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Emerging living styles post-COVID-19: housing flexibility as a fundamental requirement for apartments in Jeddah

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Abstract

Purpose – The COVID-19 pandemic resulted in the compulsory quarantine of many of the world's inhabitants, and by staying at home, several functional developments emerged in residential spaces in Jeddah that affected the role of the house as a contributor to individuals' quality of life under the pressures of quarantine. Given the necessity of the apartments to adapt to these emerging developments, this study explores the determinants associated with the flexibility of residential apartments by looking at the extent to which they meet the new psychological, social and cultural roles required by their users post-COVID-19.

Design/methodology/approach – The qualitative approach (1) extracted concepts related to the flexibility of housing from the available literature and (2) extrapolated the flexibility of the residential apartments from the participants' study (12 families) in different areas of Jeddah by analyzing the results of targeted interviews.

Findings – There is a gap in the participant's understanding of the quality of housing and the level of satisfaction with a housing design that differs before and after their quarantine experience. The participant's adaptation to self-quarantine was mainly through furniture distribution, and housing flexibility was less reliant on the physical transformation of the place than on the change in the inhabitants' perceptions. There was an indication that the deficiencies of flexibility in design relates to the functional, cultural and structural aspects of residential buildings.

Originality/value – This study generated suggestions to develop the foundations for flexible housing design and activate its role under the post-quarantine context according to social and cultural variables. Some proposals should become future requirements for residential apartments to benefit officials and stakeholders to develop housing flexibility.

Keywords Housing, Flexibility, Adaptability, COVID-19, Lifestyle

Paper type Research paper

1. Introduction

The house is considered one of the most important spaces that contributes to the quality of life of individuals and groups. With the emergence of the COVID-19 pandemic, the house renewed its role in supporting family ties and the psychological, spiritual, social and cultural aspects, customs and traditions of individuals and families.

With the implementation of quarantine and the general context of preventive policies and measures taken by most countries to deal with the pandemic, most policies have progressed from partial to total quarantine in accordance with a number of operational measures. This was also the case in Jeddah, Saudi Arabia, where a 24-h curfew was introduced in April and May 2020. It should be noted that the quarantine period, which lasted from March to June, is an important period in the life cycle of the residents of Jeddah, as it is characterised by moderate temperatures (spring and early summer) and relates to the end of the school year (exam period). This period also includes preparations for the summer vacation season, which, in 2020, coincided with the holy month of Ramadan and Eid al-Fitr. These seasons are normally characterised by the revitalisation of social relations between families and friends,

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the intensification of visits to public places, entertainment venues, gyms and mosques and the performance of religious rituals.

In investigating the issue of post-pandemic spatiality, Salama (2020) points to a shift in the spatial features of home and work environments, which will lead to new ways of living and working, due to distancing measures and daily life in a virtual/digital world. According to the author, this change will influence the existing housing stock and working places, which will demand appropriation and adaptation of the existing housing and workplaces and new standards and specifications for new living and working settings. In this context, the role of architectural and design treatment has been put forward for residential apartments in Jeddah. The extent to which they meet the emerging requirements of individuals and families and support all psychological, social and cultural aspects can be assessed as the response to the necessities of life post-COVID-19. Architect Sergey Makhno posits that post-COVID-19, people's values, lives and habits, as well as their homes, will change under such an influence. There are seven predictions of changes that might happen: Houses not apartments, bunkers better than open-plan, self-sufficiency of power and water, filtration and neutralisation, the home as the new office, urban farming going global and the rejection of mass industry (Makhno, 2020).

By considering flexibility as an answer to the changing circumstances (Lans and Hofland, 2005), the importance of flexible housing design and its role in achieving "the compatibility of the changing relationships between events, context, and use of space" can be clearly reflected (Hill, 2003). Flexible housing is coupled with several factors, including (1) the evolution of users' needs due to the combination of rapid changes that usually arise from the size and composition of the family; (2) the changing aspirations they often aspire to and the need for adjustments over time (Gilani and Türker, 2019; Malakouti *et al.*, 2019) and (3) changes in behaviour, which require changes in housing requirements whether they belong to an individual or a family (Lans and Hofland, 2005).

Flexibility under the COVID-19 pandemic indicates the extent to which adaptation is made possible while maintaining the basic role of the house and emphasising its implicit role imposed by the current and future situations. Where the concept of the evolving needs of users is associated with the circumstance of the rapid changes related to staying at home (which imposed on the household a set of behavioural determinants in a short period of time), it also refers to the concept of changing aspirations that individuals often aspire to, which require adjustments that compensate mainly for the lack of an inside-outside relationship with the world that ranges from entertainment, social communication and mobility to adapt with the quarantine situation. It also addresses the concept of behavioural changes and the changes this imposes on housing requirements in a timely manner. These changes depend on a reality that enforces adaptation to new activities after the issuance of the stay-at-home order and the closing of schools, companies, restaurants and so on represented optimal solutions to prevent significant and continuous damage to public health. Therefore, the special conditions associated with the pandemic are considered as an opportunity to reflect on the flexibility of the residential apartments in Jeddah and the extent to which they meet the new requirements of their users and can provide a set of practical proposals to activate the role of the house and adapt it to the post-COVID-19 situation.

The study questions are as follows:

(1) Are apartments in Jeddah considered to be flexible under the self-quarantine experience during the COVID-19 pandemic?

(2) How did the inhabitants of Jeddah apartments adapt to self-quarantine? (Functional-usage updates encountered by participants/solutions.)

(3) What are the determinants associated with the flexibility of housing as a contributor to the quality of life of individuals under quarantine?

(4) What are the proposals that could develop the concept of housing flexibility to fulfil its psychological, social and cultural roles post-quarantine?

This article is organised as follows. The literature review presents the definition of housing and the most important changes that have emerged due to quarantine under the COVID-19 pandemic, in addition to the definition of flexibility in the house. Then, the methodology is presented. Last, the results and their discussion are provided, followed by the resulting recommendations.

2. Literature review

2.1 Designing dwellings or homes?

Studies on the definition of housing differ (Lawrence, 1987; Smith, 1994; Bettaieb and Alawad, 2018), as houses are considered too big to be mere "dwellings" and are instead defined through their cultural, social, demographic and psychological dimensions (Bettaieb and Alawad, 2018).

A set of data relating to society's beliefs, customs, traditions and foundations of building relationships and behaviours in the home has developed the understanding of a house as "the shelter in which the basic individual and family functions are realised, and as a field for family relations and a container for socialisation, as well as being a cultural constituent that reveals the interaction of the individual with his milieu. The interaction of the individual with the house produces comfort, warmth, privacy, and connection to the place" (Ibrahim, 2008).

Bettaieb and Alawad (2018) assessed the necessity of providing comfort, with all its psychological and physical types, through design considerations. The source of achieving psychological comfort is restricted by several factors such as aeration, lighting, colours, materials, masses, sizes, shapes, and all that is correlated to be tangible, audible and visible in a space. They stressed the need to balance these elements to give a feeling of physical comfort. They also linked the source of achieving physical comfort by building functional relationships between most of the physical components of the house by using the human dimension as a basis. The balance between these various components is considered a necessity that stimulates a sense of physical comfort while simultaneously confirms psychological comfort (Bettaieb and Alawad, 2018).

In this context, the architectural design of residential buildings in general, and interior design in particular, play a fundamental role in balancing the determinants of the engineering production of residential apartments and the requirements of the production of housing a "home" in a number of its necessary human dimensions.

The design of a residential building is generally controlled under a set of requirements for spatial regulation (municipal requirements that show rebounds, heights, construction ratio, parking lots fences and so on (Ministry of Municipality and Rural Affairs, 2019)) and a number of parameters (such as the Saudi Construction Code) to ensure safety and public health in addition to a set of architectural requirements including room space, interior space heights, ventilation shafts and entrances. These requirements are an important reference for general design considerations and an effective source in achieving maximum quality design housing.

In general, a room is the smallest practical unit in a dwelling. It derives its characteristics as an independent unit in terms of its size, shape and openings, yet it is an integral part of the dwelling when considering its relationships with the surrounding rooms or accessible roads (Femenias and Geromel, 2019). It is also an integral part of the building when considering the importance of the location of its windows as the windows are connected to a rhythmic

sequence to the outside. The façade can facilitate the reorganisation of space indoors and allow multiple entrances to time-adjustable usage where one apartment can be divided into two apartments (Zivkovic and Jovanovic, 2012; Femenias and Geromel, 2019).

Here lies the importance in the role of professionals (architects, interior architects and interior designers) in balancing the dwelling between the number of constraints to the context of the residential building project (location, direction of the building, façade, roles, etc.), the requirements of the concerned authorities (municipalities and supervisors of residential buildings) and the requirements of the quality of life of individuals and families in the framework as dictated by the psychological, social and cultural dimensions, customs, and traditions. In addition, they take into consideration essential design concepts that help users cope with changes and adapt over time.

As part of the housing efficient design performance framework, Malakouti *et al.* (2019) defined 13 quality indicators that form housing quality indicators (HQI). These indicators assess the quality of housing in relation to location, design and performance (see Table 1). These indicators are particularly important in assessing the level of occupant satisfaction with the quality of their housing and are considered an effective way of ensuring residential comfort (Malakouti *et al.*, 2019).

2.2 The house and the most important changes resulting from quarantine

With the emergence of the COVID-19 pandemic, the slogan "Stay at home" directed individuals and groups to only leave the house for the utmost necessities. This slogan was accompanied by quarantine and several preventive measures to reduce the spread of the virus. In this context, several changes have emerged for a range of concepts relating to housing, which have had important effects on users' behaviours and lifestyles. These changes are mainly related to:

(1) *Considering the inside–outside relationship*, particularly regarding the concept of housing as a central moral point from which the individual continuously leaves and returns to. This is defined as the base activity that provides a centre for departure and return (Hayward, 1977; Bettaieb and Alawad, 2018) or as the fundamental need of individuals being the basic refuge in their daily life after the dynamism of the activities of living (Ibrahim, 2008; Bettaieb and Alawad, 2018); or as the characteristic of both centrality and continuity by being a central point linking the interior and exterior (Tognoli, 1987).

In this context, the movement of an individual is affected, and everything relates to their relationship with the interior and exterior of their residence. The development of an individual's behaviour and perceptions is also affected during his/her daily activities. The relationship to their internal environment becomes affected by a number of structural,

Location	
Site	Visual impact, layout and landscaping
	Open space
	Routes and movement
Unit	Size
	Layout
	Noise control, light quality and services
	Accessibility within the unit
	Energy and green and sustainability issues
Performance in use	

Table 1.
The proposed housing quality indicators (HQI) framework (Malakouti *et al.*, 2019)

functional and aesthetic properties of the residence (the openings as a source of natural lighting, the location of the window in the room and the shape and area of the opening and the external view that it overlooks it).

(2) *The daily life activities of the individual* such as work, entertainment, sleep, food, family gatherings and communication with others through the virtual void and their accumulation in a specific and limited spatial framework at the level of space/components/material resources. Their relationship with the internal environment has become influenced by the characteristics of space, its division and the possibility of establishing new activities therein. In the case of an open space plan, the living room can frequently become an area of passage, although it cannot be used as a quiet space for rest (Femenias and Geromel, 2019). This may apply for open floor plans for families who work different hours or for families that sometimes need to separate men and women (Femenias and Geromel, 2019).

(3) *Changes in behaviour* due to the nature of the political, social and cultural changes that have taken place and the changes they imply in the requirements of housing whether belonging to an individual or a family. In this context, the house is affected as a physical structure in which an individual interacts with what is around him/her according to a set of material and moral considerations (space, shape, functions, components, design, relaxation, comfort, freedom, and communication with family members) within the framework of specific time periods (morning, afternoon and night) to relate to important psychological aspects such as privacy and comfort. Through the quarantine experience, cohabitants explore the efficiency of the design of the house in which they live.

2.3 Overview on flexibility

Based on previous research (Malakouti *et al.*, 2019), the fundamental factor related to the components of flexibility in residential spaces is the multifunctionality and capacity of expansion. Malakouti *et al.* (2019) noted the potential benefit of multifunctional spaces is the ability to adapt to different functions using minimal budgets and time frames to find diverse functions of the spaces by varying the distribution of furniture (Malakouti *et al.*, 2019).

While various stages of flexibility relating to a building's life cycle have been identified, the first stage concerns the "design phase", where designers use strategies to enhance flexibility before or after the building is occupied. The second stage is the "construction phase", which usually relates to the possibility of making design changes as the construction project progresses. The third stage (the "employment phase") concerns the occupation of the building and the changes required based on the residents' needs, desires, cultures and lifestyles (Gilani and Türker, 2020).

In this context, it should be emphasised that use is one way of achieving flexibility in the field of housing. Malakouti *et al.* (2019) studied the indicators linking the elements of flexibility to find that performance is an imperative qualitative indicator. The strong relationship between this indicator and flexibility divulges that flexibility has a tendency to grow with improved performance, and vice versa (Malakouti *et al.*, 2019).

It should also be noted that the flexibility of a space is influenced partially by the user, or as Hill (2003) explained, the change of use may be "less dependent on the physical shift of the place than the change in user perception". In this context, (Gilani and Türker, 2020) identified three types of flexibility: structural, functional and cultural.

2.3.1 Structural flexibility. Structural flexibility relates to the architectural design of the building as an effective factor in the development of new facilities and services and the use of the façade in relation to the design of openings, balconies and so on. It also relates to the house

as a structural unit that assumes, through its location in the building (e.g. floor, apartment), a number of determinants that affect the implementation of design solutions. It is not restricted to structural change as a whole but to physical change that occurs in the interior of a house when its occupants modify them to suit their needs on the basis of professional intervention (Malakouti *et al.*, 2019). Generally, structural flexibility may be achieved in terms of expansion, expansion versus contraction, the subdivision of areas vertically or horizontally or by choosing a free structural system with an open plan for future changes and a system of standardised adjustment (Gilani and Türker, 2020).

2.3.2 Functional flexibility. Functional flexibility relates to the possibility of changing circumstances by allocating new functions without professional intervention as the creation of space does not necessarily affect the overall structure of the house (Gilani and Türker, 2020). It does not require significant expenditure for implementation but can be related to the different dimensions of the rooms when matching new spaces and meeting new requirements without additional expense (Raviz *et al.*, 2015). Furthermore, functional flexibility relates to a range of important design concepts such as open space, movable furniture, space juxtaposition, fixed versus flexible space and mixed-use spaces with simple structural modifications (Gilani and Türker, 2020). Flexible housing provides an opportunity for residents to participate in the design of their home and arrange their living space according to their lifestyles and needs by creating new places and temporary spaces during the day and night (Raviz *et al.*, 2015).

Functional flexibility revolves around the ability to exchange and change spaces, to accommodate a variety of spatial schemes and activities by changing the composition of space (Gilani and Türker, 2020), to redistribute certain functions or activities based on available space or by using unused space or by moving or reconfiguring complex elements in the dwelling or using the removable parts and/or open plans, which according to Hill (2003) are descriptions for both use and shape and are characterised by tight space-to-use convenience.

Moreover, functional flexibility relates to the integration of various activities when necessary and promotes the diversity and multiplicity of links between adjacent spaces without geometric changes in the form of architectural spaces (Raviz *et al.*, 2015). This is achieved through the possibility of creating new spaces with different types of spatial relationships through the sequence and interconnection of spaces using sliding doors, walls and flexible elements. These new spaces meet the needs of their residents, which originates from the activities of family members during the day or night (Raviz *et al.*, 2015).

2.3.3 Cultural flexibility. Culturally appropriate flexible design is one of the key elements that leads to the design of a sustainable dwelling at the micro level (Gilani and Türker, 2020). By considering the different characteristics of individuals living in a house as a unit that reflects a small-scale version of the need to sustain the internal environment, this study focuses on cultural flexibility according to Gilani and Türker (2020) who focused around: (1) individuality/personalisation, as an apartment's adaptation features users as different individuals in terms of interests, tastes and preferences, which are all renewable and (2) providing privacy between the outside and the interior, between public and semi-private areas and between semi-private and private areas and other various levels. This also includes physical privacy by some physical controls and visual privacy where access and visual communication between spaces is controlled by some physical elements.

This study seeks to explore the flexibility of residential apartments in Jeddah, Saudi Arabia, by considering the extent to which they meet the requirements of their new users and by presenting a number of practical proposals to activate their role in adapting to post-COVID-19 life.

3. Methodology

This study relied on analytical and inductive approaches (see Figure 1). An analysis of the literature built concepts related to housing, its flexibility and the most important developments in the quarantine situation. In addition, the results of semi-structured interviews were analysed, and the most important functional-use developments faced by the participants in their experience were extracted alongside the most important solutions they have developed to adapt to the stresses of the quarantine situation.

An inductive approach was also used by extrapolating the elasticity of residential apartments in Jeddah during the pandemic period in terms of design and use (functional, structural and cultural flexibility) and by generating proposals to develop the flexibility of residential apartments to activate the role of housing in terms of social and cultural variables imposed to coexist with the virus post-quarantine.

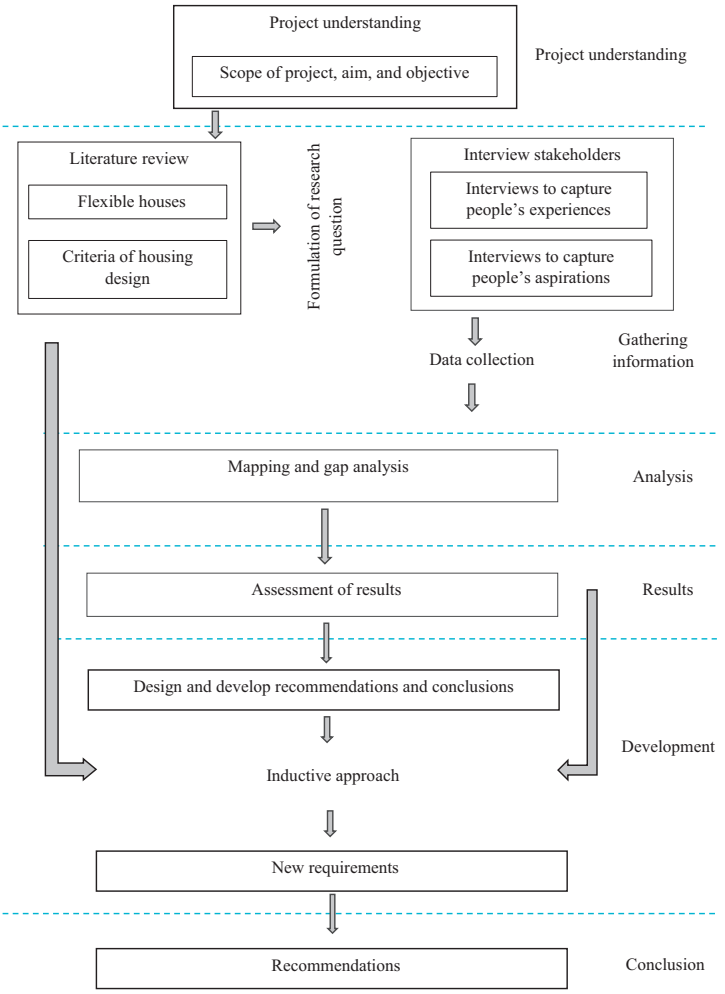

Figure 1.
Study approach

3.1 Data collection procedures

First, the researchers identified several concepts related to the flexibility of a dwelling (see Figure 2).

Second, an interview was conducted using an open-ended question according to the context of the study. In the first stage, an interview was presented to a group of colleagues in the fields of interior design and statistics. In the second stage, a pilot interview was conducted with a family. These two stages made it possible to verify the clarity of the language, themes and questions. During these stages, some suggestions were made regarding the number of questions and the structure of the axes. Based on the comments, some questions were deleted, the axes were reclassified and the criteria for choosing an apartment before the COVID-19 pandemic were defined as a separate axis after considering the importance of the housing quality indicators that relate to the pre-quarantine period.

The participants represented 12 families, each residing in one of Jeddah's regions (North, South, East, and Central). Three families were identified in each region. The researchers clarified the purpose of the study and emphasised on confidentiality; the information would only be used in the field of scientific research. The participants were counted according to a set of criteria, including:

(1) Saudi nationality.

(2) Each family lived in a four-room apartment.

(3) Each family consisted of two parents and their children, and the number of inhabitants ranged between four and six people.

(4) The age group of young parents.

(5) The parents' educational level was not lower than bachelor-level.

(6) The social level was the middle-income class.

Mothers were chosen to participate in the interview for their cultural responsibility at home, referring to their ability to conduct the family's affairs, understand the family's needs and make purchasing decisions. The interview was conducted remotely via the Zoom video conferencing application due to the pandemic.

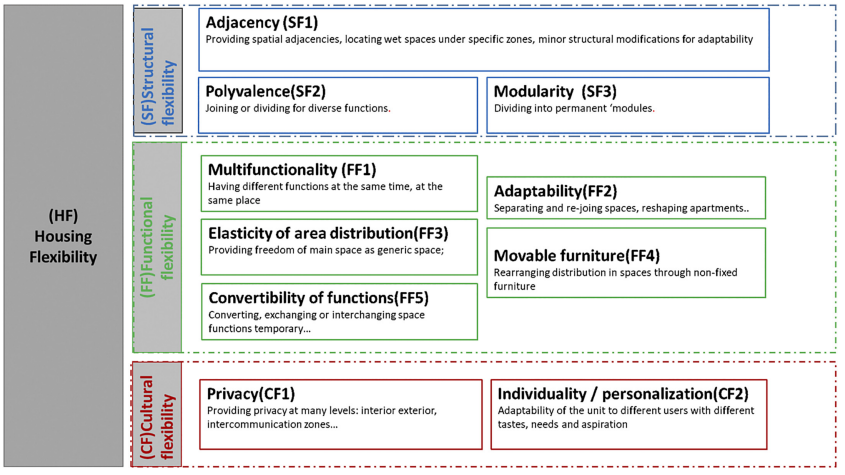

Figure 2.
The proposed housing flexibility (HF) framework

3.2 Instrumentation and development of the interview

A model of interview card was built to collect basic data relating to the research problem of the difficulties faced by apartment dwellers in Jeddah in adapting to the developments of the COVID-19 pandemic and its impact on the quality of their daily lives due to the inadequacies of their housing.

The data were collected with the aim of: (1) checking the availability of HQIs; (2) understanding the participants' experience in adapting to the quarantine situation regarding functional-use developments during their daily lives and the solutions they have developed to counter them and (3) understanding the participants' aspirations towards the structural changes of housing according to their new needs. The card included four axes.

The first axis determined the primary information for the participants (their families and their housing) and included information about the number of family members, their ages, the employment and study status of each individual, the number of rooms and toilets, the residential area, the roles and the years of occupancy.

The second axis related to the criteria for choosing a residential apartment before the COVID-19 pandemic according to the theoretical HQI framework (Malakouti *et al.*, 2019), with minor amendments aimed at focussing on the design aspect and the level of satisfaction with the design of the apartment. The criteria for selecting both the location and the area of the apartment included the suitability of the number of rooms for individuals, the extent of the presence of openings and external windows, the presence of a distinctive external view, the quality of the design of the empty spaces, the level of finishing, the suitability of the rental fee, the extent of the presence of architectural services (such as elevators and parking) and facilities (such as external balconies, a driver's room or shared roof).

The third axis related to the participants' behaviour in adapting to the quarantine situation when facing functional-use developments during their daily lives.

The fourth axis related to the participants' aspirations towards the structural changes of the dwelling according to their new needs at the level of the building's facilities and services (the architecture as a whole) and the level of the architectural structure of the dwelling (division of spaces, openings and external spaces).

3.3 Data analysis procedures

First, the characteristics of the participants (families and their dwellings) were analysed (see Table A1) according to the number of individuals, their ages and their jobs, as well as the characteristics of the apartments, including the number of rooms and bathrooms, the location of the dwelling and the number of years of occupancy. The ages of the participants ranged from 21 to 44 years for mothers (with an average age of 32.5 years) and from 28 to 50 years for parents (with an average age of 39 years). The ages of the children ranged between 1 and 11 years, and the ages of the adolescents ranged between 13 and 16 years. There were employed persons in 58% of the families, and the number of years of occupancy ranged between 1 and 11, at an average rate of five years.

Second, the HQIs were checked when selecting the participants according to the theoretical framework (Malakouti *et al.*, 2019), with some modifications according to the context of this study. The participants were asked about specific HQIs (see Table A2) and answered "yes" or "no" without delving into detail. The "yes" and "no" answers were coded as "1" and "0", respectively, to extract the most important indicators that satisfied them before the COVID-19 pandemic. The results (see Figure 3) show that the most important indicators of housing quality were the participants' reasons for owning the house before the COVID-19 pandemic (which mostly received 1), such as the location (I1), the building services (I4) aspects relating to the housing design meaning the space and quality of design, finishing and suitability of the number of rooms (I6, I7, I8, and I9) and the effectiveness of the performance of use (I13).

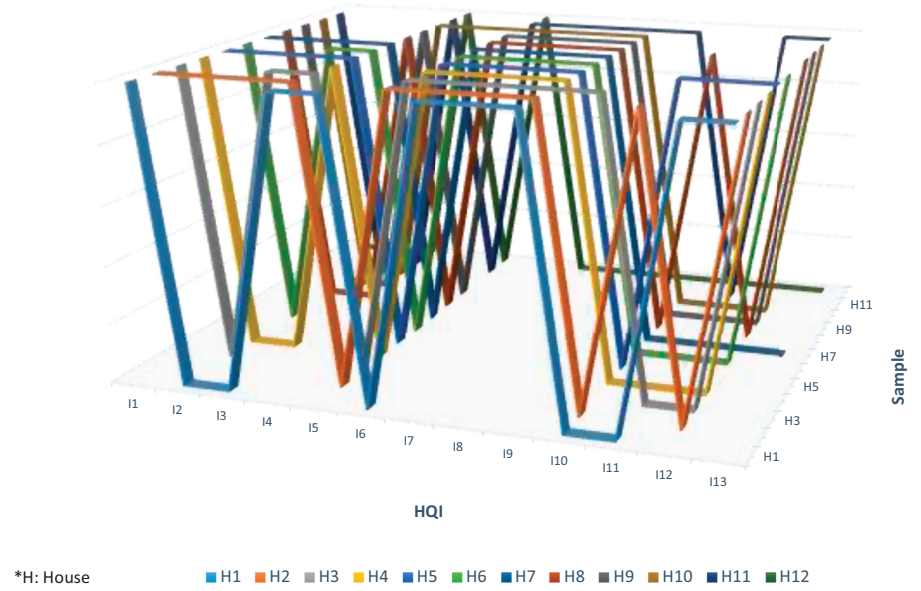

Figure 3.
The most important HQIs (before COVID-19) according to the participants

Third, the information obtained during the interviews was analysed separately in preliminary tables according to the total usage and functional activities that were identified through the theoretical part of the flexibility axis. Then, it was unified in a comprehensive table, with details of the special activities appearing according to the cultural specificities of the participants (see Table A3).

4. Results and discussion

Quarantine is considered as an important experience in which to extrapolate the effectiveness of housing design through its "performance in use" flexibility as it is the most important qualitative indicator that relates to flexibility elements (Malakouti *et al.*, 2019). The results of the quarantine period experience are shown in the following sections.

4.1 Adaptation of residential apartments to quarantine pressures

The participants were able to cope with functional-use developments daily by several measures. First, they increased the acquisition of electronic devices as a kind of compensation for not practicing external activities (whether for children or adults) either through the purchase of additional televisions or computers to work remotely or to study. This required an increase in electrical loads and additional extensions of electrical wires inside the residential space—a dangerous element if methods of safety were ignored. In addition, they compensated for drinking coffee as a form of entertainment, as is the habit and tradition for the participants in cafes, by allocating a corner within the residential space for this activity. The new corner was often uncomfortable due to the lack of privacy and the associated noise.

The participants also redistributed functions within the house as they showed desire for specialists to provide practical solutions, such as the redivision of functions and allocation within the space (multiple functions were sometimes irritating from the dynamic activities of some family members while others required calm and focus) or by providing advice for

materials used in furniture that absorb noise from inside the apartment or insulation materials that protect against external noise from the street or neighbours.

Furthermore, the participants rethought the use of the reception space, which is usually closed and is temporarily opened to receive guests. Customarily, apartments are designed with the reception room next to the entrance, making it the main façade of the apartment as it occupies a large area. The participants also changed the function of the reception room and started using it as a space for daily living and play or as a home office. In addition, they rethought the priorities and uses of reception furniture (space, size and furniture), as well as started using some spaces inside the apartment for remote work, study and training or for entertainment and sports.

Another measure was the creation of a play or sports space, as many residents discarded furniture in the house to adapt to these needs. In addition, the participants allocated storage spaces for toys and entertainment at the expense of functionality. Finally, the participants updated the lighting system and started using artificial lighting due to the lack of external windows or their small size. All participants complained about the opening of some of the main spaces' ventilation shafts (a space dedicated to lighting and ventilation of rooms and construction facilities according to specific requirements (Ministiry of Municipality and Rural Affairs, 2019)).

The most important functional-use developments were summarised as working from home, online studying, frequent and long family communication (watching TV, communication, games), drinking coffee at home as compensation for going to cafes, practicing recreational activities, storing important quantities of supplies and sterilisation practices before storage as a necessity of the situation.

The functional-use developments varied with the characteristics of families and differed according to the average age of the children and their needs for spaces according to the nature of their activities inside the house. It also varied according to the interests of the children and adolescents and the different levels of their needs related to the nature of activities. Furthermore, the results indicated that a large percentage of the families looked to increase the level of privacy in their homes according to the housing design. The flexibility of the home was also important for the participants in the context of the necessity to respond to the variables that could occur to families, such as the average number of years of occupancy (five years) or the ages of the young children.

4.2 Determinants related to the flexibility of housing as a contributor to the quality of life of individuals under quarantine pressures

In the context of classifying the difficulties according to the determinants of flexibility types, the results generally showed a gap in the participants' understanding of the quality of housing and the lack of a corresponding level of satisfaction between the design of the house before and after the quarantine experience (see Figure 4). This gap was found between participants' expectations and their realities in the usages during the quarantine.

For the functional flexibility determinants such as the possibility of "change without professional intervention" (Malakouti *et al.*, 2019), the most important functional user difficulties of the participants related to the availability of spaces, the characteristics of spaces (shape and mobility), the technical problems, relationships and distribution between rooms (room distribution/room juxtaposition) and inadequate availability of natural lighting. The results also show that flexibility is "less dependent on the physical shift of place than the change in user perception" (Hill, 2003).

For the cultural flexibility determinants, the most important difficulty was in the adaptation of the house to the accumulation of the daily life activities of individuals within a specific and limited space for users of different ages, interests, activities, tastes and

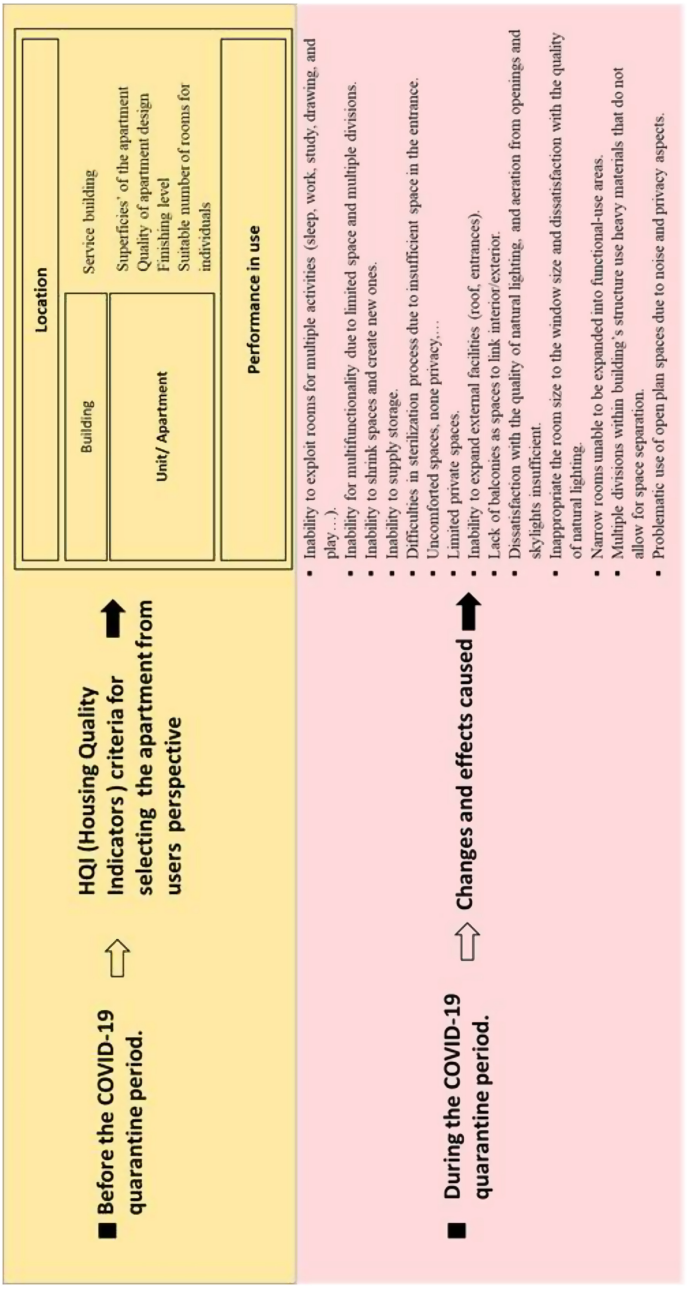

Figure 4.
Perception and experience of users before and during the COVID-19 quarantine period

preferences due to quarantine, which negatively affected the privacy aspect and adaptation to users' differences in spaces.

Although the nature of these functional-use difficulties were temporary circumstantial difficulties related to the status of the COVID-19 pandemic, they demand consideration as they relate to the lifestyle quality of the individuals and groups. As such, it is necessary to reconsider them as future necessities in the design of apartments in the post-COVID-19 period.

In general, most of the solutions for participants were related to circumstantial solutions that were essentially implemented to adapt to the situation through the distribution of furniture (Malakouti *et al.*, 2019) through dividing and recombining spaces by moving furniture; rearranging furniture in places through non-fixed furniture; using unused spaces indiscriminately and temporarily exchanging or switching spatial functions in addition to integrating different activities into one place with the irritation of physical and moral discomfort.

For the structural flexibility parameters such as the possibility of "professional intervention change" (Malakouti *et al.*, 2019), the results reported a number of aspirations for the structural changes of the apartment and the building in accordance with their new needs in terms of the development of facilities and services for the building (architecture as a whole), such as having a common rooftop area and a common gym in the building. At the level of the architectural structure of the house, inhabitants aspired for the ability to open additional windows on the outside, the presence of a balcony and the presence of a space for gardening inside or outside the apartment. According to the results of the study, Figure 5 summarises the spatial flexibility of the house from the participants' experiences.

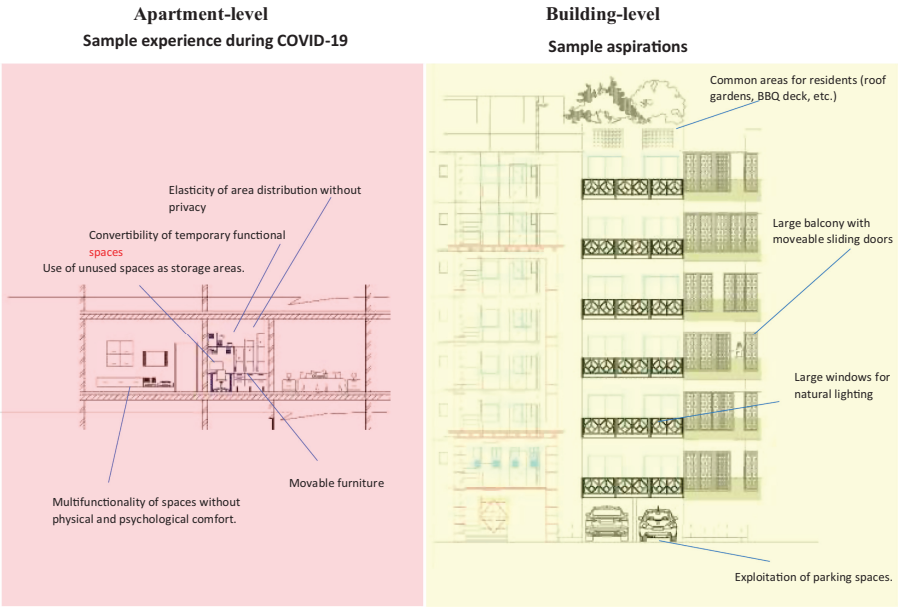

Figure 5.
Spatial flexibility from users' experiences during the COVID-19 quarantine period

4.3 Proposals to develop the concept of housing flexibility and activate the psychological, social and cultural roles of accommodation post-quarantine

The quarantine experience is an important experience in which to reflect upon the effectiveness of the overall performance of apartment design. In this study, the participants' characteristics reflected a strong proposition to address housing flexibility and its role in achieving quality of life through design treatment. Families undergo changes in size, structure and members' aspirations, and with these changes comes changes in their needs (Hill, 2003; Forty, 2004; Malakouti *et al.*, 2019; Gilani and Türker, 2020). This, alongside the changes in behaviours and the accompanying changes in accommodation requirements (whether for the individual or the entire family) emphasises the need for housing flexibility (Lans and Hofland, 2005).

The results indicated that the participants, who live in apartments in Jeddah, lack several factors that are essential in achieving housing flexibility. There has been a lack of emphasis on this concept and on the principle of building sustainability in the past decade, especially for the middle-class and difficulty in its execution for multiple reasons (technological, economical and so on).

In pursuit of the Saudi Vision 2030 goals of improving the lifestyles of Saudi individuals and society, the treatment of residential space design plays a crucial role as it promotes the inclusion of the human factor in architecture, supports familial bonds and supports spiritual, psychological, social and cultural aspects, customs and traditions of individuals and families. In this context, a number of proposals have been generated to develop the concept of housing flexibility and activate its role in the post-quarantine situation (see Tables 2 and 3).

5. Conclusion

This study explored the determinants associated with the flexibility of residential apartments by examining the extent to which they meet the new psychological, social and cultural roles required by their users in the post-COVID-19. It generated suggestions to develop the foundations for flexible housing design and activate its role under the post-quarantine context according to social and cultural variables. Some proposals should become future requirements for residential apartments so as to benefit officials and stakeholders to develop housing flexibility.

By finding a gap in the participants' understanding of the quality of housing and the level of satisfaction with the housing design that differs before and after their quarantine experience, the participants' adaptation to self-quarantine occurred mainly through furniture distribution, and housing flexibility was less reliant on the physical transformation of the place than on the change in the inhabitants' perceptions. There was an indication that the deficiencies of flexibility in design relate to the functional, cultural and structural aspects of residential buildings.

5.1 Recommendations

Given this context, the researcher recommends to:

(1) Conduct future in-depth studies of residential environmental quality criteria post-COVID 19.

(2) Adopt the concept of flexible housing by professionals (architectural design, garden design and interior design) as being fundamental in the design philosophy for residential buildings.

Table 2.
Proposals for the development of housing structural flexibility

Types of flexibility	Factors for the flexibility of housing			Proposals for the development of housing flexibility
Structural flexibility	Building	Facilities	Parking	(1) Revisit the design philosophy of parking lots (2) Use garden design as a new starting point, with a review of architectural treatment of common spaces and the building block-level as a whole
		Services	Common rooftop areas	(1) Utilise rooftops as a common areas shared with neighbours by assigning a square metre for each resident to practice social and recreational outdoor activities. To maintain privacy, specific times can be assigned to each family in the building, or all neighbours can gather to build stronger bonds (2) Provide essential safety elements in terms of fence heights, shade and sufficient ventilation away from drainage vents
			Storage space	(1) Provide rooms in parking lots to be used as private or shared storage spaces
	Housing	Openings	Ventilation shaft	(1) Rethink the concept of using ventilation shafts and its characteristics and design (2) Redraft and detail ventilation shaft requirements and restrict opening windows (e.g. bedroom, living room, kitchen and dining room windows) with collaboration from relevant authorities (Ministry of Municipal and Rural Affairs) (3) Add botanical and aesthetic elements to the ventilation shaft area if used, while increasing window area to enable more light to enter the space
			Windows	(1) Redraft requirements for opening windows to be in all rooms of the residence with clear criteria to allow natural light in, thus reducing electrical consumption of the apartment (2) Propose criteria for opening large and wide windows extending from the floor to the ceiling to allow entry of sunlight and connection with nature, while taking into consideration neighbours and the corresponding property to allow privacy for all (3) Use double-glazed glass to insulate sound, reduce heat and reduce energy consumption
			Balcony	(1) Draft requirements for adopting the balcony as a necessary space for each building with a sufficient area of at least six square metres per apartment to be used for activities such as gardening, children's leisure, recreation and connection with nature
		Technology	Keeping up with emerging needs	(1) Provide a large number of electrical outlets inside the residential space and increase the number of electrical outlets inside rooms
		Dividing spaces		(1) Adopt flexibility in dividing spaces through using sliding doors, walls and flexible elements to facilitate changing the functions of the space as needed and with the lowest cost (Hill, 2003)

Types of flexibility	Factors for the flexibility of housing			Proposals for the development of housing flexibility
Functional flexibility	Housing	Design philosophy	Entrances	(1) Review the design of the entrances to residential apartments (main and/or secondary entrance) in terms of shape, space and function and consider the emerging need to store, wear and sterilize shoes when leaving and entering the house
			Creating spaces for emerging activities	(1) Allocate spaces within the residence that are suitable for effectively practicing new activities such as a workspace, storage space and sports and entertainment spaces via allocation of a corner within the residential space
			Expanding and shaping room spaces	(1) Consider the flexibility of using rooms without simply applying the requirements by adopting composite shapes to create visual dynamics and reduce monotony
		Furniture	Keeping up with development	(1) Exclude large pieces of furniture and use medium-sized pieces when furnishing (2) Using easy-care materials that are in line with the climate of the region (3) Using multi-use furniture

Table 3.
Proposals for the development of housing functional flexibility

(3) Activate the roles of interior designers to study residential interiors and consider their intervention as a necessity rather than a luxury in residential projects for all classes in society.

(4) Impose new laws that emerge from society's needs to enhance functional flexibility and housing adaptation factors and enact laws that enhance the psychological well-being of the population with the need to further define clear procedural policies within the requirements of residential buildings, especially since it promotes the concept of sustainability.

5.2 Limitations/implications of the research

The study's limitations relate to the characteristics of the participants at the level of apartments that are restricted to the city of Jeddah. Future studies should include participants from different cities and regions in Saudi Arabia, use different category of housing that varies in terms of family and apartment properties (such as Saudis versus residents, ownership versus rental apartments) and assess the effect of differences between needs and requirements according to psychological, social and cultural frameworks. Future studies should relate to emerging concepts and flexible housing in a post-COVID context by delving deeper into the indicators presented by the architecture (Makhno, 2020).

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Annex

Table A1.
Sample characteristics

Years of occupancy	Residential area	Number of bathrooms	Number of rooms	Code home	Situation	Ages	Code members	Number of families members	Families
5	E	3	6	H1	Onsite	36	FF1	4	F1
					Academic	31	MF1		
					Student	3	C1F1		
					HM	35	HMF1		
1	E	2	4	H2	Onsite	28	FF2	4	F2
					Academic	28	MF2		
					Student	3.5	C1F2		
					HM	25	HMF2		
1	E	3	5	H3	Onsite	29	FF3	4	F3
					Student	21	MF3		
					Infant	1	C1F3		
					HM	20	MF3		
11	C	3	6	H4	Academic	37	FF4	5	F4
					Academic	32	MF4		
					Student	11	C1F3		
					Student	5	C2F4		
					Infant	2	C4F4		
8	C	3	6	H5	Onsite	36	FF5	5	F5
					Academic	31	MF5		
					Student	11	C1F5		
					Student	8	C2F5		
					Student	1	C3F5		
5	C	2	4	H6	Onsite	34	FF6	4	F6
					Academic	30	MF6		
					Student	4	CF6		
					HM	35	HMF6		
5	C	2	4	H7	Academic	42	FF7	4	F7
					Interior designer	35	MF7		
					Student	14	C1F7		
					Student	12	C2F7		
	S	2	5	H8	Onsite	35	FF8	5	F8
					Housewife	31	MF8		
					Student	11	C1F8		
					Student	6	C2F8		
					Student	3	C3F8		
6	S	2	5	H9	Onsite	41	FF9	6	F9
					Housewife	36	MF9		
					Student	17	C1F9		
					Student	13	C2F9		
					Student	11	C3F9		
					HM	35	HMF9		

(*continued*)

Years of occupancy	Residential area	Number of bathrooms	Number of rooms	Code home	Situation	Ages	Code members	Number of families members	Families
8	N	3	6	H10	Onsite	55	FF10	6	F10
					Academic	44	MF10		
					Student	20	C1F10		
					Student	18	C2F10		
					Student	14	C3F10		
					HM	40	HMF10		
8	N	3	6	H11	Onsite	50	FF11	6	F11
					Housewife	38	MF11		
					Student	16	C1F11		
					Student	13	C2F11		
					Student	7	C3F11		
					HM	37	HMF11		
4	N	3	6	H12	Onsite	37	FF12	6	F12
					Academic	33	MF12		
					Student	9	C1F12		
					Student	6	C2F12		
					Student	3	C3F12		
					HM	33	HMF12		

Residential area Codification of sample characteristics	Homes	Members	Families
N = Northern Jeddah city C = Central Jeddah city E = Eastern Jeddah city S = Southern Jeddah city	H1, H2, H3, and so on	F = Father M = Mother C = Children HM = Home maker	F1, F2, F3, and so on

Table A1.

Table A2.
HQIs when selected (before COVID-19)

				Apartment (unit)				Building		Site			
Performance in use I13	Services I12	Light quality I11	Noise control I10	Suitable number of rooms for individuals I9	Finishing level I8	Quality of apartment design I7	Superficies of the apartment I6	Building facilities I5	Building services I4	Presence of external openings and windows I3	Visual impact, layout and landscaping I2	Location I1	Code home
Y	Y	N	N	Y	Y	Y	N	Y	Y	N	N	Y	H1
Y	N	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	H2
Y	N	N	Y	Y	Y	Y	Y	N	Y	Y	N	Y	H3
Y	N	N	N	Y	Y	Y	Y	N	Y	N	N	Y	H4
Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	H5
Y	N	N	N	Y	Y	Y	Y	N	Y	Y	N	Y	H6
Y	N	N	N	Y	Y	Y	Y	N	Y	Y	Y	Y	H7
N	N	N	N	Y	Y	Y	Y	N	Y	N	N	Y	H8
Y	N	Y	N	Y	Y	Y	Y	N	Y	N	N	Y	H9
Y	N	N	N	Y	Y	Y	Y	Y	Y	N	N	Y	H10
Y	Y	N	Y	Y	Y	Y	Y	N	Y	N	N	Y	H11
N	N	N	N	N	N	N	Y	N	Y	N	N	N	H12

Note(s): Y = yes (1); N = no (0)

Functional updates: use within the scope of functional flexibility														Functional developments: use within the scope of cultural flexibility		Aspirations within the scope of structural flexibility			
Sample	Multi-use place (FF1) (4: multifunctionality)	Alternative room functions, changed spaces, juxtaposition relationships (SF1) adjacency	Moving furniture (FF5), movable furniture	Exploiting the open void/ open space (4: multifunctionality)	Use of removable parts (FF3), elasticity of area distribution	Reshaping complex elements in the dwelling (FF2) (5: adaptability)	Use of unfrapped spaces (FF3) (6: elasticity of area distribution)	Redistribute some functions or activities by available space (FF3) convertibility	Change the composition of the space (FF3) (6: elasticity of area distribution)	Exchange and change of spaces (FF3) (6: elasticity of area distribution)	Integrate various activities when necessary (SF3) (4: multifunctionality)	Creating new spaces and temporary spaces during the day and night (FF2) (5: adaptability)	Allocation of new jobs without professional intervention (5: adaptability)	10 Individual/personalisation (CF2)	Privacy (CF2)	Facilities, polyvalence, and services (SF2)	Architectural structure/dwelling/zoning, modularity	Architectural structure of dwelling/openings 3 (SF3) modularity	Architectural structure of the dwelling/outdoor spaces 2 (SF) polyvalence
H1	Y	Y	Y	N	Y	Y^2	Y	Y^7	Y	Y	Y	Y^1	Y^9	N	N	Y	Y	Y	Y
H2	Y	Y	Y	N	Y	Y^4	Y	Y^6	Y^5	Y	Y	Y^2	Y^9	N	N	Y	Y	Y	Y
H3	Y	Y	Y	N	Y	Y	Y	Y^3	Y	Y^6	Y	Y	Y^9	N	N	Y	Y	Y	Y
H4	Y	Y	Y	N	Y	Y^2	Y^2	Y^3	Y	Y	Y^7	Y	Y^9	N	N	Y	Y	Y	Y
H5	Y	Y	Y	Y	Y	Y	Y^8 Y^5	Y^7	Y	Y^2	Y	Y^1	*Y*	N	N	Y	Y	Y	Y
H6	Y	Y	Y	N	Y	Y^2	Y	Y	Y	Y	Y^6	Y	Y^9	N	N	Y	Y	Y	Y
H7	Y	Y	Y	N	Y	Y	Y	Y	Y^2	Y	Y^{626}	Y^1	Y^9	N	N	Y	Y	Y	Y
H8	Y	Y	Y	N	Y	Y^2	Y	Y	Y	Y	Y	Y	Y^9	N	N	Y	Y	Y	Y
H9	Y	Y	Y	N	Y	Y^2	Y	Y^4	Y	Y	Y	Y	Y^9	Y	N	Y	Y	Y	Y
H10	Y	Y^3	Y	Y	Y^8	Y	Y^3	Y	Y^{79}	Y	Y	Y	Y^9	N	N	Y	Y	Y	Y
H11	Y	Y	Y	N	Y	Y	Y	Y^4	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
H12	Y	Y	Y	N	Y	Y	Y^3	Y	Y	Y	Y	Y	Y^9	N	N	Y	Y	Y	Y

Note(s): - The table is encoded as follows: Y = yes (positive attitude); N = no (negative attitude).

- Y = yes and 1, 2, 3 is related to identification of the specific category of sample activities

- Codification of sample activities:

Sports corner	Y^1	Prayer corner	Y^5
Play corner	Y^2	Dining corner	Y^6
Corner for Memorisation/study/work	Y^3	TV screen	Y^7
Coffee and relaxing corner	Y^4	Corner for 'gardening activities'	Y^8
		Storage corner	Y^9

Table A3.
Analysis of sample activities according to the proposed housing flexibility framework

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