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Housing flexibility in terms of changes, opportunities, and sustainability of goals and values

Damla Özinal*
Onur Erman**

Abstract

Flexible design in architecture is the ability of buildings to adapt to changing situations in their use, functioning, or context. The ability of the users to change the space and control it according to their requirements and demands is the strongest aspect of flexible design. Flexible design, integrated into design practice with modern architecture, plays a key role in the solution of many design problems. This study, which focuses on housing flexibility, aims to determine the demands of the users regarding the flexible use of housing and to understand the internal dynamics of the process that determine the housing flexibility in this context. Within the scope of the study, it is thought that the housing flexibility is formed by evaluating the changing demands of the users within the framework of the sustainability of the goals and values and realizing them according to the existing capabilities. This process has been attempted to be conceptualized by defining it with sub-elements belonging to three components that are involved in the process defined as change, goals-values, opportunities. In the conceptual model, at the first stage, sustainability works as a control mechanism to ensure the realization of change demands arising from various factors. While sustainability checks the suitability and validity of the demands, the opportunities organize these demands to be accomplished. According to the model, the goals and values must be suitable for sustainability to the demands for change to be realized. However, to realize the demands and achieve a flexible solution, the existing opportunities must be suitable. Within the scope of the conceptual model, the effect of the process components on housing flexibility is attempted to be determined through questioning the flexibility demands of the users. In line with these aims, a questionnaire survey was conducted. 450 subjects were reached via email and 322 of them replied. The findings of the study allowed us to understand that the expectations of the users in terms of the demands, goals, and values, sustainability, and opportunities regarding the change in providing housing flexibility. The results point out that the users demand flexible housing, which enables spaces enlarged and narrowed or divided and combined. In this context, it has been determined that the flexibility of the spaces should provide long-term use in accordance with the lifestyle within the scope of goals and values. For this purpose, the necessity of technological opportunities that provide modification of spaces is understood.

Keywords: Flexible design, housing flexibility, users' demands, conceptual model

*(Corresponding author) Research Assist., Çukurova University, Turkey, damlaozinal@gmail.com
** Assoc. Prof. Dr. Ornur Erman Çukurova University, Turkey, oerman@cu.edu.tr
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1. Introduction

In the world that spins with changes, days turn from night to daytime, seasons turn from winter to spring, life turns from youth to old age, and these transformations inevitably change the space and life within time. Living in an inevitable continuum state of change requires human adaptation to changing conditions. In this dynamism, housing, as the living space of the human being, and the representation of his existence, changes with him, adapts, and gains continuity. Undoubtedly, it is clear that the common feature of permanent and sustainable elements is being adaptable. Schmidt et al. (2010, pp. 17-19) associated the adaptability concept with capacity for change, the ability to achieve suitability for purpose or minimize inappropriateness, low-cost and high-performance value, and readiness for what might happen now and in the future. Also, it is possible to state that developing technology and the innovations it brings are directly related to the change and diversification of existing needs and requirements and the variations of living conditions over time. While talking about change, it is expected to have an effect of changes in architecture which is intertwined with life naturally.

Essentially, flexible architecture is a design in which a building easily responds to the variations that occur during its lifetime. This design approach; offers long-term use, is fit for purpose, allows user intervention, makes use of technical innovations, and is more economical and ecologically suitable (Kronenburg, 2007, p. 7). In addition, it has more potential to fit the changing cultural and social trends. In this respect, instead of trying to produce the most accurate or the most beautiful design, flexibility aims at the design that is the most suitable for the user and can adapt to the changes that may occur in long-term use. The capacity of the flexible design against changing conditions is associated with the design characteristics of flexible design being loose fit instead of a tight fit and its incompleteness in a way. (Hamdi, 1995; Forty, 2000). Thus, the flexible design is completed only when it is started to be used (Kronenburg, 2005).

Another feature of the flexible architecture is that it allows users to modify the space, use and control it in line with their demands by interacting with the users. This feature can be found in the first settlements used by human beings for sheltering (Estaji, 2017, p. 37-49). Tents as living spaces of nomadic people are portable and allow more than one function to be performed in the same place. Due to these reasons, they can adjust to changes by adapting to a dynamic lifestyle and changing conditions. The traditional Turkish house which is one of the most notable examples of flexible use shaped by the influence of culture is seen as the repetition of the nomad tent in terms of its central space configuration and use (Akın, 1990). The multi-functional rooms are the most important units of the traditional Turkish house, with the feature of performing more than one action in a single space (Figure 1).

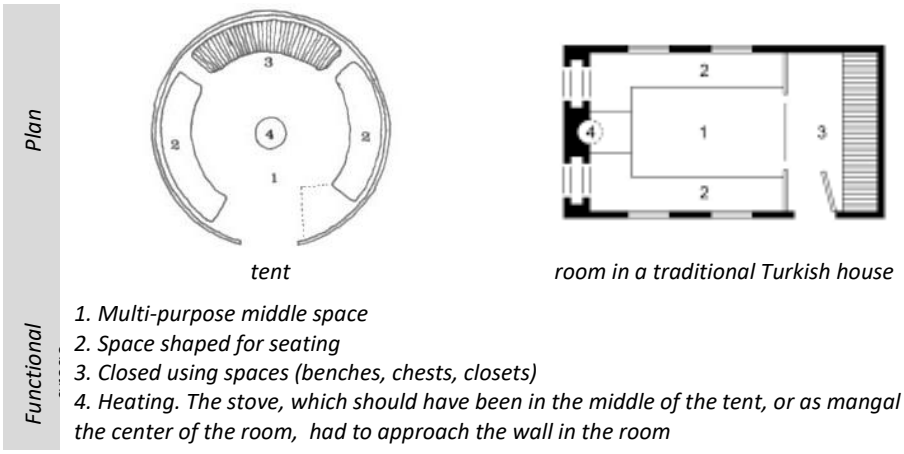
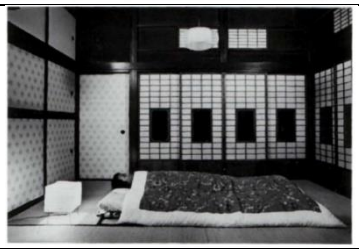


Figure 1 Multi-purpose using of a room in the traditional Turkish house and a tent (Küçükerman, 1985)

As characteristics of social life and cultural properties define the flexibility potential of the space, the inhabited area may be a reason for flexibility. Rasmussen (1994, p. 102) states that the traditional Japanese house was shaped under the effect of Japan's geography, which is an island country in an earthquake zone. Similarly, Bognar (1985, p. 35) states that traditional Japanese houses are shaped by climate and geographical conditions. They are in the most suitable form with wooden structure and lightweight separating elements which is useful to renovate rapidly after the destructive effects of typhoons and earthquakes and can resist in the humid climate. It has been a necessity for traditional Japanese houses to be resilient and adaptable as a response to environmental conditions. The multi-purpose use of the spaces that are divided or combined with lightweight and movable separating elements is the flexible use features of the traditional Japanese house. Although it is provided in different ways, the multi-functional use of spaces can be defined as a typical flexibility approach of the traditional houses (Table 1).

Table 1 Multi-functional characteristics of the traditional spaces, (Günay; 1999, Nergis; 2005)

	Turkish house	*Japanese house*
eating and gathering		
daily routines		
sleeping		

The knowledge about flexibility is mostly based upon studies that focus on the necessity of flexible design, its history, methods, and examples that consider changing purposes and use. This study attempts to understand that the process of flexible design through the residential user's perspective in the context of housing flexibility. With this aim, components of flexibility and their effect on the flexible design process within the context of housing flexibility have been tried to be defined and discussed. Therefore, descriptive factors of the flexible design conditions in the housing were specified, and then the relationship between these conditions in the process of flexibility was tried to be represented through a conceptual model. A case study was conducted based on the conceptual model, which allowed the determination of design expectations and priorities of the residential user.

2. Development of Flexible Housing Design Practices in Phases

The minimum dwelling idea offers ideal functional solutions that can satisfy the basic minimum requirements for a living (Teige, 2002). Minimum dwelling as a result of the modernization process has been a method aiming to quickly obtain the number of dwellings needed by the housing crisis after World War I. In modern architecture, spaces and functions are precisely defined and inseparably linked. As a result, spaces can only be used for predefined functions at certain times as the architect predicted, like day and night-time spaces. While the effect of minimal design attempts continues, the variety and changeability of needs in modern life have started to lead designers to new searches. With developments, the impact of technological innovation in both design and building has supported flexible use. Furthermore, open or free plan idea has emerged to make space use more efficiently, and that has been supported by the development of structural systems. As a result of load-bearing walls have lost their importance, new life patterns that the user can build and even change have begun to form (Schneider and Till, 2005, p. 157-166). For sure, the common goal of this entire attempt was that the spaces created with minimum standards can adapt to the life of the user. In free plan designs, the flexibility provided by the help of panels and divider components that move in a specified way was one example of this (Figure 2). In this period's examples, although spatial freedoms are provided to the user owing to the elements moved in a certain configuration with limited technical possibilities and certain space, pre-constructed configurations create flexibility. Gropius describes flexibility during this period as a kind of illusion that enables architects to sustain their authority and control over buildings in the future (Hill, 2003, p. 29). Although flexibility cannot find its full meaning in this period, it can be considered as a representation of modern life and the production of modernity.

a *b*

Figure 2 Flexible use arrangements with movable parts, *a)* Loi Loucheur, Le Corbusier, 1928 (Benton, 1984), *b)* Schröder House, G. Rietveld, 1924 (URL-1)

The second phase in housing flexibility that follows can be described with the industrialization of housing. In this period, architects focused on technical solutions for the housing problem that is prominent again and fabricated housing production has been started with industrial solutions used in construction systems (Schneider and Till, 2007). The idea that the housing problem can be solved with mass production has transformed the house into an industrial product that is produced with standardized and rational solutions, modular and prefabricated elements. In this period, the main purpose is obtaining the transformation and changeability of mass-produced housing, concerning the various users and diversified needs over time. In fact, Norberg-Schulz (1966) interpreted flexibility in two ways according to the spirit of the period. The first is the flexibility provided by parts that are added or removed in a way that does not impact the integrity of the structure. The second is flexibility, which allows the relations between the parts to be changed (Figure 3). At this phase, it can be said that technical solutions supported by standardization and fabrication are effective in providing flexibility.

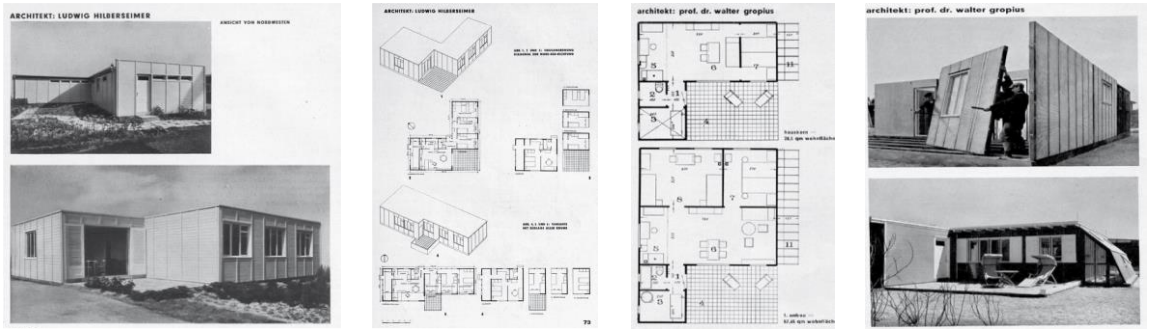


Figure 3 Growing House (Das wachsende Haus, 1931) working groups studies on standardization of housing, (Schlorhaufer, 2020).

Besides the thought of not just using technical possibilities will not be efficient for flexible design solutions, also the idea of increasing the effectiveness of the user in the design and usage process formed the foundations of the next period. At this point, it is seen that a flexibility approach that prioritizes user participation and user preferences has become widespread. John Habraken and John Turner have been pioneers of this approach which provides the user with greater variety and choice, gets together user participation and construction possibilities in the flexible design. Habraken opposed the idea of standardization of the dwelling and argued that the user should be involved in the design process. He has produced an alternative design method in which the user can have a say in housing design in line with his/her wishes and needs, instead of the standardization that occurs with industrialization in the housing. In Habraken's theory, the structure consists of supports designed as the main bearer of the structure and infills, which are short-lived equipment, components, or elements that can be changed and adapted by users, suitable for flexible design (Habraken, 1972), (Figure 4). In the context of the user-centred design approach, where constructional technical potentials are featured, the use of movable dividing panels that allow convertible and versatile use of spaces, bathrooms with replaceable pieces of equipment, and plumbing ducts, etc., drew attention.

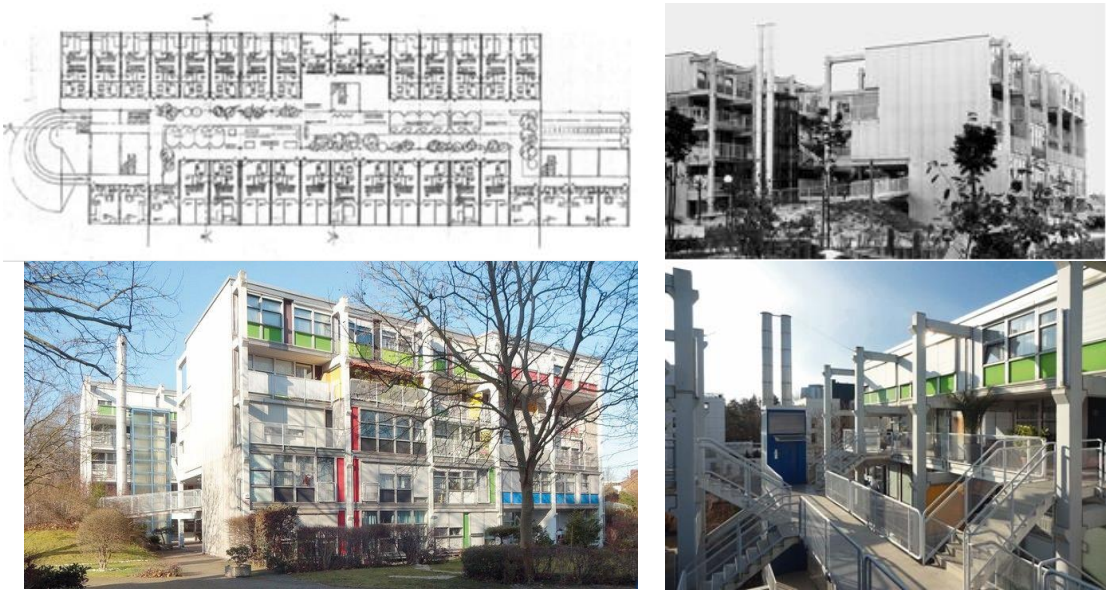


Figure 4 Supports and infills, 'Elementa', O. Steidle & Partners, 1972, (URL-2)

Another approach in this period, in which the user plays an active role, is polyvalence that was introduced by Hertzberger as a new concept. Polyvalence can be thought of as a combination of an open-plan approach where the relationship between function and space becomes ambiguous, and spatial redundancy that allows for more different uses has been caused by changes in user perception and life (Hill, 2003, p. 45). In other respects, the obvious negative consequences of mass

housing settlements, dissatisfaction, and the problem of alienation in housing areas have caused the designer to be more sensitive to the context of user demands. With this respect, flexibility has been tried as a tool to increase the quality of life in dwellings and to overcome the identity problem in settlements (Beisi, 1995; Altaş and Özsoy, 1998), especially in mass housing settlements where different sociocultural groups can live in the way they prefer. Nemausus (1985-1988) social housing project, designed by Jean Nouvel in different types of 114 houses, single-storey, two and three-storey, can be considered as one of these examples (Figure 5). Nouvel states that the core ideas of the design are user-centred design and changeability. He also states that with the help of flexibility in design, the dwelling can be personalized and the user can predict what kind of life he/she will lead in it in the future.

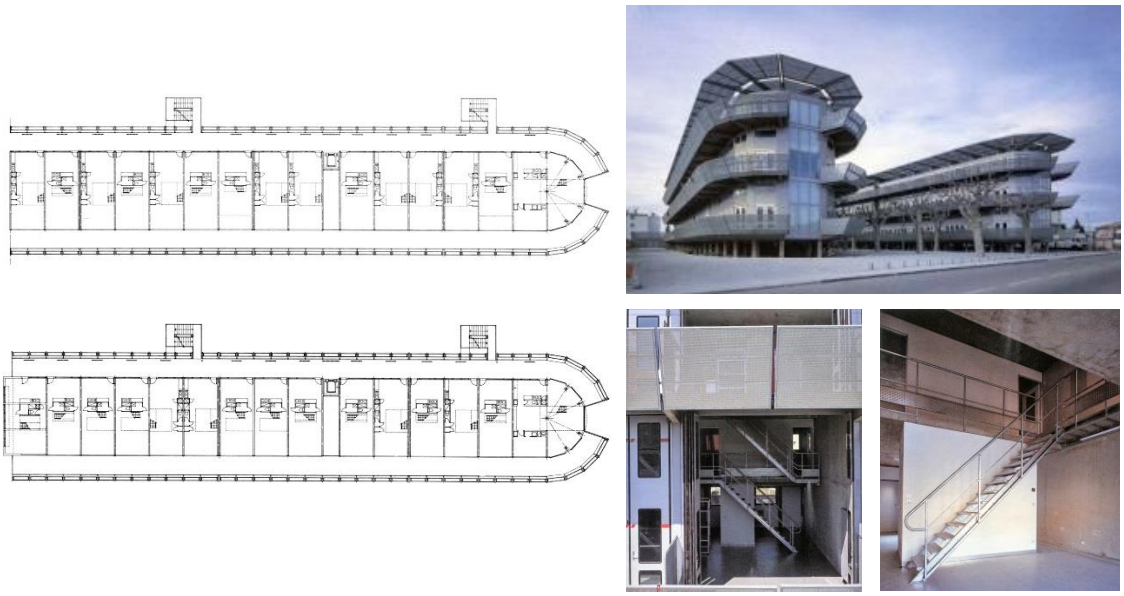


Figure 5 Nemausus settlement, J. Nouvel, 1987, (URL-3)

In this period, it is seen that flexibility is mostly used to overcome differences and eliminate uncertainties in housing design. Characteristic of the period, especially in social housing or mass housing design, can be described by providing the needs of an unidentified and inhomogeneous user profile and trying to allow for other components that cannot be predicted by the uncertainty of the future. While technical possibilities create an alternative for flexibility, it is seen that spatial characteristics come to the fore with user-centred design.

Today, it is seen that flexibility is in another phase and advanced technology provides several possibilities for flexibility. While producing innovative solutions with functional and dimensional content in the focus of space, flexibility has also come into prominence in design in terms of façade features. In this regard, flexibility has become a method for providing environmentally conscious design beyond user-centred design. Recently, not just user needs, but also environmental control, and sustainable design goals have been included in the field of activity of flexibility with the help of kinetic applications via the multi-sided effect of technology.

The developments that have emerged in successive periods show that the objectives and strategies regarding achieving flexibility change over time with the conceptual content. To summarize, it is seen that the conceptual content of flexibility has developed under the influence of modernism, in different lines such as minimal space and functionalism, industrialization and standardization, user participation, and sustainability. It is also seen that the practices are focusing on two centres as versatility and convertibility related to the flexible use of the space. Taken all together, it can be said that flexible design approaches put flexibility into practice in spatial applications, design and construction processes, and in the building system through technical possibilities. Thus, when the flexibility ideas and practices are evaluated, it is thought that flexible

design methods can be grouped in the following headings; functional flexibility, which includes spatial possibilities for different functions and multiple uses, spatial-dimensional flexibility, which includes changes such as the dividing, combining and expanding of space, and structural flexibility, which includes the contribution of structural elements that can be or not load-bearing and equipment to flexibility (Erman and Özinal, 2018), (Figure 6).

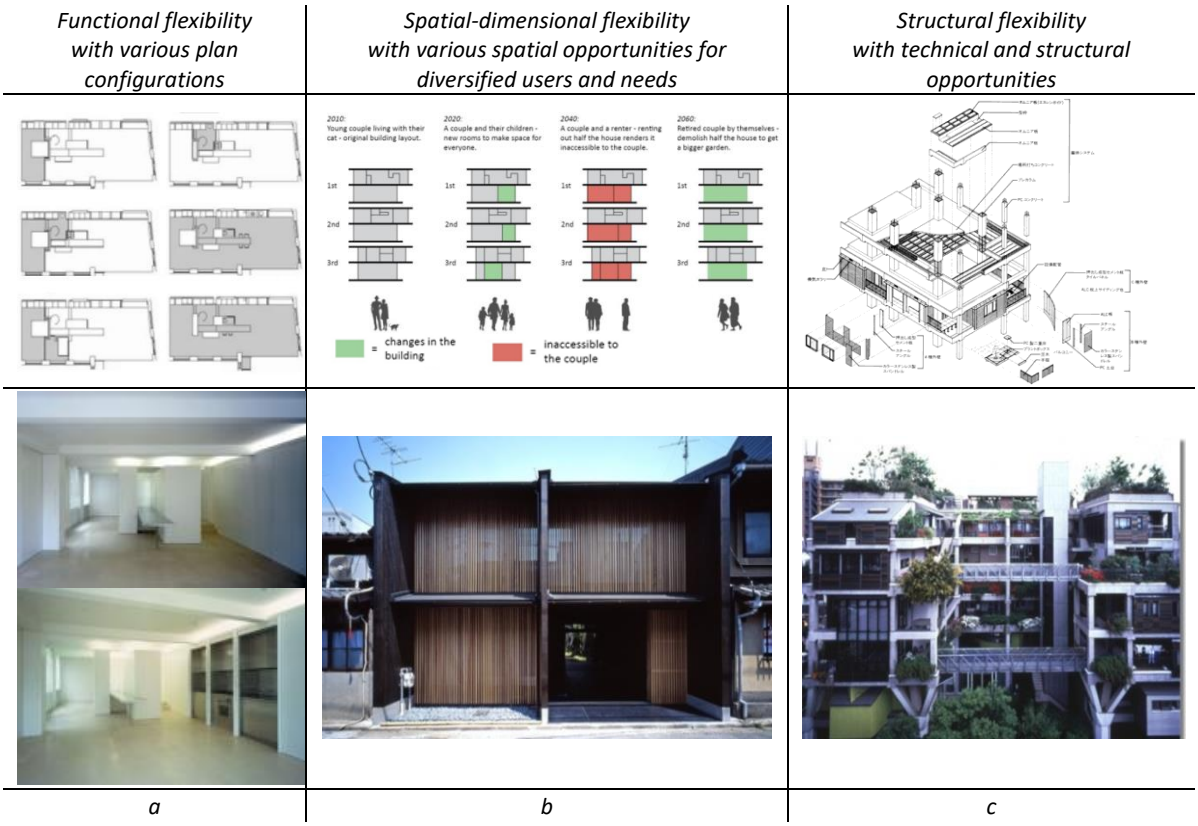


Figure 6 Flexibility types and methods, (a: URL-4, b: URL-5, c: URL-6)

3. Factors Determine the Conditions of Housing Flexibility

People's effort for adaptation is mostly formed in the housing space, and undoubtedly housing will also encounter changes in the future. However, as it can be understood from the previous section where the development of flexibility was considered, it is seen that some factors affect the realizing the requested flexibility although there are demands for changing. From this point on, effective factors can be defined as the user's demands for change, the sustainability of goals and values, and existing opportunities. The conceptual model of housing flexibility simply determines the factors that find out the demands for change, the goals and values that keep these factors under control, the existing opportunities for the transformation of the demands into flexible design practices, state the relationship of these elements and the flexibility achieved as a result (Figure 7).

Figure 7 The conceptual model on the relationship of the factors involved in housing flexibility (developed by authors)

According to the model, the factors related to change cause new requests and needs of the users in the living space of the housing, in line with the revealed conditions. The validity of the suggestions developed in response to changing requests and demands is based on their sustainability by coinciding with the goals and value system of the individual and the community. Sustainability works like a control mechanism, checking the suitability and validity of the demands, while the opportunities organize the realization of these demands. For this reason, the opportunities must be suitable for the change to take place although it fits the sustainability criteria. The elements involved in the housing flexibility process and their effects are explained below.

3.1. Factors Related to Change

As it is known, change stands out as one of the main reasons that require flexibility. The factors that affect the housing form and cause the change of housing can be listed as social factors, lifecycle, and household structure factors, technological factors, and economic factors (Uzel, 2001).

Social Factors: Considering that individuals constitute social groups, communities, and societies on a larger scale, it is expected that large-scale effects and happenings will not only affect the individual but also have consequences on society, and thus cause social change. In this respect, every circumstance that affects the individual or society causes a change and also creates the demands for adapting to the change. Social change can be caused by increasing human knowledge, economic and technological developments, expansion and acceleration of the communication network, and as well as social events and destructions that appeared as a result of epidemics, natural disasters, and wars. The effects of these situations impact social life, bringing about changes and innovations, and even their reflections can be seen on a spatial scale. As a matter of fact, while the Industrial Revolution and the World Wars had profound effects on the social scale, they changed people's lifestyles and created new spatial configurations. It is likely that the current Covid-19 pandemic that is experienced worldwide and whose social effects have begun to be seen, will cause a similar change.

Lifecycle and Household Structure Factors: Changes in the income of the family, the increase or decrease in the number of people living in the house due to joining or leaving of the children or elders, and diversifying of the needs depending on the living conditions may cause the changes in the spatial needs in the dwelling. In addition, changes in the lifecycle such as singleness, establishing a family, enlarging a family, the launching of children, and retirement naturally cause life to change and the need to make changes in the housing space arises (Atasoy and Ünügür, 1983).

Flexible design solutions can be developed by anticipating the demands that may arise to meet the needs of the user due to changes in the lifecycle and household composition (Figure 8).

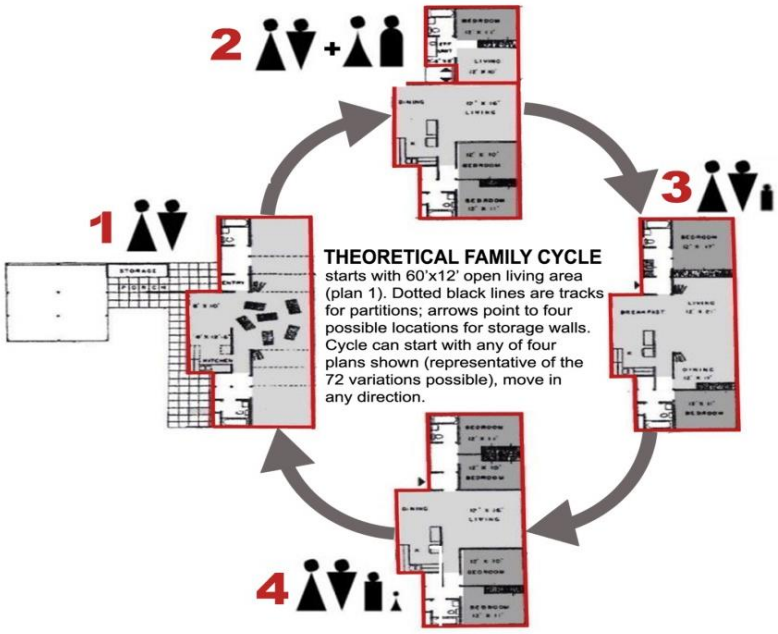


Figure 8 Modifying spatial order in a flexibly designed housing respecting the changes in the lifecycle, (Friedman, 2002, *revised by authors*)

Technological Factors: Changing working conditions with technological developments, innovations, and improvement in life, new tools, and equipment sometimes create the need for new spaces and sometimes cause the loss of some usages and functional areas. This situation can be interpreted as the effect of technology on life. In addition, innovations and developments in subjects such as production, construction, and structural systems are important technological changes that affect the design, construction, and use processes of architecture and cause the demands of users to change in a similar direction.

Economic Factors: The lifetime of the structures is related to their physical strength as well as their usability. As time passes, housing will inevitably become functionally obsolete in the conditions of the period. To ensure the usability of the house against changes, the user's ability to meet the maintenance, repair, and renewal costs or to have a more suitable new housing for himself/herself depends on economic factors. Today, the global economic crisis, the ever-increasing mortgage interest rates, and the fact that the house has become an element of rant make it difficult for everyone to move and alter the house easily. In this respect, the economy becomes a factor in the demands for change.

3.2. Factors Related to Sustainability of Goals and Values

Flexibility can be considered as the basic element of the sustainability of the building, as the building can respond to changing needs and preferences and bring long-term use (Broome, 2005). The realization of the demands formed by the new requests and needs that arise with change depends on the sustainability of the goals and values. While sustainability performs like a control mechanism to check the suitability and validity of the requests, opportunities organize the realization of these requests. Communities, individuals, and families aim to sustain life, habits, traditions, and thus their existence. Although innovation and change may seem like a positive development, they can sometimes contrast with the social agreements and values of the community and have a negative impact. In this case, the community may resist and reject the change that conflicts with its values. Therefore, sustainability becomes an eligibility criterion that supports or prevents the realization of the demands. The elements of the sustainability of goals and

values can be listed as the future goals of the community or individual, social-cultural sustainability, environmental sustainability, economic sustainability, functional sustainability.

Social-Cultural Sustainability: The potential to meet present and future users' needs determines the social sustainability opportunities of the house. Housing flexibility with practices such as design for all; does not allow the society to be grouped as the elderly, the disabled, and families with children, etc. Flexibly designed houses, which are not affected by the changes created by the life-cycle, eliminate the need to move and allow individuals to get older into the social environment they belong to. In addition, the ability of communities to sustain their lifestyle as they are and to keep it alive as a cultural value is an important criterion in terms of the social-cultural sustainability of the dwelling.

Environmental Sustainability: Housing inevitably creates an environmental impact throughout its construction process and lifetime. Reducing wastes, using renewable resources, saving energy and water use supports the environmental sustainability of the housing. Moreover, designing spaces for long-term and flexible use eliminates the need for destruction and renovation, helping to avoid wasting energy and resources.

Economic Sustainability: Flexible design, which allows for future changes, is economically sustainable as it reduces or eliminates the costs of requirements such as renewal, replacement, repair, and move in the long-term (Durmisevic, 2001). Also, it can be said that the increase in the adaptability potential of the housing can increase user satisfaction and decrease residential mobility. Reducing the costs in the use process is a component of economic sustainability. Thereby, in the demands regarding the renewal, transformation, maintenance, and repair of the house during its use, the economy becomes a factor in terms of sustainability.

Functional Sustainability; can be considered as the prevention of functional obsolescence, which is seen with the housing not responding to the needs, not keeping up with the life changes. Flexibility raises the lifespan of the dwelling because it increases the renewal and adaptability potential of the dwellings. Technological systems and spatial arrangements that enable flexible use of housing support functional sustainability. Thereby long-term usability of the house is obtained, and the request to move reduces.

Future Goals of the Community or Individual: As an individual or as a social community, the family has future goals within the scope of its existence. These may be goals such as the growth of the family, the fact that the children have their own rooms, the opportunity to work from home, and the desire to spend the rest of their life at that house. These goals also include aims and intentions for the future desired by the individual or the community and the spatial equivalents of them with their comfort conditions.

3.3. Opportunities

Although there are demands for change and the solutions developed are accepted as sustainable, the inadequacy or inappropriateness of existing opportunities affects applicability. Construction opportunities, economic opportunities, and technological opportunities which will be effective in the processes of design, construction, and use, enable to obtain flexible designs by taking into account change demands and sustainability conditions.

Technological Opportunities: Technology is a crucial element in ensuring the realization of proposed flexible use. Advances in design, construction and material technologies directly affect flexible design practices. Although the building is designed to be very suitable for flexible use, its construction depends on current technological opportunities.

Construction Opportunities: Existing construction techniques, production opportunities, use of materials, and research and development activities can be counted among the construction opportunities. In addition, technicians' professional knowledge and abilities can be evaluated

within these opportunities. Matrix tiles and raised floor systems are notable examples of construction opportunities. These systems create a flexible infrastructure that allows the installation pipes to be easily moved horizontally. In this manner, the wet areas difficult and costly to relocate such as kitchens, toilets, and bathrooms can be freely reshaped. In the same way, while a regular slab might have to be totally replaced, a raised floor system can be reconfigured more easily and economically (Figure 9).

a *b*

Figure 9 Matrix tile system and raised floor system applications (a: Kendall, 2016 b: Fukao, 2011)

Economic Opportunities: The economic value of the proposed flexible system is explained by the costs of construction, use, and maintenance. The specified use becomes possible within the economic limits determined by all these costs. Although there is an opinion stating that acquiring flexible housing will cost more than standard housing, flexibility provides profit in the long-term as it prolongs the life of the building (Schneider ve Till, 2005). Rabeneck, Sheppard, and Town (1974) suggested that the cost difference between flexible housing and standard housing construction is 5-7%. Considering that the flexibility may vary according to the project scale, materials and technologies used and the production system, it is not possible for this cost difference to be the same for every project. The fact that the flexible design is more economical for the users can be explained by the fact that the profit over the lifetime is higher than the initial investment (Gücesan, 2015).

Concisely; flexible design solutions can be achieved within the frame of the tripartite relationship defined by considering the sustainability of the goals and values of the community, the change demands supported by the opportunities such as construction opportunities, economic opportunities, and technological opportunities.

4. Examining the Efficiency and Relationship of the Factors in Housing Flexibility

At the time of the study, the contagious Coronavirus pandemic (COVID-19) has spread worldwide. There was lockdown, and people stayed at home in this period, and life continued with the applications support working at home and distance education. It is thought that the application of the survey questionnaire in this extraordinary period when users are questioning their expectations from “housing” can create important data in terms of determining in which direction the flexibility expected from the housing is. In the study, the focus of the question “What is the opinion of users regarding flexible design?” is to evaluate the demands for change in the housing space based on opportunities, goals, and values. Thus, it was tried to determine the thought of the users about the flexible use of the housing.

The survey was conducted during May and June in 2020, and the subjects who were adults, older than 18, voluntarily participated. The questionnaire link was sent to 450 contacts selected randomly in the authors’ e-mail database. 322 of 450 questionnaires were completed and response rate is 71.5%. The survey form consists of thirty-three questions designed by using multiple-choice, rank order, and Likert scale methods. 4-point or 5-point Likert scale was used concerning the question. To make a deeper analysis, the respondents are directed to the next question according to their

answers, so the number of answered questions differs among the respondents. Based on the relationships in the conceptual model, the first part asked about the demographic characteristics of the respondents', the second part asked characteristics of the household and the house currently in living, and in the final part, the expectations of the users from flexible design, their demands for change in housing and the opportunities of change, their goals and values were questioned.

The data were analyzed with different statistical methods using the "IBM SPSS 22.0". In addition to frequency distribution and cross-tabulation analyses, select case analyzes were conducted due to the selective progression of the questions and the formation of different groups according to the answers given. The Likert scale questions involving perceptual evaluations were tested by Cronbach's alpha.

4.1. Findings of the Study

Frequency distributions of the demographic data show that the majority of 322 respondents were female (210, 65.2%), most of them in 26-34 (94, 29.2%) and 18-25 (90, 28%) age groups, undergraduate graduates (177, 55%), and actively working (187, 58.1%). There is complete equality in the number of married (161, 50%) and single (161, 50%) respondents. The majority of respondents did not have children (180, 55.9%), while the respondents with children were mostly two (75, 23.3%) and had only one child (57, 17.7%). Most of the respondents live in metropolitan cities and the majority of them live in Adana (157, 48.8%). The number of respondents from the metropolitan cities listed as Ankara, Istanbul, Izmir, and Bursa is 81 (28.3%) in total. To understand the previous experience of the respondents, their knowledge about flexible design is asked. 220 (68.3%) of them indicate that they had no knowledge about flexible design.

Based on the assertion that flexible design emerges in line with changes and is realized with possibilities in the context of sustainability of values and social goals, the data obtained from the survey have been tried to be interpreted.

4.1.1 Findings on Change

First of all, using the questions in this section, reliability analysis was performed to estimate the internal consistency of the scales, and the Cronbach's alpha (α) coefficient was found. The values are 0.682, and 0.668, respectively. It was seen that the scales were consistent and in the acceptable alpha value ($0.60 < \alpha < 1.00$), (Kalaycı, 2010).

The primary findings on change are about the use, that the housing provides with flexible design. With aim of determining the leaded demands of the users about the change in housing flexibility, it has been tried to understand what the priority is in terms of spatial-dimensional, functional, and structural flexibility in housing flexibility. The combining and expanding capabilities of the spaces (271, 84.2%) were found as respondents' major priority regarding housing flexibility. Arrangements that support the lifelong usability of the house (196, 60.9%), and changing the location of spaces, including wet areas in the house (162, 50.3%) were defined as consecutive priorities. Results highlight that respondents demand spatial-dimensional flexibility first, followed by functional and structural flexibility, respectively (Table 2).

Table 2 Priorities regarding the flexibly designed house

What are your priority demands regarding a flexibly designed house?	*Agree*	*Neither agree nor disagree*	*Disagree*	*Undecided*	*Total*
Having features that allow the housing to be used for a lifetime	*196 (60.9%)*	73 (22.7%)	27 (8.4%)	26 (8.1%)	322 (100%)
The dividing, combining and enlarging, or narrowing of spaces within the housing	*271 (84.2%)*	31 (9.6%)	5 (1.6%)	15 (4.7%)	322 (100%)
Changing the location of the wet areas such as kitchen, bathroom, toilet, balcony)	*162 (50.3%)*	81 (25.2%)	55 (17.1%)	24 (7.5%)	322 (100%)

Cronbach alfa (α) factor is 0.682 ($0.60 < \alpha < 1.00$)

It has been stated that demands and requests are formed by changes occurring in life, named as social factors, factors related to the life cycle and household structure, technological factors, and economic factors. In this context, the respondents were asked what features they would like to have in the house in line with the occurred changes, to understand the needs of the respondents that may arise with change and their expectations about flexible design in housing. With this aim, a question was composed with a Likert scale with five options that have a neutral one at the center, and the strength of opinion increases at either end. According to the results, expanding one of the rooms when needed (142, 44.1%), having more rooms when needed (124, 38.5%), and combining the rooms when the family gets smaller (113, 35.1%) were determined as mostly requested flexibility options respectively. On the other hand, altering the location of rooms without demolition and renovation (96, 29.8%) was the least preferred choice. The most negatively evaluated flexibility option is using the room multi-purposely without making any modification required (116, 36%), (Table 3).

Table 3 Preferred housing flexibility options towards changes

Which of the following features would you like to have in your house?	*Much prefers*	*Prefers*	*Undecided*	*Not prefers*	*Never prefers*	*Total*
Using the room multi-purposely in different times without any modification	34 (10.6%)	52 (16.1%)	66 (20.5%)	*116 (36%)*	54 (16.8%)	322 (100%)
Ability to expand one of the rooms when needed	*142 (44.1%)*	137 (42.5%)	22 (6.8%)	16 (5%)	5 (1.6%)	322 (100%)
Altering the location of rooms without demolition and renovation	92 (28,6%)	*96 (29.8%)*	59 (18.3%)	55 (17.1%)	20 (6.2%)	322 (100%)
Combining the rooms when the family gets smaller	76 (23.6%)	*113 (35.1%)*	69 (21.4%)	50 (15.5%)	14 (4.3%)	322 (100%)
Having more rooms when needed	*124 (38.5%)*	122 (37.9%)	49 (15.2%)	19 (5.9%)	8 (2.5%)	322 (100%)

Cronbach alfa (α) factor is 0.668 (0.60 < α<1.00)

The answers contributed to understanding the users' preferences regarding converting or multi-functional space use in housing flexibility. It has been observed that the answers such as "much prefers" and "prefers" are positive choices mostly collected that belong to convertible flexible solutions such as upsizing-downsizing, altering location, and integration-separation of the rooms. The negative choices such as "not prefers" and "never prefers" are mostly collected in the answers towards multi-purpose use. In this respect, results revealed that the respondents' demands for flexibility are in favor of convertible solutions.

4.1.2. Findings on Sustainability of Goals and Values

Towards to understand the impact of flexible housing on the sustainability of the goals and values of the respondents, their desire to have flexible housing was evaluated first. Thereafter to identify their priorities regarding sustainability, the reasons to have a flexible house were asked, and appropriate options were marked by making multiple choices. According to the frequency results of the answers, the majority of the respondents (248, 77%) stated that they wanted to have a flexible house, while the second largest group in which the answers were collected was “doesn't know” (50, 15.5%). While only 19 respondents (5.9%) have negative attitudes, five respondents (1.6%) reported that they already have. Responses definitely indicate that there is an explicit demand for flexible designed houses (Table 4).

Table 4 Attitudes respecting to have a flexibly designed house

Would you like to have a flexible designed house?	*Frequency (n)*	*Percentages (%)*
Like to have a flexible designed house	*248*	*77%*
Doesn’t like to have a flexible designed house	19	5.9%
Already have a flexible designed house	5	1.6%
Doesn’t know whether to have or not	50	15.5%
Total	322	100%

The suitability of the housing within the scope of functional purpose, the long-term livability of the housing within the scope of future goals, its adaptability for lifestyle in terms of social-cultural sustainability, and whether it is more economical to live in flexible housing in terms of economic sustainability were questioned. According to the answers obtained by multiple choices, it was seen that the functional purposes of the users were considered as the highest priority feature (224 preferences), followed by social-cultural sustainability (129 preferences) and future goals (129 preferences). On the other hand, economic sustainability (79 preferences) remained in the lowest rank among the purposes questioned in the evaluation (Table 5).

Table 5 Distribution of the reasons for those who want to own a flexible house

I want to own a flexible house, because…	*Frequency (n)*
A flexible house is more useful	*224*
I can live for many years in a flexible house	129
A flexible house better suits my lifestyle	129
Living in a flexible house costs less	79

Respondents who do not want to own a flexible house think that flexible housing is not suitable for their lifestyle (7 preferences), flexibility is not a priority demand for housing use (6 preferences), flexible design of the housing is unimportant (6 preferences), and its use is costly (4 preferences). Respondents' foremost reason for rejecting flexible housing was that it was not suitable for their lifestyle, while functional sustainability took second place. In this case, the priority of those who prefer the flexible design was functional sustainability. While the primary reason for those who did not prefer that they thought it was not suitable for their lifestyle. However, the respondents who would not prefer flexible housing (13 preferences) have not encountered or experienced this situation before. Although this answer was excluded from the goals and values of the users, it should be considered as an important sign for flexible housing designs to become widespread in everyone's interests (Table 6).

Table 6 Distribution of the reasons for those who do not want to own a flexible house

I do not want to own a flexible house, because…	*Frequency (n)*
Flexible housing does not suit my lifestyle	*7*
Being flexible is not my primary demand for housing.	6
Flexible designing of the house is unimportant for me	6
Thought that it is more expensive than the house with the same features and size	5
Living in flexible housing costs more	4
Not to prefer since there is no flexible housing example	13

4.1.3. Findings on Opportunities

It has been tried to determine how the innovation brought by the flexible design in terms of change and sustainability can be achieved within the opportunities. In this context, first of all, it was tried to determine the possibilities of the participants to make changes in their residences and the relationship of this situation with the occupancy period of the house. Therefore, respondents who moved from their houses in the last 10 years were asked about the reasons for moving. The reasons for moving of 212 people (66.2%) who moved in the last 10 years at least one time are listed (Table 7), and it was found that the leading reason for the moving was found as leaving from the city lived in (71%, 33.5%). This was followed by functional inadequacy (47, 22.2%), owning a house (39, 18.4%), and economic reasons (19, 8.9%). The effect of the change in the number of households on moving from house remained at the lowest value with 1 person (0.5%), (Table 8).

Table 7 Number of moves in the last 10 years

How many times did you move in the last 10 years?	*Frequency (n)*	*Percentages (%)*
1time	72	%22.4
2 times	64	%19.9
3 times	47	%14.6
4 or more times	29	%9
Never moved	*110*	*%34.2*
Total	322	%100

Table 8 Reasons for moving from the house

What is your reason for moving?	*Frequency (n)*	*Percentages (%)*
Left from the city lived in	*71*	*%33.5*
Functional inadequacy of house	47	%22.2
Owning a house	39	%18.4
Economic reasons	19	%8.9
Adding a new member to the family	1	%0.5
Others	35	%16.5
Total	212	%100

47 respondents, moved from their houses due to functional inadequacy, were asked why they thought the house was inadequate. The answers were, in order of preferences, “there were few rooms” (19 preferences), “rooms were small” (15 preferences), “there was not enough storage space” (12 preferences), “it was not suitable for a lifestyle” (4 preferences), (Table 9).

Table 9 Inadequacies of the formerly settled house

What were the inadequacies of your former house that caused you to move?	*Frequency (n)*
There were few rooms	*19*
Rooms were small	15
Was not have enough storage space	12
Was not suitable for my lifestyle	4
Others	13

It was aimed to determine whether having the opportunity to make changes in the house is a factor affecting the mobility of the housing, and thus how it affects the long-term use of the housing. For this purpose, the answers of the respondents who could make modifications in the house and those who could not be compared. According to the data, it was determined that 153 respondents (47.5%) made modifications in the house but 169 respondents (52.5%) could not make any modifications.

The majority of the 153 respondents who made the modifications are homeowners (141, 92.2%), and the least of them are tenants (12, 7.8%). Also, it has been identified that the majority of the participants have never moved in the last 10 years (72, 47.1%), living in a flat (130, 85%) which has 3+1 rooms (82, 53.6%) and 100-150 m2 size (66, 43.2%). However, the 169 respondents who could not make changes, the majority of them were tenants (88, 52.1%), living in a flat (143, 84.6%), moved at least once or more in the last 10 years (131, 77.5%), living in houses with 3+1 rooms (86, 50.9%) and 100-150 m2 (67, 39.7%) were determined. Considering the reasons for moving of 131 respondents who have moved at least once, in the last 10 years, in the group of 169 people, the most common reasons to move are changing city to live (52, 39.7%), the previous house's inadequacies in fulfillment the needs (27, 20.6%) and economic reasons (15, 11.5%). It was observed that it was not suitable for lifestyle (3, 1.11%) and the difference in the number of households (1 person, 0.8%) remained at the lowest values. 27 respondents declared that they moved due to inadequacies of the house, and 10 (37%) out of them stated the number of rooms

was few, 9 (33.3%) out of them stated the rooms were small, and 4 (29.7%) of them stated the storage space was not enough.

These findings show that even though the size of the housing and the number of rooms are the same, the ownership of the housing affects the desired changes in the housing, and this situation is a determiner in the decision to move from the housing. It is also thought that the most important reason for moving is that the housing cannot meet the needs, and this problem is caused by the few numbers of rooms and the insufficient size of the rooms. In this respect, it is thought that the tenants' reasons for the moving are that the houses are not designed and built in a flexible and convertible way and that the modifications to be made in this regard should be permanent and costly renovations. Therefore, enhancing the flexibility capabilities of the housing appears as an effective method that can reduce housing mobility.

169 respondents who did not make any changes in their houses were asked whether they would like to make changes if they had the opportunity, 114 (67.5%) answered positively and 55 (32.5%) answered negatively. Then, 114 respondents who answered positively were asked about the changes they wanted to make and they were asked to answer seven different multiple-choice options so that they could mark more than once. The most preferred option was to change the size of the room (69 times). Then, combining the rooms (37 times), converting the balcony into a room (33 times), integrating the balcony into the room (32 times), separating the rooms (18 times) were preferred. Therefore, changing the number of rooms and the size of spaces via combining were identified as mostly demanded modifications. These results indicate prominently that residents need a convertible housing space (Table 10).

Table 10 The modifications thought to be realized in the housing where possible

Would you like to make modifications to your house, if it is possible?	*Frequency (n), (%)*		
No	55 (%32.5)	*Which changes do you want to make?*	*Frequency (n)*
Yes	*114 (%67.5)*	*Changing the size of the space*	*69*
		Combining the rooms	37
		Transforming the balcony into a room	33
		Integrating the balcony with a room	32
		Separating the rooms	18
		Others	8
Total	169		

When the willingness of the respondents to have housing that can be converted with technological opportunities and used flexibly with sliding or moving elements are evaluated, 259 respondents (88.4%) signified that they requested and expressed their positive opinion, while 63 (19.6%) are negative. To understand the factors affecting the decision of the subjects within the scope of possibilities, their opinions about the cost of flexible housing were asked. 53 (21.3%) out of the 248 respondents, who stated that they want to have flexible housing (Table 4.), think that flexible housing can be more affordable than housings designed with the same size and number of rooms.

It has also been tried to question how the respondents' moving demands and the fact that the housing becomes suitable for life in all aspects can affect the desire to moving. In this context, it was determined that the highest percentage of the 322 respondents (229, 71.1%) was considering moving out of the house they live in. On the other hand, 121 (52.8%) of these 229 respondents stated that they do not want to move if they can make the changes they want (Table 11). This finding shows that if the housing can be adapted to the user's requests and the demanded changes can be made, the desire to move can be largely eliminated.

Table 11 Respondents' attitudes about moving regarding the flexibility opportunities

Would you like to move from your current house to another house?		*Frequency (n), (%)*
Yes 229 (%71.1)	*I will definitely move*	108 (%33.5)
	If I can make the demanded changes, I won't be moved	*121 (%37.6)*
No 93 (%28.9)	*I am very satisfied with my house and will not move*	93 (%28.9)
	Total	322 (%100)

5. Conclusion

The main aim of the study is to understand the demands of the users regarding the flexible use of the house and to determine the expected flexible using opportunities in the house. The study also aims to figure out the internal dynamics of the process of housing flexibility. The previous studies in the field tried to develop, explain and exemplify the purpose, components, methods, and approaches of flexible design. This study particularly attempted to identify the effective factors in housing flexibility and to define the relationships between these factors. For this purpose, the conceptual model developed within the scope of the study shows how the factors involved in flexibility are effective in the flexible housing design process. According to the model, even though the users request flexible use in the house, this depends on the effect of the user's goals and values on the sustainability and realization of the existing opportunities. So the relationship between the effective factors for achieving a flexible design in the housing has been tried to be conveyed through the model. A case study was conducted to understand the effectiveness of the relationships suggested in the model and to see the corresponding user preferences of these relationships. Due to the COVID-19 conditions, the survey was carried out online with a limited subject group. This circumstance should be indicated as the limitation of the study. It should also be stated that using different survey techniques and widening the subject group would contribute to the study in terms of data diversity.

The results of the study, enabled us to understand the expectations of users regarding housing flexibility in terms of demands for change, goals, and values of sustainability and opportunities. Users stated that they want to have a house with a flexible designed although they have neither knowledge nor experience about housing flexibility. The most demanded factors referring to change have been determined as versatile of the house according to needs and adaptation to changes in the life cycle. The most demanded factors referring to housing flexibility have been determined as adaptability and convertibility of the house according to changes in needs and the life cycle of the users. It has also been revealed that the multi-purpose use of the spaces is the least preferred. In this case, the primary request of the users for change is that the spaces are convertible. Another finding that supports this result is that the users demand flexibility ensured through technological opportunities.

From the point of view of the sustainability of the goals and values, functional sustainability is the most desirable for those who prefer flexible design. Those who do not prefer flexible design think that it is not suitable for their lifestyle. This finding shows that functional sustainability allowing long-term use of housing and compliance with lifestyle appear as two important factors in the sustainability of goals and values in flexible design.

The achieved results concerning the opportunities are also quite remarkable. The most important result obtained at this point is that the opportunity of making changes in the user's house can eliminate the reason for moving from the house. It is thought that flexibly designed houses ensure the possibility of long-term living in it, in that way housing sustainability can be provided, and unearned income from the housing and economic losses that occurred by housing mobility can be avoided. It is seen that these results are in accord with the studies in the field. Similarly,

Schneider and Till (2005, sf:164) state that houses built for flexible use can be used for a longer period, and users who cannot make changes they want have no choice but to move. It should be taken into account that ensuring the long-term use of the house will support people to live in their own environment which eventually allows for flexible designs to support social sustainability. In addition, studies in the field show that the number of rooms for the users is an important factor in residential use (Schneider ve Till, 2005). In this study, it was determined that the users found the flexibility opportunities to increase the number of rooms important.

With the help of its results, the study points out that users clearly demand flexible housing that is suitable for their lifestyle, provides long-term use, supported by technological facilities that allow the spaces to be enlarged and narrowed or divided and combined. This result also clearly refers to the dynamics between components of housing flexibility. Therefore, the relationship between the user's demands for change for flexible use, their expectations regarding the sustainability of their goals and values, and the possibilities that can ensure the realization of them have been determined. The results of the study are thought to contribute to the field by revealing how the components of housing flexibility affect housing design and the relationship between these components and the user demands.

The major contribution of this study to the research area is indicating that, in terms of housing flexibility, adapting to functional changes alone is not sufficient, so ensuring the sustainability of the users' goals and values should be taken into consideration in applications. In this way, the user will live in a sustainable and harmonious manner not only with his/her house but also with his/her social-cultural and physical environment. All in all, this study strengthens the idea that flexible housing design can be effective if user's demands, the sustainability of goals, and values are taken into account and if these factors were implemented within the scope of opportunities in housing flexibility.

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Ethics Committee Approval

This study was approved by Ethics Committee of Çukurova University (113/21 meeting and decision number).

References

Akın, G., (1990). *Asya Merkezi Mekan Geleneği*. Ankara: Kültür ve Turizm Bakanlığı Yayınları.

Altaş, N. E., and Özsoy, A., (1998). Spatial adaptability and flexibility as parameters of user satisfaction for quality housing. *Building and Environment*, 33(5), 315-323.

Atasoy, A., and Ünügür, M., (1983). *Türkiye'de Konut İhtiyacının Karşılanmasında Uygulanan Yaklaşımların Değerlendirilmesi*. İstanbul: İTÜ Mimarlık Fakültesi baskı atölyesi.

Beisi, J., (1995). Adaptable housing or adaptable people. *Architecture & Behaviour*, (11), 139-162.

Benton, T., (1984). Le Corbusier and The Loi Loucheur. *AA Files*, (7), 54-60.

Bognar, B., (1985). *Contemporary Japanese Architecture*. New York: Van Nostrand Reinhold.

Broome, J., (2005). Mass housing cannot be sustained. In P. B. Jones, D. Petrescu & J. Till (Eds.), *Architecture & Participation* (pp.72-86). New York: Spon Press.

Durmisevic, E., (2001). Towards flexible infill systems. *Open House International,* 26(3), 63-68.

Erman, O., and Özinal, D., (2018). Esnek Tasarımda Yeni Bir Yaklaşım Olarak +Mekan. *Proceedings of the 3th International Mediterranean Science and Engineering Congress*, Adana, Turkey, 340-346.

Estaji, H., (2017). A Review of Flexibility and Adaptability in Housing Design. *International Journal of Contemporary Architecture*, 4(2), 37-49.

Forty, A., (2000). *Words and buildings: A vocabulary of modern architecture*. London: Thames & Hudson.

Friedman, A., (2002). *The Adaptable House: Designing Homes for Change*. New York: McGraw-Hill Professional.

Fukao, S., (2011). The history of developments toward open building in Japan. New Architecture, 6:14-17.
Gücesan, M., (2015). *Esneklik kavramının konutlarda irdelenmesi ve İstanbul metropolünden seçilen örnekler üzerinden karşılaştırmalı analizi* (Doctoral dissertation). Retrieved from https://tez.yok.gov.tr/UlusalTezMerkezi/
Günay, R., (1999). *Türk Geleneği ve Safranbolu Evleri*. İstanbul: YEM Yayın.
Habraken, N. J., (1972). *Supports: An Alternative to Mass Housing* (2nd edition). United Kingdom: Urban International Press.
Hamdi, N., (1995). *Housing without houses: participation, flexibility, enablement*. London: Intermediate Technology Publications.
Hill, J., (2003). *Actions of Architecture: Architects and Creative Users*. New York: Routledge, p. 29.
Kalaycı, Ş., (2010). *SPSS Uygulamalı Çok Değişkenli İstatistik Teknikleri* (Vol.5). Ankara: Asil Yayın Dağıtım.
Kendall, S., (2016). Retrieved July 13, 2021, from http://drstephenkendall.com/wp-content/uploads/2016/12/Infill-System-Products-US.pdf
Kronenburg, R., (2005). Flexible Architecture: the cultural impact of responsive building. *Open House International,* 30(2), 59-65.
Kronenburg, R., (2007). *Flexible: Architecture that Responds to Change* (1st ed.). London: Laurence King.
Küçükerman, Ö., (1995). *Anadolu Mirasında Türk Evi*. İstanbul: Türkiye Cumhuriyeti Kültür Bakanlığı Yayınları.
Norberg-Schulz, C., (1966). *Intentions in Architecture*. Boston: MIT Press.
Rabeneck, A., Sheppard D., and Town, P., (1973). Housing flexibility. *Architectural Design*, 43(11), 698-727.
Rasmussen, S. E., (1994). *Yaşanan Mimari*. İstanbul:Remzi Kitabevi, p. 102.
Schlorhaufer, B., (2016). The Growing House, Retrieved May 12, 2021, from http://txt.architecturaltheory.eu/?p=2085&lang=en
Schmidt III, R., Eguchi, T., Austin, S., and Gibb, A., (2010). What is the meaning of adaptability in the building industry?. *Proceedings of the 16th International Conference on Open and Sustainable Building,* Bilbao, Spain, 17-19.
Schneider, T., and Till, J., (2005). Flexible Housing: Opportunities and Limits. *Arq: Architectural Research Quarterly*, 9(2), 157-166.
Schneider, T., and Till, J., (2007). *Flexible Housing*. United Kingdom: Architectural Press, Routledge.
Teige, K., (2002). *The Minimum Dwelling*. United Kingdom: MIT press.
URL-1: Retrieved February 01, 2021, from http://architectuul.com/architecture/view_image/rietveld-schroder-house/19289
URL-2: Retrieved May 12, 2021, from https://www.db-bauzeitung.de/architektur/in-die-jahre-gekommen-elementa-72-in-nuernberg/#slider-intro-7
URL-3: Retrieved January 11, 2021, from https://www.atlasofplaces.com/architecture/nemausus/
URL-4: Retrieved January 11, 2021, from http://www.guardtillmanpollock.com/soho-1/
URL-5: Retrieved May 22, 2021, from https://www.archdaily.com/106601/kyoto-model-a-house-with-3-walls-shigenori-uoya-miwako-masaoka-takeshi-ikei?ad_medium=gallery
URL-6: Retrieved January 11, 2021, from http://www.open-building.org/ob/next21.html
Uzel, N., 2001. *Esnek ve adapte olabilir konutlar için değerlendirme rehberi* (Doctoral dissertation). Retrieved from https://tez.yok.gov.tr/UlusalTezMerkezi/
Yagi, K., (1986). *A Japanese Touch for Your Home*. Tokyo: Kodansha International Ltd.

Resume

Damla ÖZİNAL graduated from Çukurova University in 2017. She is continuing her master's degree at Çukurova University Faculty of Architecture. Since 2020, she has been working as a Research Assistant in the Department of Architecture, Faculty of Architecture at Çukurova University. She does researches in architectural design.

Assoc. Prof. Dr. Onur ERMAN; teaches architectural design and various theoretical courses in architectural education. Her main academic and professional interest areas are architectural education, design theory and methodology, spatial configuration and spatial analysis in scope of space syntax. At present, she works as academic in Faculty of Architecture at Çukurova University.