DETERMINING THE CRITERIA FOR ATTAINING FLEXBILITY TO THE MULTIPLE HOUSING DESIGN

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DETERMINING THE CRITERIA FOR ATTAINING FLEXBILITY TO THE MULTIPLE HOUSING DESIGN

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ABSTRACT

DETERMINING THE CRITERIA FOR ATTAINING FLEXIBILITY TO THE MULTIPLE HOUSING DESIGN

Multiple housings are a type of housing that is produced regardless of a specific dweller group and they must be designed with the flexibility to meet the needs of dwellers for change in order to appeal to a wide audience of dwellers who will use the housing. Flexibility is a design parameter that must be considered to ensure the adaptation between the house and the dweller and that the housing can be used for long when the needs for change in the housing arise. From this point on, this thesis aims to determine the criteria that may help to attain flexibility in multiple housings by focusing on the reasons that lead to the need for flexible housing. The chapters and contents of the thesis are as follows:

In the first chapter, the intention of doing this study, the extent of the thesis and the methods followed throughout the study are compiled under the title of the thesis method. Existing studies, articles, theses, books are examined.

In the second chapter, the flexibility concept is described, classified and the need for flexibility in housings is emphasized. Flexible housing examples from past to present have been examined.

In the third chapter, the main reasons for the need for flexibility in housing design are mentioned.

In the fourth chapter, flexibility in multi-house production is generally evaluated under the headings of strategies, collaborative planning, modular design.

In the fifth chapter, it is aimed to set criteria for flexible multi-housing design in the consideration of the obtained data and the production of two existing multi-housing design is illustrated and evaluated under the criteria.

In the sixth final chapter, the overall results of the set criteria to attain flexibility to multi-housing design is put forth.

ÖZET

ÇOKLU KONUT TASARIMINA ESNEKLİK ÖZELLİĞİ KAZANDIRABİLME KRİTERLERİNİN BELİRLENMESİ

Çoklu konutlar belirli bir kullanıcı grubu gözetmeksizin üretilen bir konut tipi olup, konutu kullanacak geniş bir kullanıcı kitlesine hitap edebilmesi için kullanıcıların değişim ihtiyaçlarına cevap verebilecek esneklikte tasarlanması gerekir. Esneklik, konutta değişim ihtiyaçlarının ortaya çıktığı dönemlerde, konut ile kullanıcı arasındaki uyumu ve konutun uzun dönemler için kullanılabilmesini sağlamak adına göz önünde bulundurulması zorunlu bir tasarım parametresidir. Bu noktadan hareketle tez kapsamı içerisinde, esnek konut ihtiyacını doğuran nedenler üzerinde durularak, çoklu konutların esneklik özelliği kazanmasına yardımcı olabilecek kriterlerin belirlenmesi amaçlanmıştır. Tez çalışmasını oluşturan bölümler ve içerikleri şu şekildedir:

Birinci bölümde bu çalışmayı yapmaktaki amaç, tezin kapsamı ve çalışma süresince uygulanan metotlar tezin yöntemi başlığı altında derlenmiştir. Konu ile ilgili mevcut çalışmalar incelenmiş, makaleler, tezler, kitaplar incelenmiştir.

İkinci bölümde, esneklik kavramı açıklanmış, sınıflandırılması yapılmış ve esnekliğin konut tasarımını yönlendirmesi üzerinde durulmuş, geçmişten bugüne esnek konut tasarım örnekleri incelenmiştir.

Üçüncü bölümde, konut tasarımında esneklik ihtiyacının temel nedenlerine değinilmiştir.

Dördüncü bölümde, konut tasarımında esneklik sağlama araçları genel olarak, stratejiler, katılımcı planlama, modüler tasarım başlıkları altında değerlendirilmiştir.

Beşinci bölümde tüm elde edilen bilgiler ışığında esnek çoklu konut tasarım kriterlerinin ortaya konması amaçlanmıştır ve mevcut iki çoklu konut üretimi örneklendirilerek, belirlenen kriterler çerçevesinde değerlendirilmesi yapılmıştır.

Altıncı bölüm olan sonuç bölümünde çoklu konut tasarımına esneklik özelliği kazandırabilmek için belirlenen kriterler ile ilgili elde edilen genel sonuçlar ortaya konulmuştur.

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LIST OF SYMBOLS/ABBREVIATIONS

AD-APT	Addable apartment
COVID	Corona virus disease
C.S.	Construction site
F.A.R.	Floor area ratio
L.C.	Lot coverage
SAR	Stichting Architecten Research
TOKİ	Public Housing Administration in Turkey
UK	United Kingdom
USA	United States of America

1. INTRODUCTION

Multiple housings are often residential areas intended for an ambiguous, anonymous group of dwellers, produced to meet the housing needs of the city's population. The deindividuation of actual dweller in multi-storey housing designs leads to the necessity for changeability so that the dweller who will settle in the house can find answers to their individual needs and adapt to the house. Against the background, multiple housing that needs constant change must be designed in accordance flexible usage so that dwellers with different characteristics can adapt to different life patterns and a specific dweller to the changes in his life cycle. Otherwise, as a result of mass productions that are designed according to a standard dweller type, the dwellers with different social and cultural structures are unable to adapt to their houses and have to live in a non-qualitative environment for themselves.

In multi-housing design, as well as the quantitative values, such as the number of spaces, dimensions of the spaces, materials used, etc., flexibility and changeability should also be contextualized as an important sense of design. The goal of flexible housing designs is to ensure that the houses are used with full efficiency, as well as how the requirements can best be met in space. Against the background, existing effective tools for providing flexibility to design are addressed after the concept of flexibility in architecture, the orientation of flexibility in housing design and the main reasons for the need for flexibility in multi-housing design was scrutinized. to attain flexibility to multi-housing design, it is aimed to set common criteria and to evaluate these criteria on a selected multi-housing example.

1.1. LITERATURE RESEARCH FOR RELATED STUDIES

In this section, scientific articles, theses and books are explained as literary studies on the current flexible housing design, which are effective on the thesis.

- Articles;

Within the scope of the thesis in, in examining the concept of flexibility in housing design in different architectural processes, including design, construction and use, Ömer Ş. Deniz's [1] article named "Multi-Storey Flexible Housing Design Approaches" was utilized.

Flexible housing design aims to build comfortable houses that can be used for a long time with a variety of design that can meet changing dweller characteristics and needs. Deniz, within this frame of reference, two basic building subsystems were based on the design of multi-storey flexible housing; the support level, each of which has different decision-making levels within a hierarchical organization, and the infill level. Accordingly, multi-storey housing design approaches that can meet the characteristics and needs of changing dwellers have been scrutinized and recommendations have been developed in this direction.

Within the scope of the thesis in, another source utilized in examining the concept of flexibility in housing design in different architectural processes, including design, construction and use, is Ahmet Ender Okutan's [2] article named "Concept of Flexibility in Social Housing Design and Its Effect on Project Success". It enables the scrutinization of the design, construction and usage processes for the modifiable parts that can help the houses to show flexibility, which should be designed to meet the personal changing dweller characteristics and needs of a certain segment and even individuals belonging to that segment and allows the house to appeal to its dweller for longer by adapting to its dweller.

In this study, the concept of flexibility within different periods of the production process of housing was scrutinized and the significance of flexibility in the production of housing was referred to.

Within the scope of the thesis, in the explanation of flexibility, Özer Özçelik's [3] article named "Evaluation and Reconfiguration of the Space within the Scope of the Flexibility and Functionality Context in Interior Space Organization" was utilized.

In housing design, providing flexibility to the house for additional needs that the dweller may want to add to the living space in the future, as well as pre-determining the basic needs of the dweller is a design criterion that should be considered.

The combined growth or division of spaces to create new spaces allows the dwellers to be able to attach different functions for their needs and also affects the functional use of the housing.

This Özçelik's study examined the different roles of interior spaces in the housing within the scope of concepts associated with flexibility.

- Theses;

Within the scope of the study, Nebahat Uzer's thesis named [4] "An Evaluation Guide for Flexible and Adaptable Dwellings" has been of the helpful resources in determining the tools needed to provide flexibility in housing design.

The housing design process is also the process of making decisions for the future. Accordingly, it should be aimed to design housing that can adapt to the new needs of dwellers that may change or arise in the future. This aim required that the flexibility has to be considered in housing design for the house to be able to appeal to different types of dwellers for longer. By overlooking the aim of flexibility, the houses that are produced to meet the needs of a particular group of dwellers fail to achieve the dweller's satisfaction. Accordingly, in the Uzer's study, the basic points to be considered in housing designs for flexibility and adaptability, which is generally considered to be the ability of the house to adapt to the dweller, are laid out in the design, construction and use processes.

In Nükhet Ak's [5] thesis named "Determining the Emerging Concepts for the House of the Future", the development of housing design from the past to the present was examined and the concepts that will guide futuristic housing design were addressed. The concepts of sustainability, flexibility and mobility were identified to form the basic concepts of century housing design. The predictions are given for the futuristic housing design by addressing the effects of these design concepts, which are the return of technological, social and environmental developments, on housing design.

The aim of providing flexibility in housing design determined as a thesis subject is directly related to the housing user. Rabia Alga's [6] thesis named "The Factors Effecting House Design According to Human Life-Cycle" is a study in which the effect of the user in housing design is discussed. Housing is a place that reflects the values of its dweller, such as social, cultural, economic, etc. Therefore, changing the dweller profile leads to demands for change in the housing space. Where the demands for change arise, the house should be designed with flexibility that can ensure adaptation to its dweller. Besides the different types of dwellers, the needs of a settled dweller also change during his lifetime. The design criteria for flexibility must be considered for the house to meet dweller's needs that may change over time and to be able to appeal to the dweller for longer.

Within this Alga's the scope of study, the characteristics, needs and demands of different dwellers at different stages in the life cycle were identified to shape the design for the adaptation between the house and the dweller. It is aimed to determine how these different types of dweller use the house according to their life cycles.

- Books;

In the scope of the thesis, İhsan Bilgin's [7] book called "Free Plan, Free Front, Free House" selected from various books has been one of the auxiliary resources in order to examine the relations of structure elements in flexible structure design.

İhsan Bilgin, reports in his book, Le Corbusier, one of the pioneering figures in the first years of modern architecture, intended to create a new style that complied the needs of the era with the "free plan" and the "free facade" approach he chased up. What he meant by "freedom" was to separate and make the elements that make up a structure independent of each other and able to create more free, wider spaces by this means. He aimed to avoid the construction, planning, facade, windows, roof and even floor of the structure, which used to be closely connected, being conditioned by each other.

This study tries to understand how and why Le Corbusier has established the principles of its architectural approach and to study his ideology by examining his techniques.

1.2. AIM OF THESIS

The housing is generally designed according to two different approaches. One of these approaches is to design for dweller's needs, while the other is to design for the needs of 'average' dweller, unknown to reside in the house. The fact that the criteria for the spaces that are produced in the second approach to be adaptable to different dwellers are often overlooked causes the dwellers either to live in an uncomfortable environment or to move out of the house. The above-mentioned second approach is particularly important in the design of multiple housing and that uniformity for the dweller causes maladaptations between the dweller and the house.

Since housing spaces are places where the dweller interacts one-on-one, contain elements, such as long-term use, belonging, and meet fundamental requirements, the scrutinization of the change of the dweller and space becomes important.

Therefore, this study aims to evaluate the criteria used in the production of flexible multiple housing designs that can adapt to the changing needs of changing dwellers, which is the aim of the housings that are designed with the second approach mentioned.

1.3. SCOPE OF THESIS

The thesis is generally limited to multiple housing designs. Against the background, the designs are considered within the framework of flexibility. Therefore, the concept of flexibility is looked over and the adaptation of this concept to multiple housing design is scrutinized.

In the thesis, the relevant design criteria are set by studying flexible housing design strategies. Finally, the production of a selected existing multiple housing is evaluated within the framework of these criteria.

1.4. METHOD OF THESIS

The record and document review, which are the basic approaches that can be used to identify dwellers demands and needs, the fieldwork and observational studies have been used as a method in this thesis and described with the following steps.

At the first stage, the literature on flexible housing was researched, published articles and books on the issues were examined. Thereafter, the concept of flexibility in housing design was explained using literature research, classified and the basic flexibility approaches applied to date were pointed out. Tables and diagrams have been created about how basic concepts and approaches related to flexibility shape housing design and on the changes in the life cycle. Then, the fact that the orientation of flexibility in housing design was addressed as a movement was put forth by explaining examples from the past to the present.

Based on evaluating the concepts of flexibility in architecture for housing designs, researching all literature and examining the existing examples, the main reasons for the flexibility need in multi-housing design have been determined. In consideration of those reasons, by which means flexibility can be achieved in mass housing production has been set forth.

Later on, in the study, a checklist was created to set multi-flexible design criteria and evaluate designs in accordance with these criteria through all these flexibility tools.

At the end of the thesis; the existing examples of multi-housing design was evaluated and interpret according to the flexible design criteria of housing units with evaluation tables that are created for each instance.

2. CONCEPT OF FLEXIBILITY

The term flexibility, when considered etymologically, means the state or quality of being flexible, flexibleness, eligible for different interpretations, able to restore its shape with removing the effect of being exposed to transformation, such as elongation, shortening, bending, etc. by an external force [8]. There are also many discourses in the architectural literature about flexibility, which is a concept that is often used in all fields today, and in this part of the study scrutinizes the concept of flexibility in the architecture discipline.

2.1. FLEXIBILITY AND ITS CONCEPTS IN ARCHITECTURE

Flexibility has become a common concept in architectural design in the 20th century. The concept of flexibility has an important place in architectural design in terms of the fact that space can respond to the changing demands of changing types of dwellers.

In the new concept of housing, which had emerged in the first half of the 20th century, the fact that components and reinforcements indoors exhibit interchangeability and transformability characteristics have shaped flexible design in modern architecture. In the housing design for flexibility purposes, it is based on minimizing the needs of the dweller in the house and ensuring that they can comfortably meet their expectations in a limited space. Besides, the infrastructure needs to be modifiable and adaptive flexibility for additional needs and new technologies that the dweller would like to include into the living space in the future.

One of the first determinations of flexibility in architecture was made by Gropius. According to Gropius' discourse in 1954, an architect should think of structures not as monuments or artworks, but as structures that serve the flow of life, and set a flexible ground sufficient to cover the dynamic characteristics of modern life [5]. According to this approach, considering that life is a developing, changing structure, it is important that architecture also serves in accordance with this flow, that the structures are designed to offer developable, changeable, different alternatives for use. Therefore, flexibility is seen to become a frequently emphasized concept in studies related to housing design methods in modern architecture and that the definitions in this respect to increase.

2.2. CONCEPTS OF FLEXIBILITY IN ARCHITECTURE

Many definitions have been made related to the concept of flexibility in housing design. Some of these definitions are as follows,

The concept of flexibility in architecture is defined as “the capacity to respond to different dwellers’ needs and multiple functions in the same design without changing the building system” or “the growth and downsizing of the building by adding or removing elements and without losing its integrity, the ability to change elements and relationships” [2].

Flexibility is the ability to respond to the changing needs of dwellers in the house. It is the construction of the house in accordance with each dweller’s needs instead of anonymous dwellers, the change of housing as the dwellers and their needs change. Flexibility is the ability of the same design unit to meet different dwellers’ requirements without changing the building system, and the possibility of using the same volumes for multiple functions. It is the ability to change the boundaries of the housing unit or to allow changes in the flooring and function and different space layouts through additional new construction [4].

Briefly, it can be said that what is understood from the definitions of flexibility in architecture is that the flexibility can be attained in various sizes and scales from the construction of a building to its usage. Against the background, flexibility in architecture can be associated with many concepts that incorporate the physical change, which needs an expert workforce, and the configuration of space that exists only by the dweller.

Flexibility, which has a structure formed by layered components, consists of the engagement of the concepts, such as adaptation, transformation, mobility, modular change (Figure 2.1.).

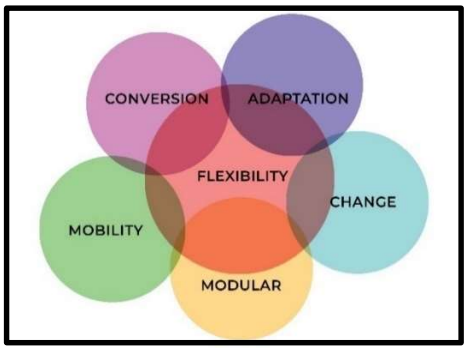


Figure 2.1. Concepts related to flexibility, translated into English by author [2].

- Adaptation;

Adaptation is the ability to adapt against change. Everything around us is under change and transformation with economical, geographical, cultural, social, political and technological factors. In this life cycle, architectural structures either adapt to the change together with the transformations they had at different times or disappear. Changes in the life cycle can be defined as abandonment, destruction, reconstruction, and adaptation, in which, depending on time, the object has a different life process than when it was first designed [9].

According to this discourse, an architectural structure produced by the principles and methods of its period can survive by acquiring a new function in a way to adapt to the conditions of a different period. This adaptability can be achieved by the wearings, which is the return of the corrosive effect of time, as well as by the interventions, such as bringing different functions to the components of a space, like walls, columns, beams, stairs, windows, doors, etc. and making additions.

The extent of the interventions can vary with the influence of decision mechanisms, such as the dwellers, investors, architects and approving institutions as well as the natural conditions on one hand, and on the other hand, economical, geographical, political, cultural, technological factors. Accordingly, architectural space becomes reusable with interventions. Particularly, the preservation of historical buildings today and their use for new purposes can be exemplified as a typical adaptation feature.

- Change and Transformation;

The concepts of change and transformation are the main characteristics in creating flexibility. More flexible adaptive housing design approaches have been developed due to the lack of design diversity in housing construction in the 20th century and the inability of housing to meet the needs of dwellers for change. This design approaches for flexibility can be listed as design approaches that can be changed and transformed in the form of growing spaces in the housing by being combined, creating new spaces by being divided, attaching different functions in these spaces, increasing the functionality of reinforcements in the housing and meeting the new needs that arise.

- Mobility;

Mobility is a concept of functionality in design. Functional designs, allowing changes for needs, such as extensibility, divisibility, multi-purpose use, are the designs that can exhibit flexibility depending on the mobility strategy.

The mobility strategy is the allowance of different configurations with changes in space and reinforcement level that the dweller can achieve during its use without touching the bearing system. By using partition elements, new spaces can be created and different functions can be attached in these spaces, or when the created new spaces are not used, partition elements can be removed and the housing can be transformed back into a single large space. The mobility feature allows a space to be used for more than one function or a different purpose by different types of dwellers.

- Modularity;

Design flexibility is the flexibility that the decisions made by the designer during planning and construction to provide to the dweller.

The dweller can have the possibility to use a different scale of structure, space and reinforcement within the space offered to him. This flexible approach is mostly limited by the possibilities offered by the construction system to the dweller. Modularity strategy is a flexibility strategy that covers the design phase. Modularity is a step that leads to grid organization in design, and this brings flexible design along with it, as it is possible to make various changes within the modular structure, such as additions and removals [8].

The dwellers are expected to perform functions at times, on a scale different from spaces or reinforcements inside the house. Against the background, space elements and reinforcements, in case of necessity, should be able to meet the new needs and offer new configurations in the space by increasing their size without changing their function and basic form but by increasing their size.

2.3. THE ORIENTATION OF FLEXIBILITY IN HOUSING DESIGN

The basic inputs in a housing design can be listed as follows in general:

- Dweller qualities
    - Household size
    - Cultural structure
    - Economic level
    - Dweller's needs - demands
- Environmental qualities
    - Climate and Vegetation
    - Insolation
    - Topography
    - Noise and environmental pollution level
    - Ground structure
- Local construction conditions (zoning status)
    - Building height
    - L.C. (Lot Coverage)
    - F.A.R. (Floor Area Ratio)
    - C.S. (Construction Site)
    - Housing Function

In the event that the dweller is anonymous at the design stage, all other dweller attributes and local construction conditions are variable, both while current and in the future life cycle, except for the environmental qualities of these inputs. In the event that the dweller is identified, all these inputs are constant at the design stage of the housing, that is, while current, and in the life cycle, they turn into a variable state, as shown in Table 2.1.

Table 2. 1. Variability of basic inputs in housing design according to current time and future life cycle, prepared by author.

HOUSING DESIGN ENTRIES		SUB ENTRIES	IN THE CURRENT PERIOD	IN THE NEXT PERIOD
USER QUALIFICATIONS		Household Size	Certain	Verribal
		Cultural Structure	Certain	Verribal
		Economic Level	Certain	Verribal
		User Request	Certain	Verribal
ENVIRONMENTAL QUALIFICATIONS	NATURAL	Climate	Certain	Certain
		Insolation	Certain	Certain
		Topography	Certain	Certain
		Soil Structure	Certain	Certain
		Flora	Certain	Certain
	CILTURAL	Environmental Construction	Certain	Verribal
		Historical Items	Certain	Certain
		Road Condition	Certain	Verribal
		Noise Level	Certain	Verribal
		View	Certain	Verribal
LOCAL BUILDING CONDITIONS (ZONING STATUS)		Building Height	Certain	Verribal
		L.C.	Certain	Verribal
		F.A.R.	Certain	Verribal
		C.S.	Certain	Verribal
		Function (Housing)	Housing	Verribal
MATERIAL AND CONSTRACTION TECHNOLOGIES		Material Types	Certain	Verribal
		Construction Technology	Certain	Verribal
		Electronic Devices	Certain	Verribal
		Installations Systems	Certain	Verribal

All these variable housing design inputs in Table 2.1 require designs of any space in the housing that exhibit flexibility from different angles. This requirement is described in Figure 2.2, which is specified as “The orientation of flexibility in housing design”.

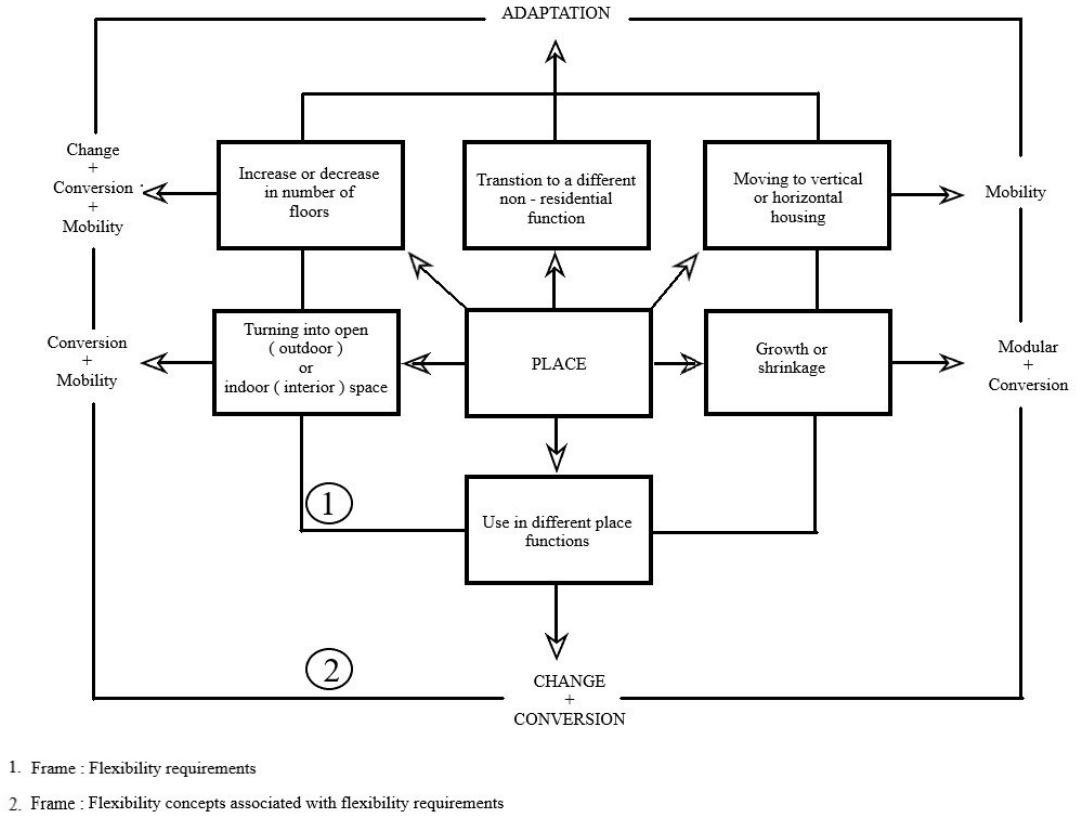


Figure 2.2. The orientation of flexibility in housing design, prepared by author.

When the flexibility approaches in housing design are examined, the concept of flexibility is seen to be formed by the engagement of multiple concepts and able to be achieved with certain strategies, including the construction and use process. Some of these flexibility strategies are addressed in the structural aspect, while some in the spatial and some in both the structural and spatial aspects. While structural flexibility approaches depend on decisions made during the design process, the spatial flexibility approaches appear to be a set of strategies that come forward depending on the decisions made during the use phase, thus enabling different uses.

All these strategies will make it possible to apply one or more of them in various forms from the design to the usage phase simultaneously in the goal of creating a successful, efficacious space that meets the expectations of its dweller and to design flexible structures, spaces that have the ability to change against economic, social factors, leading to the need for flexibility in design, and give the designer and the dweller right to choose as a result of this cooperation.

It can be brought out that socioeconomic, demographic and technological factors that can be considered as the main reasons for the need for flexibility in housing design, like the concepts related to flexibility, also have a sophisticated structure that interacts with each other. A change in one of these specified factors is the reason for a change in others. Considering the development and changes in the housing production process would increase the rate of meeting the need for flexibility, which is expected by the dwellers from the housing.

2.4. EXAMPLES OF FLEXIBLE HOUSING DESIGN FROM PAST TO PRESENT

The flexibility has become an important design principle to be considered in modern housing production for the adaptation of the house to changing living conditions and a larger dweller group diversified in this context. When examining the studies in this field, it is seen housing design approaches for flexibility have a started to be effective since the first half of the 20th century. The flexibility feature of the housing works by Le Corbusier in the 1900s has an important role in the introduction of modern architecture. His first work with this sense was Domino House (1914), followed by Citrohan House (1919-22).

In the first half of the century, the concept of flexibility shaped the design through the interchangeable partitions and reinforcements in the interior. In Fuller's Dymaxion House project in the first half of the 20th century, the interior partitions were designed as interchangeable [5].

On the other hand, the anti-architecture approach, which was developed following the failure of the modern movement's existing architectural approaches especially in the 1960s, proposes new flexible housing, offered by modern architecture, planned to its finest detail, an expression of individual preferences and desires in response to housing machines. During this period, flexibility was used as a metaphor for the future that would shape architecture. The architecture was redefined as responsive, flexible and interchangeable. In the 1960s and 1970s, futuristic scenarios were shaped by the ideals of social freedom, freedom of movement and individualism.

Many different architectural approaches for the future, bound the tradition of the House of Dymaxion, but also influenced by the "high-tech" and "pop art" movements, emerged in the 60s and 70s. Most of the remarkable projects during that period were produced by the

Archigram group. Archigram has prioritized the concepts of flexibility and interchangeability while shaping futuristic projects. They supported housing designs, shaped in the line with the concepts of metamorphosis, change and adaptation, with easy-to-shape materials and structural systems that allow flexible use. These projects are notable for their radical attempts that redesign the traditional typology of housing, the expression of the material, and the reinterpretation of the family structure [5].

- Domino House – Maison Domino, Le Corbusier, 1914;

“Free plan” (plan libre) and “free facade” (facade libre), were the slogans that Le Corbusier (1887-1965), one of the most aggressive figures of the first half of the 20th century, persistently followed. As one of the leading figures of modernist architecture, he wanted to break down old conventions on one hand and also mediate the construction of new ones on the one hand. So “freedom” should mean something more than the arbitrariness of the “subject doing” for him [7].

Regardless of the tradition that he followed, one of the most distinctive features of a conventional house is that the individual elements, such as the wall, window, door, roof, stairs, room, corridor, sofa have separate areas of existence that are irreducible to each other, and the second one is that they come together by specific patterns and form the whole. What Le Corbusier wanted was to reverse both features: On one hand, he aims to solve the independent realm of existence of elements, on the other hand, the patterns of their articulation with each other and fuse them in their construct. He discovered the tool that would make all possible at the very beginning: the reinforced concrete carcass.

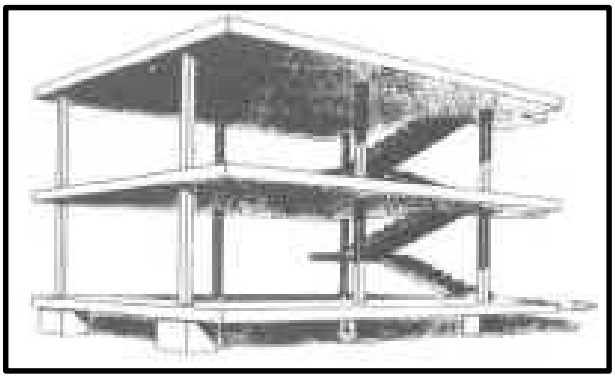


Figure 2.3. Maison Domino 1919 [7].

The first painting of Maison Domino, published in 1919 and shown in Figure 2.3., is a reinforced concrete carcass perspective: This is a carcass consisting of columns rising above the foundations, floor slabs intersecting those columns, and a stairway. This photo points to the possibilities of reinforced concrete that has not been used throughout the 19th century.

The construction process of a conventional house and the elements that will eventually form the house do not separate; as the construction rises, the walls, rooms, and windows are also shaped. However, Maison Domino is still an abstract possibility; the substantial elements of the house are not developed yet. Substantial objects that will make the house a home have turned into elements “transported outside” that will be added on, inside, on the edge of this abstract possibility, later or even being waived if desired [7].

Through open-plan structures, the walls and partitions could be changed at any time. This characteristic of the structure was compatible with the principles of flexibility and pragmatism in modern architecture. The structure, whose production was rationalized and quickly assembled in place through the prefabricated elements, contained a minimum of structure elements [10].

Le Corbusier was aiming to get rid of the established rules of the traditional house, so to speak, the rules that tied architecture down by thinking the house as a machine.

The traditional house was constant both in terms of usage and living habits and the construction technique. Life inside it was constant because the rules of the traditional world had gradually established over the centuries. There was a social consensus about him. Similarly, the construction techniques, such as masonry brick walls or wooden structures have not changed for centuries, the construction technique has been maintained while the house was transferred from one master builder to another [11].

As Yırtıcı cited, Le Corbusier knew that the rules of the traditional house in the countryside would not apply to public housing that would be designed in cities as a result of migration to the city [11].

Domino House, the first experimental studies of Le Corbusier in the pursue of ways to solve the housing need that will arise after the World War I, is a precursor of five principles that he has published for the new architecture:

1. The rise of the structure on the pilotis, the continuity of the Earth and the independence of the soil, the ground
2. Integration of the structure with a terrace roof.
3. Use of different, free plan scheme on each floor with the possibilities of reinforced concrete carcass structure.
4. Release of the free facade and facade layout by pulling back reinforced concrete columns.
5. Letting the structure to get the maximum light in with horizontal ribbon window.

While the pre-modern world was lost and instead, the institutions and rules of the modern world appeared in a revolutionary way, both versions of the house was unlikely to remain constant. The invention of concrete as we know and the development of reinforced concrete construction technique allowed fast and rapid housing production, and the agglomeration in cities was forcing the production to be in this direction. But there was a much more fundamental change. For the first time in history, he supposed to design a structure, in which the architect did not know who and how will live in, for an anonymous dweller whom the architect had not seen [11].

Against the background, the traditional rules used in residential architecture with modernism were broken and functionality that had never been discussed before began to be considered in residential construction. As seen in the Domino House project and mentioned by Bilgin, reinforced concrete for Le Corbusier was just a tool. The goal is to be able to achieve the possibilities of space fiction that are not dictated by the construction process.

- Citrohan House – Maison Citrohan, Le Corbusier, 1919-22;

in Maison Citrohan, Le Corbusier's next work after the Domino House project, he achieves space fiction, independent from the bearing system and the construction process, not with a reinforced concrete carcass, but with parallel ring walls that demarcate the house and carry the entire building [7].

Citrohan House by Le Corbusier, whose floor plans and perspective are shown in Figure 2.4., is his first project in which all his theories of architecture was applied. Citrohan was a workers' city of 40 homes. The houses were a reflection of the artist's desire to create a functional and affordable space with social ideals. The buildings were supported by columns,

took the natural light through facades with their large and panoramic windows and had roof terraces [12].

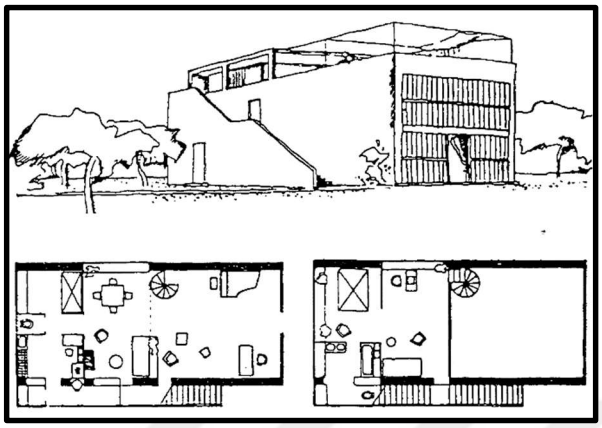


Figure 2.4. Perspective view and floor plans of the Citrohan House [4].

Le Corbusier has prepared projects to be built in series. As in the case of the Citrohan House, which he prepared in 1920, the industrial revolution should be used. The way out is only in the industry. Houses should be designed like bus or ship cabin and mass-produced in factories. So, people can have quick, sanitary and cheap houses. Basically, it is possible to talk about a durable support structure and a nondurable infill structure in Le Corbusier's projects. Considering the entire building as a generalized durable shell and adding nondurable special attachments to it comprise the essence of design approaches for flexibility [13].

- Dymaxion House, Buckminster Fuller, 1927-29;

In the first half of the 20th century, the concept of function became a significant concept that was overstressed in the field of architecture, and therefore it can be said that the house was designed for everybody as a tool that functions efficiently just like a machine, and handled in a way to be produced quickly and conveniently

One of the most remarkable examples that reflect the principles of machine aesthetics, mass production and universality of the modern architecture is Fuller's Dymaxion House. Fuller aims to revolutionize the housing industry with this design. According to Fuller, the housing can respond and adapt much better to the machine-based living of modern life [5].

Fuller first designed the Dymaxion House, described as a 4D (four-dimensional), between 1927 and 1929 as a prototype for single-family to be assembled in any area or environment

in a way to efficiently use resources, and in 1946, revised this design and constructed the House known as the “Wichita” House. Some of the design criteria can be listed as mass production, affordability (being economical), ease of transportation and assembly, and environmental efficiency. Fuller designed the Dymaxion House in a package that is suitable for mass production and portable way and developed this design to be easily assembled on the construction site. When a family buys a house, they will never have to sell their house and buy a new one. Regardless of the place they want to live, they will call a “4D house moving firm” and their house will have been moved and assembled within a few days by air to the area where they want to live or move [14]. Figure 2.5. also shows Dymaxion House.

Figure 2.5. Dymaxion House-as its assembly completed: all materials are moved inside the tube on the left side of the photo [14].

Dymaxion is designed according to the concept of efficient ideal structure in accordance with the concept of housing machine. The round form of housing was especially preferred to minimize heat loss and the material to be used. The structure is isolated from external conditions, such as climate and earthquake with the materials and techniques applied in the structure. Besides, the materials used were selected by aiming that the structure does not require periodic maintenance. The house, which includes a central mechanical system, such as electricity, water, fresh air and waste disposal, has a flexible floor plan in which the dimensions of the rooms can be changed by the dweller at any time. Due to its lightweight and easy assembly, it was aimed to be transported by air all over the world [5]. Figure 2.6 shows a photo of the assembly of the Dymaxion house, and Figure 2.6 of the layout.

Figure 2.6. Assembly photo, showing the aluminium cladding of the Dymaxion House [14].

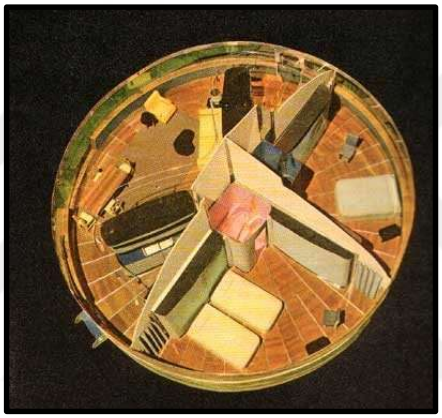


Figure 2.7. Dymaxion House plan [15].

In the era of the machinery, the house needs a room that is equipped with a state-of-the-art typewriter, calculator, telephone, television and radio and an equipment room with all kinds of technological products. The equipment unit that Fuller thought of at the time can be considered as the counterpart of today's game room or media room.

According to Fuller, as Altın [14] mentioned , man is very important, and he created all his designs and works for a man and his welfare and comfort.

Dymaxion House maintains its characteristics of being a futurist project even today. Except for the prototype, Fuller's Dymaxion House was unfortunately not able to go into mass production. One of the building's prototypes was purchased by a businessman of Wichtita and assembled lakeside next to his house by removing some of its features, such as the ventilation system at the top. This example, known as the Wichita House, was reverted to its original design in 1992 and restored and placed in the Henry Ford Museum and is still on display here, as seen in the photo in Figure 2.7. [14].

Figure 2.8. Dymaxion House exhibition at Henry Ford Museum [16].

- House of Future, Archigram,1967;

Six architects came together under the leadership of Peter Cook in England between 1950-1960 and initiated an architectural movement that questions the elitist architecture of the period, criticised to be considered utopian. This movement, anticipating how future technological changes will be reflected on the space, was mounted by being blended with Pop Art and triggered the emergence of the High-Tech trend. The Archigram, which pushes the opportunities that have come about with technology and point the farthermost end where the industrial age has come to in terms of architecture, is called the cult of Cybernetic Age. The humorous architectural movement they created by compositing the world of computer and science fiction also accommodates comic book references and American superhero aesthetics. The main goal of these architects, known for their projects, such as" Walking City"," Living Pod", through their science and fiction visuals, was their research on modern city systems that accommodated the facts, such as cybernetics and automation, which they wanted to pivot around their work [17].

Archigram's concept of flexibility in housing projects was reflected not only in the space organization and formal structure of the housing but also in its relationship with the city. The house, contrary to modernist visions of the future, was designed as a compatible attachment that can be relocated within the city upon the dweller's request.

The house of the future, designed by Archigram in 1967, was shaped by a flexible understanding of space (Figure 2.8.). Walls, ceilings and floors in the living space can vary upon to the dweller's wishes. The flooring can become hard enough to dance on or soft enough to sit on when desired. Places to sit or lie are not fixed; they are planned to be inflated with air when needed. The house is an articulated organism to the city and connected to the extensive service network that meets the needs of all houses.

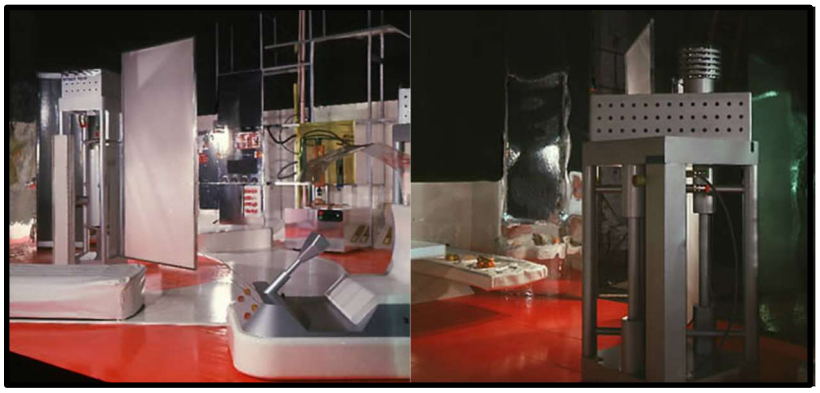


Figure 2.9. Archigram-House of the Future, 1967 [5].

Flexibility in this project was achieved by designing a responsive residential space. The idea of creating a responsive environment, an issue that is highly emphasized especially in smart housing designs today, was interpreted as the freedom and ease of use provided by technology to the person in Archigram's "The House of the Future'. Inflatable beds, ultrasonic kitchen equipment, service robots, floating seats were used in the project, which can be controlled from a master control panel. Residential space and equipment are sensitive to time and space and have been designed to be programmed every two hours according to their new functions [5]. Thereby, residential equipment and interior space were provided to be modifiable and flexible.

3. THE MAIN REASONS FOR THE FLEXIBILITY NEED IN MULTIPLE HOUSING DESIGN

In the previous section, the flexibility feature, which started to be used as an important design approach in the 20th century has been examined through examples from its period. While these examples developed over single houses in the 20th century architecture, they have become much more effective in the design of multiple houses, whose production has accelerated in today's 21th century architecture and which are widely and popularly referred to as ‘‘mass housing’’, are created together. Multiple houses are types of dwellings in which the houses of users with many different needs, lifestyles and personalities are within a structure or structure group. For this reason, in the thesis, the concepts of ‘‘multiple dwellings’’ is used in the sense of the design of multiple dwellings more than one together for the housing-dominated designs in neighboring or neighborhood units where several building groups or residences that contain many houses together, as well as various housing types in housing areas and housing blocks are collectively designed.

In this respect, factors especially in multi-housing production, such as anonymous dwellers, the need for fast and economical mass production, and is sustainable for the future, also bring the need for flexibility to the forefront in its design. Therefore, flexible housing design, in which the dweller can adapt to space and that can respond to the changing needs of changing dwellers, changing times and conditions, should be regarded as an indispensable requirement. For this purpose, in this chapter, flexible housing design, in which the dweller can adapt to space and that can respond to the changing needs of changing dwellers, changing times and conditions, should be regarded as a requirement. House has to be flexibility against the changing times and conditions. The need for flexible design required by today's multiple housing production is also based on many other main reasons that change today. This chapter mentions the main reasons that contain the social, technological factors together with the culture, family structure, social and economic status and personal characteristics of the person who influences the design and that require flexibility to multi-housing design from the 20th century to the present. It has been mentioned with a point of view.

3.1. IDENTITY DISORDER

The concept of flexibility came into the field of modern architecture with a new housing concept that had emerged in the industrial cities of Europe in the first half of the 20th century. The basic facts of the emergence of this concept can be listed as rigid, restricted and monotonous houses formed by identity disorder, alienation and industrialised methods caused by mass production (Forty, 2000) [5]. Giedion (1995), like Forty, suggests that flexibility would define housing beyond the rigid aesthetic understandings of modernist houses, and also diverge from rigid functionalist approaches to design [5].

Identity disorder is addressed as a problem of standardisation, non-placement, and lack of belonging, which is considered as the return of modernism in the field of architecture. The place forms the main idea of the concept of identity. According to Auge (2016), while the place bears traces of custom, habits and rituals brought about by socialization specific to a particular geography, it also allows a person to internalize the space, in which he is in, with individual experiences, and to feel trust and belonging there. The place is a concept that responds to the needs and sensations of an individual and has the quality of forming an identity. Modernism leads to the strength of identity, associational, historical ties that ensures the communication between the individual and the structure gradually diminish and disappear with the gradual disappearance of the features that create the sense of place (the identity of a place, dependency and place addiction) and make the place a place [18].

Another view of the concept of place in the discipline of architecture is that the concept of ‘genius loci’, popularized by Norberg Schulz and explained as space gains the quality of place, refers to the distinctive features of a place, ‘the spirit of place’ and ‘the sense of place’. Schulz tells that the place cannot be explained through analytical and scientific patterns, and aims to reveal the ‘spirit of place’ by the phenomenological method. Norberg Schulz describes architecture as ‘making the spirit of the place visible’, the demonstration of the qualities of the place through structures made by human [18].

The sense of place that is ignored in the field of today’s modern architecture has to communicate with its dweller to be transferred to the spaces. Instead of structures that increasingly resemble each other all over the world, the structures with identity should be built that communicate between its dweller and surrounding and reflect the features that

make the place a place. At this point, flexible housing design aims to enable design diversity to build eligible houses that will adapt to its dweller and surrounding.

3.2. SOCIO-CULTURAL CHANGE

Residential space reflects social, cultural, economic, values to which the person who lives inside belongs. and over time, the rapid development of these values has started to change the profile of the dweller and his expectations from the house.

Changes that began with enlightenment and industrialization are rapidly close up the original cultures today. As the differences between cultures became indistinct, the differences in cultures in themselves began to deepen. The elements that make up the cultural change since the beginning of the 20th century are industrialization, urbanization/being urbanized and, accordingly, the changes in the intellectual structure of societies. People who had previously produced and consumed what they produced now began to work with the rules that were set by someone else in the workplaces and had to march with a completely different rhythm of time with the industrial revolution [6].

Along with the Industrial Revolution, the increase in job opportunities brought about the fact of urbanization. People living in the countryside migrated to cities where there are more job opportunities, and cities rapidly grew. This made the static structure in countryside dynamic and increased mobility. With rapidly increasing urbanization, the role of working women in society had changed, and literate women had gained their political and economic freedom within the growing capitalist economy. Apart from being housewives, women working in factories have acquired new rights and assumed new responsibilities. In consequence, maids were needed to do housework.

Banham called the period after World War II as the 2nd Machine Age. Particularly, electronic technology, space travel, the concepts of individuality and freedom in this period literally led to a cultural revolution. Electronic household appliances, which has become widespread in all parts of society with mass production, has started to transform domestic life. During the war, the society, which focused on meeting its basic needs, replaced their needs with desires with the improvement of post-war conditions. Especially in the mid-

1960s, the verb “to need” became “to want”. The structure of society experienced a significant cultural change with the dynamics of consumption.

In consequence of the attempts of stimulating the market and enabling trade after World War II, the fordism movement came into play in all areas of social life. Along with the fact that having an automobile is affordable and accessible, the suburbs developed, a tendency to move away from the city and live in residential areas downstate got off the ground. The irrepressible growth of cities and transforming into a cosmopolitan structure have a great effect on the formation of suburban housing. The suburban culture evolved into a new culture of the settlement over time and created self-sustained self-enclosed housing estates [5].

One of the most significant effects of technological change and development on society is to enable the family members to turn towards new goals over time and their behaviour and actions diversify. One of the reasons why the concept of home-office draw attention with the increase of electronics and communication technologies inside the house is that the concept of time is becoming more and more important in modern life from the last quarter of the 20th century to this day. Working at home is considered favourable by the people for saving time.

Increase in the diversity of technological equipment has also led to the formation of private living spaces for family members. The autonomy of the individual within the house has been ensured. Functions have augmented with flexible planned housing concept. While a family member is using a computer in the bedroom, the other is able to watch television in the workroom. According to Çivi (2002), the resulting change in communication technologies has led to the reorganization of the house by attaching new functions into it. Within this period, the house basically lost its function of being the consumption centre of the family and instead turned into a central structure in which the family activities, such as production, entertainment, shopping that can be done outside [5].

The summarization related to the change in socio-cultural structure over all this time suggests that housing is an expression of social and cultural values as well as a physical structure. Therefore, housing should have space configurations in accordance with the social and cultural structures of the dwellers. Space succeeds to the extent that it meets the needs of its dwellers. Accordingly, it can be said that the primary reasons that affect the needs of dwellers in housing are the social and cultural values.

3.3. DEMOGRAPHICAL CHANGE

Changes in the family structure create the need to move to new configurations within the housing space. With the industrial revolution, the nuclearization family structure also changed the spatial configurations of housing. In addition to the concept of a nuclear family today, the number of families without children, couples living together, people living alone is observed to increase.

Besides the emergence of these different family types, the reasons, such as an increase in the number of children or the joining of one of the family elders to the family due to old age can be seen to cause an increase in the family population. The houses should also be designed in a diversity, suitable for these different family types, and flexible to provide the spatial configuration suitable for the use of each family member.

3.4. TECHNOLOGICAL DEVELOPMENT

Technology is an important concept that influences housing design through its impact on society. Technological developments shape the diversity in dweller's actions. Alongside the diversity of these dweller's actions, new spaces are also needed. For example, there is a need for working spaces besides residential spaces inside a house, which was designed according to the home-office concept that comes up with the increased use of computers in the houses and communication technologies, such as personal mobile phones. Against the background, the house is expected to meet the spatial needs of its dweller.

As another result of technological developments, the materials and construction systems used in housing design are seen to have changed. These developments offer many possibilities for the use of new and functional materials in design. For example, the development of computer technology, as well as the development of communication and information systems have created the concept of "smart house" and the houses with smart features, which is seen as an indicator of being prestige all over the world, have begun to be produced.

Utilising innovations that will make dwellers' lives more comfortable and easier (automation systems, remote control of air conditioning systems, lighting systems, security systems, etc.) also allows determining the features found in the spaces [5].

3.5. CHANGE OF ENVIRONMENT CONDITIONS

Structures interact with their surroundings throughout their life cycles. Therefore, architectural design needs to be created with awareness of the facts around it. Another factor that affects housing design and the concept of flexibility is the increasingly complex and changing environment conditions today. The effects of emerging epidemics on houses, as on every building type, in consequence of worsening environmental factors and changing ambient health conditions, such as rapidly changing climatic conditions, global warming, decrease in natural resources, animal and plant species, dangerous state of the ozone layer, has been evolving and surfacing across the world. Changing environmental conditions has caused the priorities change in housing design.

3.5.1. Climate Change

It is not possible to think of a structure independently of its surroundings. The climate and topographic factors must be taken into account to effective use of energy, especially in houses. Weather conditions, climatic data, such as temperature, amount of precipitation, wind direction and speed, humidity, etc. can be established as basic data to be used to calculate the amount of energy consumption, required in the house. When considering the comfort conditions of its dweller, the necessity of knowing the climatic conditions to provide the required thermal comfort and determining the proper ventilation type in the structure arises [19].

Climatic comfort is associated with the location of the building, the application way of windows to the building, the correct and sufficient lighting and ventilation of the space in a natural way and the use of the correct equipment according to the type of light and heat. The environment is polluted by the waste generated from the sources that a man consumes while maintaining his life. Therefore, it is inevitable that nature will be harmed by all actions from the production of every material used in a structure to the disposal of waste. The concept of

‘ecological architecture’ has come up as a new solution in architecture against rapidly changing climatic conditions and increasingly worsening environmental problems. today, ecological and sustainable approaches in housing architecture have led to changes in design priorities and expectations. Laws have been enacted by governments for the production of energy-saving structures that can generate their energy. Many developed countries, such as USA the UK, the Netherlands, Germany, Japan and Australia prepared certifications on ecological structures and sustainable designs starting in the early 1990s and encouraged the designs with qualifications that may have these certifications to be built by promising certain privileges. Thus, sustainable, environmentally friendly, energy-saving ecological structures are no longer just a matter of social necessity or preference and have become a matter of law and rule. Ordinary dwellers who have been affected personally by the changing climate conditions have also raised awareness, reviewed and changed their priorities. They became aware of how flexible the properties, in which they will live as dwellers, are in terms of ecology, sustainability and energy saving and production rather than the possible flexibility of the partition elements in the house. They focused on ecological and sustainable approaches by changing their preferences and attraction criteria again [20].

The damage of an artificially produced building in a natural environment to that environment can be minimized with ecological approaches, such as the design where natural resources are used efficiently, use of recyclable materials, use of renewable energy sources.

3.5.2. Changing Environment Health Conditions

Housing that was designed for flexibility has to regenerate itself under changing conditions. With the change of health conditions that may occur in the environment in which the house exists, the expectations from the house will also change. In particular, multiple housing is the most affected type of housing with a possible change in environmental health conditions since many families reside together. The reason why this chapter was included in the thesis is that the world has encountered a pandemic during the course of the study. Effects of changes in all areas of life after the pandemic caused by the COVID-19 (Corona) virus, which has recently affected our world a lot, on housing architecture are also spoken by designers and architects. Given that the places where we spend most of our time especially during this period are residences, houses, private spaces, the importance of addressing the

issue through housing design can be seen. Yet, this period is thought to be the most efficient time in which the issues of applying flexible approaches in housing design, preferring designs that allow different functions in the same space will be brought to the agenda.

Architectural firm Woods Bagot has designed a modular system that will make people's homes suitable for work, fun and cooking, as they spend more time at home due to coronavirus. Modular AD-ADT by Woods Bagot, whose model is shown in Figure 3.1., consists of a set of adjustable walls and glass that can be used to divide an open-plan apartment into several private areas, including a home office, gym, entertainment area and bedrooms. The Woods Bagot developed the scheme in response to the Coronavirus pandemic; this means that many people isolate themselves and getting used to working from home [21].

Figure 3.1. Modular AD-ADT by Woods Bagot changes apartments to work from home [21].

> As more people become comfortable working remotely, they will expect to be able to do so more often," said Simon Saint, the director of the company. "This will change the way we design and use our workplaces, schools and homes. While we expect the offices and classrooms to change physically over time, the changes in our homes can happen much faster [21].

One of the frequently confronted comments, when the period we are in is addressed in terms of the existing housing designs specifically, is that people feel trapped in their homes since the spaces in which they live are disconnected from nature.

> In the long term, it will be necessary to focus not only on design but also on our broader relationship with nature. to have a quality time in homes, the housing designs with their balcony, terrace or garden that allow going outdoors will be focused. Intensive urbanization in this last century, vertical architectural products are eliminated with this epidemic, and urban evolution can force us to return to our old understanding of architecture. In ancient Anatolian architecture, many houses had an inner courtyard, a garden, that is, 'life'. Standard vertical construction can be assimilated over time under the influence of this epidemic and replaced by new housing types suitable for the climate and region [22].

High buildings were designed to organize as many people as possible in one place. Health and hygiene were not taken into account. In times of pandemic, the contact with everything that is used in multi-storey buildings: elevators, elevator buttons, door handles, surfaces and, above all, the neighbours must be reduced. We will all desperately want to own a house after mandatory insulation, usually without a balcony or terrace on floors other than the ground. It may be small, but a house with a courtyard and a terrace where you can have coffee in the morning. The primary function of the house over time has been security. A house, which initially served to shelter from bad weather and predators in the beginning, was then built with high stone castles to prevent the enemy from intruding. People today need a house that can effectively provide social isolation. A house now offers an escape from viruses and infections, more than an escape from routine and urban chaos [23].

The Western world has been rediscovering the habits that have established in some cultures, the spaces are transformed by new technologies, and it is being discussed whether existing spaces are really necessary. There are even those who describe COVID-19 as a public housing/housing disease [24].

Newham was found to have the highest COVID-19 death rate of England where 144.3 people per 100,000 population died from the pandemic in early May. The east London borough also has the worst overcrowded housing problem. John Gray, Newham Council's lead member for Housing Services, told Inside Housing: "We need to act together, especially in Newham, in the context of worst death rates in the country, depending on age. Housing is certainly linked to that fact" [25]. "It's a housing disease. We're trying to bring some ideas and plans together for how we can handle this situation." [25]. Adam Tinson, who is a senior analyst at the Health Foundation, told:

> Overcrowded living conditions can help the coronavirus spread because it makes it “very difficult” for people with symptoms to isolate themselves, and low-income families are more likely to live in an overcrowded house [25].

Considering the comments made on possible innovations in housing design due to the pandemic, it is understood that rather than building multiple housing as standard structures, they should be considered as spaces in which people may have their own living spaces.

3.5.3. Change in Requirements for Environment and Parcel-Baced Housing Development

Over time, the construction conditions of a multi-housing site may change by the zoning plan. In cases where the said changing conditions are in favour, the most economical and desirable way may be to renovate the structure according to new conditions without being demolished. With this regard, it is clear that the flexible housing design stands out.

For example, if the housing can be increased to 6 floors according to the new construction conditions while 4 floors are available, it will be possible for the carrier system to be calculated accordingly through a flexible project and design. Otherwise, it is possible to demolish the building for renewal and instead, it may be resorted to preserve its current state until the housing structure will collapse. Similarly, in the change of settlement ratio to the land that was determined by the TAKS construction coefficient, ground floors can be transformed from indoor into outdoor and from outdoor into indoor with a flexible housing design approach. Thereby, the sustainability of multiple housings will also be provided.

It should also be expressed that the evolution of many multi-housing areas for summer and winter use instead of only summer use due to the possible transformation of a settlement leads to the need for flexible multi-housing designs.

3.6. CONTRIBUTION TO SUSTAINABILITY

Sustainability is defined as continuing to use natural resources, while on the other hand, as ensuring that these resources can be used by future generations [26]. The concept of sustainability becomes important in all areas to avoid environmental problems around the

world and to create better quality and healthier environments in the future. Sustainability is also the most attention-called issue in the life model studies for the future in architecture.

The concept of "Sustainable Structure" was defined in the Maastricht Treaty, which was signed by the European Community in 1992 as the structures that;

- Provide energy and resource conservation,
- Allow reuse with the products used, emit minimal levels of toxic substances throughout the life cycle,
- Compatible with climatic, cultural, environmental conditions,
- Increase quality in the maintenance of human life, but also do not harm the ecosystem at both macro and micro levels [26].

It can be seen that the items mentioned in this definition also reflect the needs specified in this chapter, which are addressed as "The Needs to Provide Flexibility In The Multiple Housing Design in the thesis". Sustainability, flexibility, ecological concepts in housing design are concepts that we start to hear very often together. Since flexibility in design aims to design by considering scenarios that may take place in the future, it is directly related to the concept of sustainability. Through sustainability is expressed by definitions, such as being durable, getting up to date. The only solution for a design to remain sustainable over time in today's world where everything is developing faster is to be flexible and remain flexible. Therefore, the houses designed for flexibility contribute to sustainability. In other words, it can be called a flexible structure=sustainable structure.

Considering the main reasons for the flexibility need in Multi-Housing Design, it seems that the common point is dweller's requirements. Allowing the dwellers able to adapt to the environment, in which they live, to their requirements, brings about the flexibility need.

The houses in this sense are the artificial environments in which their dwellers act. Besides being a physical structure, housing is a reflection of social and cultural values. A change in any one of the physical, social-cultural and economic environments causes the change of the others.

In this case, the need for flexibility should be treated as a dweller's requirement, and alternative solutions that can meet this need should be generated when designing multiple housings. As long as flexibility tools that are developed for a solution can be reflected in

multiple production processes, the potential of housing to meet the flexibility need of dwellers will increase.

4. TOOLS FOR PROVIDING FLEXIBILITY IN MULTIPLE HOUSING PRODUCTION

Evaluating the reasons for the flexibility need multiple housing design, described so far, there is a need to investigate the tools that respond to them. As the first step, the evaluation of the designers' approaches to flexible housing design was thought to cast light upon identifying the tools and the approaches on this issue can be evaluated as follows:

The formation of a house is generally a series of activities, ranging from decisions about housing at the macro level to problems that eventually arise during use [4]. Based on this point, it can be said that the fact of flexibility in housing design can be successful by going about the production separately in each of them, starting from respectively the design, then the construction and thereafter to the use stage.

After different definitions of flexibility in architecture, different strategies have also been developed about how this fact can be brought into multi-housing design.

Mies Van der Rohe, one of the pioneering architects in the history of modern architecture, also worked on flexibility in the periods corresponding to the post-war years. In his designs, Rohe pursued the principle of flexibility to prevent the structures to be demolished that could not meet functional changes within the period. He established a relationship between flexibility and prefabrication in his structures and used interchangeable elements. This approach is considered the first step of the prefabricated systems used today. In the building by Mies van der Rohe (1927), designed for the Weissenhofsiedlung, the floor plans are completely open-plan, except for one or two internal bearing columns. According to Kirsch (1987), Mies van der Rohe sees flexibility as one of the most essential concepts of architecture that tread a fine line between the construction and changing dweller's requirements [8].

In the 1960s, there were discussions on whether architectural projects should be left unfinished to allow possible future changes or the design must be completed but should be strictly flexible. British architect John Weeks has been a proponent of "unfinished" solutions on the grounds that it is impossible to predict the changes that may be required after the use of large institutions, such as airports and hospitals [8].

K. H. Ripnen (1960) states that the first step in a flexible design is to install simple circulation systems and argues that this circulation system should transport the dweller to stairs, elevator shafts, and wet areas [8].

John Habraken proposed an open plan system in 1961 as a strategy for providing flexibility and pointed out that the inflexible forms where the dweller is not included in the design would be uniform. Along the lines of these considerations, the SAR (Stichting Architecten Research) Research Foundation was established in the Netherlands in 1965 and Habraken was asked to lead this organization. Habraken argued that including the dweller to the design in the planning process should be planned following simple basic principles called support and infill structure [8].

Support units referred to permanent, durable parts that comprise the basic infrastructure whereas the infill units referred to nondurable and adaptable parts that the dweller determines in the structure. Limits have been set, but making different configuration within those limits is a decision that the dweller can make. According to Habraken's approach, the architect's role is not to design a space, but to design a bearing system in which space can be placed [8].

Hertzberger (2009) suggested areas related to the incomplete structure that can be filled internally and externally by the dweller and promoted the idea that there should be a temporary frame that can be filled in the actual design. According to Hertzberger, who highlighted that the skeletal system should be in a way that allows flexible space fictions to be shaped by the dweller, it is necessary to make structural evaluations to provide flexibility [8].

Like Hertzberg's strategy, Hill (2003) also stressed on that the flexibility can be achieved through strategies, such as spatial abundance, technical tools, and an open plan [8].

Yürekli (1983), in his study aiming to change in design, mentions the flexibility decision points of flexible and adaptable design approaches, rather than the classification of its types and levels. These decisions are related to planning and configuration (number of specific/indefinite elements, service distribution decisions, format decisions, grid decisions) and construction technique and construction system (inter-connection and technological properties of elements) [8].

Architect Yona Friedmann, who often addresses the concept of flexibility in his professional life, speaks of four critical points for providing flexibility. Friedmann (2002) says:

> The manipulation of volumes (Combined use of several units when necessary to get a larger unit and division of them when necessary by reverting its state), the Spatial Configuration (Combining suitable spaces during the design stage), Growth and Division: is another form of adaptation of expansion by making additions outside the structure (add-on) or inside the original volume (add-in), Manipulation of subcomponents: The lower-level components of the buildings should be fixed inside the house after the building is constructed and horizontal and vertical distances should not step out, it should be designed to be easy to use and the second part should allow for improvement and correction [8].

Forty (2000), highlights that the abundance of flexibility (with spatial fields of stock spaces to adapt to uncertain future developments, whose function is uncertain) can be achieved with technical tools (with the elements in a fixed structure based on ease of movement of lightweight construction elements and the positioning of the mechanical installation independently of the space) and political strategies [8].

According to Schneider and Till (2005), one of the basic principles of flexible space design is to avoid inflexibility. In other words, the design of inflexible parts of a structure is important to provide flexibility. Bearing systems and service areas are permanent building components. There are two controversial methods in flexible housing design, which are regarded to belong to the “rhetoric of flexibility” Schneider & Till, 2007: a determinate way of design that refers to movable transformable spaces and an indeterminate way of design that points to endless changes. These two ways indicate a foreground consideration of flexibility in the design process.Under the umbrella of these approaches, tools for providing flexibility in the production of multiple housing can generally be evaluated under the topics of strategies, collaborative planning, modular design [8].

4.1. STRATEGIES

As İslamoğlu [8] quotes from strategies for providing flexibility in the historical process, it seems that some of the approaches of designers are structural assessments, some are spatial, while some are both spatial and structural. While the strategies for providing structural flexibility depend on the decisions made in the design process, the spatial flexibility

strategies depend on the decisions made in the usage phase. Against the background, the approach adopted under the thesis is that the applications that are thought to attain flexibility in the housing should be evaluated in the design stage, design + construction and usage with different decision-making processes, in a hierarchical organization.

4.1.1. Strategies for Providing Flexibility In The Desıgn + Construction Process

It is necessary to attain flexibility in the structural systems of multiple housings that are intended to be of a design variety that can meet changing dwellers' characteristics and needs. In housings designed for flexibility, the relationship to the structural subsystem capacities of the building can be established on two separate bases. These decision-making levels can be listed as follows;

- Support (Bearing Structure) Level
- Infill (Outer Shell) Level

4.1.1.1. Support (Bearing Structure) Level

According to this strategy, developed by John Habraken and the SAR Research Foundation, which he founded in 1965, the architect's role should not be to design the house but to design support systems in which housing will be located. According to the SAR system, the dweller has the opportunity to create his structural environment with fixed elements in a modular support system given to him as a planning decision [27].

In multi-storey housings, the support structure is the configuration of permanent and shared systems that provide services to all dwellers of the building and offer spaces and the bearing system contains building shell system, common installation and circulation systems [1].

The support structure design of a housing block must be designed by considering the social, cultural characteristics and common needs of all dwellers of that building, as well as the physical environmental conditions. Therefore, using a bearing system that can allow new space configurations is an essential decision that can be taken with regard to design approaches for flexibility. At the support (bearing structure) level, which is a sub-system

that keeps the building system up, the designer can benefit from two different strategies. These are neutral areas strategy and strategy for different plan types.

- **Neutral Areas Strategy**

In support structure design, partially blocked neutral spaces and neutral spaces can be created by the organization of horizontal and vertical subsystems (installation shafts) with horizontal and vertical bearing systems (beams, columns and bearing walls). In the design of partially blocked neutral spaces, it is necessary to designate the location of wet spaces, installation shafts, one or more of the components of the bearing system that limit residential units. The locations of such barrier spaces and components should be designed so that they will allow as much opportunity as possible to freely divide living spaces to be designated later. While the building floor plan shown in Figure 4.1 includes the holistic area of flexible housing units in the form of an independent space, the building floor plan in Figure 4.2. locates the wet walls and installation shafts and includes the design of the shapes and sizes of the houses.

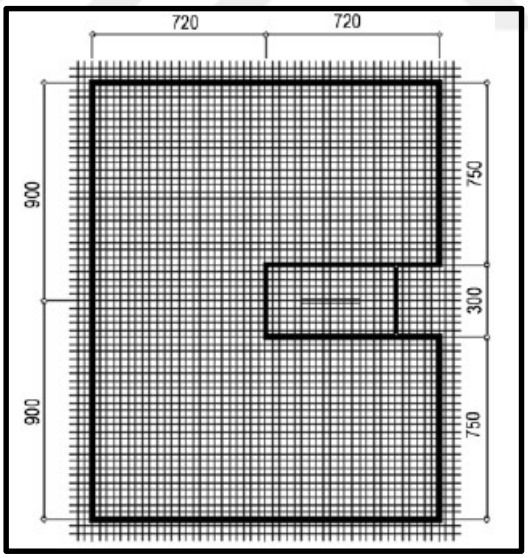


Figure 4.1. Design of building floor plan geometries and dimensions covering the holistic area of flexible housing units in the form of neutral space [1].

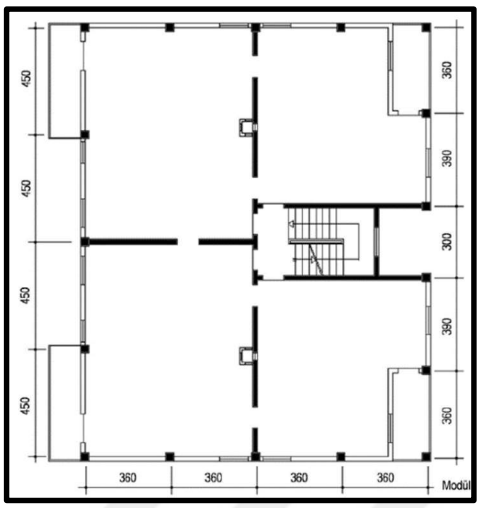


Figure 4.2. Designing the most appropriate floor plan scheme of the support building by determining their locations, shapes and dimensions of the components, such as wet space walls, installation shafts that provide the most flexibility [1].

In a housing project that was implemented in France in 1968, which was seen to allow different space organizations in Figure 4.3., applying 120-square meter concrete flooring without transverse walls and intermediate columns provides maximum flexibility to the dweller.

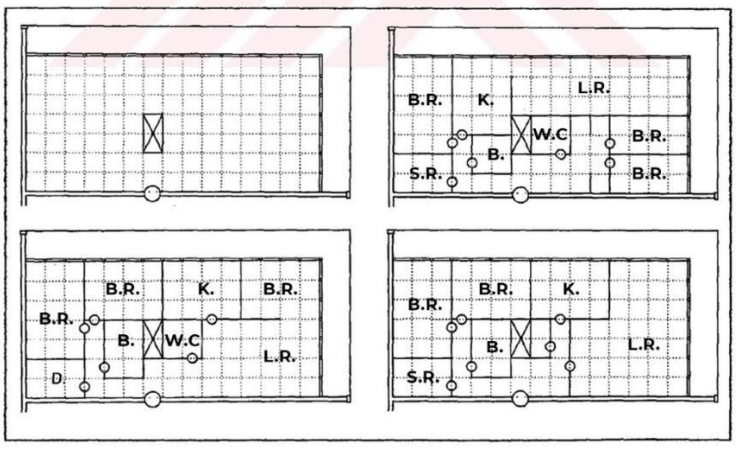


Figure 4.3. Support structure floor plan of flexible housing block applied in France and possible alternative space organization examples in a housing unit inside the block, translated into English by author [4].

In support structure design, solutions with fully accessible space can also be used in the approach of creating neutral space. Addressing the dweller's groups who demand a high degree of flexibility, this solution is suitable for diversity in housing units and space organizations. In this solution, the main installation distributions can be integrated with the bearing system to provide high flexibility to space. However, this approach, able to cross wide clearances without any blockage and require a special bearing system with installation distributions, is not widely used due to its high cost.

Multi-storey support structure plan types to be designed in accordance with these design approaches for creating a neutral space can be classified depending on the number of preferred housing units, settlement status and an area of the building that will provide service to all dwellers. The support structure plan types of multi-storey flexible housing design shown in Figure 4.4. are grouped according to the association between the housing units and the stairway house that provide services to all dwellers of the building.

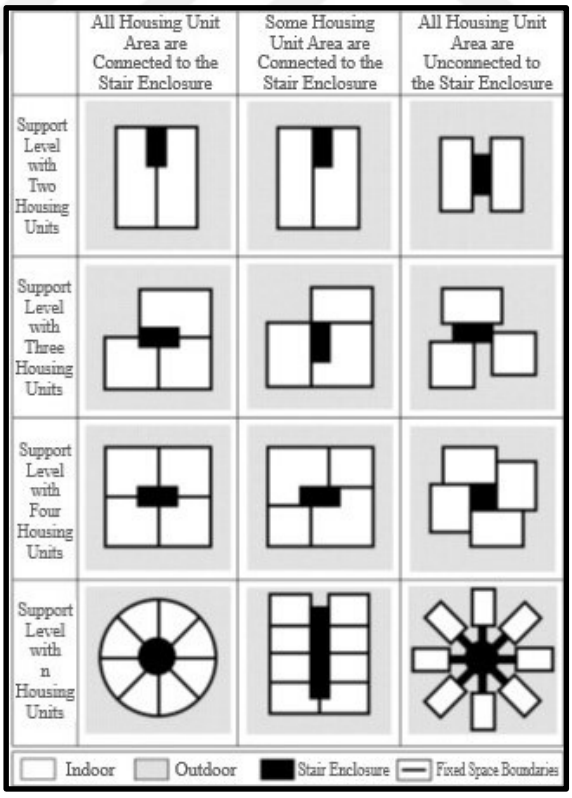


Figure 4.4. Support structure plan types, grouped by the association between housing units - stairway house in multi-storey flexible housing design, translated into English by author [1].

- **Strategy for Different Plan Types**

In support structure design, applying different types of plans in a housing block can offer the dweller flexibility in choosing the appropriate space for him.

As a result of the dimensional analysis and organization of the spatial units of all housing units to be included in the multi-storey flexible housing, according to their preferred programs and sizes, the plan geometries (rectangular, square, L-shaped, Z-shaped, etc.) of each said housing unit that will allow for various spatial organizations as possible are designed. Based on these plan geometries, the floor area of the building determined in the previous step is divided properly to obtain various housing unit layouts, and all alternative plan schemes that enable different configurations of the floor area are set forth. Thereby, all alternative space configuration layouts and sizes of the housing units with different programs and sizes in the building as well as the plan scheme alternatives are also designed (Figure 4.5).

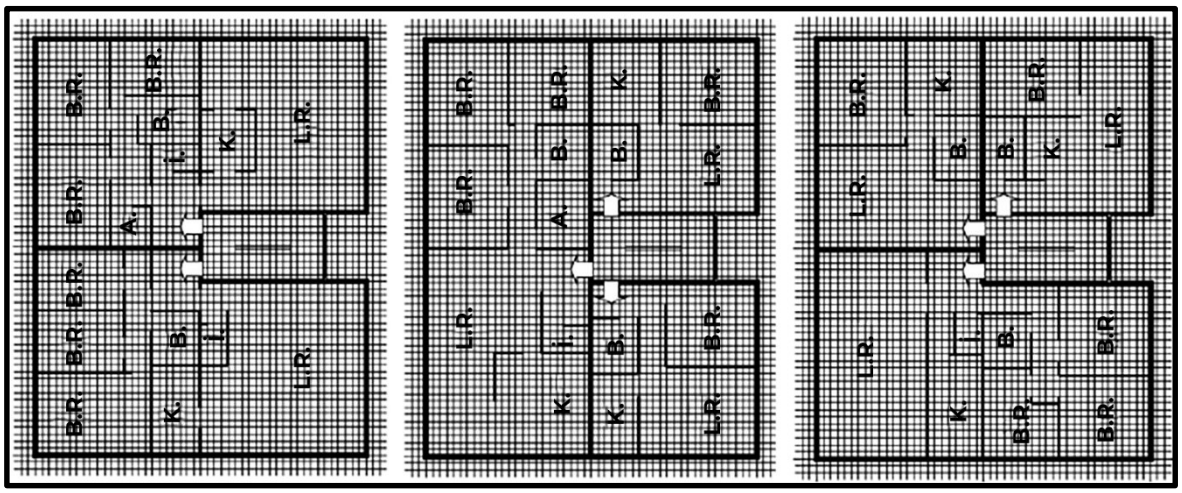


Figure 4.5. Different floor layout plans designed to enable the diversity of spatial configurations of housing units in support building design, translated into English by author [1].

4.1.1.2. Infill (Outer Shell) Level

Infill structure design covers the housing unit space configurations and their forming structural components, where the dwellers' the needs of change that may arise during their first settlement and use of the housing are met [28]. Existing legal regulations in Turkey do

not inhibit (Development Law, Property Ownership Law) any change in the infill structure sections of the building (within neutral housing units) during its use, provided that certain requirements (avoiding any increase in the housing unit land and quality reduction, avoiding any damage to common places and bearing systems) are met.

Infill structure design includes the organization of spaces of the housing units (living space, kitchen, bathroom, bedroom, balcony, etc.) without touching the bearing systems and the configuration of interchangeable structure components of these spaces (partition walls, wet space walls, installation components, walls, floors, ceiling claddings). Infill structure design can be created for a specific group of dwellers in accordance with the data, obtained in the support structure process and the prerequisite program.

The decisions to create infill structure design solutions can be taken with two different strategies, depending on the level of knowledge and forecast status obtained for the future dweller; the design strategy for the anonymous dweller type and the design strategy for the identified dweller type.

- **The Design Strategy for the Anonymous Dweller Type**

As mentioned in Chapter 2.2., most of the structural components are expected to be modifiable and to create an initial infill structure that compromises with the existing support structure, as it is necessary to design a housing unit where future change needs are not determined in cases where the housing dweller is anonymous. Initial infill structure refers to a wide range of design solutions to be presented to the dwellers, ranging from the areas of unfinished housing units to be completed whenever possible by the dwellers to a detailed completed indoor organization. This highly flexible design strategy allows dwellers of all types to make configurations that they can adapt to any change needs that may arise in the future. On the other hand, providing this high flexibility is an approach that is considered negative by the dwellers, as it also leads to high investment costs and complexity in the construction process.

For the achievement of the desired result, this design strategy should follow certain coordination rules that ensure the adaptation of infill structure components from the same or different production, which will form the building and the adaptation of support structure to dimensional and junction point. Thereby, the dwellers with different characteristics and needs are allowed to easily physical changes in the housing unit before and during use

through a structural system with as little and complex as possible junction point relationship and the incompatible dimensional relationship between its components. For this, designers need to know the principles of modular coordination prescribed in existing construction systems, the formal, dimensional and joining rules of components, and develop design solutions based on them [1].

- **Design Strategy for the Identified Dweller Type**

In the design of the housing, which is intended to appeal to a specific type of dweller, the possible future needs of the dweller are also predetermined. Thereby, design solutions can be generated for space organization changes that may occur in the housing unit.

Information for dwellers, needed to prepare a change scenario that will put forth the flexibility needs of multi-storey housing dwellers may be;

- Dwellers' household type (young individual, elder, single-family, married family, etc.),
- Dwellers' family life cycle phase (newly married family, a family without children, family with pre-school children, family with school-age children, family with major who left the house, etc.)
- Income level of dwellers (income status of family members based on income sources, such as work, property),
- Housing mobility of dwellers (proximity or distance of the house to work, the interaction of the environment with family traditions, settlement change ratios of the environment that is affected by the factors, such as social, cultural and commercial opportunities and will determine the length of stay in the housing),

In-house behaviour of the dwellers (forms of use space use that emerge according to the social and cultural characteristics and economic status of family members) [1].

According to the design strategy for identified dweller type, the dweller is not restricted to general solutions by the designer and the infill structure components to be included in the designed space organizations create a solution for the need for flexibility by being designed in a suitable way to meet the change needs of dwellers.

4.1.2. Strategies for Flexibility During Use

Flexibility during use is the flexibility that can be attained at the space and reinforcement without touching the dweller's bearing system during use. During this process, the dweller can attain the flexibility he needs from the beginning of using the structure with established strategies for reinforcements that provide the indoor layout. These strategies are the reconfiguration, growth and multipurpose use strategies, replaced by permanent, classical space concept of 20th-century design.

4.1.2.1. Reconfiguration Strategy

The housings should be designed that allow new space configurations for the adaptation of dwellers to changing needs during the day or changes that may take place in the family structure over time. Such designs are especially needed in houses where space is limited and narrow, and in these houses, the dwellers are allowed to meet their spatial needs by using mobile and functional partitions panels, which are the indoor reinforcements, and furniture whose function is transformed. The reconfiguration strategy includes changes that the dwellers can make themselves without touching the bearing system, with the mobility of indoor reinforcements, which is the subcomponent of flexibility. For this reason, the aim of increasing the effectiveness of using transformable furniture in the scope of interior architecture, also requires flexibility in residential architecture design. Therefore, the use of transformable furniture can be considered as a sub-tool in the rearrangement strategy, which is one of the tools to provide flexibility in collective housing design.

According to the strategy under this extent, the dweller is able to configure his living spaces himself by the flexibility of the structure and reinforcement elements during use. The design and construction process should be raised with few vertical bearers that will allow the bearer system to pass through more clearance and horizontal bearers that will not dangle from the ceiling to reconfigure the space with partition elements freely during use and to make the desired change.

Thereby, special channels, rails, wheels that allow the movable partitions work will be able to function correctly, there will be no problems with the floor, ceiling and wall junctions.

Figure 4.6. Ability to configure spaces by applying mobile and functional furniture as a partition panel [3].

While mobile and functional furniture serve as cabinets and storages, they can be used as partition panels to divide the spaces by acting as an internal wall between two spaces. They also allow the spaces to grow by combining them when desired (Figure 4.6.).

The ability to increase the size of the furniture in the house to meet the needs without changing its function when needed allows you to reconfigure the space. This furniture may consist of sitting, lying, eating, working elements for all types of needs. The use of all these elements can be increased if necessary (Figure 4.7, Figure 4.8.).

Figure 4.7. Extendible table [29].

Figure 4.8. The table, which can provide single and double working area [29].

4.1.2.2. Growth Strategy

The growth to design the housing suitable for offering its dweller new areas of use to meet the new needs that may be caused by the changes in lifestyle.

The designs for this strategy aim to enable other spaces to be used with configurations suitable for flexible planning, except for except kitchen and bathroom spaces that are accepted to be stable during design and called wet volumes, and the elements of the bearing system.

Figure 4.9. Van Der Rohe's Wieissenhof Project, configuration of other spaces suitable for different uses by keeping wet volumes stable [2].

When Figure 4.6 is viewed, the growth strategy can also be seen as the growth of spaces inside the house according to the needs of the dweller or the addition of an extra neighbouring room to space. Accordingly, as shown in Figure 4.6, the partition panels are also applied to combine and grow spaces, as well as to divide them. Since they are not permanently attached to the ceiling and flooring with its mobility feature, they can be used optionally in the house.

All units that are not bearers in the housing can contribute to space growth when desired. The use of the space in window design by the architect Aldana Ferrer Garcian goes beyond the boundaries of the outer shell of the house. This window, designed by the architect especially for small houses, allows the daylight getting inside to increase and also creates a space for reading and resting (Figure 4.10.).

Figure 4.10. More Sky, Aldana Ferrer Garcian [30].

4.1.2.3. Multi-Purpose Use Strategy

In the flexible housing design, creating spaces large enough to respond to many functions with the flexibility of the structure and reinforcement elements cannot be applied to every house. In such narrow-planned housing, a single place is expected to meet all the needs. All these needs are met with transformable multi-purpose furniture. today, the living spaces in multiple housing units are observed to get smaller gradually due to the rapid increase in population and land prices located in the city centres. However, the reasons for preferring small houses, which were seen as living spaces of low-income people in the past, also varied. Changes in lifestyle and habits as the reflection of city life can lead the dwellers to prefer small houses. In such narrow-planned housing, a single place is expected to meet all the needs. These houses, where flexibility and multi-functionality stand out, have solutions to make the space suitable for working, social activities, cooking and sleeping, etc. Space-saving and functional solutions allow the house to be configured to different spaces at different times of the day.

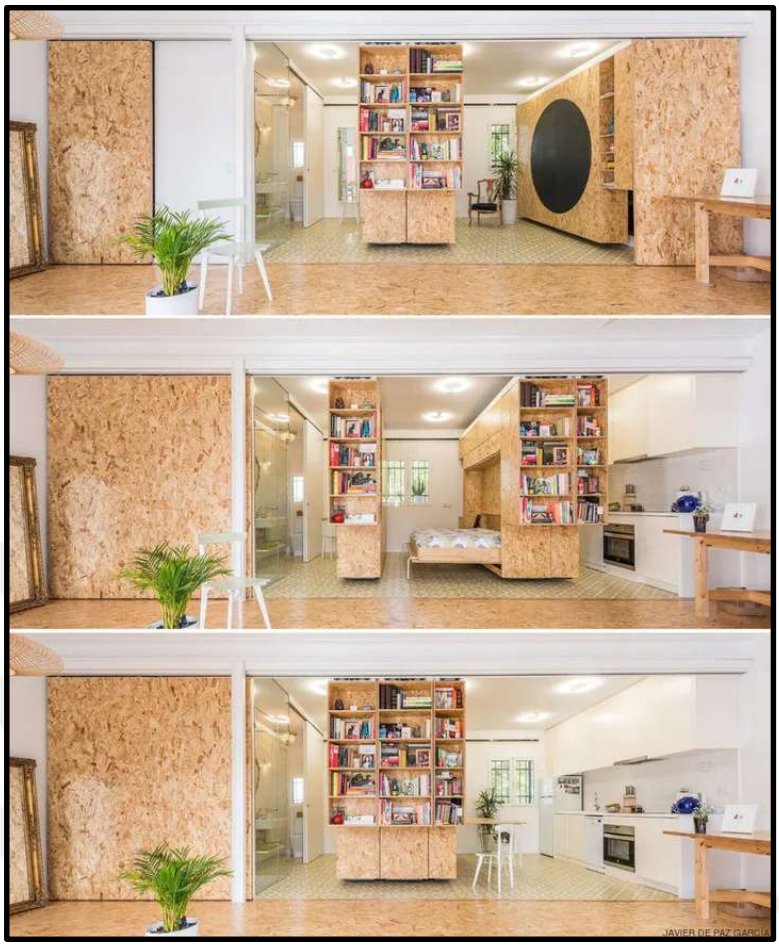


Figure 4.11. An example of a flexible housing designed by using compact furniture [31].

As can be seen in Figure 4.11., the living, sleeping and eating spaces in a narrow house are resolved in a layered manner on movable wall surfaces. The desired space can be accessed by pulling the partition wall and the mechanisms that act as storage. Thereby, adjustable wall partitions that enable the house to be used by being divided into several private areas can provide multi-purpose use.

Another significant application that aims the multi-purpose use strategy is “the use of transformable multi-function furniture”. With this method, the same space can be used in more than one function.

In addition to the functional change of the furniture to work differently by being transformed (Figure 4.12.), used only for one function, being retractable after the use and allowing to make a room has a substantial role in providing flexibility. For example, a compact bed design that is combined with a wall system provides the dweller with extra space by being unfolded when not needed (Figure 4.13).

Figure 4.12. A functional furniture example that turns from a seating sofa to a bed [32].

Figure 4.13. The compact bed design allows you to use two separate spaces: working and sleeping in the same space with optional use, Raanan Stern Studio [33].

4.2. PARTICIPATIVE PLANNING

The importance of the dweller in flexible housing design has often been stressed throughout the thesis. to identify the needs of the different types of dwellers who are expected to live in these houses accurately when designing multiple housing, it can be said that the dweller's participation is the primary criterion that can attain flexibility in the housing unit.

The position of the dweller in the architectural design is essential for the ability of the dweller to meet the future change needs and the extension of the house's functional life. Since the 1960s, "participation" in all individual-based areas, including spatial sciences, have become evident as the concept that focuses on and discusses the preferences, perceptions, experiences and behaviours of the person. As a result of such an era, there has been an awareness that it is necessary the architectural user should participate the design more systematically and consciously and the experience of the dweller from his relationships with the environment in which he lives, should be included within the design parameters. Architectural theorists also expressed the design processes formed by bringing together the dwellers with common goals as the enhancement of community sense and relationships, the availability of dwellers to intervene in the decisions to be taken about the dwellers' environment and thus, the perception of the living environment in an embracing nature instead of the anonymized perception [20]. Currently, in Turkey, the dweller is excluded from these processes in multi-storey housing designs due to rapid production.

Multiple houses are produced to meet housing need that arises in parallel with increasing population, especially in metropolises. With globalization, people prefer to live in metropolitan areas in terms of commercial and job opportunities. Life in metropolitan area combines global and local values. In the process of metropolitanization the types of buildings in the city and the high rents created by urban services affect the urban life and urban structure. Since high-rise buildings are densely located in the center of metropolises, the city dwellers and users are directly affected. The situation reveals the necessity to produce solutions for high construction and user participation issues together [34]. In this discourse, the user refers to the urbanite. As can be seen, while the user participation in the production of a building is realized by the person or people who will use the house to have a say in the design, it can be realized by the participation of the people living together in the city where the building is located. In this respect, the importance of user participation for urban planning can be addressed to realizing much longer lasting multiple houses designs that are compatible with their surroundings.

Ensuring and identifying the dweller's collaboration in programming can be at different stages of the process in various sizes and extents. This can range from a minimum participation that takes into account the dweller's demands to leaving all space usage decisions of a building whose structure is provided only. The system, developed by the SAR

housing research group that Habreken leads, also requires the participation of the dweller. According to Habreken, housing is both a social and individual fact. Mass production causes a lack of communication between the dweller and the house. The role of the architect in the new configuration to redress this miscommunication should not be to design housing but to design support systems inside the house. According to the SAR system, the dweller has the opportunity to create his structural environment with fixed elements in a modular support system given to him as a planning decision. Within the rules of Sar management, the user must select, consume, and modify the function in participation [27].

Below is a table of suggestions for Habreken's creation of user participation methods. After determination of user needs, user-based design alternatives and the architect's user-based research cover the design process as a whole. After the approval of the designated users and local authorities, the production process of the design begins. The way to reach the final product has been anlyzed by Habraken with the following table method [34].

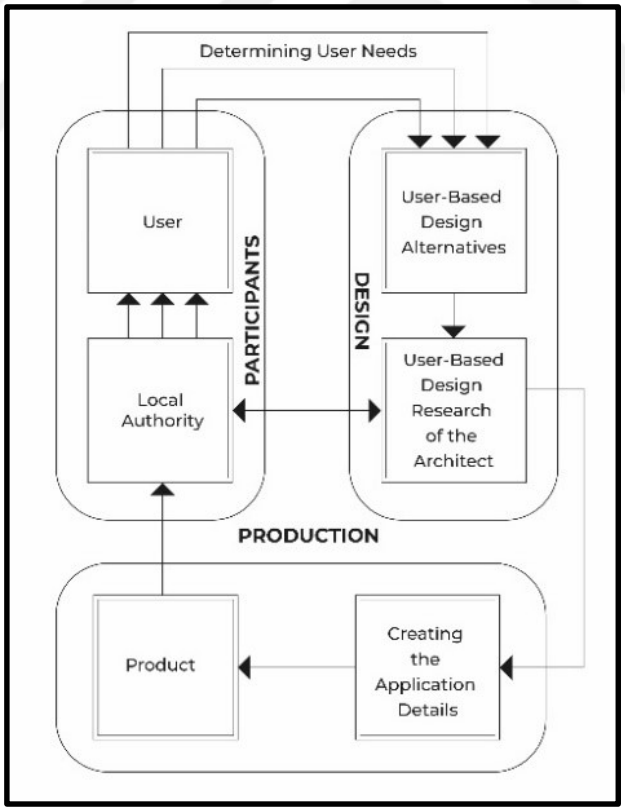


Figure 4.14. User engagement method flow – A proposal from Habreken, translated into English by author [34].

The dweller's level of participation in the design process, directly or indirectly, the architect's position in the design process and the way he constructs the process are important determinants of participative processes. These two determinants made possible a categorical differentiation in which both concepts of participation in the design process, "design for the dweller" or "design with the dweller", can evolve into each other during the design process. Figure 4.14 shows the dweller contribution to the housing design process for flexibility.

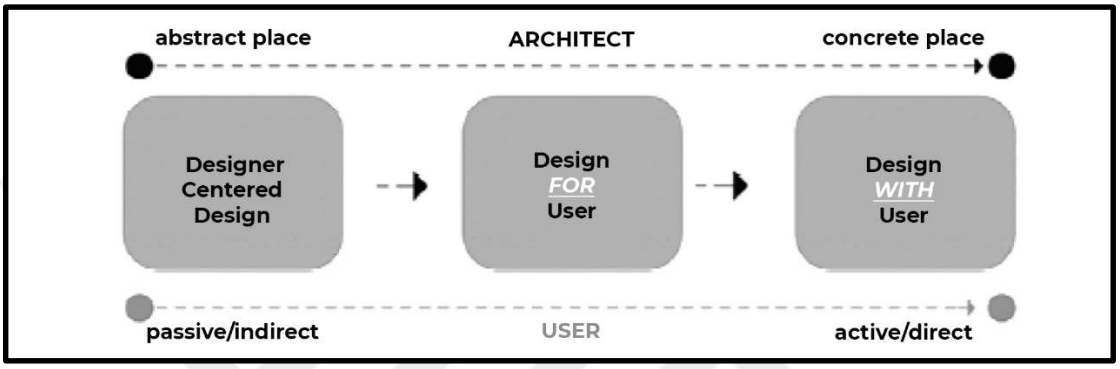


Figure 4.15. Stages of dweller's participation ın the design process of housing for flexibility, translated into English by author [2].

When we consider these two concepts, which express a humanistic point of view, together with today's large-scale housing design process, it is clear that producing project specific to each dweller is not possible due to the nature of the process. However, reflecting user preferences into the project by considering different methods will both allow dwellers to internalize the project and reduce the psychological and economic burden they will have when adapting the project to their needs [2].

If the dweller group is identified in multiple housing projects with dweller's participation, the maximum needs of that group can be identified and each dweller can adapt their house according to their changing needs. If a dweller group is not directly known, criteria can consist of standard needs of a particular group and can also be applied to similar dweller groups. Reflecting dweller's participation in housing design improves the comfort that will be offered to dwellers by allowing the dweller to adapt the housing to his needs.

4.3. MODULAR DESIGN

Modular design is a form of design that allows you to make various modifications in the design, such as additions, removals, and mediates the creation of flexible volumes through this respect. The principal in designing multiple houses by considering its flexibility is that it allows different dwellers to use the same house in different ways. Another method for applying the goal of flexibility in design is the understanding of modular design, which comes with the use of prefabricated systems on a grid organization. Depending on the situation; such house may have finished but has modifiable internal structure or may grow and diversify by making additions and removals according to changing needs, starting from the core housing structure.

Modulor by Le Corbusier can be seen as the first important step in the transition to grid organization in housing design. A grid organization involves spaces and forms whose positions and relationships within space are configured by a three-dimensional grid pattern. (Figure 4.4) Since there is a modular design concept within the grid system, it is possible to make additions, removal and modifications within this modular structure and between each other [35]. This changeability, transformability that takes place within this grid organization in modular design also brings out a flexible design.

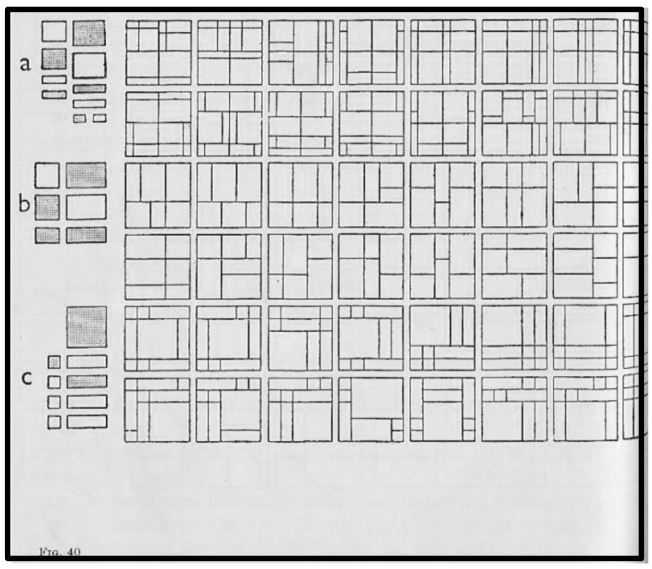


Figure 4.16. Gridal organization (Le Corbusier, 1954) [35].

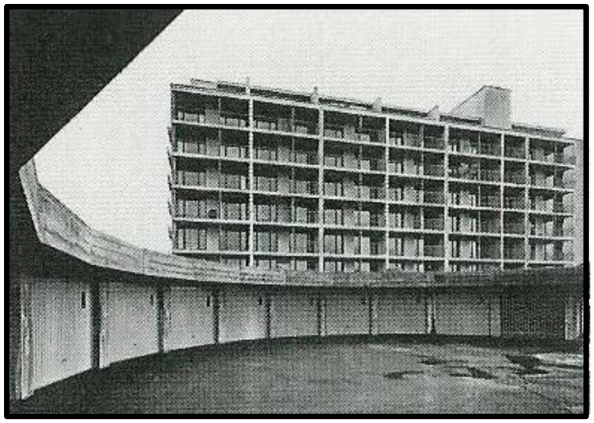


Figure 4.17. Neuwil (1966), Wohlen, Switzerland [35].

There are 49 rental units, having “flexible” indoor partition, on the eight-story building block shown in Figure 4.16. The dimensions of these units are set to a fixed size. The sizes, locations and materials of the stairs, kitchens and bathrooms are also fixed. All units are positioned towards an east-west.

The units are accessed through a common central hallway. Since the bathroom and kitchen of each unit are configured inside, they do not get natural ventilation and lighting. Spaces, adjacent to the facade, have equal sizes and the same type of balconies. Since the units are positioned towards an east-west, the front and rear facades can get enough sunlight. Since the direction of these spaces is exactly the same, the living room likely to look both ways [35].

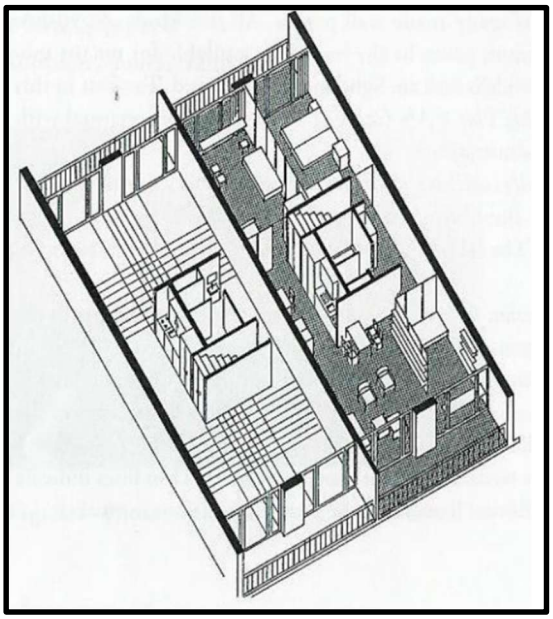


Figure 4.18. Neuwil bearing and infill system [35].

As shown in Figure 4.17, the internal layout of the housing units can be determined by tenants and changed according to their requests. Space is segmented according to a 30 cm grid system using five different types of ready-made wall panels.

The design of the project, which allows the creation of indoors as desired towards the east-west direction, is a positive point. Given that housing units will be rented, it is obvious that the internal configuration of the housing will be modified every time a new tenant arrives. This project can also be described as a successful project, as it can provide this flexibility to tenants [35].

5. SETTING MULTI-FLEXIBLE HOUSING DESIGN CRITERIA

The primary priority in housing design is the needs of the dweller. Accordingly, considering the wide range of dwellers of multiple housings, it should be aimed to design houses that can adapt to the changing needs of dwellers. Dweller's requirements vary depending on different criteria, such as cultural, social, economic structure or educational level. to ensure the desired adaptation between dwellers with different living conditions and housing units, it is necessary to define housing design criteria for flexibility. Setting such criteria requires a general analysis of the individuals of households, using the house based on the housing design inputs, specified in Chapter 2.2. At the end of these analyses, based on the "The Main Reasons for The Flexibility Need in Multiple Housing Design" described in Chapter 3, the basic qualifications, expected from multi-flexible designed housing are put forth. These qualifications, on the other hand, can be the basis for setting flexible multi-housing design criteria.

5.1. QUALITIES EXPECTED FROM MULTI-FLEXIBLE DESIGNED HOUSES

The qualifications expected from housing appear to be analysed under the following general headings when their housing design inputs specified in 2.2. is evaluated.

- **Adaptation to Time**

The profile of households in the house has varied over time. Mobility, migration, technology, alternative lifestyles, women's position in the family, different business examples, factors that change the function of the family in many cultures alter family life all over the world.

Housing, which has a very effective place in the family budget, family life and family relations, is not a permanent place to live or change throughout a family's life. Many families become dissatisfied with their houses when their income, needs and preferences change. These changes come up either because of social changes or in parallel with the development of the family. People who use house are very diverse, and each of them demands different things from the house, its surroundings, furniture, equipment and structure. An important function of the architect is to explore the tastes and needs of these people and reflect them into housing architecture. It should be paid attention to housing design to meet the

contradictory actions and demands of individuals of various ages and statuses living in the house and the closest solution should be generated [6].

Unexpected situations that may be encountered in life, such as the death of one of the spouses, health problems, joining of one of the family elders to the family to be taken care, unemployment etc., which will be discussed detailly in the next chapter under the heading "Adaptation to Family Size" also causes the house to be modified. Considering these factors, the need for housing adaptation is seen along with changes in the demands and needs in the life cycle, not only in dwellers with different characteristics but also in a consistent dweller. This has forced the housing to be considered as a design parameter that can be flexible without imposing a financial burden on the dweller to be adapted to their new needs that may change or come up over time.

It is very important for the housing to be designed with infrastructure that can be applied compatible plans with new functions without any changes in the structure system when necessary. Against the background, the correct decisions taken during the design and construction phase make it possible to modify the indoor organization freely, to make maintenance and repair of a system easily if necessary, and to be integrated into new systems to be included.

If we recognize the building as a whole formed by various subsystems, the basic structures that form the building can be classified as:

- Structure subsystem (bearing system)
- Shell subsystem (limiting system between indoors and outdoors)
- Service subsystem (ventilation, heating, cooling, lighting)

The advantages of an increased level of integration between components can be listed as follows:

- Each system has a neutral place and components within the space.
- This neutrality attains flexibility to modification in terms of modification of function or maintenance in the building in the future, other systems are not affected by the modification in one system.
- Each system can be designed relatively more neutral and flexible.

- Responsibility for each system from the design stage can be delegated as in the traditional design process, and the project can gain speed.
- The use of multi-functional components, serving multiple subsystems, reduces initial investment and operating cost [2].

The right decisions that can be taken for the development of the housing future require the analysis of the dweller or dwellers who will use the housing, and the consideration of how they prefer against events. In other words, the adaptation of the house to the time is to ensure the durability of the house. It is necessary to classify and address the adaptation between the house and the dweller to ensure that the needs that arise while living in the house are met, to identify the basic qualifications, expected from the house.

- **Adaptation to Change in Family Size**

The reconfiguration of the spaces within the houses is directly proportional to the changes in the family structure. Considering the general change that the family has undergone, which is also defined as the smallest building block of society in the historical process, it is seen that social developments have brought about the transformation of a wide family profile into a nuclear family. This nuclear family structure, which is the return of this modern era, requires differences in the indoor configurations of houses. Providing suitable spaces for the different needs and personal activities of all family members in the housing depends on the flexibility of the housing design.

Since families with different sizes also live in multiple housings and separate designs cannot be created for each family structure, adaptable and preferable houses in different plan types are of great importance in terms of design. Therefore, housing should be designed by considering the changes in the family structure.

Duvall (1957), who compiled the stages that the families have undergone in two headings; explained these stages with the concepts of (1) the growing family and (2) the shrinking family. Changes related to the family size that affect these concepts can be listed as follows;

- Newly married or childless couples
- Change in the number of children, their age and gender
- Joining of one of the family elders to the family due to old age
- The death of one of the couples [6].

Each of these changes in family size leads to different space organizations. Figure 5.1 shows the way of dwellers to meet their need to make modifications in the house. Uzel (2001) mentioned that the requirements arising from the change in the family structure are met by the dweller in three different ways:

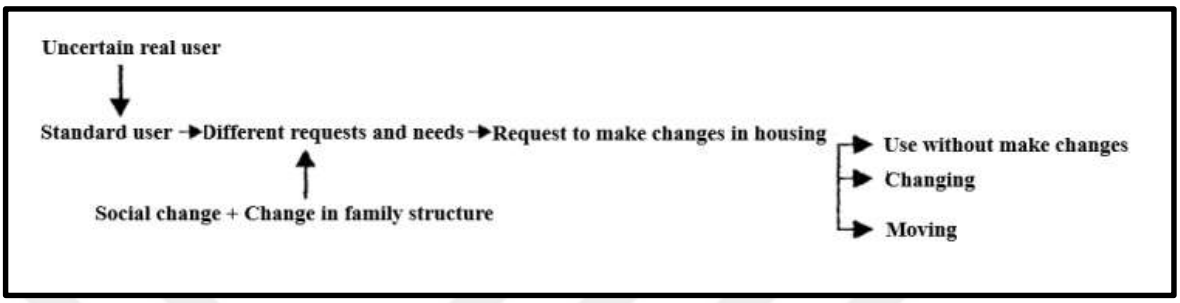


Figure 5.1. The way of dwellers to meet their need to make modifications in the house; translated into English by author [4].

1. The dwellers try to meet their new requirements without making any modifications to their houses to the extent that planning allows. Because the ability to make modifications in the house is directly related to the economic level as well as the technical conditions of the structure. A dweller who does not have the power to make any modifications to his house begins to create personal solutions. For example, solutions, such as closing the guest toilets and balconies in houses to function as storage or make one of the children sleep in the living room due to the increase in the number of children are generated.
2. The dwellers can make modifications in their houses. As long as the physical, structural features and modification cost houses allow, the dweller can renew their indoor configurations in accordance with their changing requirements. Thereby, people can use a single house for their entire lives.
3. The dwellers redress their dissatisfaction with their houses by changing it. The ability to modify houses depends on factors, such as the current state of housing stock, rent and sale costs, and moving costs.

In these conditions summarized by Uzel, as he stated in Articles 2 and 3 since the families will live in the uncomfortable environment of the house or move due to the technically and economically difficult conditions, the design should be created by considering their lifestyle along with their family size [4].

The cultural and socio-economic level to which the family belongs also affects the size of the housing. The fact that the cost of housing is directly proportional to the size of the housing is again a very important factor. On the other hand, having some hobbies that develop with the increase in economic level in the family and need extra space for these hobbies is a point that should not be missed. These hobbies may require places, such as reading room, workroom, studio, guest bedroom, gym, sauna, pool, parking, and naturally increase the family's desire for housing size. Other factors, affecting the size and formation of housing, are the worldview of the family, in parallel with its language, religion, level of education, several social attitudes, family structure and the roles of individuals in the family [6].

- **Adaptation to Common Qualified Dweller Groups**

Considering the Design strategy For Anonymous Dweller Type, one of the flexibility strategies followed in the multi-housing design discussed in Chapter 4 of the thesis, it can be said that one of the criteria for attaining flexibility in housing designs is to design houses that meet the demands and needs of dwellers with common characteristics. The criteria in designs that aim to adapt to common qualified dweller groups, can consist of standard needs of a specific dweller group, and can also be followed for similar dweller groups. Even if people lived in the same culture, it doesn't mean that everything they have should be the same. They may be included in the same group, have certain values, traditions and customs, but their environmental preferences are not necessarily similar [6]. The best example of this is social housing inhabited by the masses of a certain culture and socio-economic level and mass housing, produced with the motto of affordable housing. TOKI, which is the biggest example of this in our country, has been carrying out public housing works in different parts of Turkey. The aim of these projects is to make the dweller affordable, qualitatively adequate and habitable housing. However, these projects, which take place in different climatic regions, are criticized for not being suitable for the local architecture of those regions and for not being able to meet the architectural and social needs that change over time in public housing, where dwellers from different cultures come together. Given that this situation, if the general dweller profile is identifiable, the houses, flexible enough to be adopted by the dwellers to their changing needs, should be designed by identifying the maximum needs of that group and thereafter considering that the priority of needs has changed among dwellers even in a settled dweller group. Multiple housing can

attain flexibility in accordance with these criteria with solutions that allow the dwellers of common qualified dweller groups to configure the house.

- **Adaptation of Different Qualified Dweller Groups to Common Qualified Houses**

The reason, discussed as the "Demographic Change" under Main Reasons For The Flexibility Need In Multiple Housing Design in Chapter, is the diversity of households who live in houses resulting from social developments. This has led the dwellers of different characteristics to live together in multiple housings as well as to find a solution to the increasing housing need. In the past, the houses that accommodate large families have now become the living spaces of households that live alone, live together as a couple without getting married, consist of only parents and children, divorced parents with children. However, the preference for house size may not only be associated with the household population, it may be a personal preference. In addition to different types of dwellers, a dweller may desire to make changes to his life or face an unexpected situation. Therefore, when designing multiple housing, creating designs that meet the basic requirements of dwellers that always exist and the new needs of the future sets the possibility of different dwellers to live in common housings as a criterion for providing flexibility. Briefly, this flexibility criterion requires the adaptation of multi-storey housing dwellers in the same housing unit.

Today, ignoring the adaptation of the dweller to the house in high-cost multi-storey housing production in Turkey causes a significant problem. The dweller is forced to live in or move to an unqualified environment of the house. Accordingly, the dweller types who can live in common qualified housing units of multi-storey housing should not be limited to general solutions, possible modification scenarios for each user should be investigated, the space organizations should be decided by evaluating the effects and results of the found design solutions. In this case, flexible designs that adapt the house to the dweller are possible.

When the analysis under the above headings is based on the main reasons explained in Chapter 3, the basic qualifications, expected from flexible multi-housing, can be listed as follows;

Depending on the cause of “Identity Disorder”;

- The ability of the house to reflect the identity of the dweller
- Allowing the dweller to communicate with the environment suitable for his identity

Depending on the cause of “Social and Cultural Change”;

- The ability of the house to adapt to local culture
- The quality of the house that combines urban-rural differences
- In addition to the accommodation function of the house, the ability of the house to respond to the functions, such as office work, resting, etc.

Depending on the cause of the “Demographic Change”;

- Suitability of the house to change in household size

Depending on the reason for “Technological Development”;

- The adaptability of the house to new technological developments
- Being in a suitable design to replace new building materials

Depending on the sub-reason of “Climate Change” of the reason for “Change of Environment Conditions”;

- The ability of the house to adapt climatic changes,

Depending on the sub-reason for “Change of Environmental Construction Conditions”;

- The adaptability of the house to the change in construction conditions of the zoning plan of the house, its environment and parcel

Depending on the sub-reason for “Change of Environmental Health Conditions”;

- The ability of the house to respond to the requirements against epidemics

Depending on the reason for “Contribution to Sustainability”;

- Long construction life of the house, adaptation to long-term changes basic qualifications can be identified.

5.2. TRANSFORMATION OF BASIC QUALIFICATIONS INTO DESIGN CRITERIA

In this chapter, how the qualifications, expected from multi-flexible designed housings and set in the previous chapter, are reflected in the design is needed to be explained with explanatory examples and the design criteria into which these reflections can be transformed to put forth and the flexible design tools that can be used to be determined.

Transforming the qualifications, expected from flexible multi-housing design, into flexible multi-housing design criteria depending on the reasons that require flexible design and the tools that can be used in the design are shown in Table 5.1.

Table 5.1. Table of flexible multi-housing design criteria, prepared by author.

CAUSES		QUALITIES EXPECTED FROM MULTI-FLEXIBLE DESIGN HOUSES	REFLECTION TO DESIGN	EXPLANATORY EXAMPLE	DESIGN CRITERIA	TOOLS
IDENTITY DISORDER		Ability to reflect the dweller's identity	Design of both indoor and outdoor spaces, whose function is determined by the dweller	Spaces that can be converted into functional fields such as a library, gym, playground, allotments	Convertible spaces from indoor to outdoor or vice versa Flooring details suitable for both space types either indoor or outdoor	Neutral Areas Strategy
		Allowing the dweller to communicate with the environment suitable for his identity	Suitable design to different purpose appurtenances between the structure and the environment that do not disturb the environment	Garage, bicycle, motorcycle, etc. parks, multi-purpose storages, pet or stray animal kennels, etc.	Environmental-related multi-purpose appurtenance, adjacent to the residence	Strategy for Different Plan Types Infill Structure Strategy
SOCIO-CULTURAL CHANGE		Ability of the house to adapt to local culture	Housing designs reflecting the local architecural features of the region	Building facades that comply with the conventional architecture within the historical texture of the city	Compatibility with different facade solutions	Infill Structure Strategy
		The quality of the house that combines urban-rural differences	Specific areas that convert into common outdoors that establish neighborhood	Back yards adjacent to neighboring residential backyards	Exclusive outdoors that can be converted into joint use with neighboring residences	Collaborative Planning Reconfiguration Strategy Growth Strategy Modular Design
			Outdoor suitable for rural functions	Outdoor suitable for having pet or farming		
		Ability to respond to different functions, such as working and doing physical exercise as well as housing	The open design of the housing, suitable for functional transformation	A library or music room that can be converted into one another	Multi-purpose spaces other than housing spaces	Design strategy for anonymous dweller type Neutral areas strategy Reconfiguration strategy by using convertible furniture
DEMOGRAPHICAL CHANGE		Suitability of the house to change in household size	Flexible design of the number of bedrooms to change	A single bedroom that can be divided into two bedrooms or a bedroom formed by being separated from the terrace ayrılarak oluşturulan yatak odası	Flexibility in the number of personal spaces	Reconfiguration Strategy Growth Strategy Infill Structure Strategy Modular Design
			Convertible design of wet spaces to different wet spaces by being combined	Ability to split one bathroom into two separate one or ability to combine and separate a bathroom and a laundry room		
			Design that the number of spaces specific to dwellers can be reduced or increased.	Ability to convert a jointly used playroom into a child's room		
TECHNOLOGICAL DEVELOPMENT		Adaptability of house to new technological developments	Designing newly developed technological systems that influence architecture to be ready for the technical installation when needed	Having the installation place suitable for smart technological security systems ready Designing the position of the solar collectors in a way not to disrupt the architecture of the structure but rather integrate with the architecture, if necessary	Compatible space and fittings to new emerging tools that improve quality of life	Collaborative Planning Bearing Structure Strategy Modular Design
		Being in suitable design to replace new building materials	Selecting standard measurements for fittings that allow replacement with new materials	Fixed cabinets especially in wet volumes inside the house, having a size and construction that is easy to change with the examples manufactured with new materials		
CHANGE OF ENVIRONMENT CONDITIONS	Climate Change	Ability of the house to adapt climatic changes,	Designing spaces in different locations that are suitable for both summer and winter life.	Flexible design, having parts in the living volume that get minimum direct sunlight radiation in summer and maximum sunlight in winter	Increasing foldable/unfoldable outdoors in the structure, ensuring isolation and optimal direction	Modular Design Infill Structure Strategy Growth Strategy
			Designing the window systems in a pattern that follows the movement of the sun			
			Isolated design of the building against heat loss and gain	Isolating the entire outer shell		
			Convertible design of the spaces to indoor or outdoor according to climate	Foldable inner courtyards if necessary, unfoldable winter gardens		
	Change in Requirements for Environment Structuring	Transformability of the house in time by development requirements	Ensuring flexibility of the building for horizontal and vertical upsizing and downsizing, in case of changes in the construction conditions, such as TAKS, KAKS, and gabarite in the design	High-tolerance design of the structure's bearing system to increase the number of floors	Providing flexibility in the dimensions of the building mass	
				Upsizing the structure by converting the housing space, open terraces on the ground into partial indoor		
	Changing Environment Health Conditions	Flexibility of the house to respond epidemics	Designing residence suitable for functions other than housing for the increase of time spent in the residence	Flexible design of the spaces that can be converted into offices	Increase in multi-purpose spaces in the structure, private space flexibility	
				Allowing more space to different outdoor, such as terrace, balcony and garden as daily functional spaces (sports, recreation, etc.)		
			Convertible design of common living spaces into a personal space, when required	Allowing a wet volume adjacent to each indoor		
CONTRIBUTION TO SUSTAINABILITY		Long construction life of the house, adaptation to long-term changes	Avoidance of the structure and support system of the building to be affected by the flexible configuration of the building indoor	Configuring partition walls in layouts and movements independent of columns and beams	Structure support system, independent of changes and flexibility in natural energy use, independent of artificial use	Bearing Structure Strategy Infill Structure Strategy
			Compatible design of the building to new needs	Flexible design for renewable energy use		

The flexible multi-housing design criteria were set as:

- Convertible spaces from indoor to outdoor or vice versa,
- Flooring details suitable for both space types either indoor or outdoor,
- Environmental-related multi-purpose appurtenance, adjacent to the residence,
- Compatibility with different facade solutions,
- Exclusive outdoors that can be converted into joint use with neighbouring residences,
- Flexibility in the number of personal spaces,
- Compatible space and fittings to new emerging tools that improve quality of life,
- Increasing foldable/unfoldable outdoors in the structure, ensuring isolation and optimal direction[36],
- Providing flexibility in the dimensions of the building mass,
- Increase in multi-purpose spaces in the structure, private space flexibility,
- The structural support system, independent of changes and flexibility in natural energy use, independent of artificial use in Table 5.1.

5.3. EVALUATION OF THE MULTI-FLEXIBLE HOUSING DESIGN CRITERIA ON A MULTIPLE HOUSING EXAMPLE

In consideration of the criteria set in the previous chapter, two separate examples of multi-housing units are evaluated. For this evaluation, Fuaye Süreyyapaşa and Nef Çamlıtepe multi-housing projects have been selected because they are up to date projects belonging to the regions that have just started to be built. Because today, new housing areas are increasing rapidly due to the expansion of cities in parallel with population increase. For this reasons, it is important to design these areas with the flexibility to be included in the city.

The project types of the mentioned multi-housing areas are evaluated for their compliance with common criteria to attain flexibility to multi-housing design.

It has been deemed appropriate to prepare a template table and be used for each type of housing in the application based on the scrutinization and evaluation of selected multiple housing areas according to flexible multi-housing design criteria.

5.3.1. Fuaye Süreyyapaşa Multi-Housing Area

The information on Fuaye Süreyapaşa Multi-Housing Area that is shown in Figure 5.2., Figure 5.3. and Figure 5.4. is given below.

Table 5.2. Information about Fuaye Süreyyapaşa Project, prepared by author.

Project name:	Fuaye Süreyyapaşa
Land area:	106.000 m2
Completion date:	2012
Architectural design:	ATELYE70 PLANING & DESIGN GROUP
Contractor:	Yılmaz İnşaat
Number of residences:	186
Housing size:	120 - 212 m2

Figure 5.2. Fuaye Süreyapaşa layout plan [37].

Figure 5.3. Fuaye Süreyyapaşa [38].

The project with a land area of 106,000 m2 was constructed as 26 blocks in total; nine of 4-storey, seven of 5-storey, ten of 6-storey blocks C and D, and includes apartment of 6 alternative plans in total from 2+1 to 4+1 residences. It has a garden and normal floor alternative with 2+1 and 3+1 and penthouse alternatives with 3+1 and 4+1. The evaluation tables in this section are based on the residence types of Block C. Block C has six different residence types. Against the background, the project offers the dweller flexibility to select the appropriate space with different plan types. The houses have been designed by identifying future dweller types. The designing houses as 2+1, 3+1, 4+1 with yards or garden floor can be told to be a solution for dwellers' needs to adapt to the differences in the household type, income levels, and the use way of the houses.

The interior spaces of the houses are separated from each other by partition walls. In this respect, the houses do not offer new usage spaces to meet new needs without removing partition walls that separate the spaces. Nevertheless, these spaces can be used to enable different functions by the convertibility of outdoor terraces to indoor spaces in the house types with yards. Besides, these yards allow the dwellers feeding pets and farming as well as the outdoors to be jointly utilized with neighbouring dwellers.

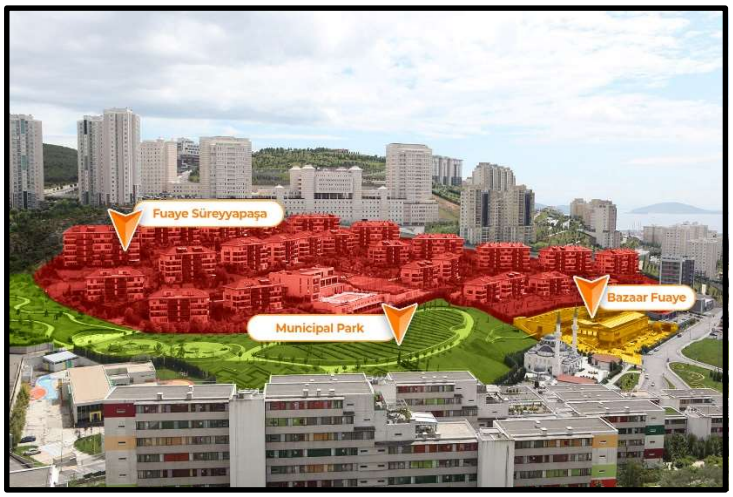


Figure 5.4. Fuaye Süreyapaşa, municipal parking lot, Fuaye Bazaar [38].

As well as the adaptation of dwellers to the artificial environment created for living, the adaptation of that artificial environment to its location also important for long-term use.

Against the background, if it is discussed, the Fuaye Süreyyapaşa project is situated in a location where many multi-housings exist together It can be said that the physical features of the project adapt to its environment, which is mostly used as a housing district. It can be said that Fuaye Süreyyapaşa, one of the first constructions in the vicinity in which it exists, communicates with its environment through Fuaye Bazaar that is available to use by other nearby residences. Moreover, the parking area, which was included in the project when it was decided to be constructed but was later removed and allocated to the municipality, has integrated with the environment through the joint use of the project dwellers and neighbouring residences.

The compliance of residence types of Fuaye Süreyyapaşa multi-housing area with the flexible multi-housing design criteria, set out in chapter 5.2., is shown in the examples of evaluation tables; Table 5.2., 5.3., 5.4., 5.5., 5.6, 5.7., used for each type of residence.

Table 5.3. Evaluation table for 2+1 residence type with garden floor of block C, Fuaye Süreyyapaşa project, prepared by author.

RESIDENCE TYPE	DESIGN CRITERIA	SUITABLE	NOT SUITABLE	COMMENT	
The 2+1 Residence Type with Garden Floor	Convertible spaces from indoor to outdoor or vice versa	X		The 2+1 Residence Type with Garden Floor, one of the housing types of the Fuaye Süreyyapaşa project, offers different functions to the dwellers with its front and back yards for indoor and outdoor use. The dwellers can utilize these spaces as gym, playrooms, and places where they can place kennels. Since there are no multi-purpose storages and bicycle, motorcycle parking lots for the dwellers, they try to meet their needs by using in front of the vehicles in parking garages. The dwellers can use the lawn in front of the terrace of the front yard, which has been detailed through the flooring, as outdoors that can be converted to a shared garden suitable for farming with neighbouring houses. There is also a yard within the project where the dwellers can grow fruit and vegetables. The interiors of the houses are designed to provide comfortable living spaces for the dweller and allow easy settlements with their rectangular and square plannings. The houses don't have a suitable infrastructure for the use of technology systems. However, there are no applications related to the use of multi-purpose space that is provided by converting a space that provides maximum flexibility within the house into another space.	 FLOOR PLAN
	Flooring details suitable for both space types either indoor or outdoor	X			
	Environmental-related multi-purpose appurtenance, adjacent to the residence		X		
	Compatibility with different facade solutions	X			
	Exclusive outdoors that can be converted into joint use with neighboring residences	X			
	Multi-purpose spaces other than housing spaces		X		
	Flexibility in the number of personal spaces		X		
	Compatible space and fittings to new emerging tools that improve quality of life		X		
	Increasing foldable/unfoldable outdoors in the structure, ensuring isolation and optimal direction		X		
	Providing flexibility in the dimensions of the building mass	X			
	Increase in multi-purpose spaces in the structure, private space flexibility		X		
	Structure support system, independent of changes and flexibility in natural energy use, independent of artificial use		X		 APARTMENT PLAN

Table 5.4. Evaluation table for 2+1 residence type with normal floor of block C, Fuaye Süreyyapaşa project, prepared by author.

RESIDENCE TYPE	DESIGN CRITERIA	SUITABLE	NOT SUITABLE	COMMENT	
The 2+1 Residence Type with Normal Floor	Convertible spaces from indoor to outdoor or vice versa	x		There is a floor garden apartment in the 2+1 Residence Type with Normal Floor of Block C, one of the housing types of Fuaye Süreyyapaşa project. A door from this floor garden apartment is opening to a shared hall that will be used also by the neighbour. The dwellers can use this area as storage. Furthermore, since there are no multi-purpose storages and bicycle and motorcycle parking lots for the dwellers without going to their apartments, they try to meet their needs by using in front of the vehicles in parking garages. There is a suitable yard within the project where the dwellers can farm. The spaces inside the houses are designed in sizes that will provide comfortable living spaces for the dweller and allow easy settlements with their rectangular and square plannings. As the interiors of the houses are positioned to utilize daylight, the isolation of the building is designed in compliance with the heat loss and gain. Therefore, man-made systems are rarely needed. The houses don't have a suitable infrastructure for the use of technology systems. However, there are no applications related to the use of multi-purpose space that is provided by converting a space that provides maximum flexibility within the house into another space.	 FLOOR PLAN
	Flooring details suitable for both space types either indoor or outdoor	x			
	Environmental-related multi-purpose appurtenance, adjacent to the residence		x		
	Compatibility with different facade solutions	x			
	Exclusive outdoors that can be converted into joint use with neighboring residences		x		
	Multi-purpose spaces other than housing spaces		x		
	Flexibility in the number of personal spaces		x		
	Compatible space and fittings to new emerging tools that improve quality of life		x		
	Increasing foldable/unfoldable outdoors in the structure, ensuring isolation and optimal direction		x		
	Providing flexibility in the dimensions of the building mass	x			
	Increase in multi-purpose spaces in the structure, private space flexibility		x		
	Structure support system, independent of changes and flexibility in natural energy use, independent of artificial use		x		
					 APARTMENT PLAN

Table 5.5. Evaluation table for 3+1 residence type with garden floor of block C, Fuaye Süreyyapaşa project, prepared by author.

RESIDENCE TYPE	DESIGN CRITERIA	SUITABLE	NOT SUITABLE	COMMENT
The 3+1 Residence Type with Garden Floor	Convertible spaces from indoor to outdoor or vice versa	X		The 3+1 Residence Type with Garden Floor, one of the housing types of the Fuaye Süreyyapaşa project, offers different functions to the dwellers with its front yard for indoor and outdoor use. The dwellers can utilize these spaces as gym, playrooms, and places where they can place kennels. The dwellers can use the lawn in front of and next to the terrace of the front yard, which has been detailed through the flooring, as outdoors that can be converted to a shared garden suitable for farming with neighbouring houses under certain standards. There is also a yard within the project where the dwellers can grow fruit and vegetables. The interiors of the houses are designed to provide comfortable living spaces for the dweller and allow easy settlements with their rectangular and square plannings. The houses don't have a suitable infrastructure for the use of technology systems. However, there are no applications related to the use of multi-purpose space that is provided by converting a space that provides maximum flexibility within the house into another space.  FLOOR PLAN  APARTMENT PLAN
	Flooring details suitable for both space types either indoor or outdoor	X		
	Environmental-related multi-purpose appurtenance, adjacent to the residence		X	
	Compatibility with different facade solutions	X		
	Exclusive outdoors that can be converted into joint use with neighboring residences	X		
	Multi-purpose spaces other than housing spaces		X	
	Flexibility in the number of personal spaces		X	
	Compatible space and fittings to new emerging tools that improve quality of life		X	
	Increasing foldable/unfoldable outdoors in the structure, ensuring isolation and optimal direction		X	
	Providing flexibility in the dimensions of the building mass	X		
	Increase in multi-purpose spaces in the structure, private space flexibility		X	
	Structure support system, independent of changes and flexibility in natural energy use, independent of artificial use		X	

Table 5.6. Evaluation table for 3+1 residence type with normal floor of block C, Fuaye Süreyyapaşa project, prepared by author.

RESIDENCE TYPE	DESIGN CRITERIA	SUITABLE	NOT SUITABLE	COMMENT
The 3+1 Residence Type with Normal Floor	Convertible spaces from indoor to outdoor or vice versa	x		There is a floor garden apartment is available in the 3+1 Residence Type with Normal Floor of Block C, one of the housing types of Fuaye Süreyyapaşa project. A door from this floor garden apartment is opening to a shared hall that will be used also by the neighbour. The dwellers can use this area as storage. Furthermore, since there are no multi-purpose storages and bicycle and motorcycle parking lots for the dwellers without going to their apartments, they try to meet their needs by using in front of the vehicles in parking garages. There is a suitable yard within the project where the dwellers can farm. The spaces inside the houses are designed in sizes that will provide comfortable living spaces for the dweller and allow easy settlements with their rectangular and square plannings. As the interiors of the houses are positioned to utilize daylight, the isolation of the building is designed in compliance with the heat loss and gain. Therefore, man-made systems are rarely needed. The houses don't have a suitable infrastructure for the use of technology systems. However, there are no applications related to the use of multi-purpose space that is provided by converting a space that provides maximum flexibility within the house into another space.  FLOOR PLAN  APARTMENT PLAN
	Flooring details suitable for both space types either indoor or outdoor	x		
	Environmental-related multi-purpose appurtenance, adjacent to the residence		x	
	Compatibility with different facade solutions	x		
	Exclusive outdoors that can be converted into joint use with neighboring residences		x	
	Multi-purpose spaces other than housing spaces		x	
	Flexibility in the number of personal spaces		x	
	Compatible space and fittings to new emerging tools that improve quality of life		x	
	Increasing foldable/unfoldable outdoors in the structure, ensuring isolation and optimal direction		x	
	Providing flexibility in the dimensions of the building mass	x		
	Increase in multi-purpose spaces in the structure, private space flexibility		x	
	Structure support system, independent of changes and flexibility in natural energy use, independent of artificial use		x	

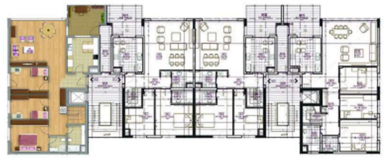
Table 5.7. Evaluation table for 3+1 residence type with penthouse duplex of block C, Fuaye Süreyyapaşa project, prepared by author.

RESIDENCE TYPE	DESIGN CRITERIA	SUITABLE	NOT SUITABLE	COMMENT
The 3+1 Residence Type with Penthouse Duplex	Convertible spaces from indoor to outdoor or vice versa	x		There are two floor garden apartments; one in the ground floor, the other on the penthouse in the 3+1 Residence Type with Penthouse Duplex of Block C, one of the housing types of Fuaye Süreyyapaşa project. The door from the floor garden apartment on the lower floor is opening to a shared hall that will be used also by the neighbour. The dwellers can use this area as storage. The living space in the penthouse and the floor garden can be utilized for different functions with its indoor and outdoor use. Furthermore, since there are no multi-purpose storages and bicycle and motorcycle parking lots for the dwellers without going to their apartments, they try to meet their needs by using in front of the vehicles in parking garages. There is a suitable yard within the project where the dwellers can farm. The spaces inside the houses are designed in sizes that will provide comfortable living spaces for the dweller and allow easy settlements with their rectangular and square plannings. As the interiors of the houses are positioned to utilize daylight, the isolation of the building is designed in compliance with the heat loss and gain. Therefore, man-made systems are rarely needed. The houses don't have a suitable infrastructure for the use of technology systems. However, there are no applications related to the use of multi-purpose space that is provided by converting a space that provides maximum flexibility within the house into another space.
	Flooring details suitable for both space types either indoor or outdoor	x		
	Environmental-related multi-purpose appurtenance, adjacent to the residence		x	
	Compatibility with different facade solutions	x		
	Exclusive outdoors that can be converted into joint use with neighboring residences		x	
	Multi-purpose spaces other than housing spaces		x	
	Flexibility in the number of personal spaces		x	
	Compatible space and fittings to new emerging tools that improve quality of life		x	
	Increasing foldable/unfoldable outdoors in the structure, ensuring isolation and optimal direction		x	
	Providing flexibility in the dimensions of the building mass	x		
	Increase in multi-purpose spaces in the structure, private space flexibility		x	
	Structure support system, independent of changes and flexibility in natural energy use, independent of artificial use		x	

FLOOR PLAN

APARTMENT LOWER AND UPPER FLOOR PLANS

Table 5.8. Evaluation table for 4+1 residence type with penthouse duplex of block C, Fuaye Süreyyapaşa project, prepared by author.

RESIDENCE TYPE	DESIGN CRITERIA	SUITABLE	NOT SUITABLE	COMMENT
The 4+1 Residence Type with Penthouse Duplex	Convertible spaces from indoor to outdoor or vice versa	X		There are two floor garden apartments; one in the ground floor, the other on the penthouse in the 4+1 Residence Type with Penthouse Duplex of Block C, one of the housing types of Fuaye Süreyyapaşa project. The door from the floor garden apartment on the lower floor is opening to a shared hall that will be used also by the neighbour. The dwellers can use this area as storage. The living space in the penthouse and the floor garden can be utilized for different functions with its indoor and outdoor use. Furthermore, since there are no multi-purpose storages and bicycle and motorcycle parking lots for the dwellers without going to their apartments, they try to meet their needs by using in front of the vehicles in parking garages. There is a suitable yard within the project where the dwellers can farm. The spaces inside the houses are designed in sizes that will provide comfortable living spaces for the dweller and allow easy settlements with their rectangular and square plannings. As the interiors of the houses are positioned to utilize daylight, the isolation of the building is designed in compliance with the heat loss and gain. Therefore, man-made systems are rarely needed. The houses don't have a suitable infrastructure for the use of technology systems. However, there are no applications related to the use of multi-purpose space that is provided by converting a space that provides maximum flexibility within the house into another space.  FLOOR PLAN  APARTMENT LOWER AND UPPER FLOOR PLANS
	Flooring details suitable for both space types either indoor or outdoor	X		
	Environmental-related multi-purpose appurtenance, adjacent to the residence		X	
	Compatibility with different facade solutions	X		
	Exclusive outdoors that can be converted into joint use with neighboring residences		X	
	Multi-purpose spaces other than housing spaces		X	
	Flexibility in the number of personal spaces		X	
	Compatible space and fittings to new emerging tools that improve quality of life		X	
	Increasing foldable/unfoldable outdoors in the structure, ensuring isolation and optimal direction		X	
	Providing flexibility in the dimensions of the building mass	X		
	Increase in multi-purpose spaces in the structure, private space flexibility		X	
	Structure support system, independent of changes and flexibility in natural energy use, independent of artificial use		X	

5.3.2. Nef Çamlıtepe Multi-Housing Area

The information on Nef Çamlıtepe Multi-Housing Area that is shown in Figure 5.4., 5.11. and 5.12. is given below.

Table 5.9. Information about Nef Çamlıtepe Multi-Housing Area, prepared by author.

Project name:	NEF Çamlıtepe
Land area:	52.000 m2
Completion date:	2020 June
Architectural design:	Selin Maner Architects , VİVA Architects
Contractor:	NEF
Number of residences:	497
Housing size:	64 - 266 m2

Figure 5.5. Nef Çamlıtepe layout plan [39].

Çamlıtepe project is the first stage of the three-staged Nef Çekmeköy project, which has a land area of 239,500 m2. Çamlıtepe stage was constructed as 19 blocks of 5-storey, except for the basement and ground floor, and includes residences that are designed for different needs and expectations from 1+1 to 4+1. All residence types from 1+1 to 3+1 have 3 alternatives as garden, terrace and balcony. In addition, the 3+1 residence type has five alternative plans with two different duplex options. Only 4 + 1 residence type has a uniform layout with a garden. The project with 12 alternative plans in total offers flexibility to the dweller to select the appropriate space through this aspect.

The evaluation tables in this section are based on the residence types of Block I. Block I has six different residence types; 1+1 with Balcony, 1+1 with Terrace, 1+1,5 with Balcony, 1+1,5 with Terrace, and two different 3+1 Duplex plan.

The interior spaces of the houses are separated from each other by partition walls. The spaces are not designed to convert a space into another space that can respond to different functions. However, all residence alternatives with balconies and terraces can enable either indoor or outdoor spaces whose function will be determined by the dweller. Except for the residence alternatives, Foldhome, the company's patented application in the project, provides flexible spaces for dwellers. The event hall, lounge, cinema hall, PlayStation room, private fitness room, indoor basketball court, soccer field, music room, party-karaoke room, guest accommodation room spaces of Foldhome, whose indoor photos are shown in 5.8., 5.9. and 5.10., can be hired by the dwellers at any time and used as a continuation of their houses. Foldhome spaces, whose scheme is also shown in Figure 5.5, are included in all Nef projects and the dwellers are not limited to using those spaces only within their project but it also applies for all Nef projects. The owner of a residence in the Çamlıtepe project is also able to use the Foldhome spaces in another Nef project. It is possible to mention the spaces that can respond to different functions other than the housing with this application.

Figure 5.6. Nef Çamlıtepe Residences, Foldhome-Lounge, photographs were taken by the author.

Figure 5.7. Nef Çamlıtepe Residences, Foldhome-Cinema Halls, photographs were taken

Figure 5.8. Nef Çamlıtepe Residences, Foldhome - Indoor Football and Basketball Courts, photographs were taken by the author.

Figure 5.9. Nef Çamlıtepe Residences, Foldhome - Party and Karaoke Room, photographs were taken by the author.

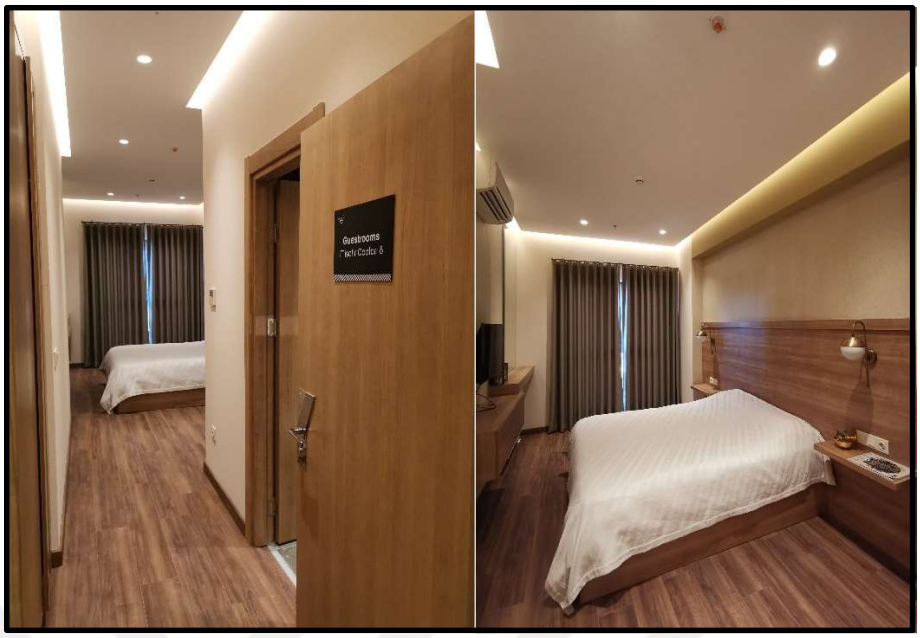


Figure 5.10. Nef Çamlıtepe Residences, Foldhome-Guest Room, photographs were taken

The architectural project also has a square with business units that were designed apart from Foldhome social areas, fitness centre, child's playroom, indoor and outdoor swimming pool, walking tracks, cycling tracks, barbecue field, biological ponds playgrounds, basketball court and housing blocks. The fact that there are no uncontrolled spaces, except the entrances of the housing along with the square with business units and the municipal lawn, enables the communication with the environment. The outer facades of the buildings are mainly produced by being sheathed. It has building facades in harmony with the urban texture with the use of wood and natural stone coating.

Figure 5.11. Nef Çamlıtepe Residences outdoor photos [40].

Figure 5.12. Nef Çamlıtepe business units and municipal lawn [39].

The compliance of residence types of Nef Çamlıtepe multi-housing area with the flexible multi-housing design criteria, set out in chapter 5.2., is shown in the examples of evaluation tables; 5.8., 5.9., 5.10., 5.11., 5.12, 5.13., used for each type of residence.

Table 5.10. Evaluation table for 1+1 residence type with balcony of block I, Nef Çamlıtepe project, prepared by author.

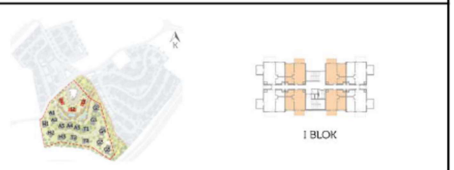
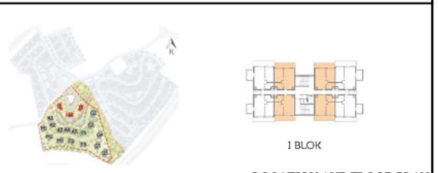
RESIDENCE TYPE	DESIGN CRITERIA	SUITABLE	NOT SUITABLE	COMMENT
The 1+1 Residence Type with Balcony	Convertible spaces from indoor to outdoor or vice versa	X		The 1+1 Residence Type with Balcony of Block I, one of the housing types of Nef Çekmeköy project, has a space that can be partially converted to indoor with a balcony that it has. There are no applications related to the use of multi-purpose space that is provided by converting a space that provides maximum flexibility within the house into another space but, the Foldhome, the patented application of the company, is included in all Nef projects and offers spaces suitable for many functions to the dwellers of all types of apartments in the projects where they can additionally benefit at any time and pay only when they have used. However, as in each apartment type, we can say that this apartment type also has multi-purpose spaces (guest room, cinema room, music room, etc.) that are suitable for functional conversions. In this respect, the dweller is not limited to the residential area and able to reach the spaces that could be utilized for his needs. The residence is designed for multi-purpose appurtenances, such as parking lots, garages, bicycle parks, pets and animal kennels related to the environment. However, there are no multi-purpose storages that the dwellers can use outside their homes. The isolation of the building is designed to avoid heat losses at the maximum level. With regard to the use of technological systems, the residence is equipped to meet 50% of the world's smart home systems that can be used worldwide.  LOCATION AND FLOOR PLAN  APARTMENT PLAN
	Flooring details suitable for both space types either indoor or outdoor	X		
	Environmental-related multi-purpose appurtenance, adjacent to the residence	X		
	Compatibility with different facade solutions	X		
	Exclusive outdoors that can be converted into joint use with neighboring residences		X	
	Multi-purpose spaces other than housing spaces	X		
	Flexibility in the number of personal spaces	X		
	Compatible space and fittings to new emerging tools that improve quality of life	X		
	Increasing foldable/unfoldable outdoors in the structure, ensuring isolation and optimal direction		X	
	Providing flexibility in the dimensions of the building mass	X		
	Increase in multi-purpose spaces in the structure, private space flexibility	X		
	Structure support system, independent of changes and flexibility in natural energy use, independent of artificial use		X	

Table 5.11. Evaluation table for 1+1 residence type with terrace of block I, Nef Çamlıtepe project, prepared by author.

RESIDENCE TYPE	DESIGN CRITERIA	SUITABLE	NOT SUITABLE	COMMENT
The 1+1 Residence Type with Terrace	Convertible spaces from indoor to outdoor or vice versa	X		The 1+1 Residence Type with Terrace of Block I, one of the housing types of Nef Çekmeköy project, has a space that can be partially converted to indoor with a balcony that it has. Besides, this terrace is designed to be converted into two separate indoors with its separate exits from the living room and bedroom. There are no applications related to the use of multi-purpose space that is provided by converting a space that provides maximum flexibility within the house into another space but, the Foldhome, the patented application of the company, is included in all Nef projects and offers spaces suitable for many functions to the dwellers of all types of apartments in the projects where they can additionally benefit at any time and pay only when they have used. However, as in each apartment type, we can say that this apartment type also has multi-purpose spaces (guest room, cinema room, music room, etc.) that are suitable for functional conversions. In this respect, the dweller is not limited to the residential area and able to reach the spaces that could be utilized for his needs. The residence is designed for multi-purpose appurtenances, such as parking lots, garages, bicycle parks, pets and animal kennels related to the environment. However, there are no multi-purpose storages that the dwellers can use outside their homes. The isolation of the building is designed to avoid heat losses at the maximum level. With regard to the use of technological systems, the residence is equipped to meet 50% of the world's smart home systems that can be used worldwide.
	Flooring details suitable for both space types either indoor or outdoor	X		
	Environmental-related multi-purpose appurtenance, adjacent to the residence	X		
	Compatibility with different facade solutions	X		
	Exclusive outdoors that can be converted into joint use with neighboring residences		X	
	Multi-purpose spaces other than housing spaces	X		
	Flexibility in the number of personal spaces	X		
	Compatible space and fittings to new emerging tools that improve quality of life	X		
	Increasing foldable/unfoldable outdoors in the structure, ensuring isolation and optimal direction		X	
	Providing flexibility in the dimensions of the building mass	X		
	Increase in multi-purpose spaces in the structure, private space flexibility	X		
	Structure support system, independent of changes and flexibility in natural energy use, independent of artificial use		X	



LOCATION AND FLOOR PLAN

APARTMENT PLAN

Table 5.12. Evaluation table for 1+1,5 residence type with balcony of block I, Nef Çamlıtepe project, preperad by author.

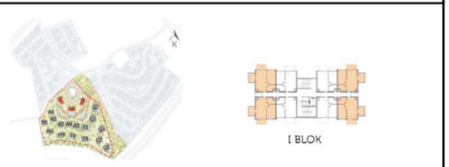
RESIDENCE TYPE	DESIGN CRITERIA	SUITABLE	NOT SUITABLE	COMMENT
The 1+1.5 Residence Type with Balcony	Convertible spaces from indoor to outdoor or vice versa	X		The 1+1,5 Residence Type with Balcony of Block I, one of the housing types of Nef Çekmeköy project, has also a space that can be partially converted to indoor with a balcony that it has. There are no applications related to the use of multi-purpose space that is provided by converting a space that provides maximum flexibility within the house into another space but, the Foldhome, the patented application of the company, is included in all Nef projects and offers spaces suitable for many functions to the dwellers of all types of apartments in the projects where they can additionally benefit at any time and pay only when they have used. However, as in each apartment type, we can say that this apartment type also has multi-purpose spaces (guest room, cinema room, music room, etc.) that are suitable for functional conversions. In this respect, the dweller is not limited to the residential area and able to reach the spaces that could be utilized for his needs. The residence is designed for multi-purpose appurtenances, such as parking lots, garages, bicycle parks, pets and animal kennels related to the environment. However, there are no multi-purpose storages that the dwellers can use outside their homes. The isolation of the building is designed to avoid heat losses at the maximum level. With regard to the use of technological systems, the residence is equipped to meet 50% of the world's smart home systems that can be used worldwide.  LOCATION AND FLOOR PLAN  APARTMENT PLAN
	Flooring details suitable for both space types either indoor or outdoor	X		
	Environmental-related multi-purpose appurtenance, adjacent to the residence	X		
	Compatibility with different facade solutions	X		
	Exclusive outdoors that can be converted into joint use with neighboring residences		X	
	Multi-purpose spaces other than housing spaces	X		
	Flexibility in the number of personal spaces	X		
	Compatible space and fittings to new emerging tools that improve quality of life	X		
	Increasing foldable/unfoldable outdoors in the structure, ensuring isolation and optimal direction		X	
	Providing flexibility in the dimensions of the building mass	X		
	Increase in multi-purpose spaces in the structure, private space flexibility	X		
	Structure support system, independent of changes and flexibility in natural energy use, independent of artificial use		X	

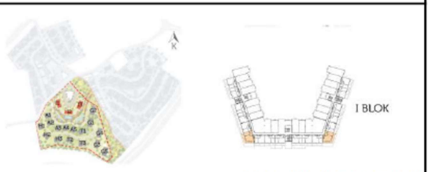
Table 5.13. Evaluation table for 1+1,5 residence type with balcony of block I, Nef Çamlıtepe project, preperad by author.

RESIDENCE TYPE	DESIGN CRITERIA	SUITABLE	NOT SUITABLE	COMMENT
The 1+1.5 Residence Type with Terrace	Convertible spaces from indoor to outdoor or vice versa	X		The 1+1.5 Residence Type with Terrace of Block I, one of the housing types of Nef Çekmeköy project, has a space that can be partially converted to indoor with a balcony that it has. Besides, this terrace is designed to be converted into two separate indoors with its separate exits from the living room and bedroom. There are no applications related to the use of multi-purpose space that is provided by converting a space that provides maximum flexibility within the house into another space but, the Foldhome, the patented application of the company, is included in all Nef projects and offers spaces suitable for many functions to the dwellers of all types of apartments in the projects where they can additionally benefit at any time and pay only when they have used. However, as in each apartment type, we can say that this apartment type also has multi-purpose spaces (guest room, cinema room, music room, etc.) that are suitable for functional conversions. In this respect, the dweller is not limited to the residential area and able to reach the spaces that could be utilized for his needs. The residence is designed for multi-purpose appurtenances, such as parking lots, garages, bicycle parks, pets and animal kennels related to the environment. However, there are no multi-purpose storages that the dwellers can use outside their homes. The isolation of the building is designed to avoid heat losses at the maximum level. With regard to the use of technological systems, the residence is equipped to meet 50% of the world's smart home systems that can be used worldwide.  LOCATION AND FLOOR PLAN  APARTMENT PLAN
	Flooring details suitable for both space types either indoor or outdoor	X		
	Environmental-related multi-purpose appurtenance, adjacent to the residence	X		
	Compatibility with different facade solutions	X		
	Exclusive outdoors that can be converted into joint use with neighboring residences		X	
	Multi-purpose spaces other than housing spaces	X		
	Flexibility in the number of personal spaces	X		
	Compatible space and fittings to new emerging tools that improve quality of life	X		
	Increasing foldable/unfoldable outdoors in the structure, ensuring isolation and optimal direction		X	
	Providing flexibility in the dimensions of the building mass	X		
	Increase in multi-purpose spaces in the structure, private space flexibility	X		
	Structure support system, independent of changes and flexibility in natural energy use, independent of artificial use		X	

Table 5. 14. Evaluation table for 3+1 residence type with duplex of block I, Nef Çamlıtepe project, prepared by author.

RESIDENCE TYPE	DESIGN CRITERIA	SUITABLE	NOT SUITABLE	COMMENT
The 3+1 Duplex	Convertible spaces from indoor to outdoor or vice versa	X		The 3+1 Duplex Residence Type of Block I, one of the housing types of Nef Çekmeköy project, has a space that can be partially converted to indoor with a balcony that it has. Besides, this terrace is designed to be converted into two separate indoors with its separate exits from the living room and bedroom. There are no applications related to the use of multi-purpose space that is provided by converting a space that provides maximum flexibility within the house into another space but, the Foldhome, the patented application of the company, is included in all Nef projects and offers spaces suitable for many functions to the dwellers of all types of apartments in the projects where they can additionally benefit at any time and pay only when they have used. However, as in each apartment type, we can say that this apartment type also has multi-purpose spaces (guest room, cinema room, music room, etc.) that are suitable for functional conversions. In this respect, the dweller is not limited to the residential area and able to reach the spaces that could be utilized for his needs. The residence is designed for multi-purpose appurtenances, such as parking lots, garages, bicycle parks, pets and animal kennels related to the environment. However, there are no multi-purpose storages that the dwellers can use outside their homes. The isolation of the building is designed to avoid heat losses at the maximum level. With regard to the use of technological systems, the residence is equipped to meet 50% of the world's smart home systems that can be used worldwide.  LOCATION AND FLOOR PLAN  APARTMENT LOWER AND UPPER FLOOR PLANS
	Compatibility with different facade solutions	X		
	Exclusive outdoors that can be converted into joint use with neighboring residences		X	
	Multi-purpose spaces other than housing spaces	X		
	Flexibility in the number of personal spaces	X		
	Compatible space and fittings to new emerging tools that improve quality of life	X		
	Increasing foldable/unfoldable outdoors in the structure, ensuring isolation and optimal direction		X	
	Providing flexibility in the dimensions of the building mass	X		
	Increase in multi-purpose spaces in the structure, private space flexibility	X		
	Structure support system, independent of changes and flexibility in natural energy use, independent of artificial use		X	

Table 5.15. Evaluation table for other 3+1 residence type with duplex of block I, Nef Çamlıtepe project, prepared for author.

RESIDENCE TYPE	DESIGN CRITERIA	SUITABLE	NOT SUITABLE	COMMENT	
Other 3+1 Duplex	Convertible spaces from indoor to outdoor or vice versa	X		The Other 3+1 Duplex Residence Type of Block I, one of the housing types of Nef Çekmeköy project, has a space that can be partially converted to indoor with a balcony that it has. Besides, this terrace is designed to be converted into two separate indoors with its separate exits from the living room and bedroom. There are no applications related to the use of multi-purpose space that is provided by converting a space that provides maximum flexibility within the house into another space but, the Foldhome, the patented application of the company, is included in all Nef projects and offers spaces suitable for many functions to the dwellers of all types of apartments in the projects where they can additionally benefit at any time and pay only when they have used. However, as in each apartment type, we can say that this apartment type also has multi-purpose spaces (guest room, cinema room, music room, etc.) that are suitable for functional conversions. In this respect, the dweller is not limited to the residential area and able to reach the spaces that could be utilized for his needs. The residence is designed for multi-purpose appurtenances, such as parking lots, garages, bicycle parks, pets and animal kennels related to the environment. However, there are no multi-purpose storages that the dwellers can use outside their homes. The isolation of the building is designed to avoid heat losses at the maximum level. With regard to the use of technological systems, the residence is equipped to meet 50% of the world's smart home systems that can be used worldwide.	 LOCATION AND FLOOR PLAN
	Flooring details suitable for both space types either indoor or outdoor	X			
	Environmental-related multi-purpose appurtenance, adjacent to the residence	X			
	Compatibility with different facade solutions	X			
	Exclusive outdoors that can be converted into joint use with neighboring residences		X		
	Multi-purpose spaces other than housing spaces	X			
	Flexibility in the number of personal spaces	X			
	Compatible space and fittings to new emerging tools that improve quality of life	X			
	Increasing foldable/unfoldable outdoors in the structure, ensuring isolation and optimal direction		X		
	Providing flexibility in the dimensions of the building mass	X			
	Increase in multi-purpose spaces in the structure, private space flexibility	X			
	Structure support system, independent of changes and flexibility in natural energy use, independent of artificial use		X		 APARTMENT LOWER AND UPPER FLOOR PLANS

6. CONCLUSIONS

- While the concept of flexibility that has been increasingly brought in every sphere of life by rapid changes, controlling today's world, has been affecting the structural use in every function in architecture, it also affects the use and thereby the design of multi-housing for large audiences and mostly anonymous dwellers.
- The concepts of adaptation, change, transformation, mobility and modularity affect the evaluation of user characteristics, cultural environmental attributes, local construction conditions that vary according to the futuristic life cycle and the main inputs in the housing design of the materials and construction technology and lead to flexible housing design, responsive to multiple and different applications at once.
- While the flexible housing design that has been on the agenda from the first half of the 20th century was developing on single houses in the early years, it is much more effective in the multi-housing, rapidly produced today.
- Main causes that require flexibility in multi-housing design can be determined as the identity disorder, socio-cultural change, demographic change, technological change, change in environmental conditions and contribution to sustainability. In case of the epidemic diseases that are included in, particularly, change in environmental conditions, the importance of private spaces in houses, the prolonged use of the house during the day and the need to enjoy outdoor inside the houses take the flexible housing design under review as a solution. The transformation that is required for the usage times of the houses during the year, such as the ability to use summer multi-housing also in the winter due to the vital transformation in the housing areas is also an applicable reason that requires flexible multi-housing design.
- Since it is long-lasting for the future, its contribution to sustainability, in terms of both material and energy-saving, is regarded as a significant reason for the need for flexible multi-housing design.
- Tools for flexible multi-housing design are classified as modular design, collaborative planning and strategies in the design, construction and use processes. The strategies for flexible multi-housing design with a wide range, extending from the "support structure layout" and "infill structure layout" strategies in the design and construction process to the "reconfiguration", "growth" and "multi-purpose use"

in the usage process is in continuity, in which new strategies that can be generated as R&D study outputs for new applications over time can be added and developed.

- The qualities that are expected from houses depending on the reasons that require flexibility in multi-housing design and the following “flexible multi-housing design criteria” are set based on the reflection of these qualities on design:
    - Convertible spaces from indoor to outdoor or vice versa,
    - Flooring details suitable for both space types either indoor or outdoor,
    - Environmental-related multi-purpose appurtenance, adjacent to the houses,
    - Compatibility with different facade solutions,
    - Exclusive outdoors that can be converted into joint use with neighbouring houses,
    - Flexibility in the number of personal spaces,
    - Compatible space and fittings to new emerging tools that improve quality of life,
    - Increasing foldable/unfoldable outdoors in the structure, ensuring isolation and optimal direction [36],
    - Providing flexibility in the dimensions of the building mass,
    - Increase in multi-purpose spaces in the structure, private space flexibility
- As can be seen from the evaluations of example residence projects, the joint “foldhome spaces” application that can be linked to the housing units in multi-housing projects when necessary, but based on the space design of different purpose can be deemed as a strategy that has been currently used.
- The jointly used service areas, such as lawns, squares, etc. allocated as service areas of the settlement outside the residences of multi-housing areas are observed to have a potential for flexible use the application of example housing projects and this can be emphasized to be important for the settlement designs that focus on flexible multi-housing areas in urban planning.
- For the evaluation of the compliance of the thesis with the flexible multi-housing criteria, set according to its objective, the number of applicable criteria in the selected multi-housing area, the Fuaye Süreyyapaşa residences, is low, whereas it is much higher in Nef Çamlıtepe residences. This may be attributed to the implementation of the “foldhome spaces” strategy that was developed with regard to the importance of the flexible design of these housing units.

- The design of Nef Çamlıtepe residences, which is one of the existing multiple housing examples evaluated in the research, fits most criteria such as “convertible spaces from indoor to outdoor or vice versa”, “flexibility in the number of personal spaces”, “compatible space and fittings to new emerging tools that improve quality of life”. On the other hand, The Fuaye Süreyyapaşa design, as partially complies with the criteria such as the “conversion of the spaces from closed to open and from open to closed”, “private open spaces that can be converted into common use with neighboring residences”. These results reveal the positive effect of flexibility and concepts in multiple-housing design.
- It can be concluded that the concepts of standardizations gradually gains importance in terms of both housing production and the production of materials and the fittings used in housing at the current stage of flexible multiple housing design.

REFERENCES

1. Deniz ÖŞ. Çok katlı esnek konut yaklaşımları. *Çevre-Tasarım Kongresi, Yıldız Technical University, İstanbul;* 2011.

2. Okutan AE. Sosyal konut tasarımlarında esneklik kavramı ve bu kavramın proje başarısı üzerindeki etkisi. *Uluslararası Peyzaj Mimarlığı Araştırmaları Dergisi.* 2017;1(2):48-55.

3. Özçelik Ö. İç mekân örgütlenmesinde esneklik ve fonksiyonellik kavramı bağlamında mekânın değerlendirilmesi ve düzenlenmesi. *İleri Teknoloji Bilimleri Dergisi.* 2017;6(3):301-312.

4. Uzel N. Esnek ve adapte olabilir konutlar için değerlendirme rehberi. Master Thesis. İstanbul Technical University, 2001.

5. Ak N. Geleceğin Konutu: Tasarımında ortaya çıkan kavramların belirlenmesi. Master Thesis. İstanbul Technical University, 2006.

6. Alga R. Yaşam döngüsüne bağlı olarak konut tasarımını etkileyen faktörler. Master Thesis. İstanbul Technical University, 2005.

7. Bilgin İ. *Serbest plan, serbest cephe, serbest ev*. İstanbul: Yapı Kredi Yayınları; 1999.

8. İslamoğlu Ö. Mimari tasarımda esneklik yaklaşımlarına kuramsal bir bakış. *Turkish Online Journal of Design, Art and Communication.* 2018;8(4):673-683.

9. Aksoy M, Özgül GHY. Mimarlık nesnesinin yaşam döngüsündeki adaptasyonları. Master Thesis. İstanbul Technical University, 2016.

10. Archeetect, Dom-ino Evi: Le Corbusier'in Deneysel Mimarisi. [cited 2020 10 April]. Available from: https://archeetect.com/le-corbusier/

11. Yırtıcı H. Ev bir makine midir? [cited 2020 10 April]. Available from: https://www.gazeteduvar.com.tr/yazarlar/2019/08/29/ev-bir-makine-midir/

12. Kilsan Blog, Le Corbusier. [cited 2020 10 April]. Available from: https://www.kilsanblog.com/onemli-ozgun-mimarlar/le-corbusier/

13. Özcan K. Mimarlık öğrencileriyle söyleşi. [cited 2020 10 April]. Available from: https://www.konseptprojeler.com/mimarlik-ogrencileriyle-soylesi

14. Müjde A. Bir sürdürülebilir mimarlık örneği: otonom binalar - dymaxion evi. [cited 2020 18 April]. Available from: https://www.academia.edu/10003225/Bir_Sürdürülebilir_Mimarlık_Örneği_Otonom_Binalar_-_Dymaxion_Evi.

15. BuildingandInteiors, The Dymaxion House: A futuristic dwelling invented by ar. buckminster fuller, [cited 2020 18 April]. Available from: https://buildingandinteriors.com/the-dymaxion-house-a-futuristic-dwelling-invented-by-ar-buckminster-fuller/

16. Dymaxion House. [cited 2020 10 April]. Available from: https://www.thehenryford.org/visit/henry-ford-museum/exhibits/dymaxion-house/

17. Şpat S. Teknolojinin iç mekân tasarımına etkileri ve toplumsal yansımaları. Master Thesis. Hacettepe University, 2017.

18. Özcan U. Yersizleşmeye rağmen: Tadao Ando'yu 'yer' bağlamında okumak. [cited 2020 10 April]. Available from: https://yapidergisi.com/27116-2/.

19. Kariptas FS. Konut iç mekanına sürdürülebilir yaklaşımlar. *Yakın Mimarlık Dergisi*. 2019;2(2):27–39.

20. Koş FS, Kızmaz KC. Esneklik kavramında kullanıcı katılımının önemi ve güncel yaklaşımlar. *Beykent Üniversitesi Fen Ve Mühendislik Bilimleri Dergisi.* 2015;8(2):111-142.

21. Klein K. Woods Bagot's modular AD-APT modifies apartments for working from home. [cited 2020 28 Aug]. Available from: https://www.dezeen.com/2020/04/13/woods-bagots-modular-ad-apt-apartments-working-from-home/

22. Türetken M, Kara K. Pandemi, tasarım ve mimariye yeni kriterler getirecek. [cited 2020 28 Aug]. Available from: https://www.aa.com.tr/tr/turkiye/pandemi-tasarim-ve-mimariye-yeni-kriterler-getirecek-/1871700#

23. Makhno S. Life after coronavirus: how will the pandemic affect our homes? [cited 2020 31 Aug]. Available from: https://www.dezeen.com/2020/03/25/life-after-coronavirus-impact-homes-design-architecture/

24. Aşkın S. Covid-19 sonrası konut. [cited 2020 31 Aug]. Available from: https://manifold. press/covid-19-sonrasi-konut.

25. Barker N, Heath L. Council with highest COVID-19 death rate brands illness a 'housing disease. [cited 2020 31 Aug]. Available from: https://www.insidehousing.co.uk/news/council-with-highest-covid-19-death-rate-brands-illness-housing-disease-66608

26. Serin E. Ekolojik konut tasarımı kriterlerinin araştırılması ve İzmir ili için bir tasarım modeli önerisi. Master Thesis. Dokuz Eylül University, 2011.

27. Andiç Z. Türkiye'de açık ev olanaklarının incelenmesi. Master Thesis, İstanbul Technical University,1999.

28. Deniz ÖŞ. Sürdürülebilir yapma çevre için bir tasarım ve yapım yaklaşımı: açık yapı. *Arredamento Mimarlık Dergisi.* 2011;244(1):69-77.

29. Origami drop leaf dining table. [cited 2020 21 May]. Available from: https://www.designrulz.com/design/2014/09/10-space-saving-dining-tables-tiny-apartment/

30. Norden gatelag table. [cited 2020 20 May]. Available from: https://www.archdaily.com/777309/see-more-sky-with-these-collapsible-window-seats

31. Movable walls: a solution for small homes. [cited 2020 20 May]. Available from: https://www.huffpost.com/entry/movable-walls-a-solution-for-small-homes_n_562a51fde4b0443bb563ad3b

32. 20 pieces of convertible furniture you'll actually use. [cited 2020 21 May]. Available from: https://tr.pinterest.com/pin/778489485577524056/

33. Raanan Stern:studio. [cited 2020 18 Sep]. Available from: https://www.domusweb.it/en/news/2014/02/27/raanan_stern_studio.html

34. Baba EC. *Tasarım demokrasisi ve İstanbul*. İstanbul: Sosyal Yayınlar; 2012.

35. Yücel O. Toplu konutlarda modülerlik ve esneklik kavaramlari, istanbul'daki toplu konutlarin plan tipleri üzerinden analizi.Master Thesis. İstanbul Technical University; 2008.

36. Karagüler S. İstanbul'da konutlarda enerji kullanım kontrolünün planlamadaki etkileri. Master Thesis. Istanbul Technical University; 1979.

37. Fuaye Süreyyapaşa, [cited 2020 25 Nov]. Available from: https://www.kiptas.istanbul/pdetail.aspx?ID=48&lang=tr&page=2

38. Fuaye Süreyyapaşa, [cited 2020 25 Nov]. Available from: http://www.yilmazgrup.com.tr/fuayesureyyapasa.php

39. Nef Çamlıtepe, [cited 2020 05 Dec]. Available from: https://www.nef.com.tr/medium/document-file-18.vsf

40. Nef Çamlıtepe, [cited 2020 05 Dec]. Available from: https://www.nef.com.tr/projeler/nef-camlitepe#galeri