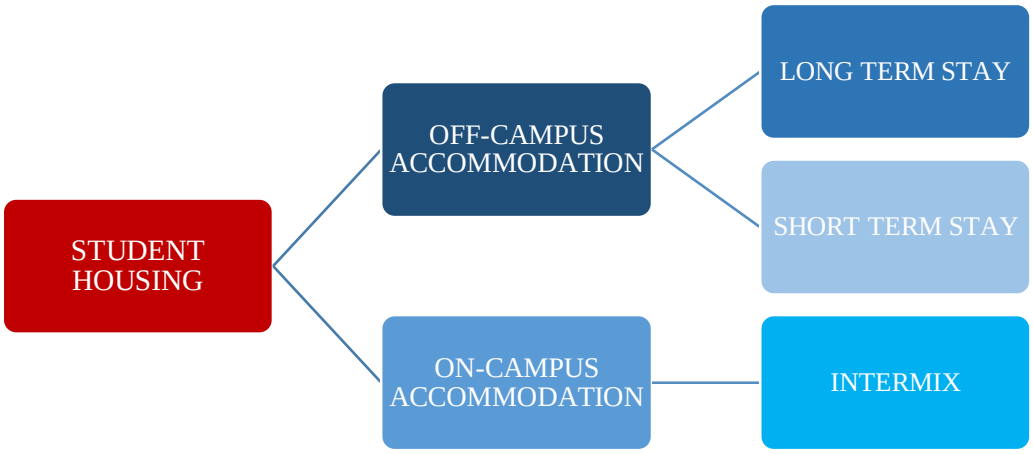


Figure 1.1 Student accommodation housing structure.

1.1 Understanding Flexibility in Architecture

Flexibility is the ability to achieve a change of conditions without changing the system. Flexibility can be achieved not only by the design of space itself, but also by building systems that support (Dluhosch, 1974). In the book 'the idea of buildings' written by Steven Groak (1992, p.17), distinguish between 'adaptability', taken to mean: capable of different social uses, and "flexibility", taken to mean: capability of different physical arrangement. The building's capacity for accommodating changed uses will depend on the extent to which it is adaptable and/or flexible.

- **Functional Flexibility:** The space performs various intended functions, but that's all. There is no room for users' interpretation.
- **Adaptable Flexibility:** Space is interpreted and is used in various ways within a certain boundary.

1.2 Importance of flexible and adaptable space design in Student Housing

- Flexible and adaptable student housing compels the clients (universities and private sectors) to take control of their dwelling over the lifetime of their property.
- It provides room for adjustment of accommodation requirements/needs of students with regards to their financial capability thereby serving more students of different income levels without discrimination.
- Flexible and adaptable hostels can create dual use of space. The living area at day time can be adjusted at night as sleeping area while still maintaining fixed aspects such as the toilet and bathroom with sliding walls and cupboards to create the remaining spaces.
- Flexible and adaptable spaces offer greater individualization. Hertzerberger, (2005) notes that flexibility can contribute to creating an environment which offers far more opportunities for people to make their markings and identifications in such a way that it can be appropriated and annexed by all, as a place that truly belongs to them.
- Construction of buildings isn't complete until people inhabit and use the space. The student (roommates) having the liberty, can continue to change functions easily, multiple purposes in line with their activities of each time of the day, accommodating users' interventions and having greater potential to remain relevant to cultural and social trends of the university while the architecture remains the same.
  ''what stays fixed in the drawing will still stay fixed in the building overtime'' Peter Calthorpe (nd. Quoted in Brand, 1994).

2.0. Literature Review

Student housing is a purpose-built facility constructed for the accommodation of students while pursuing their education to create an environment that supports healthy living, learning and social interaction. It could either be completely built and managed by the university or built by private developers/investors alone or in partnership with the university to accommodate and cater to student's needs. Nigerian universities continue to experience a significant rise in student's enrolment over the past two decades. According to Ahthelia, Nigeria has the biggest university system in Sub-Sahara Africa with a total of 141 approved federal, state and privately-owned universities as at 2015, 161 in 2017 and 165 in 2018 at 2.5% growth of 2017 with over 20,000 students enrolled in each. Figures from the national universities commission (NUC) shows that the surge in student's enrolment has not been matched by a corresponding growth in student accommodation (fig. 1.1). Nigerian universities accounts for less than 30% of Students housing needs. According to the National Universities Commission (NUC), and as of 2 November 2018, Nigeria has 43 Federal Universities, 47 State Universities, and 75 Private Universities. Besides, while students' enrolment in tertiary institutions is growing at an average of 12% per annum, the provision of new purpose-built students' housing is limited. This is evident in the provision of students' housing which is less than 30% of demand and which in turn, creates opportunities for the development of students' housing in many cities in Nigeria by the private sector. (PROSHARE, 2019).

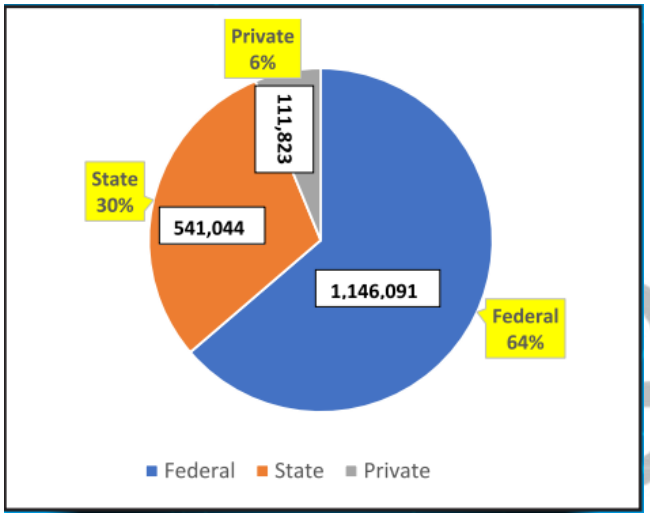


Figure 2.1 Undergraduate enrolment in Federal, State, and private universities and percentage of total system enrolment. Source: (Nigerian Universities Commission (NUC), 2018)

2.1 Historical background of Adaptable Architecture

Schneider & Till suggest two scenarios for the development of flexible housing in history. The first indicates that development came as a result of evolving conditions in vernacular housing (Schneider & Till, 2012). Vernacular architecture tends to be very adaptable. Usually constructed by hand using local materials, structures can be easily added on to or demolished and recycled naturally. Although adaptability in the form of the vernacular is not exactly applicable to contemporary modern architecture, vernacular architecture offers many ways that a building might naturally evolve and expanding to fit its occupants, reducing or gaining layers through different seasons, etc. The second scenario developed in response to external pressures that have prompted designers to create alternative design solutions. This is the contemporary version of adaptability involving architects and other experts. (Abdullah & Muhammad, 2018).

The first phase came about in the 1920s (following the First World War) in response to the need for European social housing programs to provide mass housing for the working class. To supply housing to as much of the population as possible, smaller space standards were adopted. Schneider & Till term this phase "modernity and the minimal dwelling," arguing that early modernist architects sought to make these minimal dwellings as functional as possible using elements of adaptable design. Dutch architects such as Johannes van den Broek experimented with the changeability of use and it was concluded that due to the fact that some rooms went unused for much of the day, these spaces should afford different uses during that time. For example, a bed could fold up to provide an additional living room or office space during the day. In the Schröder Huis, designed by Gerrit

Rietveld, a complex system of sliding walls and folding screens adapted to suit the daily cycles of the family. (Abdullah & Muhammad, 2018).
The second phase in the evolution of adaptable housing began in the 1930s and was essentially based around the belief that flexible housing could be available to all using prefabrication and other emerging technologies. (Abdullah & Muhammad, 2018)
The third phase began in the 1960s when the move towards participation and user involvement led to a new interest in adaptable housing as a means of providing user choice. John Habraken recommended the idea of the building of "supports", which consists of the primary structure, the building envelope, circulation spaces, and mechanical systems. These supports can then be infilled by occupants in a systematic order to accommodate a variety of floor plans and features (Habraken, 1972). Since the era of Supports, Habraken's ideas for residential open building practices are being adopted for use more frequently, especially in Finland, Japan and the Netherlands (Abdullah & Muhammad, 2018)
In the 21st century, adaptable architecture is characterized mainly by the use of energy-efficient materials and sustainable principle and methods of construction. The goal here is how architects and engineers can achieve an adaptable and flexible space with re-usable parts, and the building envelope capable of housing different functions and interior with moveable parts that respond to user needs without any form of structural instability. This could also be referred to as the fourth phase in the evolution of adaptable housing.
"If a building doesn't support change and reuse, you have only an illusion of sustainability." (Croxton, 2003)

2.2 Flexibility and Resilience

Flexibility as a term, may appear to be vague and difficult to understand, but is a fundamental aspect of sustainability.
Flexibility in design can allow a building to evolve over time as the user needs change. The flexibility of a building or elements of its design can allow it to be used efficiently despite change in operational requirements, whereas an inflexible building might become obsolete.

Flexibility might include active flexibility, such as moveable partitions, but can also include the provision of features that are inherently flexible, such as multi-use spaces, open plan offices, large floor-to-ceiling heights and high-capacity service voids.

Flexibility was an important resource for mass social housing, which sheltered the abundant working masses and their families (leupen, 2004).

Flexibility in design has two major approaches; Open building (OB) and Extendable core (EC) design or the grow approach (Jusan 2010a). The EC approach is also classified into "Add-in and Add-on" strategies (Friedman, 2001). Both approaches allow users to make some modifications to their houses according to their future needs by adding a space or moving and replacing a space with another. The user will be given a ready-built house but with future possibility to modify according to predictions made by the designer. These modifications will be conditioned to cost, need, and time which give the user two options between renovation or moving into another place. (Alaraji & Jusan, Flexible architectural design and user participation, 2012)

Open building (OB) approach was first articulated by Habra ken (1972). Later, its application became internationally widespread, focusing on creating open spaces that allow for specific and planned type of participation according to certain expected function. One of the theories that open building depends on is the Level Theory, which defines who controls what and when, and decides the role of each parties in a building design (Kendall, 2000).

2.3 Strategies of Flexibility

An investigation of the utility of flexibility strategies results in adequate implementation and stimulates a reflection on the qualified forms for achieving a goal.

Schneider and till (2005b) evaluated flexibility used in 20th century projects by comparing determinate versus indeterminate design. According to them, the type of construction (reduction of loads and solid partitions), the technology adopted (reduction of non-accessible or non-adaptive services), and the use of space (elimination of modernist functionalism and rooms with single use) must be critically considered.

Generic principles	
Space	Increased capacity and free use of space as less specified.
Construction	Structure allowing easy access for intervention and maintenance.
design	For adaptation capability to predict future scenarios and room options.
Layers	Structure, skin, services, internal petitions, and finishes.
Typical plan	Generic space without specification
Services	Location planning for future changes.

Table 1: generic flexibility principles.
Source: Schneider and till(2005b).

TRENDS	STRATEGIES
Spatial flexibility in a fixed surface area.	Redundancy access (two or more access points) Customize privacy and social needs Undefined environmental units Use mobile equipment (equip walls, cabinets, or prefabricated modular interior partitions.
Evolution space flexibility	Increase the surface area within the existing support (closure of spaces that are already built) Increase the surface of the dwelling Increase the surface area by the addition of living units
Technological flexibility related to construction techniques	Adjustment and adaptability of the building envelope Use dried and stratified closures structural regularity and adaptability
Technological flexibility related to the easy maintenance of the installations and building sub-systems	Integration of automated home systems Redundancy and inspection of the equipment

Table 2: Trend ad strategies of flexibility
Sources: Cellucci and Di Sivo (2015).

The study of complex systems shows a close relationship between time, uncertainty, flexibility and resilience. Typically, a system progresses through a life cycle characterized by phases of growth, maturity, decline and then 'dies' (ceases to be useful) due to the process of functional and technological obsolescence, generally caused by the inability to adapt. (Cristiana & Michele , 2015). Uncertainty understood as the absence of knowledge of a systems possible evolution; perhaps buildings can cease to be in use through physical and functional decay or loss of economic viability; this now becomes obvious enlightenment that nothing truly lasts forever. Drawing from the theory of the selection of species by the physicist, Charles Darwin, it is evident that there are living organisms which are able to adapt to life's changing environments; so are buildings expected to adapt to changing needs of man. In other words, flexibility in housing reduces buildings and spaces, the uncertainty which therefore qualifies it as resilient, adaptable and sustainable.

Flexible student housing reduces the uncertainties associated with changes in user demands and it is the solution that mitigates against the risks derived from the accelerated evolution of the context- 'risks' associated with technological obsolescence. Flexibility is therefore the design function that makes the building resilient and capable of absorbing environmental disturbances and user needs without necessarily undergoing major alterations in its functional organization, structure or identifying characteristics.

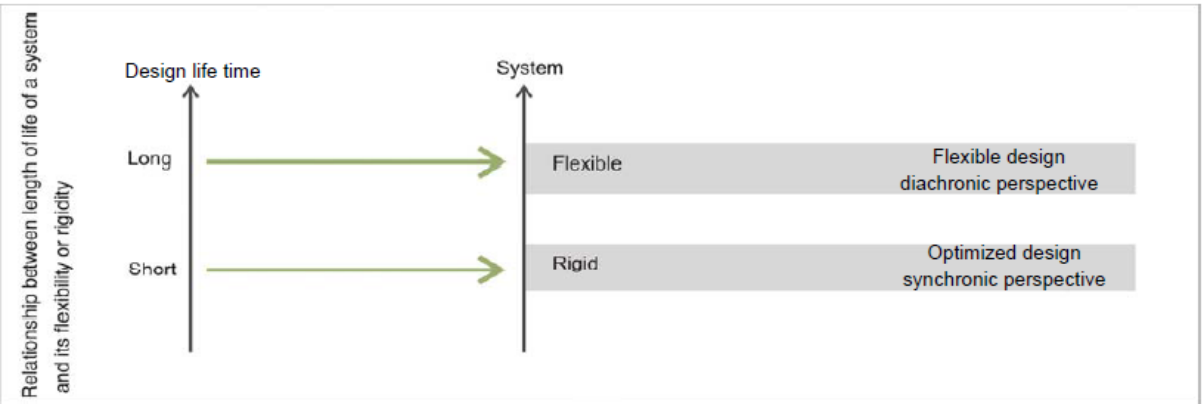


Figure 2.2 Relationship between the length of life of a system and its flexibility or rigidity. Source: (Cristiana & Michele , 2015)

3.0. Case Studies.

The purpose of case studies is to aid the visualization of existing practices and theoretical intentions in the space flexibility concept as by some Architects by scanning key functions for a coherent result.

Two case studies were carried out namely:

a. Casa de las Flores as presented by Montellano, (2015) and
b. Bergpolder apartment building as presented by Raviv et. al (2015)

For further investigations on ideal flexibility strategies to be adopted for student housing projects, the tendency 'Spatial Flexibility in a fixed surface is' as proposed by (Cristiana & Michele , 2015) was also studied and discussed.

3.1 Casa de las Flores

As presented by Montellano, (2015), Casa de las Flores was built in 1931 by Secundino Zuazo in Madrid. The aim was to understand the concept and relevance of indeterminate spaces. He studied 18 of the 28 apartments in *Casa de Las Flores* (Figure 3.1). Throughout time, he found 12 different models of domestic organization and 21 apartment configurations, including previous configurations and adaptations in progress.

Figure 3.1 Casa de Las Flores block and several apartments. Source: (Sabine & Carlos, 2018) ***originally cited from the survey source: Mila et. al (2003) and Montellano, (2015*).**

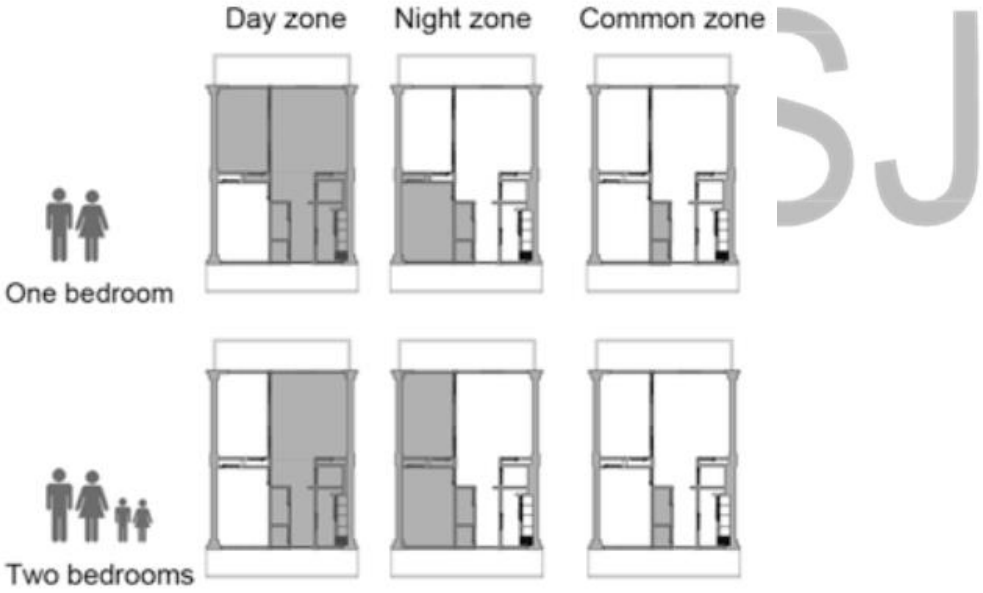
All rooms in the apartments were once used as living rooms, which demonstrated the high versatility of the apartments. Changes in use were observed in 14 of the 18 apartments, and junctions or separations of rooms were found in 15 apartments. Montellano, (2015) explained that these configurations represent changes in the family structure, domestic trends, and professional demands of the inhabitants. These adaptable features exemplified the opportunities created by indeterminate spaces. Montellano, (2015) concluded that the disadvantage of *Casa de Las Flores* is the impossibility of transversal connection between rooms because a load-bearing wall that cannot be modified exists.

3.2 Bergpolder apartment building

Figure 3.2 Bergpolder apartment building: Fixed and changing spaces. Source: (Seyed , Ali , Ezequiel , & Antonio , 2015)

Designed by Willem van Tijen in Rotterdam (1934) in Rotterdam. The block comprises of 72 flats and an area of 50 m^2 and is comfortable despite its small dimensions.

The floor plan of the *Bergpolder* apartment building is also systematized according to a day/night cycle. Raviz et al. (2015) remarked that the day/night cycle expands options and releases movement because of space autonomy and dynamics. Both cases included a multifunctional room with indirect access that allowed for different uses. Organizing the interrelated flexible spaces has enabled its inhabitants' freedom of choice. Each family member has the autonomy to engage various activities in complete freedom thereby achieving functional efficiency in Housing.



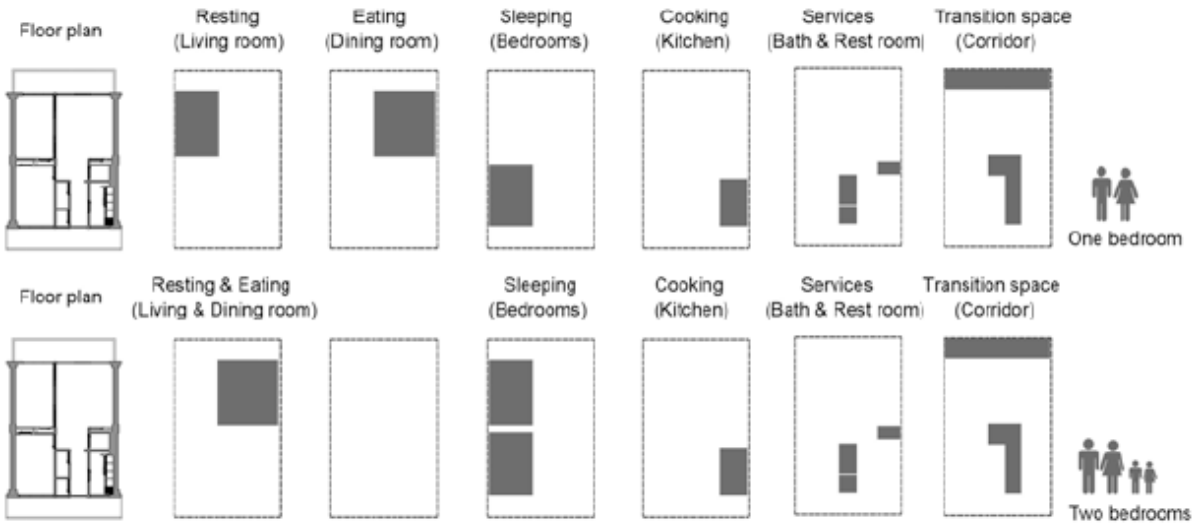


Figure 3.3 Bergpolder apartment building: Day and night-time spaces according to different spatial organization. Source: (Seyed , Ali , Ezequiel , & Antonio , 2015)

As shown in below in fig. (3.2), the kitchen and bathrooms are considered 'static' spaces and the living/dining rooms and single bedroom are considered 'multifunctional' spaces according to a hierarchy of user requirements. The use of sliding doors, walls and other flexible elements, demonstrated how the apartments incorporate various activities by varying connections without geometrical changes.

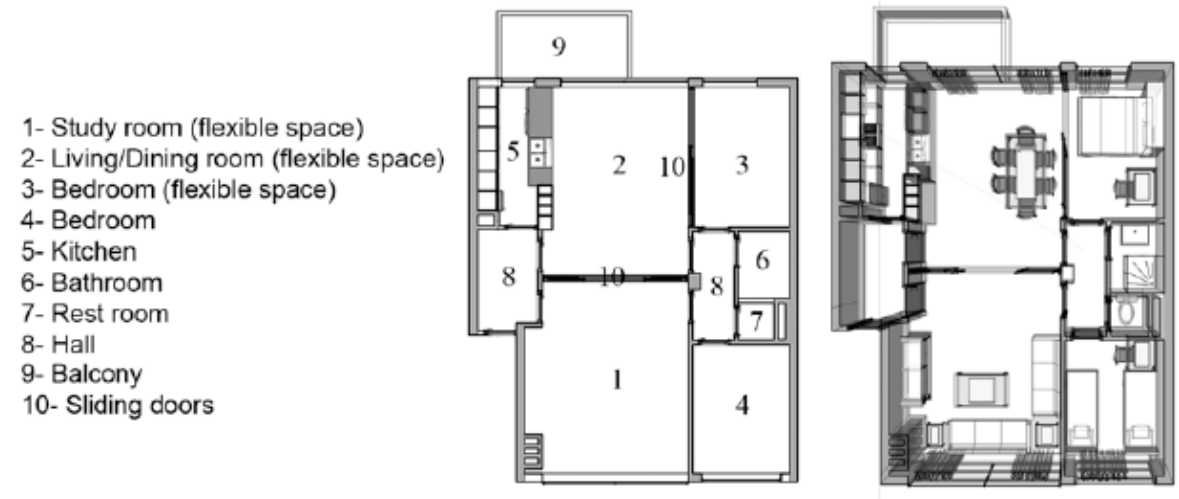


Figure 3.4 Bergpolder apartment building showing different flexible space configurations. Source: (Seyed , Ali , Ezequiel , & Antonio , 2015)

3.3 Spatial Flexibility in a fixed surface area.

This consists of the study of possible design strategies capable of conferring high internal convertibility without modifying the total volume of the building. This requires the provision of interface spaces that can be assigned different functions over time and also results in the setup of technical systems and installations which are compatible with possible changes in the distributive layouts. This type of flexibility is achieved through equipped technical zones contained in very small poly-functional spaces or through fixed or mobile technical nuclei within a single flexible space. (Cristiana & Michele , 2015).

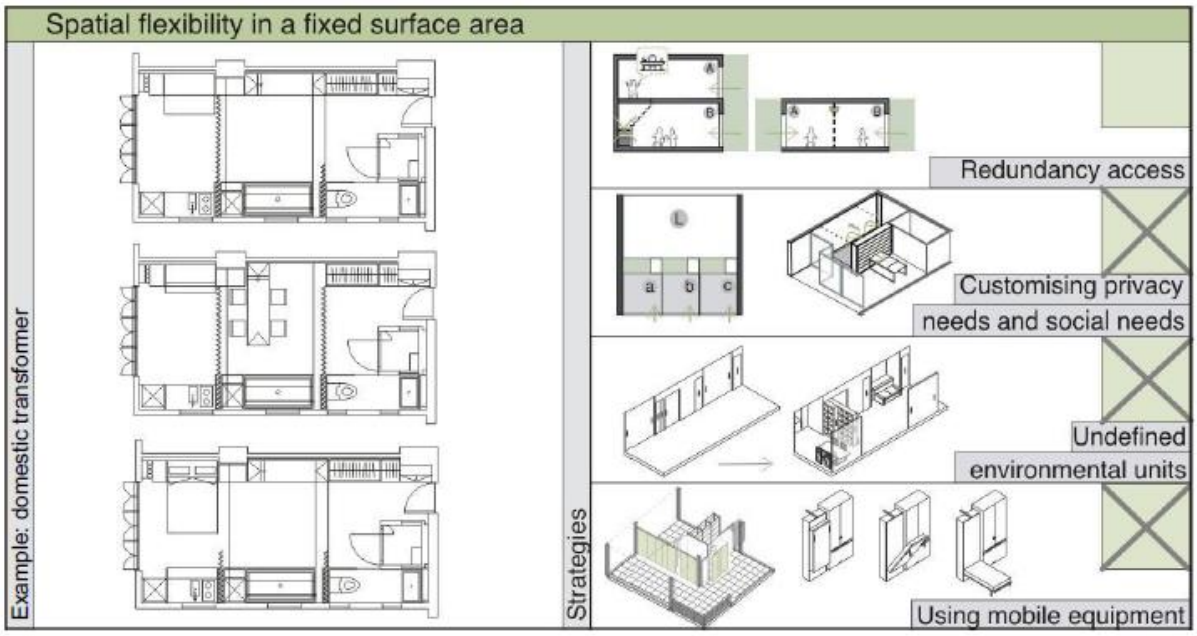


Figure 3.4 Domestic transformer, Gar Chang, Hong Kong, China, 2007. Source: (Cristiana & Michele , 2015)

Figure (3.5) shows four distinct strategies used to achieve spatial flexibility in a fixed surface area. The redundancy access provides two entrances with the option to decrease the size of the dwelling at any given time, when the household no longer needs the entire surface area of the house and can divide it into two or more units, or can assign part of the surface area to another dwelling or activity e.g. office, study area etc. depending on the overall area of the apartment unit/house. This can have a significant impact on the overall cost attached to any eventual division of the dwelling into two units.

By customizing privacy and social needs, an equal balance is created between the privacy needs and the social needs of the household, through the organization of a space that guarantees the seclusion of the different internal spaces and the sharing of the living units where the cohabitants socialize.

By undefined environmental units, we mean equipping the house with undefined spaces that can adapt their usage without having to physically change. This is possible either through the neutral sizing of the living units to accommodate any function and the elimination of hierarchy between them (whereby a bedroom can convert to a study, etc.) or through the conception of the space as a universal container where adaptable living units are organized by moving walls or furniture (wardrobes, bookcases, etc.). (Cristiana & Michele , 2015)

Using mobile equipment strategy allows for the spatial and functional reorganization of the entire housing unit with a quick turnaround. Prefabricated modular interior partitions are mounted with dry joints. This solution is effective especially in small spaces, without partitions, where the partitioning is done through the use of mobile equipment which enables the user to use the same surface differently.

4.0 Discussions

In the case of Casa de las Flores, the flexibility of the room is capable of allowing re-configuration to suit different family structure, domestic trends and professional demands can be adopted for student housing of multiple apartment blocks. This system is best applicable to student housing where users need to upgrade. The first-year student usually can start with a single room with shared facilities but often in the final year, might require a little more privacy. Instead of relocating, partitions could be adjusted to give him more space as required without necessarily affecting other users and structural stability. Likewise given room for affordability for students with financial challenges. From experience gotten from the Casa de las Flores apartments, when designing for flexibility, beams should be incorporated along the axis for load-bearing and service ducts. Load-bearing walls preferably positioned at the corners of external walls to allow for transversal connections between rooms.

Bergpolder apartment building model can be adopted in student housing with multiple shared facilities such as cooking areas, baths and restrooms, common rooms etc. by zoning the units into fixed-private zones and shared-

public zones, this could allow for efficient transformation of space to suit different domestic trends and user activities.

Spatial flexibility refers to the capacity of a spatial structure to change. The spatial flexibility in a fixed surface area allows for rapid change of spaces on a virtually instantaneous basis, allowing for day to day reconfiguration. It also provides a built-in capacity for long-term modification to the basic layout for years. Where the structures are characterized by modular design depending on the selected strategy as explained in (3.3) above. Student Hostel designed with this strategy is categorized into long-term elements which provide the structure such as columns, beams, and floors; short term elements and services which can be adjusted without interrupting the overall system. The flexibility factors to consider using this model are:

- Generous floor to floor height for projects more than a story or high head-room for single floor allowing space for utility distribution and thus allowing ducts and pipes to route independently.
- Reduced depth of beams in the mid-span thereby allowing the ducts and pipes to pass over the beams without using sleeves.
- Flexibility is attained by the designer's intention and users' adaptation based on given conditions.
- There is no obvious hierarchy between rooms, and the plan is almost reduced into some geometrical patterns following different use scenarios.

Flexible student housing presents an opportunity for the students/users to re-arrange their living spaces according to their lifestyles and needs by creating new and temporary spaces during the day and night time as seen in the *Bergpolder* apartment building in section (3.2). Based on presented case studies, architectural spaces may be subject to change to meet inhabitants' requirements. This entails the autonomy of incorporating various activities when necessary and enhancing the variability and versatility of the connections between adjacent spaces without any geometrical change in the form of the architectural spaces.

5.0 Conclusion and recommendation

As stated by Schneider and Till, (2005), flexibility should be addressed in terms of the following:

i. Modernism- Use of material and finishing that are in trend and aesthetically pleasing
ii. Finance- Should be economical in the long term
iii. Participation- Should encourage user involvement in the design process i.e. a survey can be carried out on student's perception on certain issues regarding accommodation.
iv. Use - Flexible housing should be able to adapt to several usages over time
v. Technology- Method of construction used should be achievable with the advances in construction technology.
vi. Sustainability- Flexible housing should stand the taste of time.

The university is a good breeding growth for emerging sustainability issues therefore, the university should consider partnering with the private sector/investors in constructing student housing that will serve as a model of sustainability while also catering for student housing needs.

The character of inhabitants and their ever-changing needs is dynamic. Buildings can absorb, or adapt, to reflect changes in use throughout their lifetimes. A flexible and adaptable student housing/dwelling is a means of responding to the inconsistency of habitation and population growth. Flexibility can also be achieved through the design layout and accommodate future occupational needs. Buildings no longer symbolize a static hierarchical order; instead, they have become flexible containers for use by a dynamic society. A flexible and adaptable student housing/dwelling should be capable of offering choice and personalization. ''Good Architecture should always be capable to adapt, rather than stagnate, transform rather than restricts, is motive rather than static; interacts with its users, rather than inhibits''. Dluhosch, Eric. "Flexibility/Variability and Programming." Industrialization Forum 5, (1974): 39-46. p. 39

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