Shaping Limited Residential Spaces with Multifunctional Furniture Design Language: Solutions and Ideas

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Received: 25/6/2024

Acceptance: 18/12/2024

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Cited by: Jordan J. Arts, 18(1) (2025) 107- 126

Doi: https://doi.org/10.47016/18.1.8

Abstract

Multifunctional furniture is a creative solution for managing small spaces. This study aims to explore a set of solutions and ideas for designing limited residential spaces by using the language of flexible, multi-functional furniture. This study uses a descriptive analytical approach by reviewing the relevant literature and analyzing six cases of limited residential spaces based on the language of multi-functional furniture design. The results of the study reveals several ways to achieve design flexibility in limited residential spaces, including open plans, sliding or folding partitions, and utilizing the vertical dimension of the space to create multiple levels. Furthermore, the study demonstrates that multi-functional furniture offers unique solutions and ideas that can improve design flexibility and efficiency when utilizing limited living spaces. The study recommends developing programs in architecture and interior design colleges to enhance graduates' ability to deal with small spaces and develop innovative designs for multi-functional furniture.

Keywords: Limited residential spaces, flexible spaces, multi-functional furniture.

تشكيل الفضاءات السكنية المحدودة المساحة باستخدام لغة تصميم الأثاث المتعدد الوظائف، حلول وأفكار

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الملخص

الأثاث متعدد الوظائف من الحلول الإبداعية الذكية التي يمكن استخدامها لإدارة المساحات الصغيرة. تهدف الدراسة إلى استكشاف مجموعة من الحلول والأفكار لتصميم الفراغات السكنية المحدودة من خلال استخدام لغة الأثاث المرن متعدد الوظائف. اعتمدت الدراسة المنهج الوصفي التحليلي، وذلك من خلال مراجعة الأدبيات ذات الصلة وتحليل (6) حالات لفراغات سكنية محدودة تقوم على لغة تصميم الأثاث متعدد الوظائف. أشارت نتائج الدراسة أن المرونة التصميمية في الفراغات السكنية المحدودة يمكن تحقيقها بعدة أساليب: المخطط المفتوح، والقواطع المنزلقة أو القابلة للطي، واستغلال البعد العامودي للفراغ لخلق مستويات متعددة. علاوة على ذلك، بينت الدراسة أن الأثاث متعدد الوظائف يوفر حلولا وأفكارا متميزة يمكن استخدامها لتعزيز المرونة التصميمية وتحسين كفاءة استخدام المساحات المعيشية المحدودة. توصي الدراسة بضرورة تطوير برامج كليات العمارة والتصميم الداخلي لتعزيز قدرة الخريجين على التعامل مع المساحات الصغيرة ووضع تصاميم مبتكرة للأثاث متعدد الوظائف.

الكلمات المفتاحية: الفراغات السكنية المحدودة، المساحات المرنة، الأثاث متعدد الوظائف.

1. Introduction

Cities around the world have witnessed a significant increase in the prices of houses and apartments, which is attributed to population migration towards urban centers and urban expansion, which has led to an increase in the demand for land, especially after the economic crisis of 2008 (Kavut, 2020, pp. 142-143). Under these circumstances, many families with low and middle incomes or young people living independently cannot afford to buy or rent spacious houses. Consequently, they resort to living in limited residential spaces (Kwon & Kim, 2019, p. 1).

Residential spaces play an essential role in determining the quality of life and well-being. Appropriately designed residential environments provide a lively, sociable, comfortable, and safe living environment capable of meeting residents' physiological, psychological, social, and other needs (Susanto & Ilmiani, 2018 , p. 26).

Limited space can be an obstacle in achieving these living conditions. Architects contend that the issue is not the space's small size but rather its management and design. Architects can address small spaces by designing flexible and multifunctional spaces that can adapt to the changing needs of residents (Canepa, 2017, p. 144).

There are several ways to create flexible spaces. The open plan enhances the flexibility of the space; users can divide the open space and change it continuously according to their needs (Susanto & Ilmiani, 2018 , p. 26). Moreover, to maintain privacy, architects use soft boundaries such as sliding or folding partitions (Wawira, 2019 , p. 7). On the other hand, architects can utilize the vertical dimension by dividing it into multiple levels, each serving a different purpose. These solutions help create flexible living spaces that give the user a sense of continuity and flow, while also increasing their sense of spaciousness and openness (Kim et al., 2011, p. 18).

Furniture can alleviate constraints in residential spaces. Furniture occupies approximately 40–50% of the area of residential spaces; therefore, smart furniture solutions can save space and achieve flexibility (Kandalkar, 2020, p. 3).

Multifunctional solution is one of the solutions. They are characterized by attractive and intriguing shapes. Moreover, these pieces create positive impressions and experiences for users (Wang et al., 2022, p. 360). However, these pieces enhance the efficiency and flexibility of space (Husein, 2021, p. 5; Estaji, 2017, p. 41). Therefore, their use in small residential spaces may provide an effective solution. Based on the aforementioned information, this study explores design concepts and solutions for residential spaces with limited space utilizing multifunctional furniture.

1.1 Problem statement

Due to high land prices, living in a spacious house is difficult, especially for low-income individuals. Therefore, property owners tend to build small houses and apartments that suit the prevailing economic situations of most individuals (Kwon & Kim, 2019, p. 1). While having limited space is not a problem, improper management can negatively impact one's quality of life, well-being, feelings, and impressions (Susanto & Ilmiani, 2018 , p. 26). The use of multi-functional furniture can create flexible and highly efficient living space (Wang et al., 2022, p. 360). Therefore, this study explores a set of ideas and solutions that can achieve positive shaping in a limited residential space.

2.1 The Importance of the study

Given that many people cannot afford to live in spacious homes, this study is crucial for addressing the issue of limited residential space and proposing a set of effective solutions. Moreover, this study helps interior designers make effective design decisions to enhance the design flexibility of limited residential spaces. On the other hand, the study serves as a guide for architects and designers interested in designing flexible, multifunctional furniture. This illustrates the mechanism for employing it in limited spaces in a way that enhances the quality of the living environment and limits the impact of limited space on human happiness, well-being, and satisfaction with this environment.

3.1 Study objectives

The study aims to achieve the following objectives:

A. Identify the mechanisms for dealing with limited residential spaces.
B. Identify the types and forms of multifunctional furniture.
C. Identify ideas and solutions for shaping limited residential spaces through multifunctional furniture.

4.1 Study Questions

The study seeks to answer the following questions:

A. What are the mechanisms for dealing with limited residential spaces?
B. What are the types and forms of multifunctional furniture?
C. What are the ideas and solutions for shaping limited residential spaces with multifunctional furniture?

2. Literature Review

2.1 Limited Residential Spaces

People spend a lot of time in their living spaces, engage in daily activities, interact intimately with their family members, and create unforgettable moments. Therefore, designing a living space that is comfortable, enjoyable, attractive, safe, and meets needs is crucial (Desai & Patel, 2022, p. 3255).

Meeting human needs is an essential aspect of residential space. First, space should meet physiological needs related to basic activities that keep humans alive, such as sleeping, eating, and hygiene. Essentially, the design and distribution of residential spaces should facilitate the fulfillment of these basic needs. (korny, 2020, p. 493). In addition, the biological needs related to environmental factors (temperature, noise, and visual appeal) enhance the livability of this space. Furthermore, human emotions and feelings are also related to psychological needs. Examples include a sense of comfort, safety, containment, belonging, spaciousness, pleasure, and privacy. Eventually, social needs relate to the level of interactivity that a place provides for practicing shared social activities (Mohamed et al., 2021, p. 292).

According to the above, residential space is critical for the quality of life and well-being. Meanwhile, many countries worldwide struggle to provide suitable housing. Many cities are experiencing significant population growth, which impacts the demand for land and increases its prices. However, the vast majority of families with low and middle incomes are unable to afford spacious residential spaces, instead opting for smaller ones (Susanto & Ilmiani, 2018 , p. 26; Kwon & Kim, 2019, p. 1).

It is worth recalling that, while small-sized housing has ancient roots, this research explores the modern concept of designing limited residential spaces. The idea of “tiny living” emerged in the wake of the 2008 global economic crisis. This idea began to spread to European countries. This phenomenon coincided with significant industrial development and the accompanying migration from the countryside to cities. Owing to the high population density in urban areas, providing adequate housing at affordable prices has become a challenge for planners (Kavut, 2020, pp. 142-143).

Limited residential spaces are characterized by a disproportionately small area for the number of occupants and, in most cases, include one or two rooms used for various purposes in addition to a bathroom and kitchen space (Husein, 2021, pp. 3-4). The criteria used to assess the size of a residential space vary; however, in general, the average size is 55 sq. meters (Saied et al., 2024, p. 820). In America, this type of housing, known as a studio, is 25-45 sq. meters. However, its size may not exceed 32 sq. meters in Japan, Korea, and some European capitals (Gjakun, 2015, p. 15). Limited residential spaces have smaller size compared to their counterparts, or when they are divided in a way that leads to space wastage and misuse, or when they fail to meet the needs of users (Kavut, 2020, p. 142). Nevertheless, how do we determine that the residential space is sufficient and

unlimited? Table (1) illustrates the average residential space in square meters in many countries worldwide.

Table (1): The average residential space in sq. meters in many countries around the word, (Johansson et al., 2009, p. 29; Eser, 2024 , p. 1; Wilson, 2024, p. 1)

Australia	Austria	Belgium	Canada	China	Denmark	Finland	France
214	97	120	181	60	137	82	112
France	Germany	Greece	Hong Kong	India	Ireland	Italy	Japan
112	109	126	45	47	89	81	95
Luxembourg	Netherlands	New Zealand	Portugal	Russia	Spain	Sweden	U. K
126	117	202	84	57	97	83	76
U. S	Saudi	U.A. E	Jordan	Egypt	Brazil	Mexico	South Africa
201	188	349	150	105	103	159	146

Owing to the high prices of residential apartments and large houses, young adults and some newly formed families resort to living in limited-sized houses and apartments that suit their financial capabilities. Residential spaces with limited spaces are simple to clean and require less maintenance. Moreover, these spaces tend to be more sustainable and consume less electrical load (Tremblay et al., 2014).

However, these spaces are suitable for low-income individuals; having four walls and a roof to shelter them is better than the remaining homeless. Furthermore, it fulfills the desire of young people to live independently from their families. From a different point of view, limited residential spaces raise concerns among some about their negative impact on the identity of cities, the level of social security, the feeling of psychological comfort and belonging, and the perception of the quality of life, especially in cases where these spaces are designed without considering the necessary design considerations (Kavut, 2020, pp. 143-144).

This issue does not stem from the limited size of residential spaces, but rather from their inefficient design. To achieve this, the designer must analyze the activities that will take place and the users' needs. Similarly, designers should carefully choose building materials and conduct a detailed study of the plan layout and dimensions (Kavut, 2020, p. 144).

Small spaces can be addressed based on several design concepts. In his book “Small Spaces,” Azby Brown mentioned rule (3C), which represents compactness, comfort, and convenience. Compactness refers to the integration of functions with each other, while comfort expresses ease, smoothness, and psychological stability, and suitability expresses compatibility between the design and the user’s needs (Brown, 1993, p. 75).

To address space limitations, architects can embrace the concept of flexibility, which is a smart and sustainable solution. It produces compact multi-functional spaces that are transformable. Applying the concept of flexibility improves space utilization efficiency and enhances users’ feeling of sufficiency rather than smallness (Canepa, 2017, p. 1).

The concept of flexibility emerged in the design of residential spaces at the beginning of the twentieth century as part of the rational and economic design strategies for housing. Europe then witnessed economic crises that led to the development of this concept (Postell, et al., 2022, p. 42).

The architects realized that the effectiveness and efficiency of a home do not lie in the vastness of its space but in the ability to manage the functions and design flexible spaces that are adaptable and respond to differences in activities and needs (Canepa, 2017, p. 2). For example, in 1954, architect Walter Gropius, one of the first architects to discuss the idea of flexibility in building design, confirmed that buildings should be designed in a way that is flexible in responding to the dynamic features of our modern lives (Peace et al., 2023, p. 102).

Flexibility influences the functional efficiency of residential spaces. Flexible spaces are defined as spaces that can be used for multiple functions as they can be configured in

different ways depending on the type of activity that the user wants to practice (Shatwan, 2022, p. 61; Alhilo & Hussein, 2022, p. 2344). Furthermore, architects associate flexible spaces with the ability to change the structure of a building. This flexible design enables the combination or expansion of rooms, sliding of walls or doors, and folding and repurposing of furniture for multiple uses (Chen, 2022, pp. 7-8).

An open plan allows the creation of a flexible space. The designer determines the location of the service facilities, and then the user shapes and organizes the interior space according to their needs (Susanto & Ilmiani, 2018 , p. 26; Gjakun, 2015, p. 29). The open plan (without fixed walls) provides users the opportunity to arrange the interior space according to their preferences and needs. It also helps the family to adapt to changes, such as increasing the number of members (Wawira, 2019 , p. 6; Kim et al., 2011, p. 191). Figure (1) illustrates an apartment with a limited area of approximately 20 sq. Meters and use of an open plan to enhance flexibility.

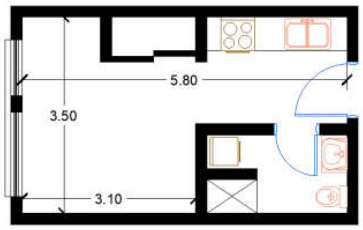


Figure (1) illustrates the adoption of an open plan to enhance flexibility in a space-limited apartment, with an area of 20.3 m^2, (Husein, 2021, p. 4)

For privacy and other reasons, an open plan may not always be suitable. However, space limitations can still be addressed by removing fixed walls and replacing them with wooden partitions that can open and close like doors. Traditional Chinese architecture features these wooden partitions abundantly. These partitions offer flexibility in interior-space design, allowing for a change or combination of space functions as needed. Moreover, the distinctive decorative design of these partitions enhances a house's attractiveness and visual appeal (Beisi & Yingying, 2011, p. 22). Figure (2) shows some of the wooden partitions used in traditional Chinese houses.

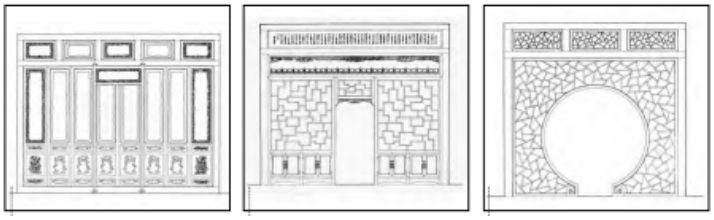


Figure (2) shows some wooden partitions used in traditional Chinese houses, (Beisi & Yingying, 2011, p. 23).

Fixed walls can be replaced not only by partitions but also by movable storage units or closets that can separate rooms, store clothes, and store other items. Its movable features allow for the fusion of interior spaces as well as the expansion or contraction of rooms as needed. Therefore, it allows the creation of a flexible and multifunctional space (Wawira, 2019 , p. 7).

Figure (3) explains how storage units combine the separation and storage functions. They also feature a bed and dining table that are capable of rolling, sliding, and closing. This allowed for concealment and reactivation during specific periods of the day (Canepa, 2017, p. 2). figure (4) shows another example of a movable partition that can change the size of rooms and divide them according to the needs of the users. figure (5) shows a wooden partition that can move and rotate at a specific angle (90 °). It is used as a partition between spaces, book-storage unit, and reading space.

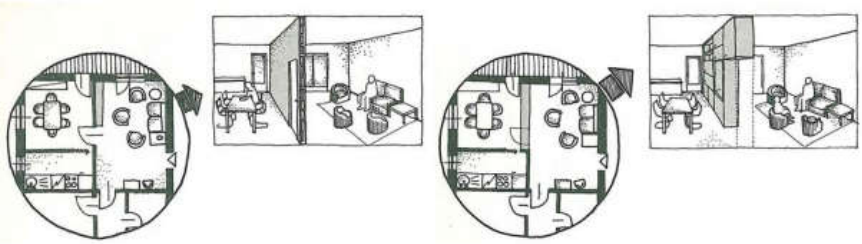


Figure (3) illustrates the wall-storage unit between the living room and kitchen (Canepa, 2017, p. 2).

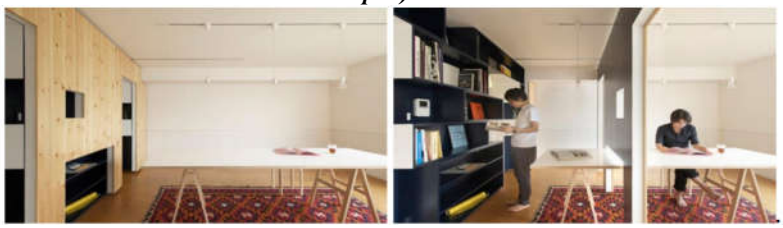


Figure (4) illustrates a movable partition that divides space and boots its flexibility (Kavut, 2020, p. 148).

Figure (5) Shows partition that can rotate at a specific angle (90 degree), (Kavut, 2020, p. 148).

On the other hand, architects can achieve flexibility in limited residential spaces by using the vertical dimension and dividing it into levels (Figure 6). This helps create space efficiency and provides visual communication between spaces. Furthermore, flow and continuity suggest that the place is spacious and open, which reduces the effect of small space (Kwon & Kim, 2019, p. 17).

Figure (6) shows dealing with space limitations through different levels, (Kwon & Kim, 2019, p. 18)

Open plans effectively address the challenges of limited living spaces by fostering a sense of openness and continuity. Fixing the location of service facilities and removing walls from the rest of the spaces contributes to a smoother transition between them. This approach not only helps to maximize the available space, but also enhances the flow of natural light, making the area appear more spacious and welcoming (Susanto & Ilmiani, 2018 , p. 26). Open plans provide flexibility in the arrangement of furniture, allowing residents to adapt the space according to their needs and preferences (Gjakun, 2015, p. 29). Partitions can separate spaces to balance the openness of a plan with the need for privacy or defined spaces (Wawira, 2019 , p. 7). Soft boundaries can be easily modified (Figure7) like; sliding doors, folding screens, or mobile storage units, to create temporary or flexible partitions, when needed (Kwon & Kim, 2019, pp. 18-19). In particular, transparent or semi-transparent glass partitions (Figure 8) provide a way to divide space without losing light or a sense of openness, especially in limited spaces (Kavut, 2020, p. 145). Therefore, by combining open floor plans with multifunctional partitions, residents of limited living spaces can live in flexible, multifunctional, airy spaces that can also provide privacy and comfort. Despite the importance of the above, it is impossible to discuss dealing with limited space within residential spaces without addressing flexible, multifunctional furniture, which is adjustable and can create a new arrangement of space according to user needs (Husein, 2021, p. 5).

Figure (7) shows open plans with soft boundaries, (Kwon & Kim, 2019, p. 19)

Figure (8) shows transparent or semi-transparent glass partitions, (Kavut, 2020, p. 145)

2.2 Multifunctional Furniture

Furniture is an essential factor in interior design; it enhances the functionality of space and shapes it visually and aesthetically. Furniture represents all the moving components used to support human activities in space. For example, sitting requires chairs, benches, and sofas; eating requires tables; and sleeping requires beds. On the other hand, furniture is used to hold and store items such as cabinets, shelves, and TV units. Furniture not only plays a functional role but is also a form of art. Designers can create distinctive designs from different materials that enrich the aesthetics of the space and give it a mood with desirable features (Rajan et al, 2019, p. 442). Furniture is a significant element in residential spaces, accounting for 40–50% of the area (Kandalkar, 2020, p. 3). Before designing or choosing any type of furniture, it is necessary to study the needs of users and the characteristics of the space in which the furniture is located. It is necessary to choose furniture pieces that facilitate users' lives, meet their needs, and at the same time are attractive and suitable for their psychology and feelings (Husein, 2021, pp. 4-5).

In residential spaces, people tend to use prevalent pieces of furniture such as beds, sofas, chairs, tables, wardrobes, and toilets. Owing to the large space required for furniture, design trends are moving towards smart furniture with multiple functions that

can improve space efficiency and sustainability, and achieve the maximum possible level of flexibility (Gjakun, 2015, p. 93; Xie, 2016, p. 2).

The term 'multifunctional furniture' refers to furniture designed in such a way that it can be used for various purposes and activities simultaneously (Estaji, 2017, p. 41). It is also known as furniture, which can adapt to different applications by transforming the spatial relationships of its parts. Other names for this type of furniture include multipurpose, transformable, space-saving, and flexible furniture. For instance, Figure (9) depicts a table that uses a chair, bookshelf, and wardrobe simultaneously (Husein, 2021, p. 5). Figure (10) illustrates a piece of furniture integrated into the wall, which functions as a bed that can be pulled out at night and closed during the day to transform into a work table.

Figure (9) depicts a multifunctional table, (Husein, 2021, p. 6)

Figure (10) illustrates a multifunctional furniture integrated into the wall, (Wang, 2013, p. 3)

The idea behind the multifunctional furniture is to use the same space for multiple purposes throughout the day. Users can transform a space into a bedroom, dining room, study space, or workroom, maximizing a limited space to meet multiple needs (Husein, 2021, p. 6). Multifunctional furniture creates flexible living spaces based on users' personal preferences and needs. However, this type of furniture facilitates the creation of diverse impressions and mood shifts within the interior space, thereby fostering new and unique experiences and mitigating negative emotions often associated with cramped spaces (Wang et al., 2022, p. 360).

There are three categories of multifunctional furniture: convertible, space-saving, and combination furniture. Convertible furniture refers to furniture that can adapt to shape, function, or style; serve multiple purposes; and enhance space efficiency. Beds that transform into sofas, expandable tables, and reconfigurable modular units are examples (Natalia et al., 2021 , p. 312) (Figure(11/a)). On the other hand, combination furniture is defined as furniture that is used for multiple purposes through parts that can be moved or separated from each other when needed. For example, a table in a living room includes a work area and storage space (Xie Y. , 2024, p. 12) (Figure(11/a)). Space-saving furniture refers to innovative pieces that can fold or conceal each other and then unfold when required, thereby conserving a significant amount of space. Some of the most important examples of this type of furniture are the built-in storage units with seating (Labib, 2019, pp. 19-20)). (Figure(11/c)).

Figure (11) Shows Multifunctional furniture types; (a) convertible furniture, (b) space-saving furniture, and (c) combination furniture (Qi et al., 2022, p. 300)

There are many distinctive and innovative designs for flexible multi-purpose furniture. While the dining table typically occupies a significant amount of space, it is often insufficient for hosting guests. Figure (12/a) shows a table with multiple applications. The design showcases a table that allows for flexible space management, serving as both a large dining table and console table. Furthermore, the two-in-one principle guides the chair design, as shown in Figure (12/b). The two chairs occupy the same space as a single chair, allowing for effortless assembly and disassembly (Kandalkar, 2020, p. 5).

Figure (12) (a): Multifunctional table, Multifunctional chair (Kandalkar, 2020, p. 5)

Many multifunctional furnitures focus on maximizing the amount of storage space available at home. Figure 13 shows a sofa with storage space and shoe shelves on either side of the armrest. This design provides ample storage space that eliminates the need to purchase an additional shoe cabinet or storage (Desai & Patel, 2022, p. 3258)

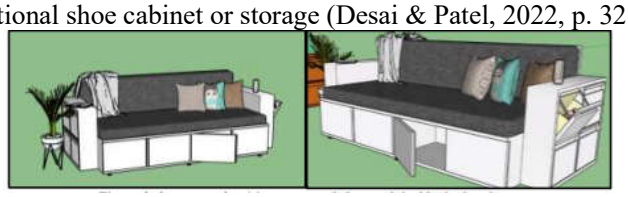


Figure (13) depicts a Multifunctional sofa, (Desai & Patel, 2022, p. 3258)

Another example of flexible, multi-functional furniture is the piece known as “Pill” (Figure 14), designed by the Emco studio, which is characterized by its ability to open and close. In the closed position, it was used as a storage unit, and in the open position, it was used as a table for work or study. Nefemi Marcos-Bello designed the "Tebur" table, as shown in Figure 15. The flexible design allows for easy disassembly and assembly using screws fixed to the table feet, which move mechanically. When not in use, the design folds away to save space (Kavut, 2020, pp. 149-150).

Figure (14) shows the pill, which is a multifunctional table used as a storage unit, (Kavut, 2020, p. 149).

Figure (15) Depicts Tebur, which can be easily disassembled, assembled and folded, space (Kavut, 2020, p. 150)

Additionally, Figure 16 displays a multifunctional TV unit that not only serves as a TV stand, but also incorporates bookshelves and an adjustable bed for sleeping. Thus, this unit serves multiple purposes simultaneously while maintaining space efficiency. When this unit is placed in the living room, it turns into a bedroom at night (Alhilo & Hussein, 2022, p. 2346).

Figure (16) shows a multifunctional TV unit, (Alhilo & Hussein, 2022, p. 2346).

2.3 Review of related study

The study	The aim	Methodology	The result
(Kandalkar, 2020)	It verifies the importance of using multifunctional furniture in low-cost, limited-space apartments	A descriptive approach through literature review	This study revealed that multifunctional furniture not only saves space but also serves multiple purposes. Moreover, multifunctional furniture is an innovative product with broad prospects for future market development, especially given the increasing demand for space and its high prices. This confirms the importance of purchasing furniture to save as much space as possible.
(Husein, 2021)	It examines the impact of multipurpose furniture on the efficient use of flats with limited space	A quantitative methodology, creating and distributing a questionnaire to 126 occupants of small-space flats in Erbil's Zanyari residential complexes	The study's findings demonstrate that tenants deal with a variety of issues relating to their apartments' limited size. Furthermore, the participants attested to the fact that adaptable, multipurpose furniture is a wise way to raise the standard of the internal environment and boost the sustainability and effectiveness of areas. Furthermore, this kind of furniture strikes a balance between the interior space's utilitarian and aesthetic values
(Saied et al., 2024)	It pointed out the negative effects of living in small apartments on residents' well-being and quality of life	A case study analysis	Since furniture occupies a large space, this study confirms that flexible, multi-functional furniture contributes to saving space and improving the vitality of the place, enhancing the well-being of residents and their satisfaction with the living environment.
(Desai & Patel, 2022)	It sought to identify the challenges faced by owners of small-space homes with regard to furniture used in living rooms	Quantitative approach by distributing a questionnaire to 270 residents of small-space homes in the Indian city of Vadodara	The study showed that most of the residents do not have enough space to store shoes. Moreover, there is insufficient space in the living room for daily life activities. To address these problems, this study developed an intervention program based on the use of multifunctional furniture. Upon surveying the beneficiaries, it discovered that multifunctional furniture enhanced the living room's space efficiency and provided areas for shoe and equipment storage
(Hilal et al, 2023)	It determines the relationship between flexible interior design and multifunctional furniture to find design solutions that enhance space efficiency in small-sized apartments.	A case study analysis	The design shows an integrated relationship between multifunctional furniture and flexible interior space. A flexible space design identifies the main service areas, such as the kitchen and bathroom, and divides the interior space by furniture instead of walls. Combinable furniture is the preferred choice. For instance, a bed can be converted into a sofa or a dining table that can be folded or converted into a workspace.
(Labib, 2019)	It Discusses the problem of the small area of residential apartments and their high prices and the importance of multi-functional furniture to solve these problems.	A descriptive approach through literature review	Multifunctional furniture is an innovative solution for apartments with limited space, as it occupies a small area compared with the multiple goals it achieves. Despite the effectiveness of this type of furniture, it is crucial to prioritize design standards and ensure it meets both functional and aesthetic dimensions, thereby enhancing the comfort and well-being of its users. Moreover, it should be affordable, especially for low-income families.

By reviewing relevant studies, it is clear that multifunctional furniture is an innovative solution to deal with the high prices and limited space of residential spaces. However, the design of high-quality multifunctional furniture can achieve many functional, aesthetic, and economic dimensions in residential spaces.

3. Research Methodology

This study uses a descriptive approach. First, it reviews the relevant literature to form the theoretical framework. Next, it examines six small residential spaces that incorporate multifunctional furniture. These case studies were selected based on a literature review.

3.1 The Case one

Multifunctional furniture offers many solutions for dealing with limited residential spaces. One piece of furniture can serve multiple purposes, thereby reducing the need to purchase multiple pieces. This not only makes a small space appear more spacious and comfortable but also serves multiple purposes throughout the day (Canepa, 2017, p. 4). Figure (17) depicts the first case study, which is a limited-space apartment that includes several multifunctional furniture. At night, the sofa doubles as a bed, and the kitchen's folded shelf transforms into a dining table.

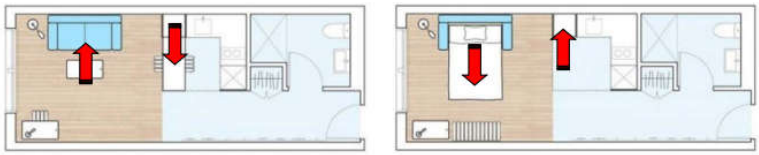
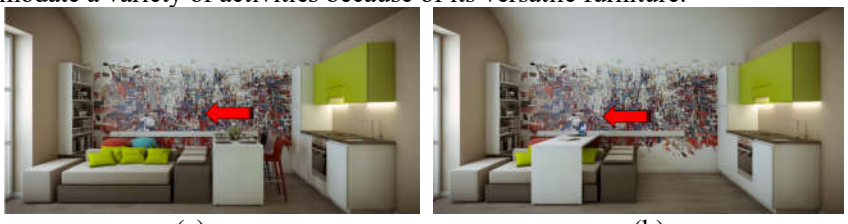


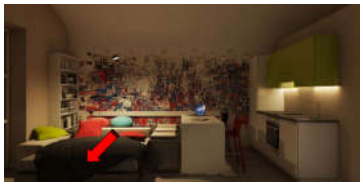
Figure (17) depicts a limited-space apartment that includes multifunctional pieces of furniture (Canepa, 2017, p. 5).

3.2 The Case two

Multifunctional furniture improves the flexibility and ability of living spaces to meet the needs of residents, especially when the available space is small. The second case study represents the design of a small apartment in Turin, Italy, which transforms old apartments into ones with a contemporary and flexible character, as depicted in Figure (18). This design is based on the presence of a table that can slide on a rail fixed to the wall and extend from the kitchen to the window. When moved closer to the kitchen (Figure 18/a), this table serves as a dining table, and when it slides towards the window (Figure 18/b), it transforms into a work and study space. Moreover, users can pull out the sofa at night and transform it into a bed (Figure 18/c). Thus, this small space was able to accommodate a variety of activities because of its versatile furniture.



(a) (b).

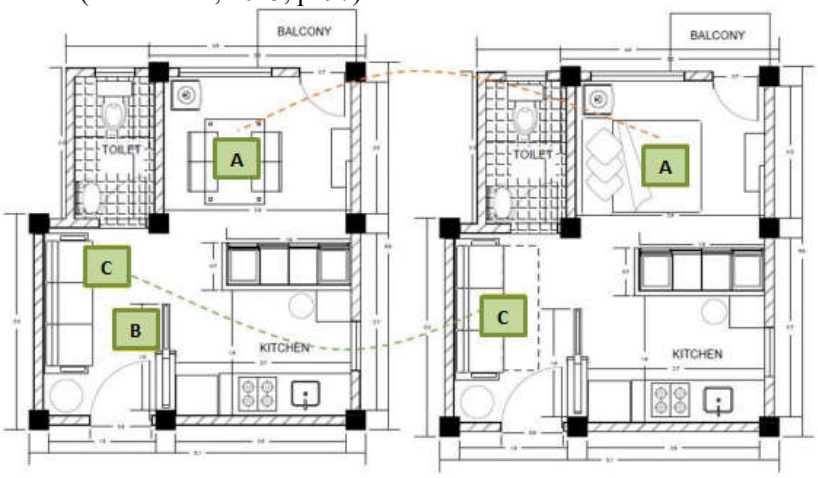


(c)

Figure (18) (a): using the sliding table on the rail as a dining table, (b): using the table as a desk for work and study, (c): The sofa has a built-in bed for sleeping, (Canepa, 2017, pp. 5-6).

3.3 The Case three

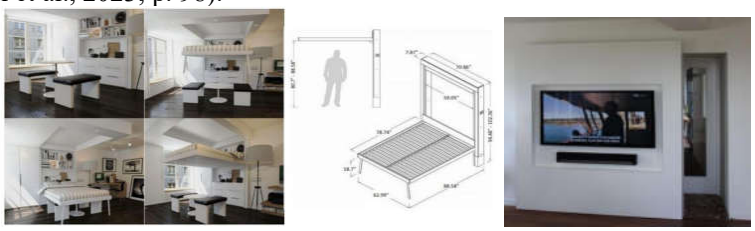
The designers intelligently dealt with the design of the third case study, which represents a limited-space apartment. The designers achieved flexibility by fixing the service areas (kitchen and bathroom) and dividing the open space through multifunctional furniture. This helps improve the space's ability to adapt and develop according to the family's needs and changing characteristics. The built-in bed in space (A) transforms from a bedroom (Figure (19)/2) to a dining room (Figure (19)/1). Furthermore, the designers incorporated an extendable and contractible sofa into space (C), which can serve as a bed when necessary. They used a sliding partition in space (B), which turned into a TV stand (Hilal et al., 2023, p. 97).



(1) (2)

Figure (19) depicts different situations in the apartment arising from the use of multifunctional furniture (Hilal et al., 2023, p. 97).

This case study utilized an UP ceiling bed, which is a multifunctional piece of furniture. The Italian company (Milano Smart Living) designed it. During the day, the bed integrated into the ceiling, transforming the space underneath it into a dining table (Figure 20/a a). The same company also designed the sofa shown in Figure (21), known as BE Easy. It is an extendable couch. Figure (20/b) shows the sliding partition that holds the TV (Hilal et al., 2023, p. 98).



(a) and (b)

Figure (20) shows (a), which is a built-in bed (Up), (b) sliding partition, and TV stand (Hilal et al., 2023, p. 98).

Figure (21) illustrates the extendable sofa (BE Easy) (Hilal et al., 2023, p. 98).

3.4 The Case four

The fourth case is a studio (small apartment), where the designer employed multifunctional furniture to enhance space efficiency. The bed was seamlessly integrated with the closet. Sofa had additional storage units. The rotating table allows users to convert the kitchen table into a study area or work area (Canepa, 2017, p. 7).

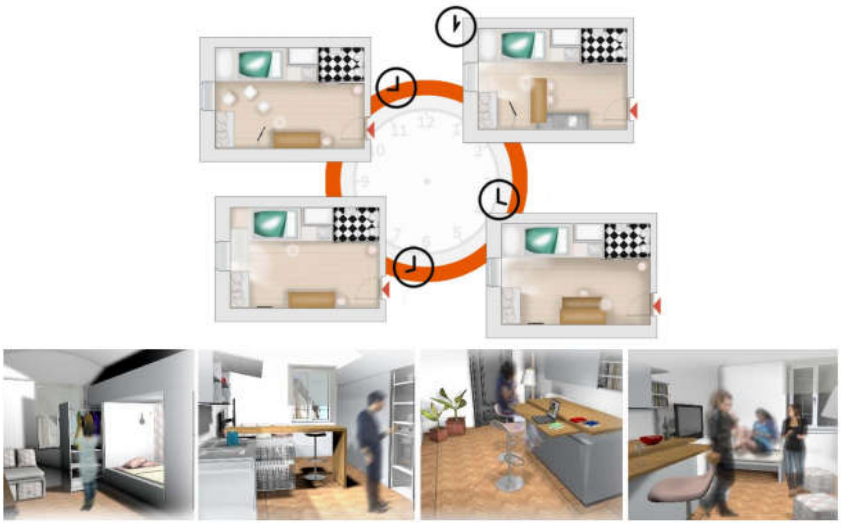


Figure (22) depicts small apartment designed using multifunctional furnitur, (Canepa, 2017, pp. 7-8).

3.5 The Case five

In the fifth case, a small studio boasts a highly efficient design. Apartments include many flexible and multifunctional furniture. A sliding storage unit holds the TV; it is rotatable (180 °) such that the viewing angle can be changed according to the user's needs. When this unit slides, it reveals built-in clothing storage. The bed is foldable. On the opposite wall, the kitchen is equipped with a pull-out dining table. This type of furniture helps to meet the different needs of the user between day and night, enhances the spaciousness of the room, and creates diverse and exciting experiences (Canepa, 2017, p. 9).

A

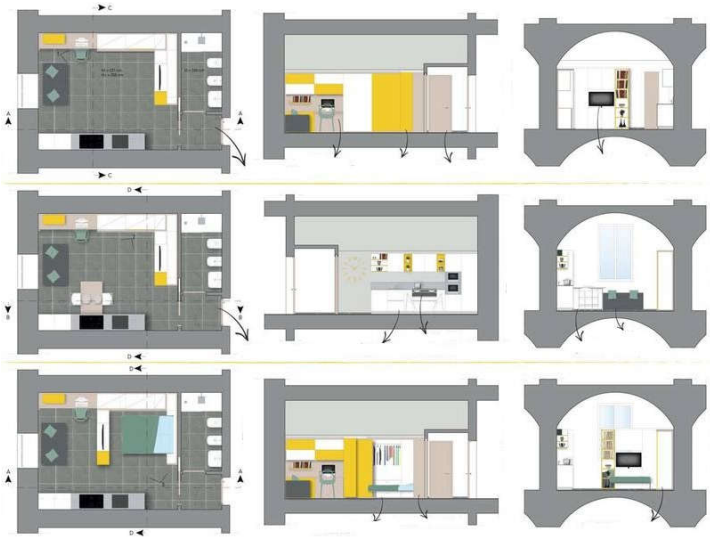


Figure (23) shows the plans and sections in a small apartment at different times based on multifunctional furniture (Canepa, 2017, p. 9).

3.5 The Case Six

The sixth case study demonstrates space efficiency through the Clei Company's flexible, multifunctional, patented furniture. The bed is known as Tango 270, which is a double bed with a 270 cm wide sofa combined with a sliding base that facilitates opening and closing (A). Moreover, an apartment with limited space includes a built-in console connected to a storage unit consisting of drawers, doors, and shelves that transforms into a dining table known as Girò (B). On the other hand, the designer employed a Kitchen Box (C) as a kitchen unit, a unit that conceals kitchen equipment when necessary and pivots at a 90-degree angle to serve as a versatile table. The kitchen also features storage units and a built-in tilt table, which when opened, aligns with the horizontal board, providing the user with a more expansive work area. When the rotating element closes, it can accommodate all the electrical appliances (Canepa, 2017, p. 9).

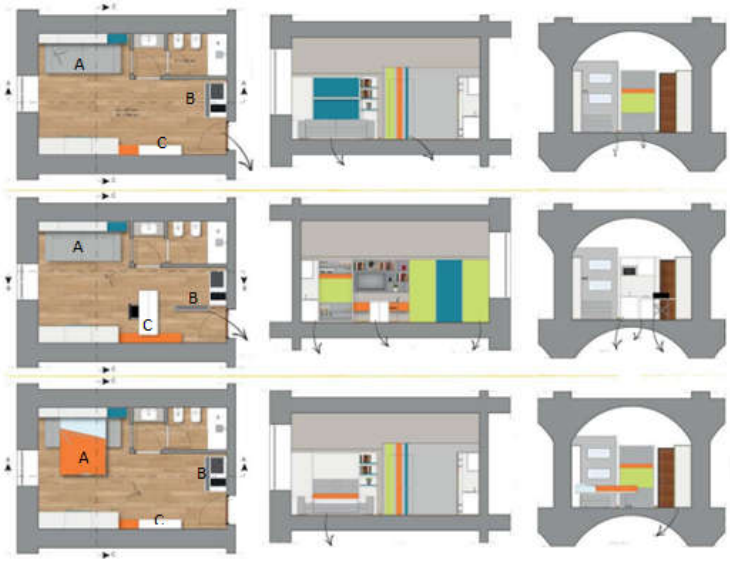


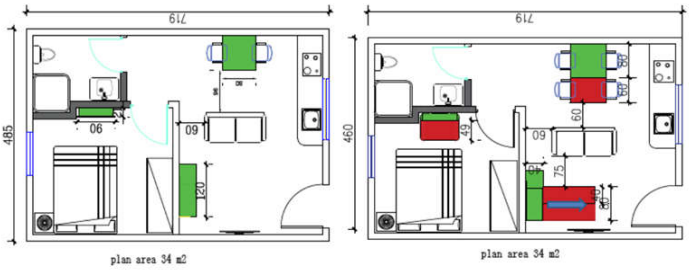
Figure (24) shows the plans and sections in a small apartment at different times based on multifunctional furniture (Canepa, 2017, p. 10).

4. Proposed designs

The researcher attempted to achieve flexibility as a practical value in improving a house with limited space by designing multifunctional furniture. Different residential units were selected to improve their designs by providing several flexible design modifications suitable for these spaces.

4.1 Design one: Apartment design Area 34m^2

The concept of a small-area plan for a two-person living studio with a surface area of 34 square meters aims to increase the flexible use of tiny spaces. Some pieces of mobile furniture that may be used in more than one setting have been created to demonstrate the possibilities of employing mobile furniture and expanding the number of users as well as the flexibility of exercising the activities of those living in a location without large design spaces that must be wasted. When flexibility is required, these solutions are frequently used. Space and boost the effectiveness of furniture pieces utilized in residential spaces, while also reducing occupied space and lowering the cost of producing and manufacturing furniture units.



(a) and (b)

Figure (25) illustrates the first design of an apartment with multifunctional furniture. a: apartment when the furniture is in a fixed state, b: apartment when furniture after a change in shape and use (Author).

The researcher designed three pieces of furniture required for this type of architectural space to emphasize the role of mobile furniture in the flexibility of small spaces, without compromising movement paths or increasing the number of users of furniture pieces when necessary. These aspects are discussed below. It describes in detail how each piece of furniture is installed and used.

The first one (Figure 26) was designed through a merging function, which included merging the dressing table with a mirror for the bedroom with a secondary use, which is for this table to turn into an office where one can work and study. As working and studying remotely has become a basic requirement that must be considered in interior design, as this requirement emerged during the coronavirus pandemic.

Figure (26) Shots of the first piece of furniture and its different positions (Author).

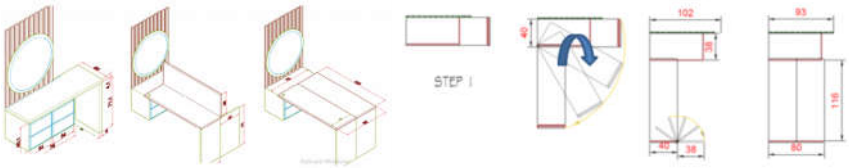


Figure (27) :Drawings of the first furniture position and how to transform it from one position to another (Author).

The second piece allows for laptop use in the bedroom, allowing many occupants to work or study without disrupting each other. figure (28) shows the appearance and installation of the finished model. Wall and method of using it without blocking the path of movement.

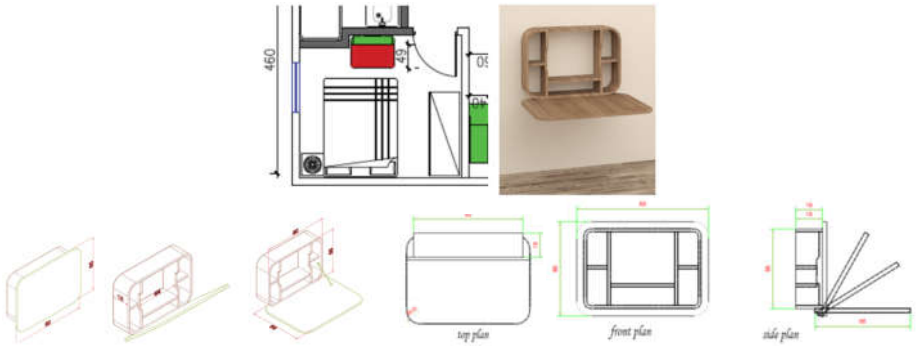


Figure (28) depicts the design of the second piece of furniture and its different positions (Author).

Third model of furniture components and their placement in the plan. It is a wall-mounted folding dinner table that seats two people in a folded position. When necessary, its area can be expanded to accommodate two or three people, while maintaining the flow of movement and making the greatest use of small unoccupied areas. To employ multifunctional furniture, reduce the space occupied in the interior space and expand the mobility channels. Figure (29) depicts hanging the table on the wall with the same dimensions and height as a fixed dining table, as well as an arrow pointing in the direction of spreading the additional piece to enlarge the area. Metal hinges, similar to door hinges, were used to aid the bending and installation procedures. In addition, an isometric viewpoint was developed to display the measurements and steps involved in using the model to clarify the concept through its dimensions.

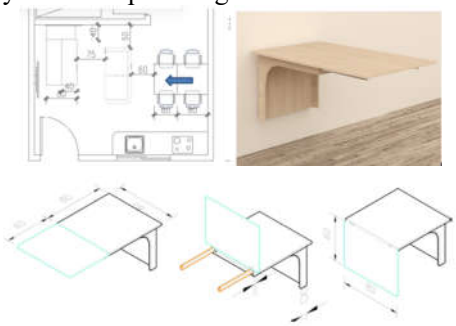


Figure (28) depicts the design of the third piece of furniture and its different positions (Author).

4.2 Design two: Apartment design Area 29 m^2

This residential plan, with an area of (29) square meters was designed as a model for limited spaces, as shown in Figure (30) to clarify and confirm the importance of using movable furniture in interior spaces with small spaces, as well as how to use it on multiple occasions without interfering with movement paths and the optimal exploitation of those spaces. The plan shows. The following illustrates the use of a multi-use and portable food container in the kitchen to maximize kitchen space for dining as well as the ability to fold the container and retain a clear route of movement.

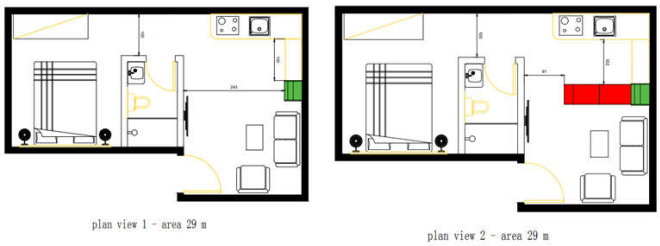


Figure (30) shows the design of the second apartment with multifunctional furniture. a: apartment when the furniture is in a fixed state, b: apartment when furniture after a change in shape and use (Author).

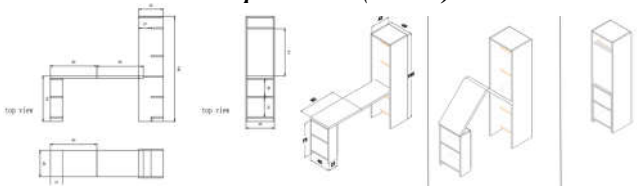


Figure (31) depicts the design of the multifunctional piece of furniture and its different positions (Author).

5. Conclusion

5.1 Results

The redesigned layouts exhibited significant improvements in several key areas.

1. Increased Space Efficiency: Dynamic furniture sets free up valuable floor space, allowing for more movement and flexibility within the limited confines of apartments. This newfound spaciousness contributes to a sense of well-being and reduces feelings of claustrophobia, which are commonly associated with small living areas.
2. Enhanced Functionality: Multifunctional furniture catered to multiple needs and activities. Wall-mounted beds, convertible sofas, and folding dining tables allowed residents to transition seamlessly between various activities, maximizing the utility of each area.
3. Improved Adaptability: The mobile nature of the furniture sets facilitated easy rearrangement to accommodate changing needs. Residents can adapt the layout to host guests, create a dedicated workspace, or simply alter the overall environment from a fresh perspective.
4. Aesthetics and User-Centric Design: The study emphasizes the importance of seamlessly integrating dynamic furniture with the overall design scheme. By considering user preferences and selecting aesthetically pleasing pieces, the redesigned layouts maintained a sense of style and comfort within compact spaces. However, the potential for multifunctional furniture design extends beyond the findings of this study.

Furthermore, the study found the following points:

1. To produce a suitable design system in the interior space of a confined area, balanced furniture items were chosen, integrated, and made flexible throughout their use to suit the nature of the space.
2. Furniture units utilized in small places must be light, easy to store, and long-lasting.
3. Using furniture units that can be expanded and shrunk to reduce the size of the design, it takes less room than the interior space when stored.
4. Furniture pieces must have straight design lines that are not complicated to satisfy the function for which they are developed to provide flexibility in the design of furniture for limited places.
5. The reductionist trend has become the dominant trend in the design of furniture pieces of geometric shapes that are easy to configure away from complex geometric lines and

accumulated decorative elements, as simple lines are commensurate with the modern technology used in furniture piece operations and suit implementation materials.
6. Technology has aided in the creation of operating methods for multipurpose furniture in small spaces, allowing designers to create different and appropriate furniture components to satisfy changing user needs.
7. The multifunctional furniture models and cases presented in this paper demonstrate innovative solutions and ideas for managing limited spaces in residential settings. For example, a built-in bed, an extended sofa, storage units that double as TV units, and a kitchen that transforms into a dining table or workspace.

5.2 Recommendation

1. Use a small amount of furniture in tight spaces.
2. Focus on furniture pieces that can be used for multiple purposes during the day.
3. Consulting an interior designer to design special multifunctional furniture for specific residential spaces.
4. Spread awareness about the potential of multifunctional furniture.
5. Develop curricula in architecture colleges to enhance architects' ability to design small spaces.
6. Included the subjects of multifunctional furniture design in architecture and interior design colleges.
7. Use local and sustainable materials in multifunctional furniture design.
8. Increase multifunctional furniture manufacturing rates and make it available at reasonable prices.

5.3 Future Research Directions:

Further exploration could delve into user preferences and identify the most desirable types of multifunctional furniture, based on lifestyle and demographic factors. In addition, research can investigate the integration of technology into these designs, such as smart tables with built-in charging stations or hidden projector screens. Finally, it is important to examine the long-term economic and environmental benefits of utilizing multifunctional furniture is of significant value. Compact furniture may require less material to be produced, leading to a smaller environmental footprint. Furthermore, the ability to adapt furniture for multiple uses could potentially decrease the need to purchase new pieces as needs change, leading to increased economic efficiency. As the field of multifunctional furniture design continues to evolve, it holds immense potential for shaping the future of comfortable and sustainable living in a world with ever-shrinking square footage. By embracing innovative design approaches and fostering user-centric solutions, multifunctional furniture can play a key role in creating compact living spaces that are not just functional, but also comfortable, stylish, and adaptable to the ever-changing needs of modern residents.

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