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ASSESSING FLEXIBILITY IN REAL ESTATE MASS HOUSING

AVALIANDO A FLEXIBILIDADE EM PROJETOS HABITACIONAIS DE MASSA IMOBILIÁRIA

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Abstract

One of the most important considerations in housing design is flexibility, which refers to the idea of including change over time. In looking at recent residential architecture of Cyprus, especially in real estate housing as a subset of mass housing, unfortunately, flexibility is not considered enough as a leading concept. The aim of this research is to evaluate notions and stages of flexibility in real estate housing projects in a recently developed residential context on the Salamis coastal line between the cities of Famagusta and Trikomo. The first step is flexibility assessment from an architectural perspective, through analyzing the architectural drawings of the projects to find out the potential for long term flexibility in terms of 'structural', 'functional' and 'cultural' notions; whereas, the second step is evaluating flexibility in three phases as 'design', 'construction' and 'usage' stages through questionnaire surveys with both construction companies and users. The results indicate the flexibility from the company's perspective and defragment the inhabitants' external and interior flexibility needs in three different stages, highlighting the role of companies and architects in designing flexible housing that can adapt to various users and their changing needs and preferences.

Keywords: Adaptability, user needs, flexibility stages, interior space, architecture.

Resumo

Uma das considerações mais importantes no design de habitações é a flexibilidade, que se refere à ideia de incluir mudanças ao longo do tempo. Ao olhar para a atual arquitetura residencial do Chipre, especialmente na habitação imobiliária como um subconjunto de habitação de massa, infelizmente, a flexibilidade não é considerada o suficiente como um conceito de liderança. O objetivo desta pesquisa é avaliar noções e fases de flexibilidade em projetos habitacionais imobiliários em um contexto residencial recentemente desenvolvido na linha costeira de Salamis, entre as cidades de Famagusta e de Trikomo. O primeiro passo é a avaliação da flexibilidade a partir de uma perspectiva arquitectônica, analisando os desenhos arquitectônicos dos projetos e descobrindo o potencial de flexibilidade em longo prazo em termos "estruturais", "funcionais" e "culturais"; enquanto o segundo passo é avaliar a flexibilidade em três fases, "design", "construção" e "uso", por meio do uso de questionários com empresas de construção e usuários. Os resultados indicam as oportunidades de flexibilidade da perspectiva da empresa e desfragmentam as necessidades de flexibilidade externas e internas dos habitantes em três fases diferentes. O estudo destaca o papel das empresas e dos arquitetos na concepção de habitações flexíveis que se podem adaptar a vários usuários e a suas necessidades e preferências na mudança.

Palavras-chave: Adaptabilidade, necessidades dos usuários, fases de flexibilidade, espaço interior, arquitetura.

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INTRODUCTION

The industrial revolution and the need to shelter more people in urban settings caused a development in the multi-unit housing type. The share of the builder or authority has shown increase; while the users were not part of their home-building process (1). As Edwards (2) mentions, designers need to make a good fit between the dwelling unit features and the changing life-cycle requirements of households in order to prevent constant movement and to simplify anticipated future modifications or additions. The lack of these will result in either unwanted moves due to physical insufficiencies of dwellings (3) or additional costs for adaptation of the dwelling to different users, as well as lifecycle changes (4).

Ferguson & Navarrete (5); and Ferguson, Smets & Mason (6) recommend developing a public-private institutional infrastructure capable of producing diverse housing solutions suited to more diverse households, including moderate or low-income majority. Besides infrastructure, in various researches on space arrangements in housing (7, 8, 9), mentioned by Teles & González (10 , p. 238), adequate architectonic planning methods are advocated, for fulfilling the operation needs of low-income users, called 'the bottom of the income pyramid' (11 , 12), to reach high quality living environments. Various researches (7, 13, 14, 15, 16) as discussed by Teles & González (10, p. 238), define changes especially in social housing environments as enlargement, modifications, adjustment or interventions. The original layouts of houses experience numerous modifications in size, interior spaces layout and styles, and extending spaces, as well as changes in both interior and external characteristics.

When public housing production remains further behind demand and slum formation, government housing agencies head for the less expensive option of upgrading slums, together with site-and-services projects, instead of developing housing units, as experienced in Latin American housing (6). As opposed to households in 'developing' countries, who build their homes progressively over a long period, households in high-income industrialized or 'advanced' countries, buy "a complete new or existing home, supported by a highly sophisticated network of mortgage lenders, secondary market institutions, title companies, infrastructure providers, developers, and others" (5, p. 312). Although this 'product approach' to housing was unsuccessful throughout the developing world, "most developing country governments perversely continue to build and finance relatively high-cost complete commercially developed units as their main approach to housing" (5, p. 310). Multi-unit housing in Cyprus, particularly in the northern part, is still experiencing this 'product approach', where the users are not involved enough in their home building processes. A high growth in the construction sector parallel to the rising demand in property and housing markets have occurred due to both the increasing number of international universities on the northern part since 1990; and the concentrated, re-unification efforts of the two parts of Cyprus, where Turkish speaking Cypriots and Greek speaking Cypriots are settled. In fact, the demand from international community to comparatively cheaper properties within EU is accepted as the main initiator of this construction boom, especially producing mass housing in the type of villas in the close vicinity of coastal main cities, such as Kyrenia and Famagusta. These real estate multi-unit housing projects as a subset of mass housing have been constructed for anonymous users, in a rapid and unplanned manner. This led to insufficient consideration of either social or cultural

demands of the potential users. Saifi, Yüceer & Bilge (17) also criticize the loss of individuality in mass-produced housing. However, it is expected from mass housing projects to be flexible enough for accommodating various kinds of users from different cultures with different life styles besides lifestyle changes in time.

According to various researches (18, 19), flexibility is highly observed in rural vernacular architecture of the island, however, it isn't sufficient in contemporary housing activities. As Oliver (20, p. xxiii) states, "all forms of vernacular architecture are built to meet specific needs, accommodating the values, economies and ways of living of the cultures that produce them". The mechanisms used for the adaptive processes of humans to extreme conditions of ecosystems over long periods of time can provide lessons for future generations (21). Learning from the principles of vernacular architecture, which is aware of not only typological and climatic considerations, but also the "values, beliefs and rituals that shape the design of the dwelling" (22 , p.129) and adapting the notions of flexibility to contemporary houses can be helpful for obtaining long-term and short-term flexibility (23).

In this respect, the main goal of this study is to evaluate notions and sub-notions of flexibility in different phases of selected real estate multi-unit housing projects in a recently developed residential context. The manuscript first presents a brief overview of the methodology and then reviews findings of a major survey conducted in the Salamis coastal line between Famagusta city and Trikomo city, initiated in 2011 and developed until the summer of 2015 through structured questionnaire surveys with both construction firms and households to determine the opportunities of external and/or interior flexibility.

AN OVERVIEW OF THE FLEXIBILITY CONCEPT IN DWELLINGS

Household composition is based on the socio-economic conditions, the availability of relatives with whom to co-reside, and household formation rules (24). Hence, household characteristics and requirements are divergent and dynamic in time, acquiring the need for flexibility. Flexibility for architects is described as "the capacity designed into buildings, building programs, or building technologies to ensure an initial good fit and to enable them to respond to subsequent change" (25 , p.51). Flexible architecture "adapts, rather than stagnates; transforms, rather than restricts; is motive, rather than static; interacts with its users, rather than inhibits" (26, p.10).

Flexible housing gives its inhabitants a "sense of belonging to their living place by fulfilling their expectations as well as by adapting it to their different demands instead of taking an architecturally pre-determined approach" (27, p.75), where architects project their control even at the usage stage (28). Habraken (29) also believes that the concept of distribution of control to a collective approach is therefore at the roots of flexible architecture.

Adaptability of dwelling spaces to different choices, due to diverse lifestyles (29, 30), in addition to temporal changes, is a feature of the ideal home. Altaş & Özsoy (31) investigate the capability of internal changes to comply various needs and changing requirements and activity patterns. Slaughter (32) indicates that increasing building's flexibility to changes over time can provide

significant cost savings, through reducing the time required to implement the changes. These long-term feasibility concepts are also stated by Schneider & Till (33), who compare 'flexibility' and 'inflexibility' concepts. Flexibility can also provide user satisfaction through multi-usability, since people don't have to move or pay extra expenses for the changes needed in time (34, 35). Flexible housing is a layout where space organization, as a quality parameter, can be adapted to inhabitants' needs through their collaboration (27) for accomplishing their expectations and, consequently, for increasing user's satisfaction (31, 36). Zebardast (37), Lee and Park (38), and Grigolon et al. (3) have demonstrated that an increase in housing satisfaction is accompanied by a significant increase in overall satisfaction in 'quality of life'.

After Walter Gropius made a discussion about the flexibility issue in architecture in 1954, Rabeneck, Sheppard & Town (39, 40) introduced flexibility and adaptability in more detail as a concept, related with permanent and fixed parts of the buildings that are the 'structural system' and the 'service spaces'. On the other hand, Habraken (41), and Habraken, Boekholt, Thyssen & Dinjens (42) explore supports for variations. Maccreanor (43) discusses the robust and timeless techniques; Friedman (44) introduces transformable structures; and Groak (45) focuses on spaces that are capable of different physical arrangements. Till & Schneider (46), Schneider and Till (33,47) improved the definition to clarify the concept of flexibility in housing for endless change through hard and soft systems. "'Hard' refers to elements that more specifically determine the way that the design may be used, whereas 'soft' refers to tactics which allow certain indeterminacy" (46, p.289). Flexibility doesn't only result from uncertainty, interchangeability or variability of a space, but from the change of the relationship among spaces.

In order to introduce a framework for the study, issues related to the concepts of flexibility are discussed under 'different classifications of flexibility'.

Types of Flexibility

Three main types of flexibility, as 'structural, 'functional' and 'cultural' flexibility, are categorized by Al-Dakheel (48, p.545).

'Structural / spatial flexibility' covers the notions of adaptability of size to accommodate changes in family demographics or lifestyles as defined by Schmidt-III & Austin (49). This can be achieved in terms of expansion or enlargement vs. shrinkage or sub-division of spaces vertically or horizontally; open-plan free structural system for future changes and a system of standardized modularization. Gülaydın (50, p.28), cited in Bakkaloğlu (51), classifies expansion / extendibility / enlargement into several sub-categories in housing context as "Expansion according to direction: horizontal expansion, vertical expansion, both horizontal and vertical expansion; according to scale: component scale, building scale, settlement scale; and according to form and direction: radial expansion, linear expansion and clustered expansion."

Two main structural methods to attain flexibility are introduced by Schneider and Till (47) as 'base structures' and 'polyvalent organizations'. The first notion covers the theory of support and infill systems, which was introduced by Habraken in 1972 (41). This theory was developed into an approach that has been generally known as 'open building concept' (52), with the potential of adjusting to numerous prospect needs of the users. This concept allows the participation of users, where long-short term; permanent-temporary; support-

infill elements have a clear categorization (53). 'Supports' are composed of fixed / common elements, whereas 'infill system' consists of flexible elements determined for each single dwelling unit (42, 54). The idea is also expressed as 'loading and support', which is "articulated as 'the absolute geometric abstraction of horizontal planes opposed to vertical supports'" (55, p.165). The second term, 'polyvalence', was introduced by Hertzberger (56). Unlike the idea of the indeterminate space of 'base structure', the space in 'polyvalent organizations' is generally divided into permanent 'modules' with standardized dimensions, appropriate for joining or dividing for diverse functions.

'Functional flexibility' can be explained as the ability to interchange and exchange spaces, in other words, to accommodate a variety of spatial layouts and activities by changing the configuration of space. This type of flexibility controls the residential spaces by creating a multilateral relationship in spatial organization that responds to the inhabitants' ever-changing requirements (27), through modifying volumes, elements and furniture, functional flexibility covers the following notions, derived from studies of Gülaydın (50), Al-Dakheel (48), Bakkaloğlu (51), Scmidt & Austin (49):

- Including design concepts as open plan, movable furniture, spatial adjacencies, and fixed versus flexible space; spatial multi-use with minor structural modifications, shortly versatility;
- Ability to convert one space from one function to another function permanently or the ability to exchange or interchange space functions with each other temporarily without any structural modifications, shortly convertibility;
- Ability of having different functions at the same time, at the same place, shortly multi-functionality;
- Ability of spaces to separate and re-join;
- Ability of rearranging the furniture organisation in spaces through non-fixed furniture;
- Ability to locate wet spaces within specific zones but not to be permanently fixed, shortly, providing freedom of main space as generic space;
- Adaptability to changing climatic conditions: the use of intelligent systems, whether automatic or intuitive, to control the use of energy defined by Kronenburg (26) as 'interaction'; using environmentally sensitive materials; orientation towards the sun; achieving natural ventilation; having external sun control devices; etc.
- Adaptability to various needs of disabled users or old people and preventing inaccessibility.

Culturally appropriate flexible design is one of the key elements leading to sustainable dwelling design at micro level (57). Within this scope, 'cultural flexibility' is the ability of customization and personalization of space responding to a variety of cultural backgrounds (37); improving privacy components (48); besides changes in wishes (58) or status. Hertzberger (56) also explores personal markings and identifications in space.

The built environment is a reflection of social expressions and values derived from the world views of cultures; which are expressed through ideals, images, schemata, meanings; leading tonorms, standards, rules, expectations; that emerge lifestyles; and, hence, activity systems (59, 60, 61, 62, 63, 64, 65). Within this perspective, the past experiences and the memories manipulate the development of place bonding (66), and place attachment becomes a unique emotional bond, which is not easy to replace or substitute (67, 68). Exploring cultural adaptation processes, Lee and Park (69) state that length of residency in new residential conditions is the primary factor affecting adjustment of behaviors. Hence, cultural flexibility covers the following notions:

- Individuality / personalization: Adaptability of the unit to different users with different cultural backgrounds, different identities / tastes and preferences by being refitable, through design tactics defined by Schmidt-III & Austin (49, p.147) as “unfinished space, bare bones (infrastructure), custom finishes, market standard, shell and core construction”.

- Providing privacy: improved by exterior privacy, defined as privacy between public and semi-private areas, and interior privacy, defined as boundaries between semi-private and private areas. The levels of privacy can be categorized as physical privacy, where access from one space to another is controlled by some physical control elements; and visual privacy, where both access and visual connection between spaces are controlled by some physical elements.

- Adaptability to cultural identity of users in spaces or the appearance of the buildings by the overlay of changing images and pattern.

Stages of Flexibility

Oxman (70) defines different stages of flexibility, during the life cycle of a building. The first stage is the ‘design stage’, where the designers utilize some strategies to promote pre or post-occupancy flexibility during the conception phase. The second stage is the ‘construction stage’, as Friedman (44, p.13) refers to “the employment of strategies that enable the builder or the occupant to make changes to the design as the project’s building progresses”. The third stage is the ‘usage stage’, when the users move into their houses and they may want to change it based on their needs, wishes, cultures, and lifestyles. Flexibility at the design, construction, and usage stages, gives the household a good short-term and long-term investment that is parallel to their financial situation, and special needs (71).

EVALUATING FLEXIBILITY OF RECENT MASS HOUSING DEVELOPMENTS IN TRIKOMO / FAMAGUSTA REGION

Real estate multi-unit housing, as an outcome of the construction boom in the northern part of Cyprus, mainly concentrates in the close vicinity of Kyrenia and Famagusta as two coastal main cities. Hence, villas as the most common typology in this type of housing are selected from projects built in rural areas

between Trikomo (İskele) and Famagusta Cities in the Famagusta District. For investigation, 19 sub-types of six projects with a total number of 213 villas from 6 well-known and most active contractor firms are selected (Table 1, Figure 1).

Figure 1: Location of different projects built by six different companies (72)

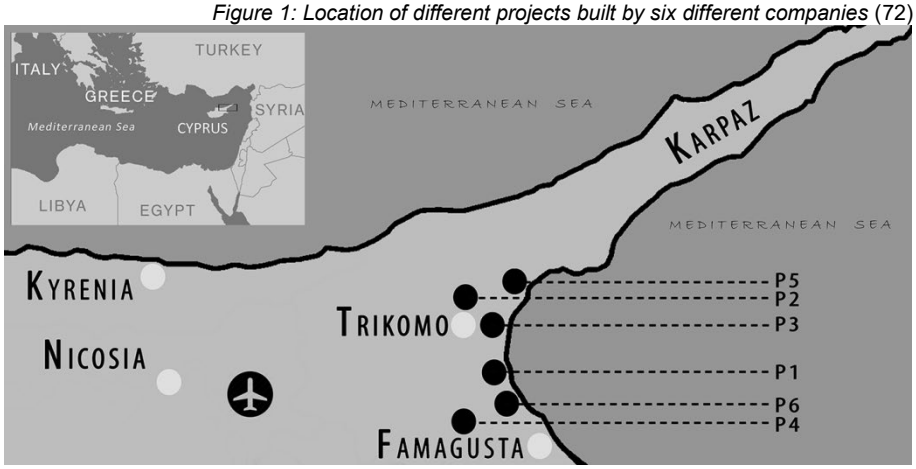


Table 1a: General overview on surveyed projects (73)

Company Code: No of Houses:	Project no – Location: Site plan:	Types	Ground floor plan	Upper floor plan
C1 22	P.1 – Famagusta	A 254m^2		
		B 328m^2		
		C 254m^2		
		D 350m^2		
		E 300m^2		
		F 296m^2		

Table 1b: General overview on surveyed projects (74)

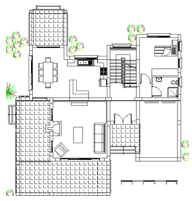
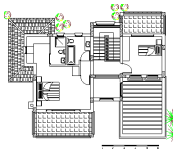
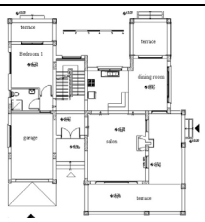
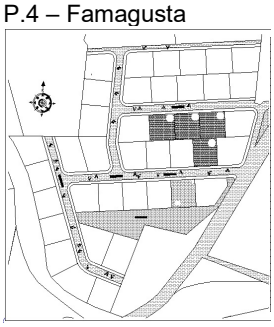
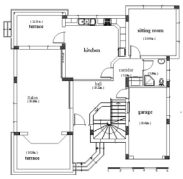
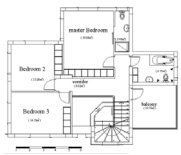
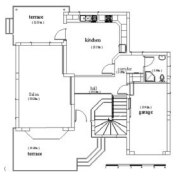
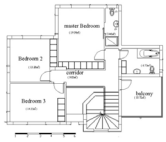
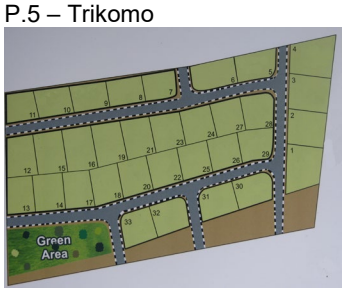
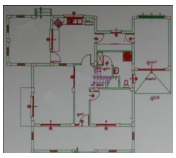
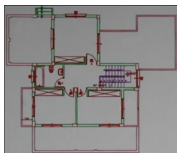
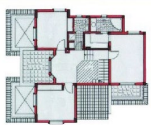
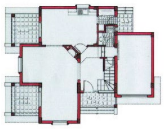
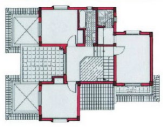
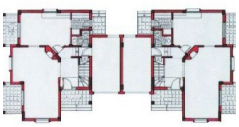
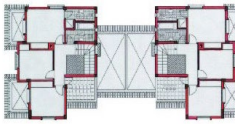
Company Code: No of Houses:	Project no – Location: Site plan:	Types	Ground floor plan	Upper floor plan
C2 31	P.2 – Trikomo 	1 164m2		
		2 183m^2		
C3 66	P.3 – Trikomo 	S 258m^2		
		G 285m^2		
C4 40	P.4 – Famagusta 	A 270m^2		
		B 250m^2		
		C 215m^2		

Table 1c: General overview on surveyed projects (75)

Company Code: No of Houses:	Project no – Location: Site plan:	Types	Ground floor plan	Upper floor plan
C5 33	P.5 – Trikomo 	A 290m^2		
		B 280m^2		
		C 240m^2		
C6 21	P.6 – Famagusta 	A 233m^2		
		B 218m^2		
		C 197m^2		
6 companies 213 Detached villas		19 types		

The research was carried out in two phases. The initial step was based on an assessment of the flexibility from an architectural point of view. It analysed the architectural drawings of the projects taken from six companies, in order to find out if the selected dwellings had potential for long term flexibility. The evaluation criteria were extracted from theoretical sources as ‘structural’, ‘functional’ and ‘cultural’ notions. The data collection method for this step consisted of observations, supported by photography on site and collection of plan layouts of projects from the companies.

The second step was an evaluation of flexibility in three phases — 'design', 'construction' and 'usage' stages — through two structured questionnaire surveys. The questionnaires related to design and construction stages were conducted by only construction firms, to determine the opportunities of external and/or interior flexibility, with or without any extra cost. Parallel to this, the questionnaires for usage stage were filled in only by the existing inhabitants of the case studies, in order to clarify the types of needs for external or interior changes, as well as to figure out in which stage ('design', 'construction', or 'usage') the accomplished changes were applied.

Flexibility assessment according to notions of flexibility

In this section, cases are classified and evaluated according to notions and sub-notions of 'structural', 'functional' and 'cultural' flexibility, which are illustrated in Table 2.

Table 2: Evaluation criteria for structural, functional and cultural flexibility notions.

Structural flexibility notions & definitions					
Spatial/ structural flexibility	Extendibility / enlargement and sub-division	According to scale and direction	Component scale	Horizontal	Ext.
					Div.
			Building scale	Horizontal	Ext.
					Div.
				Vertical	Ext.
					Div.
		According to form and direction	Radial exp./ div.	Horizontal	
				Vertical	
			Linear expansion / division	Horizontal	
				Vertical	
			Clustered expansion / division	Horizontal	
				Vertical	
	Flexible structural methods	Indeterminate incomplete buildings			
		Standardized modularization			
	Flexible façade	Openings / sun control / use of intelligent systems			
Functional flexibility notions & definitions					
Functional Flexibility	Movable Parts (Layout & Furniture)	Versatility			
		Convertibility	Conversion from one function to another		
			Exchange or interchange of functions		
		Multi-functionality			
		Ability to separate & re-join the rooms and units			
		Flexible arrangement of furniture			
		Freedom of main space as generic space			
		Adaptability to climate	Using environmentally sensitive materials		
			Orientation towards the sun		
			natural ventilation		
			external sun control devices		
		Adaptability to disabled			
Cultural flexibility notions & definitions					
Cultural flexibility	Individuality / personality		Non-fixed interior space and façade design		
			Non-fixed interior and exterior finishing materials		
			Non-fixed furniture		
	Reflection of cultural identity		Non-fixed cultural symbols		
			Non-fixed furniture		
	Providing privacy		Exterior privacy	Physical privacy	
				Visual privacy	
			Interior privacy	Physical privacy	
				Visual privacy	

Structural flexibility assessment

By evaluating structural flexibility in the case studies, it can be stated that the case studies are not structurally flexible enough. In fact, in recent times, unlike the past periods, limited land area, building codes and regulations limit users to make some exterior changes outside their dwellings, such as vertical or horizontal extensions. On the contrary, the non-modular skeletal structural system of cases with brick walls is limiting the design, instead of using its potentials as an open plan. In other words, applying 'non-flexible structural organization' and 'non-movable division walls' in the cases restrict users in making internal changes. Only one of the fifteen sub-criteria (Table 2) for achieving structural flexibility is fully provided, relating to a possibility of horizontal sub-division in the building scale.

Functional flexibility assessment

As Dhār, Hossain & Rahaman (76) indicate, people mostly demand changes in the floor layouts of their buildings over time for various reasons, however, in most of the cases in this study, versatility, convertibility and multi-functionality can be achieved in only one space or one floor. In all cases, although furniture is not fixed, the pre-defined functions and dimensions of most of the rooms, as well as some features, like non-movable brick walls, existing fixed cupboards, fixed telephone or TV sockets, can restrict users to arrange their spaces. Only two of the twelve sub-criteria (Table 2) for achieving functional flexibility are fully provided, where one of them is related with multi-functionality (only provided in living rooms), and the other one with the possibility of choosing different furniture and arranging in different ways, due to non-fixed furniture.

Cultural flexibility assessment

Through assessment of cases, it was found that the cases are not structurally and functionally flexible enough, hence, this negatively influences cultural flexibility. The drawbacks, such as predetermined finishing materials and elements, restrict inhabitants to personalize their houses based on their cultural identities, or individual preferences, and tastes, and lack of adequate elements limits achieving physical exterior privacy and visual privacy in both interior and exterior.

Additionally, having specific architectural style; predetermined functions, interior dimensions, and space organization; non-movable dividing walls; fixed cupboards, infrastructure tools and furniture; limits adaptability to various cultural life-styles. Four of the nine sub-criteria (Table 2) for achieving cultural flexibility are fully provided, where two sub-definitions are related with individuality / personalization of spaces, one with reflection of cultural identity and the other with providing physical interior privacy.

Flexibility assessment according to stages of flexibility

In this section, flexibility of cases was evaluated through structured questionnaires to clarify the inhabitants' needs for 'external' or 'internal' changes in different phases as 'design', 'construction' and 'usage' stages. The authors have contacted companies engaged in the production of the projects,

as well as the households of the investigated real estate multi-unit housing. The duration of usage average was around eight years, and the maximum duration of usage was 10 years at that time.

Flexibility assessment in design process

In this stage, the questionnaires (Figure 2) were filled in by the six selected companies. The questions were categorized into two main groups, where the first group of questions explored the possibility of making modifications related to the exterior shell of the dwellings; and the second group explored the possibility of making modifications related to the interior spaces.

Findings indicate that, in terms of external changes, findings reveal that the inhabitants were not granted an opportunity by the majority of the companies in extending / enlarging their dwellings; changing facades in terms of openings; or the form of roofs. Only two companies out of six gave customers a chance for façade extension or changing the façade finishing materials only during design stage, and which was only possible at an extra cost. It can be interpreted that the selected companies did not allow users to make changes at the exterior shell of their dwellings for preserving the harmony and unity achieved by similarity among the multi-unit housing, besides legal and legislative limitations of central authorities, such as the City Planning Department, which controls the constructions in terms of consistency with the original project.

Table 3: Possibility for changes of the dwellings by the users at design stage

		Construction firms	C1	C2	C3	C4	C5	C6
		Majority of Inhabitants	L	I	L	L	L	I
Design stage	External changes	Extension outside the house	N	N	N	N	N	N
		Changing façade (extension opacity)	N	N	N	Y +EP	Y +EP	N
		Changing façade as finishing material	N	N	N	Y +EP	Y +EP	N
		Changing form of roof	N	N	N	N	Y +EP	N
	Interior changes	Space organization	Y +EP	Y+ EP	Y +EP	Y +EP	Y +EP	Y +EP
		Function of space	Y	Y	Y	Y	Y +EP	Y +EP
		Interior finishing material	Y	Y	Y	Y	Y	Y
		Model of kitchen	Y	Y	Y	Y	Y	Y
		Electricity system	N	Y	N	Y	Y +EP	Y +EP
		Pipe system	N	N	N	Y	Y	N
		Fireplace	Y	N	Y	Y	Y	N

KEY: L – Local, I – International, N- No, Y- Yes, Y+EC – Yes with Extra Payment

In terms of interior changes, findings reveal that all six companies were open for modifications with or without extra payment, such as changing the space organization (internal wall arrangement), function of spaces, interior finishing materials, and their kitchens (converting closed kitchen into open one or vice versa). Four companies out of six did not allow users to change the pipe systems (location of wet spaces), while four companies out of six allowed

users to change the electricity system and the location of fireplace by demanding extra payment (Table 3).

Flexibility assessment in construction process

The flexibility assessment in construction process was also based on the same questionnaire conducted with the same companies, which was explained in the design stage. Findings indicate that, similarly to the condition in design stage, none of the companies allowed users to make any external changes at the exterior shell of the dwellings in the construction stage for the reason of preserving the harmony and unity achieved by similarity among the multi-unit housing, as well as for legal and legislative limitations.

The findings also revealed that the possibility of making interior changes by the users are more restricted during construction stage when compared with the design stage. Making modifications by demanding some extra payment in design stage is lower than the construction stage, so most of the changes in the construction stage require some extra cost, which is against the flexibility concept. In the construction stage, all companies allowed users to change the space organization of the interior spaces, and the function of spaces, as well as the interior finishing materials, by some extra cost. All companies allowed users to change the model of their kitchens, where five out of six demanded extra payment (Table 4).

Table 4: Possibility for changes of the dwellings by the users at construction stage

		Construction firms	C1	C2	C3	C4	C5	C6
		Majority of Inhabitants	L	I	L	L	L	I
Construction stage	External changes	Extension outside the house	N	N	N	N	N	N
		Changing façade (extension opacity)	N	N	N	N	Y +EP	N
		Changing façade as finishing material	N	N	N	Y +EP	Y +EP	N
		Changing form of roof	N	N	N	N	Y +EP	N
	Interior changes	Space organization	Y +EP	Y +EP	Y +EP	Y +EP	Y +EP	Y +EP
		Function of space	Y +EP	Y +EP	Y +EP	Y +EP	Y +EP	Y +EP
		Interior finishing material	Y +EP	Y +EP	Y +EP	Y +EP	Y +EP	Y +EP
		Model of kitchen	Y	Y +EP	Y +EP	Y +EP	Y +EP	Y +EP
		Electricity system	N	N	N	N	Y +EP	Y
		Pipe system	N	N	N	N	Y +EP	N
		Fireplace	Y	N	N	Y	Y	N

KEY: L – Local, I – International, N- No, Y- Yes, Y+EC – Yes with Extra Payment

Flexibility assessment in usage process

In this stage, another group of questions was applied to the existing inhabitants of the selected case studies to determine the ‘current needs’ of the users in terms of the flexibility criteria.

The number of sold houses was 123 out of 213 plots, and the inhabitants from 89 of them filled in the questionnaires, where 77 families are locals and 12 are international users. In each house, an adult representative member of the family was contacted to fill in the questionnaire, but, in some houses, the entire household responded altogether.

According to the findings of the questionnaires, most of the existing inhabitants (86%) are local families who are middle-aged couples with one or two children and 61% of the local and international users have bought their houses during the construction stage. Existing inhabitants were categorized according to the time that they have bought their houses (in 'design', 'construction', and 'usage' stages). The findings also indicate that these inhabitants had the chance to contribute in the formation of their houses and already accomplished some changes by accepting extra payments. The highest mentioned needs for change in the households' questionnaire show the perception of dwellers. The results of the questionnaire survey on external changes (Table 5) indicate that most of the inhabitants (local and international) do not need to make changes that affect the exterior shell of their houses, except for changing the façade finishing materials, which is mostly preferred by the majority of the inhabitants. The inhabitants who bought their houses in the construction stage managed to change the façade finishing materials based on their tastes with only a ratio of 24%, and 35% state this as a desired change; while the users who bought their houses in the usage stage still demand (79%) to change the façade finishing materials and the façade form, and personalize their houses. On the other hand, all inhabitants are satisfied with the form of the roofs.

Since the house designs repeat in multiple units, inhabitants are willing to individualize their houses starting from the exterior. However, since they are aware of the legal and legislative limitations, which do not permit changes on the mass, roof or opening sizes, their preferences are mainly concentrated on changing façade finishing materials (67%).

The findings on the questionnaire survey on internal changes (Table 5) also reveal that the existing inhabitants (local and international) prefer to change, with the highest ratio, the interior finishing materials (82%) and furniture re-arrangement of their houses (81%) based on their needs and tastes. This can also be explained with the personalization / individualization needs of users according to cultural flexibility. The findings also include the needs to change space organizations (64%) or functions of interior spaces (62%) for functional flexibility or change wall arrangements (54%) for the need for privacy; shifting location of fireplace or adding a fireplace (54%) at the construction stage. Most of local and international inhabitants who bought their houses during the construction stage have already accomplished the above mentioned changes during the construction stage by paying some extra. On the other hand, it can be concluded that changing interior space of the houses, which are more related to functional and cultural flexibility, are mostly preferred by all of the existing inhabitants.

It can be implied from the questionnaire results that the need for spatial expansion and enlargement were not among the mentioned needs of users. The reason behind this can be interpreted as: the dimensions of houses and the number of bedrooms are sufficient for the family composition of the households where the majority is local couples with one or two children. Besides, no major changes in family demographics were recorded. The

façade finishing materials were mentioned by the local and international users as the highest need for change, followed by the openings on the façade. Besides, interior changes in finishing materials, as well as furniture re-arrangement, were mentioned with the highest ratio; followed by location of fireplace. The need for more privacy is especially mentioned for the interior walls. This shows the need for personalization and individualization for the households.

According to the comparison of needs for making external and interior changes (Table 5), the most distinct difference in external changes between buying a house in the construction stage or usage stage is the increase in the need for modification in the façade openings and materials, whereas the other external needs don't show a radical difference between each other. Parallel to this, the most distinct difference in interior changes between buying a house in the construction stage or usage stage is the increase in the need for change of function of space, and location of electricity system; whereas the need for internal changes in space organization, finishing materials, furniture re-arrangement, providing enough privacy related to walls, are almost equally high in percentages. The model of kitchen and the location of the fireplace show a decrease in the need for modification from the construction stage to the usage one. The other needs with low percentages, such as need for extension, form of roof, multi-use, location of wet spaces, privacy related to openings, and layout, also don't show radical differences between each other in the different stages.

Users who bought their houses in the construction stage managed to accomplish changes by paying some extra, whereas the users who bought their houses in the usage stage mentioned the same types of changes as their needs. This shows the consistency of the mentioned requirements in the different stages.

Table 5: Inhabitants' needs for making changes during construction and usage stages

	Desired/ accomplished external changes				Desired/ accomplished interior changes											
														Privacy related: to:		
Inhabitants' needs for changes who bought houses at:	Extension (%)	Façade openings (%)	Façade Materials (%)	Form of roof (%)	Space organization (%)	Function of space (%)	Multi-use (%)	Model of kitchen (%)	Electricity system (%)	Location of wet spaces /pipes (%)	Location of fireplace (%)	Finishing materials (%)	Furniture re-arrangement (%)	Openings (%)	Walls (%)	Layout (%)
Construction stage	22	28	59	0	65	59	0	46	20	4	54	81	81	3	52	0
Usage stage	26	53	79	0	62	65	0	32	38	12	44	82	79	12	59	0
All stages	24	37	67	0	64	62	0	40	27	7	49	82	81	7	54	0

CONCLUSION

As Friedman (1) discusses, economic factors largely influence the decisions of builders to provide flexibility systems. In this study, flexibility is defragmented into notions like 'structural', 'functional' and 'cultural' flexibility in order to evaluate which notions and sub-notions of flexibility are achieved in six projects, containing 19 sub-types. The study also clarifies both the company's perspectives and the inhabitants' needs for 'external' or 'internal'

changes in different phases — 'design', 'construction' and 'usage' stages. Through the initial step, the projects are examined to find out the degree of flexibility. It has been found that the case studies carry the potential of fully provide a low ratio of flexibility sub-criteria, whereas the rest of the sub-criteria are restricted or not possible, and a few items are not considered due to legal and legislative restrictions.

In the second step, the selected companies and the inhabitants were interviewed. The selected companies were interviewed to examine their tolerance for external and internal changes in the 'design' and 'construction' stages. Through this step, as predicted, it has been illustrated that the design stage is more flexible than the construction stage. The companies demand some extra payment for changes in the construction stage, while they are more open to interior changes in the design stage. External changes are limited in all stages, due to legal and legislative restrictions of the City and Regional Planning Department, as well as the effort and motivation of companies in sustaining the harmony and unity between units of real estate mass housing. Users of 89 houses out of 213 were interviewed to find out their needs in terms of flexibility through the types of external or internal changes required in their houses in different stages — 'design', 'construction' and 'usage' flexibility. The findings reveal that, being aware of the legal and legislative restrictions, the inhabitants mention the needs that concentrate more on personalization of their homes mainly by internal changes as well as the need of change of exterior façade finishing materials, followed by change in openings.

The results of the questionnaire with the inhabitants in this study also support the fact that the design stage is the most flexible stage among the three ones in proving the types of changes that users demand, without paying any extra cost to companies. It has been illustrated that making modifications by demanding some extra payment in the design stage appears less than the changes in the construction and usage stages with some extra cost, which is against the flexibility concept. The design stage is followed by the construction stage, where changes are still possible by paying extra, however, in the usage stage, it is harder and more expensive for the user to make changes.

When compared with small / minimal dimensions of the social housing, where householders might experience insufficient size, lack of space, and / or circulation problems, real estate multi-unit housing dimensions in northern part of Cyprus are larger due to the target market. Because the space dimensions are sufficient in the projects, functional flexibility is not coming forward with a high ratio in the results, but cultural flexibility requirements come forward.

Contrarily, a similar study in social housing projects would give different results. Although it is expected that the usage stage will be the least flexible stage, since all official approvals are completed, external changes and enlargement of the houses are generally observed at this stage in the northern part of Cyprus.

The experience is different in the investigated cases. All six companies make their designs according to an optimum / standard user, since the projects are multi-unit housing projects within real estate mass housing. They are firstly designed or even built before being sold. The city planning laws and legislations limit external changes to buildings after permissions are given.

External modifications require the repetition of formal procedures or approbation of projects, hence, the companies prefer not to give the opportunity of adaptation of the projects to the user's preferences on the exterior shell or the openings even if the house is bought at the 'design stage'. Buying houses at later stages, like the construction or usage stages, strengthens this limitation. House design is specific to user and, since there is no standard user, adaptability through structural / functional / cultural flexibility is an important concept. The main difference among companies is the approach difference, however, as discussed in the flexibility assessment, according to flexibility notions and stages, the flexibility of buildings is not a priority in any of the six projects. At this point, it can be stated that it is the responsibility of the companies and designers to provide a more flexible environment, which allows users to make changes easily and without any extra cost, in all stages, including the usage stage. A high flexible design can be achieved at the design stage, where all types of flexibility with the sub-criteria should be the main design approach. When the projections for change, such as enlargement, are programmed during the design process, construction is jointly implemented with the participation of the future users. This can be initially achieved by an open-plan free 'structural' system and a flexible façade, in order to allow future changes, a system of standardized modularization to tolerate the expansion vs. shrinkage or sub-division of spaces vertically or horizontally. Secondly, the flexible residential spaces can be achieved by designing joinable or separable spaces for 'functional' flexibility, which refers to the ability to interchange and exchange spaces, in other words, to accommodate a variety of spatial layouts and activities by changing the configuration of a space through versatility, convertibility, multi-functionality, flexible spatial or furniture layout and adaptability. Thirdly, 'cultural' flexibility is supported by both structural and functional flexibility. It can be achieved by designing timeless designs for allowing individuality or personalization of spaces by different users from different cultural backgrounds, or adaptability to the cultural identity of the users, such as the reflection of the culture through style or the need for privacy, as well as the adaptability for the changing needs or wishes throughout the time.

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