PalArch's Journal of Archaeology of Egypt / Egyptology

CLIMATE SOLUTIONS FOR DESIGNING FLEXIBLE HOUSING IN INTERIOR DESIGN

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Fereshteh Karimieyvanaki, Climate solutions for designing flexible housing in interior design-Palarch's Journal Of Archaeology Of Egypt/Egyptology 17(12), ISSN 1567-214x

Abstract

Nowadays, housing has become one of the main needs and issues and the mass construction of residential units has become more important than ever due to the growing population and migration to cities. On the other hand, the construction of small residential units has increased day by day due to the high cost of land and housing.Therefore, flexible housing following climate change is needed to achieve biological goals. The question of the study is what are the factors affecting the flexibility of the interior space in terms of climate?This was a qualitative study in which appropriate frameworks were examined and defined using a descriptive-analytical approach.

Keywords: housing, flexibility, climate, interior design.

Introduction

The housing flexibility should be seriously considered by executive officials because housing is a space of human turning point as well as a place of human habitation in terms of desirable quality degrees.In this regard, designing flexible and adaptable housing, as an approach to optimal use of space, can meet most of the needs of different people living in such small housing

(Darbandi, 2015: 6).Flexibility and making changes to achieve new performance goals have always been considered as superior qualities in design. These changes can affect all components of the building such as the structures, facades, interior partitions, opening lighting, and entrances.Transformable structures and elements are important and effective tools for making changes in different parts of the building and creating multifunctional quality in the architectural space (Asefi and Garshasbi, 2011: 9).

Flexible housing should respond easily to changes in the life cycle, the use of interior architecture and its application principles in the design should allow for certain flexibility, and should allow for improvement.Such an approach has significant design advantages. For example, it can be used for a longer period, adapts to user experience and intervention, has greater economic and ecological sustainability, and easily benefits from technical innovations.Flexible housing can adapt to the changing needs of users, for example, allowing different pre-housing plans to be chosen, as well as the ability to adjust housing for a while, including the potential to incorporate new technologies to accommodate a changing population or even completely change the building's use of housing to something else (Schneider & Till, 2005: 73).According to the above, in this study, the approaches to flexibility to reduce energy consumption as climate solutions in interior design were examined.

Methodology

This was a qualitative descriptive-analytical study. In the analytical method, the theoretical foundations were analyzed, case studies concerning the flexible architecture were reviewed, and the data were collected in writing, often by the documentary method and referring to written sources and libraries.

Literature Review

In most Western countries, housing policies are increasingly focused on creating areas with specific social classes and uses. This practice was first defined in the United States and later developed worldwide (Veldbore et al., 2002: 50). In European countries, attention to social structures has been on the agenda of housing politicians for more than two decades (Bacque et al., 2011: 258).The quality of services is expected to increase in the region through the use of diverse housing uses, increase the social cohesion of users, and, ultimately, create more opportunities for social mobility (Van Kempen& Bolt, 2012: 452).There are more expectations from the positive effects of this practice on social life in deprived areas, but the set goals are not fully achieved due to various problems (Tunstall, 2003: 155). In general, the opinion of users and key decision-makers to use flexibility in buildings is the priority of the architect.This approach has pros and cons who consider it appropriate or inappropriate depending on the circumstances (Van Kempen& Bolt, 2009: 460). Flexible housing should easily respond to changes in the life cycle.Modern building systems allow for special design flexibility and improvement, while conventional building systems are not designed to change, and any deformation in the building will result in the destruction of part or sometimes all of it.Such an approach has significant design advantages. For example, it can be used for a longer period, adapts to user experience and intervention, and has greater economic and ecological sustainability. Some important points in designing new housing include the possibility of adapting the spaces of the housing units to the new and changing needs of the family, responding to various functions simultaneously, and using the intersection of housing spaces at different scales.Optimal use of designed spaces is possible and the differences between residential units of the same size become more obvious in terms of space quality with a better understanding of the concept of flexibility. In this way, an internal relationship relying on the deep concepts of design and the designer's creativity is established between the quantity and quality of the housingrather than a direct relationship (Einifar, 2003: 70).

Theoretical Foundations

Flexibility

Flexibility is the approach that the designer takes to meet the needs of users to change the performance pattern of the project according to the changing demands. Some see flexibility as the development of a building by adding parts to it.According to others, functional changes in the building can be made by changing spaces. Some argue that maximum use can be made by creating multi-functional spaces (KhaloEsmaili, 2008: 87). Flexibility includes the ability to add and expand, change, and multi-functionality.Flexibility depends on functional, social, psychological, and economic factors and becomes an important principle over time by changing the family housing system, household size, and changing activities of family members (Einifar, 2003: 64).The term flexibility refers to a wide range of concepts and is found in places that are used for a variety of purposes and offer users more choices in addition to buildings with flexible connections.In these buildings, space itself is fixed, but it can adapt to different events inside and communicate properly with the outside. In Japanese architecture, for example, there is an uncertain and fluid space that is accompanied by a state of ambiguity and variability of boundaries (Oungrinnis, 2005: 212).

Potential components affecting flexibility

Different components have different potentials to influence or intervene in flexibility. Two of these components require special attention:

Soft and hard components

There are spaces in buildings that have common facilities such as staircases, elevators, and ducts.

These spaces, which are usually considered to be the hard elements of a building, are unlikely to have very little functional change during the useful life of the building. They should be placed where there is no restriction on the

operation of the remaining spaces.One of the principles of flexibility support is to arrange the textual elements of the space as much as possible so that a variety of activities coexist as much as possible in the public domain without taking each other's place. This specifically affects the way we act to organize and direct our activities (Bentley, 2006: 160).

Types of flexibility

Flexibility has many features such as multi-functional use of space, maintaining existing spaces, adapting them to new living needs, resizing and combining spaces for new uses, reducing and increasing spaces by changing the area of the building, and so on. Each of these features (diversity, adaptability, and variability) defined in this study as types of flexibility include functional, structural, and spatial aspects.Such changeable and multi-functional spaces can also be found in traditional Japanese houses. The set of conceptual criteria mentioned in different scales of the traditional house can be discussed and analyzed.Not all concepts of flexibility are of the same type and on the same scale. Knowing the types and scales of flexibility will help to better understand its concept (Table 1).

Table 1. Types of flexibility in Iranian houses (Source: Author)

Types of flexibility		Space
Adaptability	Functional	Rooms by opening doors, connecting inside and outside the house by opening doors, windows, or sash windows
	Structural	It is a module with longitudinal divisions that is largely a function of roof coating with heavy and fixed walls
	Spatial	It is used around the room in the Iranian house.
Diversity	Functional	Room space responds to different functions at the same time or at different times.
	Structural	The structures are heavy and the walls and roof are fixed.

	Spatial	Doors between rooms allow fluid flow between spaces. The height and spatial opening of most of the hall rooms and ventilations have helped to distinguish between public and private spaces.
Variability	Functional	Vertical and horizontal house with the ability to separate and integrate multi-yard houses
	Structural	The reproducible peripheral unit allows the variable use of space with a fixed structure.
	Spatial	Changing the public and private space with the intermediate element of the porch on the threshold of the house allows the creation of a new entrance for the separable parts of the house.

The flexibility and vernacular architecture

In the vernacular architecture, houses can be found that are perfect for all periods of life of an extended family because of the architect's awareness of the lifestyle, traditions, and values of the people of the community. Flexibility and the possibility of developing the house in the future are among the features of the vernacular architecture (Rapoport, 2009: 17).Housing flexibility can be divided into internal flexibility and external flexibility. An important issue in internal flexibility is the construction of a building that can adapt to the needs of its users. Houses are divided into hard and soft parts in terms of internal flexibility.Houses with hard flexibility are those that are highly affected by design and designer decisions, while soft houses are designed with an indefinite plan and people can change them as they wish.In the second type of flexibility, the external flexibility, houses are designed considering expectations and possible future needs as well as population expansion so that they can respond to extensive family changes over time (Till, 2009: 68).An example of flexibility in the vernacular architecture can be seen in traditional houses in temperate and humid areas. In these houses, the

rooms often did not play a single and fixed role and were used for a specific purpose by the seasons of the year. The lack of fixed appliances in these rooms increased their flexibility and made it possible to use them in different situations and for specific functions.However, unlike traditional houses, in modern houses, the objects and their arrangement are essential to the spatial organization of the house, giving the space an identity, and defining its function.Single-purpose rooms and their naming based on limited functions reduce the possibility of using the space of the house, while each family member needs a dedicated room to provide his/her minimum privacy (Haeri Mazandarani, 2008: 88).

Solutions to achieve flexibility in housing design

The solutions to achieve flexibility in housing design are as follows:

Location of columns
Location of service spaces, stair access system, and humid spaces
Architectural design, and equipment for flexible use of space
The use of separate furniture to create different functional spaces or folding furniture for day and night
Consideringthe current and air conditioning

Climatic factors affecting the spatial flexibility

Proper orientation of the building

In general, the orientation of a building depends on factors such as the natural state of the earth, the need for private spaces, control, noise reduction, wind, and sunlight. Besides, architects try to make the most of sunlight in terms of thermal conditions, etc. in the design of building plans.Just as the different seasons of the year are different from each other due to the change of the earth's axis concerning the sun, so from an architectural point of view, a building is affected by the energy radiated to its walls at different hours and, therefore, its heating and cooling loads are a function of its orientation.For

example, a south wall receives three times as much sunlight as an east or west wall in winter at 40 degrees north latitude. By the way, the total amount of sunlight shining on the north and south walls is half the energy shining on the east and west walls in summer.This difference is greater at lower latitudes. For this reason, the orientation of the building can well determine the discomfort or comfort conditions inside (Kasmaei, 1993).

Interior design for natural cooling

This alternative involves adapting the building to conditions that provide the most gentle summer breeze.In the meantime, the proper placement of the windows circulates the winds, provided that the axes that guide the air upwards, i.e. the roofs and domes, etc., are designed to effectively guide the consumed air and its ventilation.

Interior design to enjoy sunlight

Maximum solar heat can be obtained by using materials with high heat capacity to absorb and retain heat in wall coatings or by using surfaces with large windows on the south side.Eastern facades with large windows increase the heat gained by the building during the morning, and shading and low windows on the western fronts prevent excess heat in the afternoon (Nari Ghomi, 2013).

The thermal mass of interior walls

The higher thermal mass of the walls and roofs increases the heat transfer time between indoor and outdoor spaces. The use of double-walled coatings in some walls can cause the maximum heat energy to be obtained during the day and consumed indoors at night (Mohammadzadeh, 2004).

Service spaces

The location of service spaces can be considered as a determining factor for the configuration of the main spaces. Service spaces can be considered as part of a fixed structural system or designed separately.

Placing wet spaces in the areas listed below allows the kitchen, bathroom, and toilet to be located within specific areas without being fixed. In this case, the main spaces remain pure with the accumulation of service spaces in one area (Rabeneck, 1974: 86).If the wet spaces are less on the bright side of the outside, they can better control the cooling of the interior space. Additionally, the prevention of light from entering the interior spaces is minimized (Figure 1).

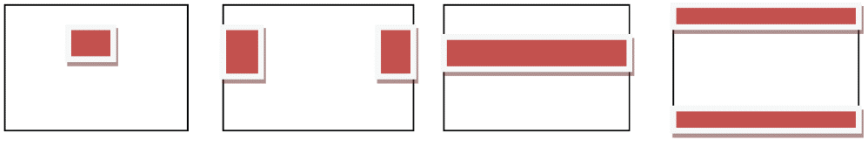

Figure 1. Service spaces are located in areas with the least interference in the design of main spaces (Eghbali and Hesari, 2012)

Also, in buildings with soft flexibility (with interior space with more space), a heat buffer can be created to keep the living areas warmer in the cold seasons by placing a series of service spaces such as kitchens in layers exposed to the outside air.

The use of flexible furniture and partitions

Flexible furniture that can act as a buffer or coating in different climatic conditions can be moved inside the space in different seasons depending on the weather conditions and temperature.

This feature, which is achieved by placing a few simple wheels under the furniture bases, makes it possible to easily clean under the furniture, etc., in addition to allowing the consumer to easily obtain any new combination with certain elements just by moving them.In addition to being light, furniture can also be easy to move around or create custom combinations. Two factors must be considered in the design of furniture to be light: the use of light-weight and durable materials, and minimizing furniture components as much as possible.As it is obvious, the system is considered as puzzles of lightweight

materials that can be easily placed on the ground or top of each other in any form (Darbandi, 2015) (Figure 2).

Figure 2. Flexible furniture can be moved according to climatic conditions (https://www.otag.ir)

Separation by partitions can be considered as an opportunity for users. The use of furniture can be considered as a functional unit.On the other hand, furniture can act as a thermal mass in walls exposed to the outside air, increase the thickness of the wall, prevent the entry of outside air in cold seasons, and serve as a functional unit that makes the room during the day to be used (Figure 3).

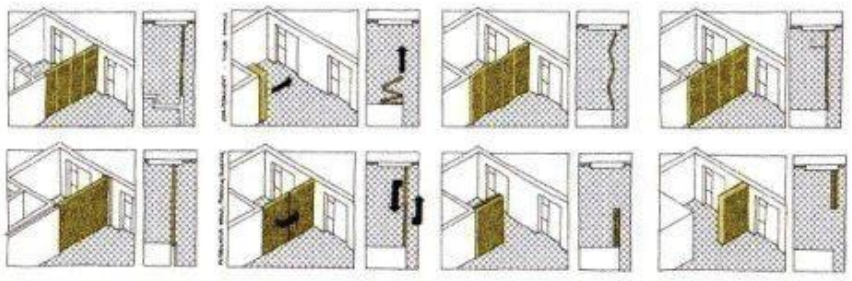

Figure 3. The use of furniture for space design (Galfetti, 2003)

Air conditioning in terms of flexibility

In this type of design, it should be tried that most parts have the same light and ventilation. For this purpose, the rooms that need to be separated should be located longitudinally in front of the exterior, and several smaller windows

should be used for lighting instead of using a large window (Darbandi, 2015) (Figure 4).

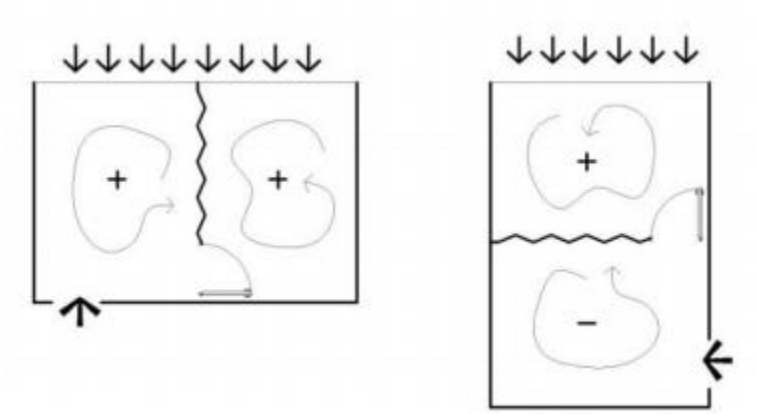

Figure 4. Preference of longitudinal placement of rooms that need to be separated in front of the light (Darbandi, 2015)

Analysis of case studies

Case Study 2: Malleable Autonomous Retreat House

Michael Jantzen is a prominent architect and designer who has presented special and interesting designs in recent years and has created a dramatic change in the modern architecture of the world. This prominent architect has unveiled his latest innovation and once again presented a strange and of course interesting design (Figure 5).

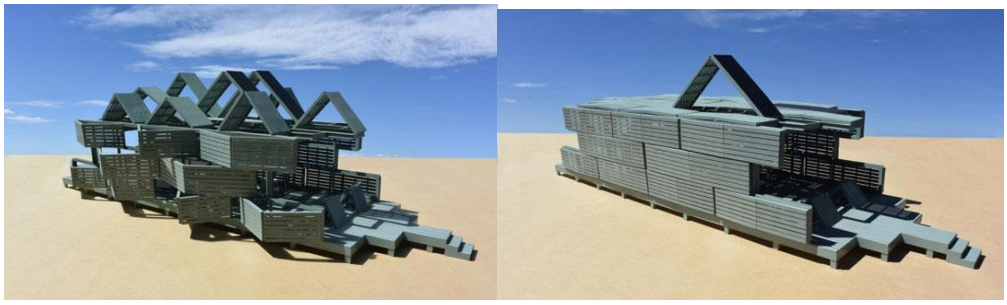

Figure 5. Design of Malleable Autonomous Retreat House (https://archinect.com/michael-jantzen/project/the-malleable-autonomous-retreat-house)

Figure 6. Design of Malleable Autonomous Retreat House (https://archinect.com/michael-jantzen/project/the-malleable-autonomous-retreat-house)

The main feature of this house is that it is changeable so that residents can change different parts of the house according to their wishes and tastes or according to the conditions. Different parts of the flexible house are made of wooden panels that can be moved manually or using electric motors. Residents can create a variety of landscapes for themselves, and the amount of light reaching different parts of the house can be controlled due to this interesting and creative design (Figure 6).

The energy needed by the house and the residents will be provided by solar panels. This wooden structure has dimensions of 9.7 meters wide, 24 meters long, and 7.3 meters high when fully opened.A similar plan had already been proposed and sold to a Korean, but Michael Jantzen has expressed hope that the flexible home will soon be completed in New Mexico.

Case Study 2: Flexible Housing Project in New York

The Small Town House project is a temporary settlement that seeks to offer flexible alternatives to urban life on a global village scale. It introduces the creative use of space as the main idea of space formation (Figure 7).

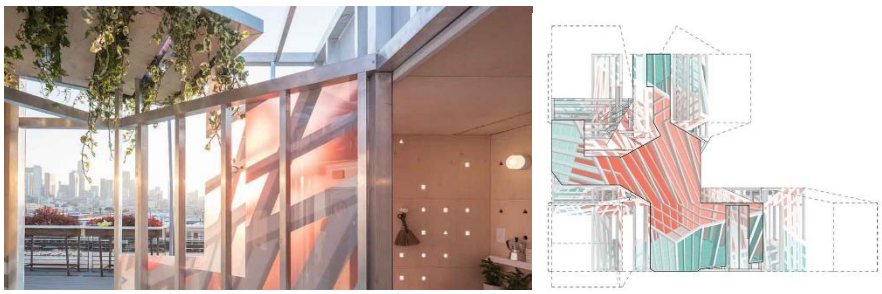

Figure 7. Flexible Housing Project in New York (https://www.archdaily.com/900568/mini-living-urban-cabin-freelandbuck)

There are 15 cabins in different parts of New York, each of which is jointly owned by individuals. The idea of co-livingwas first developed in 2018 in Shanghai, China. Each of these small homes is equipped with an experience room that is unique to a particular subject.

One of the notions considered by designers is the use of environmentally friendly materials in the design of the complex and also the use of minimum energy to achieve sustainable architecture (Figure 8).

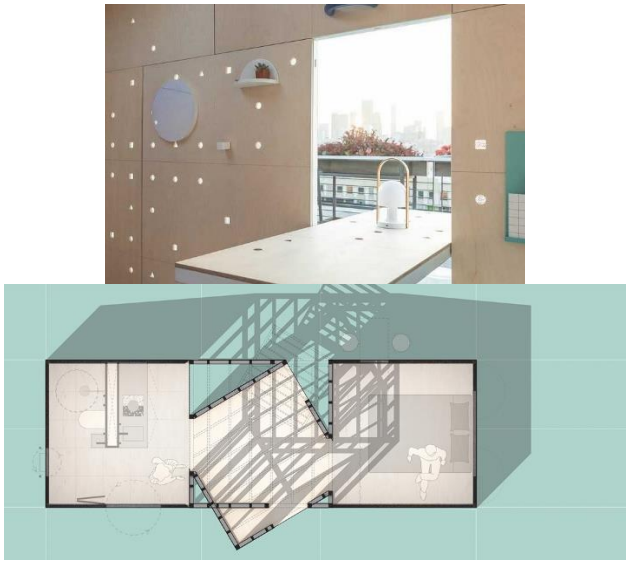

Figure 8. Flexible interior plan and space of flexible housing (https://www.archdaily.com/900568/mini-living-urban-cabin-freelandbuck)

In this architectural project, each cabin has provided maximum space to create a comfortable life for two people. This complex has flexible walls that allow the complex to change and create new spaces.

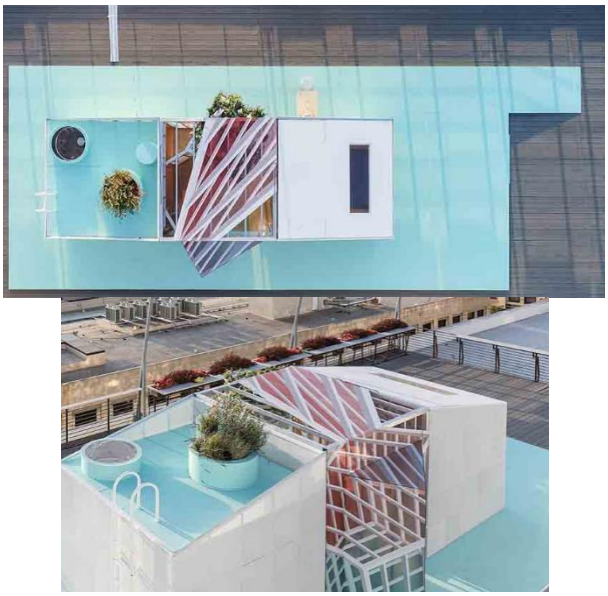

Figure 9. The flexible housing top view (https://www.archdaily.com/900568/mini-living-urban-cabin-freelandbuck)

The structure of this project shows how architecture can be created for a shared global identity that is compatible with our lifestyle (Figure 9).

Conclusion

Flexibility refers to the endless way in design that allows for endless change. All case studies in this study included four themes including structural system, service spaces, architectural plans, and equipment for space flexibility as buildings wereconstructed as load-bearing structures with limited use of permanent elements. The placement of wet spaces and the access floors are also important as permanent elements in creating a flexible space. Paying attention to their initial location in the design allows for more flexibility in the subsequent configuration of the spaces. Architecture has always sought to

implement appropriate methods in harmony with the local climate in building design.

The best possible condition can be provided for the residents by considering the flexible aspects of the space inside the house. Flexible partitions, walls, and doors all are effective in this field. Environmental comfort can also be provided by following climate patterns.The interior shape and facade of the building have a great impact on harmonizing the building with climatic conditions and modulating the transfer of outside air into the building.In areas with hot and dry climates, for example, it is very useful to pay attention to the energetic aspects of the building, the conditions of sunlight, and its direction.This is possible in two ways. First, by selecting volumes that have less a lateral surface area with equal volume and surface area. Second, by connecting the side surfaces to adjacent buildings to reduce sunlight.

The flexibility of the spaces in general was examined by several criteria as follows:

- Considering flexible and removable partitions to add to space and separate and combine two spaces such as living room and bedroom following climatic and seasonal conditions;
- Paying attention to wind flow in indoor spaces indirectly by designing windows along the facade and not placing them in front of each other;
- Connecting side surfaces to adjacent buildings to reduce sunlight;
- Considering the covered and small furniture inside different zones of the house to create a thermal buffer

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