Impact of Flexible Furniture on Small Spaces in Residential Apartment with Smart Solutions

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The importance of flexibility and creative innovation in furniture design, particularly in residential spaces are the critical factors for superior futurity and life cycle, the complexity of achieving these design goals, especially in the context of small apartments resulting from urban housing development and population growth. that these factors are shaping the future of furniture design to enhance the quality of life for residents in smaller spaces. How does the lack of the spaces influence the population living there? that the feelings of claustrophobia and crowding can have negative effects on residents' well-being, it emphasizes the essential role of furniture in these living environments, highlighting the need for solutions that enhance the quality of life for individuals living in small apartments. Furniture is attaching around half of floor space, so space-saving furniture solutions in small apartments. These solutions are seen as a key factor in promoting human well-being and prosperity in such living environments. This paper looks to investigate the connection between small apartments, furniture, and human prosperity, The article concluded the importance of understanding this imperative in the design process to create living environments that enhance the quality of life for those living in small spaces.

Keywords: small spaces; flexible furniture; residential buildings; smart solution; multifunction; human needs.

1. Introduction

The ongoing growing population and urbanization have significant influences on present-day society. This is bringing about an expanding in lodging urban communities, in which prompted higher marketing costs and the development of smaller apartments [1]. For future designing spaces with mobility and flexibility have to right to take considerations, after few calamities to underline housing, utilizing flexibility has beneficial in crises. These principles can improve the resilience of urban spaces and functionality. The historical backdrop of flexibility design and the use of adaptable structures return to early stages of human civilization. Throughout

history, humans have displayed a significant ability to create living spaces that could be easily adapted based on lifestyle needs and environmental conditions [2].

Around 30 years ago, small flats were generally around 55 square meters, there has been a completely changed in the way people distinguish or design smaller living spaces [3]. Today apartments are becoming smaller in size, assets and the furniture are taking up a significant portion of the available space [4]. Absolutely, the fundamental needs of the people remain consistent over time or perhaps greater than previously, ensuring these needs should be essential for human well-being. Flexibility of couches convertible to beds have demonstrated extraordinary help for the individuals who live in small apartments and stressed over the convenience. Flexible contribute to a more comfortable and functional environment in small space [5]. The need for flexible furniture and smart solutions is indeed essential to make the most of limited space while ensuring functionality and comfort. The emphasis furniture on modular, foldable, multifunctional, and space-saving solutions aligns with the contemporary movement of maximizing utility in compact living environments.

Objectives and Aims

The idea of this research to investigate the role of flexibility in furniture for small spaces in residential buildings with smart solutions as movable, multifunctional, foldable, and modular furniture system in an inventive way.

This article will serve the accompanying ideas:

- To emphasize identity for small spaces through using flexibility in furniture.
- To space saving in small areas through modular, multifunctional, and foldable furniture.
- To investigate the relationship between furniture, occupants' prosperity, and small apartments

2. Literature Review

2.1 Studies that managed with the subject of flexible furniture on small spaces in residential apartment with smart solutions can be outlined in the following topics:

The investigation examined the Theo Van Does burg, an organizer of the "De Stijll" system who communicates his hypotheses in atopic titled "toward a flexible architecture" that modern in interior design are an open one, in this innovative approach, the living space is not confined by fixed structures but is instead characterized by a dynamic and versatile design, allowing for required execution and application of space as needed. [2] (fig: 2).

Fig. 2 chair flexibility

Max-Neef is in his book "Human Scale Development", isolates the major needs of human in to nine critical components: protection, freedom, creation, participation, identity, leisure, understanding, and subsistence. Each of the nine elements is imperative for occupant's wellbeing, however regarding to living in small spaces and furniture, the accompanying variable ought to be most fundamental: affection, subsistence, identity, and protection [9]. (Table: 1).

Table 1: Max-Neef's human's critical components (Max-Neef, 1992)

Fundamental Human Needs	Being (qualities)	Having (things)	Doing (actions)	Interacting (settings)
Subsistence	Physical and mental health	Shelter	Feed, rest, work	Living environment, social settings
Protection	Care, adaptability	Security	Co-operate, plan, take care of, help	Social environment, dwelling
Affection	Respect, sense of humor, generosity, sensuality	Friendship, family	Share, take care of, make love, express emotions	Privacy, intimate spaces of togetherness
Identity	Sense of belonging	Home, work, customs, values	Make choices, grow	Places one belongs to, everyday settings

As indicated by Neufert from 1930's, benchmarks for satisfactory spatiality are managed by the number of occupants in dwelling unit, as appear in (table 2) for one individual dwelling ought to be associate with 40 m2, however for two person about 56 m2.

Table 2: Relation between the inhabitant's number per living units

Dwelling	Area in m^2
1-Person Flat	40,46
2-People Flat	56,47
3-People Flat	80,50
4-People Flat	103,23

2.2 Trends of flexibility in current times

2.2.1 Sliding frameworks and interior entryway

Sliding Systems play a pivotal role as one of the most critical elements that permit the idea of flexibility in configuring interior space, specialized enhancement in which created in rollers

and guide rails that offer the capability to utilize a variety of panel materials, variety of board sizes, Moreover, they ensure high resistance and durability, particularly in the context of frequent opening and closing (fig: 3) [10].

Fig. 3 Opening and completely opened view on the sliding door.

2.2.2 Floors

The utilization of the floor surface as a transformative component has the potential to significantly reshape the overall experience of a space in some cases that able to discuss the floor bunkers on specific position that serve a dual purpose, functioning as both unique design elements and practical storage solutions for larger or occasional belongings [11]. (Fig:4).

Fig. 4 Yo-home concepts - using the floor as a source for flexible spatial organization

2.2.3 Ceilings

The roofs functional fluctuation serves as a unifying element that encapsulates and shelters the various furnishings within the living space, for example storage or beds components which able to be easily collapsed down or opened when needed (fig: 5) [11].

Fig. 5 various folding scenarios from the ceiling.

2.2.4 Space Saving Beds

Space saving beds able to divide into two classes, bunks bed and ordinary beds, an ordinary space saving bed may be a desk, a shelf or integrated desk and bed, which the parts of the desk or table are able to convert into a bed. (Fig: 6) [5].

Fig. 6 Examples of space saving furniture: A desk and a bed

2.2.5 Lofts (Bunk beds)

Are designed fundamentally for these families who lives in small apartments and have more than one children, In which this sort of beds are generally shaped from steeping tool and two single size beds, both beds are joined in to an edge so let to maximum utilization of space (fig: 7) [12].

Fig. 7 Bunk beds

2.2.6 Versatile Furniture

Designing of the movable furniture is a significant sort of design which gives you chance to change your furniture so as to have diverse versatile features relying up on your necessities, versatile walls productions are the best choices and solutions about the adaptability of room, Movable children rooms furniture for example on table and wheels bed give the capacity to modify and share the space especially for small spaces in residential apartments by idea of movable furniture (Fig: 8) [12].

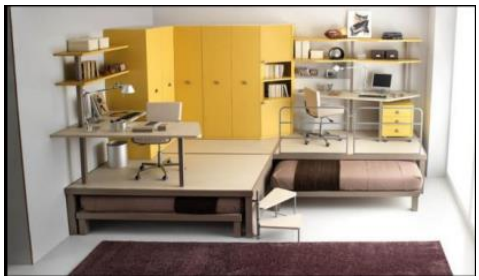


Fig. 8 Movable desks, closet, beds, and chairs that are used in area with space limitation for kids.

2.2.7 Foldable Furniture

Designing furniture with foldable system is utilized the greatest spaces for those places which need to different furniture and don't have the capacity for full furnishing in small spaces. to put more furniture, the residential apartment which their space limit and small, rooms that

need to create enrichment by methods of combining furniture, and the flexible furniture in casing of foldable, multipurpose furniture are advantageous. Moreover, the useful factor of foldable furniture that give the ability to convert the style of furniture easily especially for those who interested in decoration alteration (fig: 9) [13].

Fig. 9 Foldable single and multiple tables

2.4 Residential furniture's characteristics and categories in relative to modern innovations

Table 3: Flexible Residential furniture

changeable productions	adaptableness
Financial solution	Easy to transform
instrument of new products	safety
appropriate furniture structure	foldable
productively	Multifunctional purpose

From the above studies, because most of the apartments are with small spaces and are excessively little to compose all the essential furniture in the same time, so using space saving furniture with smart solution are important. The principal result that from the absence of furniture space, so inhabitants have to utilizing the small apartments as multipurpose space, in which they need to change and refurnish their flats during the day. That the modular, multifunctional, and transformable rooms consider to having a function.

3. Case Study; Residential Apartment

The article is depend on a previous study, the literature selection is return to the collection of articles regarding small spaces in apartments and urban lodging improvement, The research specifically focuses on the psychological and furniture-related aspects concerning human well-being and needs.

3.1 Urban lodging improvement

Living in small spaces are certifiably not another circumstance, and for many years, many people have been residing in small flats. because in greater urban populations density of population are very high, as indicated by united nations urbanization report in 2014, the population number living in huge urban communities will increase in 2050 by %66 [14].

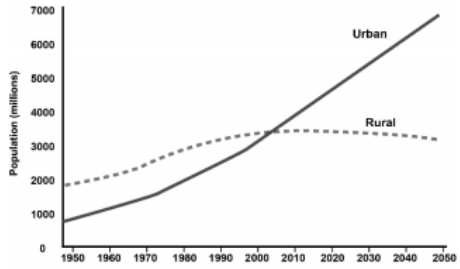


Fig. 10 The increasing number of populations in the world, (United Nations, 2014)

3.2 New advancement in residence furniture technology

In the context of contemporary advancements in modern design and innovation, the introduction of inventive furniture, such as smart furniture, has the potential to significantly enhance the quality of life for individuals. thus, this study aims to investigate the flexibility in the furniture by smart solution for interior designs, particularly in-residence apartments.

The furniture most flexible aspect for clients is moving, cleaning, and converting easily. that many clients still rely on traditional methods for these tasks underscores the need for innovative approaches to enhance the usability of furniture, The integration of new techniques in furniture production can contribute to making these aspects more user-friendly and, consequently, enhance the overall satisfaction of occupants in residential space [15].

3.3 Small apartment

Today we can find a lot of small apartments in Erbil city, as seen in (fig: 11) and have a floor space of 50 square meters for a flat.

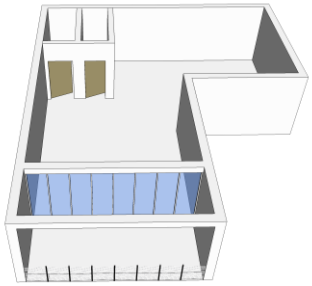


Fig. 11 Basic model of the one room flat (50 m2)

The effectiveness in form of functionality and financial execution (performance) of one person room basic model in which designed with static structure and furniture, so as to create comparative practice with other samples that depended on flexibility in its design .

3.4 practical study

After choosing variable element which relate to flexibility in a small urban apartment with limited space, in which the flat area just about 50 meter square for residential unit,

effectiveness for the terms of furniture arrangement, functionality, and space utilization, also financial and aesthetics (fig:12) (fig:13).

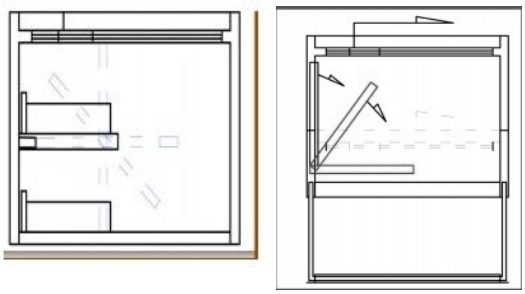


Fig. 12 Space and the Furniture can convert as the functions.

The integration of sliding systems in the design of small living spaces can offer numerous benefits in terms of functionality, efficiency, and economics. Sliding systems contribute to flexibility in interior space arrangement and can enhance the overall quality of life for those people who live in small spaces.

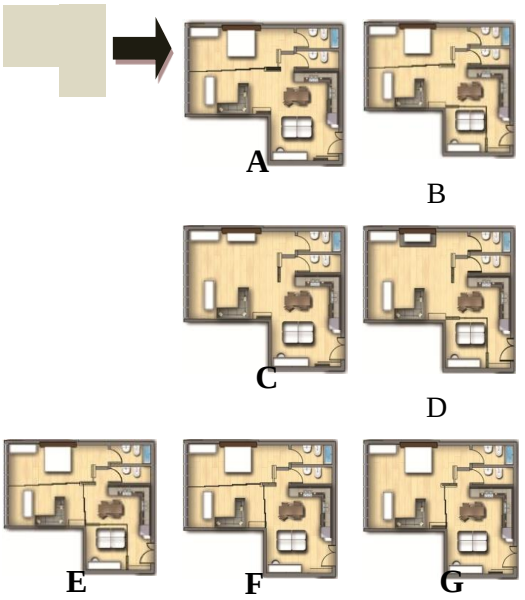


Fig. 13 Different models Example of a small apartment of 50m2 area .

As (figure: 13) above show that most of the small apartments just have one room or two rooms, this implies you need to utilize a similar space for several actions in which ordinarily isolated into various rooms; it's about multipurpose space which able to accommodate various functions and using furniture for various events and activities according to human needs.

So, the samples above A, B, C, D show anew assortment in which the space require to

accommodate, here we have both kitchen and living room in the same space, so each of these has their own necessities to function ideally that accommodates diverse activities and lifestyles.

Table 5: the efficiency in the form of financial and functionality performance of sample which designed with flexible partitions only .

	A, B		Partial level	Entire level	both
Flexibility	Furniture	Within space			
	Open and Multi-Functional Layouts	Flexible Arrangements			
Space efficiency	Space saving				
	adaptable space				
	Multi-Functional space				

Table 6: The effectiveness in form of functionality and financial execution of the sample B, C, D in which planned with flexible divider (portions) and multipurpose furniture for various activities .

	C, D		Partial level	Entire level	both
Flexibility	Furniture	Within space			
	Open and Multi-Functional Layouts	Flexible Arrangements			
Space efficiency	Space saving				
	adaptable space				
	Multi-Functional space				

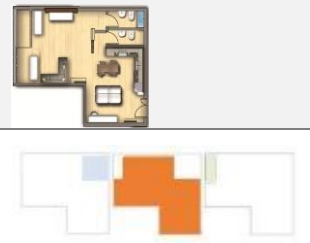
Table 7: The effectiveness in form of functionality, Transition space and financial execution of the sample E, F, G in which planned with flexible divider (portions) and multipurpose furniture for various activities .

	E, F, G		Partial level	Entire level	both
Flexibility	Furniture	Within space			
	Open and Multi-Functional Layouts	Flexible Arrangements			
Space efficiency	Space saving				
	adaptable space				
	Multi-Functional space				

The utilization of flexibility in details and planning (table 5,6,7) The discovery indicates that incorporating flexibility in design and planning leads to significant savings in both space and costs, making the approach more effective in meeting functional necessities compared to other examples. The outcome demonstrated that the essential model was the least efficient in

achieving these objectives, but model E, F, G demonstrate the highest efficiency, we can infer that the little details in design selecting practical and functional furniture able to be exceptionally helpful for space area maximization. Many people choose the furniture that able to utilize in movable, modular, foldable, multifunction for space saving in their housing unit, this will give them chance to use multipurpose furniture as per their requirements and contributes to cost savings.

Table 8: prototypes configuration (researcher)

Prototypes	Bedroom, Services, Living area, dining & kitchen, Studying room, Resting space, Transition space, Slack space		
	Option 1	Option 2	Option 3
A			
B			
C			
D			

The activities that occur in these spaces have close relationships. As a result, their spatial outline must be in an adjoining association, which consequently prompts transforming spatial hierarchy. That has considered the parts of the kitchen and bathroom as fixed spaces. The one-bedroom and living/dining room work as multifunction spaces. Space has been separated and prearranged dependent on spatial hierarchy by creating suitable associations regarding to its users' requirements, lifestyles, and behaviors.

The actualized model is an application, in which describe a virtual, flexible space with numerous smart items as, a smart wall, smart surfaces, In this prototype, users do not observe the environment as a fixed environment, however as a space where he/she can achieve a number of real-time interactions within various tasks.

3.5 Small apartment's furniture

Furniture is a fundamental part of residence buildings; it is taking up about half of normal floor space (Fig: 14) show that which type of the furniture are the most common and essential part for individuals home especially for one person bedroom apartments. The data originates from the review of individuals living in small flats.

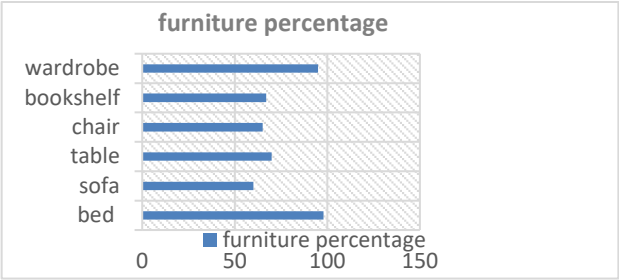


Fig. 14 Main furniture in a small apartment

Because of small apartment advancement, there is never again enough space to hold fundamental furniture like table, bed and sofa at the same time, therefore increase the interest in space saving and smart solutions.

4. The present arrangement in furniture

The findings that indicate some methods for explaining the issue for small spaces, to accommodate small living spaces, in which multifunctional furniture be able to convert into various activities. All arrangements aim for bettering space proficiency and for space saving [12].

4.1 Multifunctional furniture

The utilization of space saving furniture, multipurpose and transformable furniture is indeed a key consideration in optimizing functionality in small spaces. A model of furniture shows in (figure: 15) underneath this furniture carry out the function of bookshelf as well as a sofa and abed which hide the bed in the wall. [15].

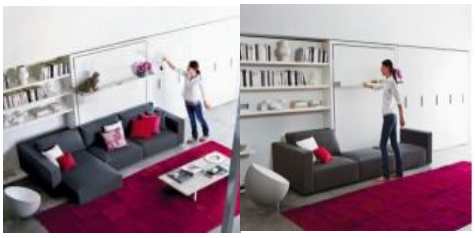


Fig. 15 multipurpose furniture sofa and bed

4.2 Modular furniture

The concept of modular furniture portioned into several pre-made parts that users can assemble according to their preferences and needs. A case of this modular seats, it's a very good idea for small spaces that fits your [15]. (Figure: 16) This approach offers flexibility and adaptability, making it particularly suitable for small spaces.

Fig. 16 modular, movable, and multi-functional furniture which convert to bed, sofa, table, and closet.

4.3 Transformable room

Transformable rooms are based on conventional Murphy bed which is being inside the wall, is a practical and innovative solution for optimizing space in small living areas. This design approach leverages specially made furniture with mechanisms integrated into the walls to seamlessly transition between different functions. For instance, open an entryway and find a table, closet, restroom, etc. (figure: 17) demonstrate a case of transformable where the bed is hauled out from the wall over the sofa [3].

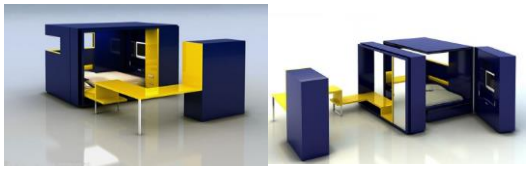


Fig. 17 various functional transformations of a unit.

5. Conclusion

This paper focuses to a critical connection between small apartments, furniture and occupant's prosperity, and physical encompassing in a flat largely affecting its occupants, it underscores a critical connection between these elements and emphasizes that previous studies have suggested various solutions for furnishing small spaces. While these solutions may focus on practical aspects such as space efficiency, the paper posits the necessity for a more holistic approach that accounts for occupants' wellbeing that living there. Living in the small spaces and its relationship with the furniture design, that everyone has not the similar requirements for furniture. Today some of the transformable furniture may work flawlessly for some issues and might be problems for some other people. In view of this uniqueness, it's essential to comprehend the activities and the preferences of the occupants before picking and designing furniture for their interior spaces. It's imperative that have the diverse needs for productivity, additionally vital organize personal opportunities, that give the occupants different methods to create their personality, in which influence their fulfillment positively.

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