Journal of Research in Science and Engineering (JRSE)
ISSN: 1656-1996 Volume-7, Issue-2, February 2025
DOI: 10.53469/jrse.2025.07(02).09

Research of Resilient Kitchen Space Storage Based on the Sustainability Perspective

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Abstract: ***Accelerated urbanization and improved living standards have brought attention to kitchen space utilization and sustainability. This paper explores innovative designs to achieve Resilient kitchen storage, improve space utilization and resource saving. The feasibility of the design solution is evaluated through comparative analysis and user research. Resilient kitchen storage strategies based on sustainable development are proposed to provide reference for future design.***

Keywords: Kitchen space, Sustainability, Flexible design, Storage systems.

1. Background

At present, the kitchen storage problems in family life has gradually been concerned, but there are still some families have a certain degree of neglect. In the traditional concept, kitchen storage has not been enough attention, more attention is paid to the kitchen equipment and aesthetic decoration, and due to the limited kitchen space and the busy pace of life, people tend to put the storage problem on the back burner. However, the importance of kitchen storage can not be ignored. Foreign families in the kitchen storage shows the diversity and characteristics, such as Japan focus on the use of space, the use of multi-functional storage boxes and wall-mounted storage racks; Europe and the United States tend to open storage, the use of shelves and hooks; Scandinavian style emphasizes the simplicity and functionality, the use of built-in drawers and hidden storage. In contrast, China's domestic family kitchen in the storage of obvious deficiencies, mainly faced with limited space, appliances clutter, storage and cleaning of ingredients difficult and other issues, especially in urban residential housing, kitchen area is small, storage space is not enough, appliances disorganized, affecting the neatness of the kitchen and the efficiency of the use of the kitchen. Therefore, to solve these problems, it is necessary to rationally plan the kitchen space, scientifically categorize and organize the utensils and ingredients, and choose the appropriate storage utensils and furniture, in order to improve the storage capacity and efficiency of the kitchen.

2. The Concept of Sustainability and Kitchen Space Organization

2.1 Core Concepts and Principles of the Concept of Sustainable Development

The Resilient Space Kitchen guided by the concept of sustainable development is a modern kitchen solution that combines green concepts with flexible design. It creates a kitchen space that meets the demands of modern life while reducing its ecological footprint through environmentally friendly materials, energy-saving design, modularized layout and intelligent management.

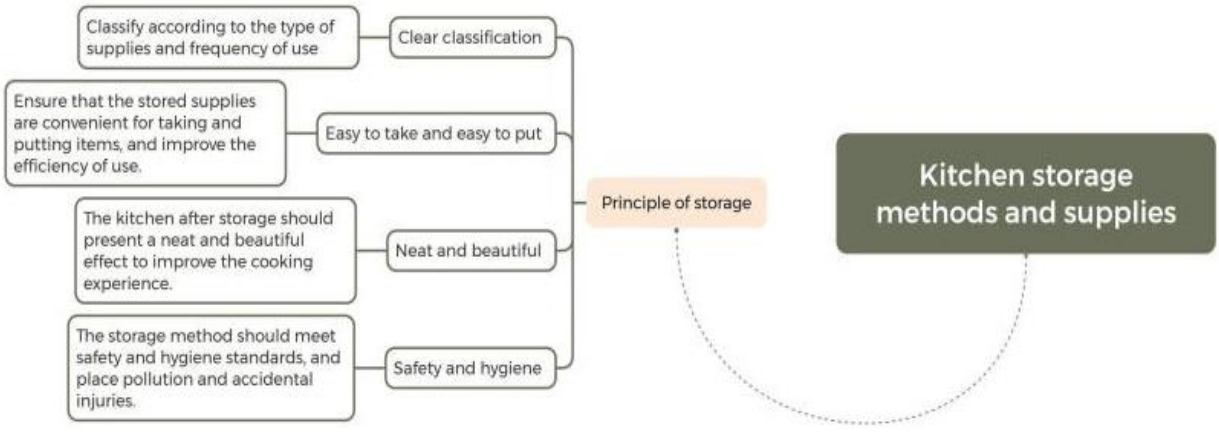

Figure 1: Kitchen storage principles

Resilient storage in modern kitchen design aims to maximize the use of limited space and balance functionality and aesthetics through scientific categorization of storage, flexible storage tools and rational space planning. It emphasizes high-frequency items within reach and low-frequency items hidden storage to ensure easy access to items and enhance the efficiency of use, while keeping the kitchen clean and beautiful. The storage method should meet safety and hygiene standards to avoid contamination or accidental injury. Resilient storage combines "space-saving" and "flexible space", and through modular design and multi-functional tools, kitchens can be flexibly adjusted to meet the needs of daily use and future changes, providing an efficient, comfortable and safe cooking environment.

2.2 Characteristics of Kitchen Space and Analysis of Storage Needs

The core of Resilient kitchen design is to systematically summarize and efficiently utilize the space, the first step is to divide the kitchen into clear functional areas, and sort out the items involved in each area and their usage needs. Through the rational planning of the preparation area, cooking area, cleaning area and storage area, combined with the smooth flow of the line design, can significantly improve the efficiency of the kitchen operation and space utilization.

Figure 2: Kitchen use areas and items involved

On this basis, the specific dimensional data of a large number of kitchen appliances are further collected, including detailed information on length, width, height, etc., to provide an accurate basis for the division and use of very small spaces. Through modular design, vertical space utilization and the introduction of multi-functional furniture, the Resilient Kitchen is able to flexibly adapt to the needs of different scenarios and maximize the use of limited space. In addition, the combination of intelligent storage solutions and adjustable furniture further enhances the adaptability and functionality of the kitchen. This data-driven, systematic planning-based design approach not only optimizes the spatial layout, but also provides scientific support for the efficient use of modern kitchens.

Figure 3: Kitchenware size 1

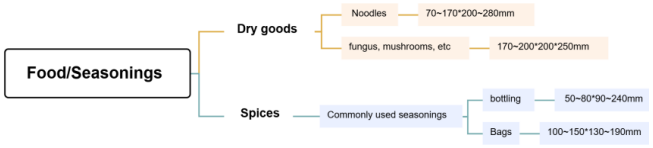

Figure 4: kitchenware size 2

2.3 The Concept of Resilient Design and Its Application to Interior Design

Resilient design uses flexible and adjustable solutions in kitchen storage to meet user needs and space constraints, reflecting modularity, versatility and expandability. Adjustable shelves, drawer dividers, modular organizers, etc. can be adjusted according to items to maximize space utilization. Hanging shelves and magnetic knife holders enhance flexibility. Combined with smart technologies, such as sensor lighting and smart labels, it optimizes the use of space and improves the efficiency of kitchen operations [3].

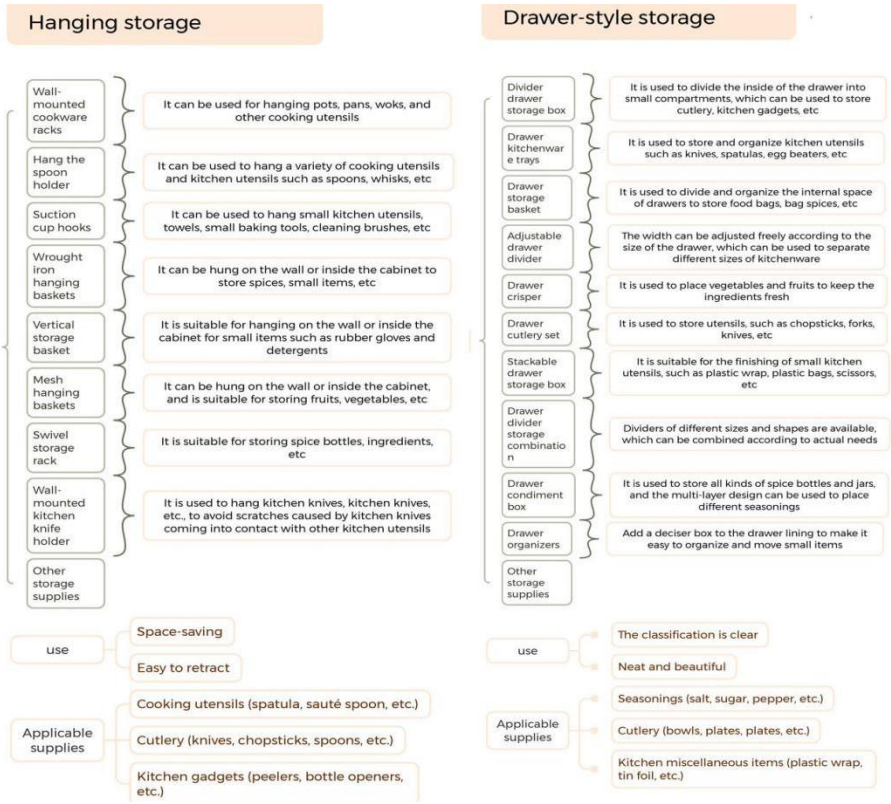

Figure 5: Hanging storage Drawer storage

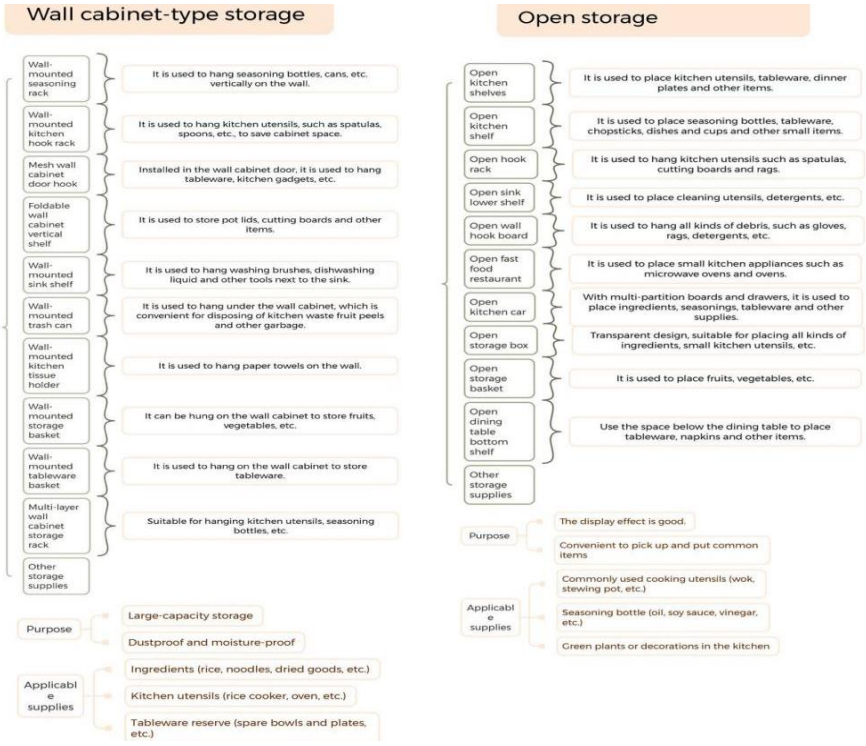

Figure 6: Closet storage Open Storage

3. Resilient Kitchen Space Storage Design Solutions

With the change in elderly care concepts, the demand for elderly care furniture has also evolved. In addition to basic functional requirements, elderly people pay more attention to the comfort, convenience, and intelligence of the furniture. As a result, the elderly care furniture market is experiencing rapid growth. Both domestic and international elderly care furniture markets are constantly developing and innovating to meet the changing needs of the elderly.

3.1 Design Scheme One

3.1.1 Design Concept and Features

The U-shaped kitchen is designed with the idea of efficiently utilizing limited kitchen space, with the design focusing on every inch of space to ensure that cooking needs are met while also providing ample storage space. Through clever layout, storage space is maximized, making full use of kitchen space. Careful planning of the location of washing, cooking, storage and other functional areas, the simplification of the operation process makes the entire kitchen operation process smooth and unobstructed, reducing unnecessary walking and turning, thus significantly improving work efficiency. The zigzag kitchen efficient storage design not only focuses on the rational use of space and the simplification of the operation process, but also emphasizes the flexibility and personalization of the design, aiming to create a practical and comfortable cooking environment for the user.

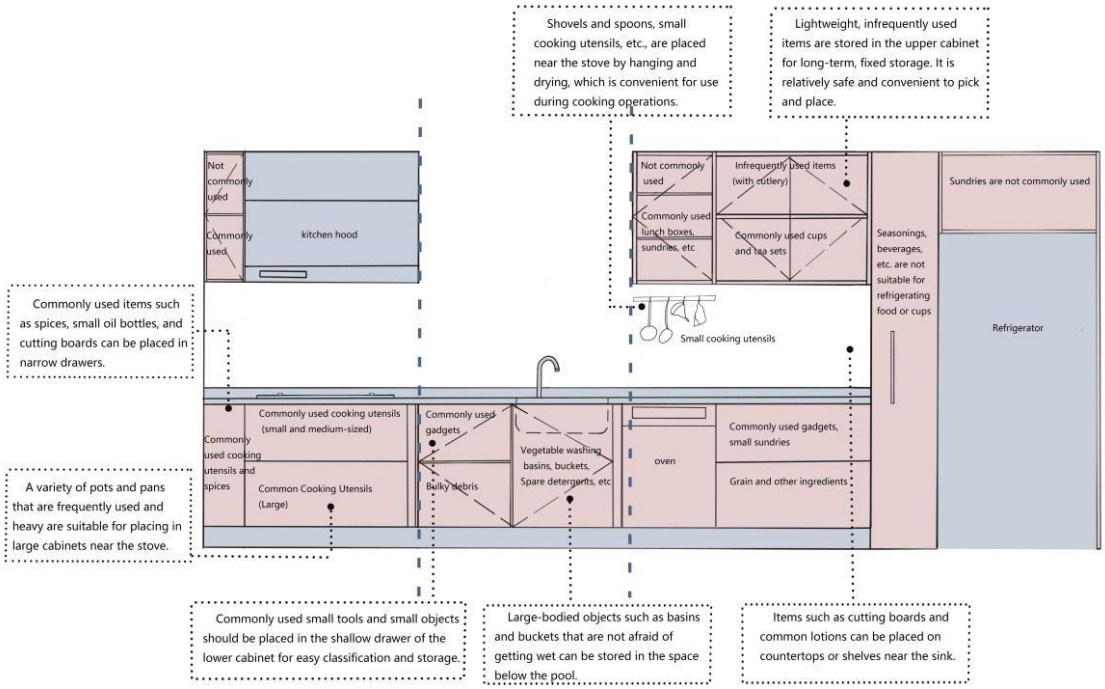

Figure 7: U-shaped kitchen design

U-shaped kitchens are characterized by their compact layout and efficient use of space. This design is particularly suitable for homes with limited space, such as apartments or small houses. The advantage of the U-shaped kitchen is that it maximizes the use of space, allowing the kitchen to meet basic cooking and storage needs while remaining clean and aesthetically pleasing.

3.1.2 Realization and Material Selection

The essence of U-shaped kitchen storage lies in its wisdom of careful planning and efficient use of space, closely matching Chinese eating habits and kitchen operating procedures. In order to achieve this goal, the implementation of functional zoning is particularly important. The washing area is skillfully set up close to the water source to facilitate the washing of food, tableware and kitchen utensils, and the storage covers daily needs such as dishwashing basins, dishwashing basins, detergents, table wipes, dish towels and draining baskets. In this area, the space under the sink is fully utilized by designing functional cabinets, stackable shelves and smooth, easy-to-pull sliding drawers that greatly enhance storage efficiency and convenience, keeping kitchen supplies organized and easily accessible.

The cooking area, on the other hand, is adjacent to the stove and oven for easy cooking operations. Here, pull-out baskets are ideal for organizing cooking utensils and spices. The extended design of the pull-out basket can easily accommodate various sizes of cooking utensils, avoiding the inconvenience and damage caused by stacking, and at the same time, the division of multi-layer space makes it possible to categorize all kinds of bottles and cans for storage, from the basic seasonings such as salt, sugar, pepper, etc. to all kinds of sauces and seasonings, which are easy to see at a glance and reach, and greatly improves the efficiency of the operation when cooking.

For the storage of small and medium-sized pots and pans as well as large bowls and utensils, the application of separator racks and dividers shows the wisdom of scientific layout. Separation rack through a reasonable layout, the cabinet interior space is divided into a number of independent areas, each area can accommodate one or more pieces of pots and

pans, to avoid collision between the pots and bowls and scratches, so that each piece of cutlery can be stable in its exclusive location, easy to pick up and return to the place. For large pots and pans, dividers provide a practical and beautiful storage solution. By installing adjustable dividers inside the cabinet, the layout can be personalized according to the size and shape of the pots and pans, ensuring that each pot and pan can be placed securely, avoiding the problem of squeezing or sliding each other.

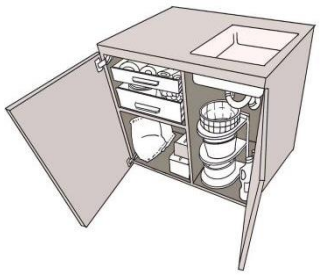

Figure 8: U-shaped kitchen design detail 1

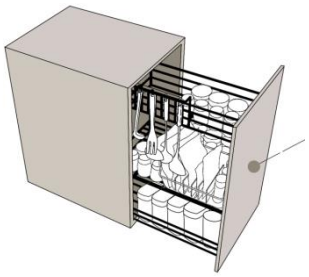

Figure 9: U-shaped kitchen design detail 2

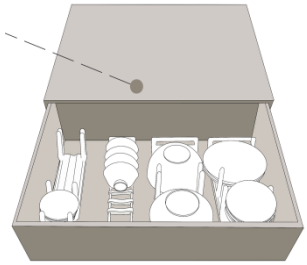

Figure 10: U-shaped kitchen design detail 3

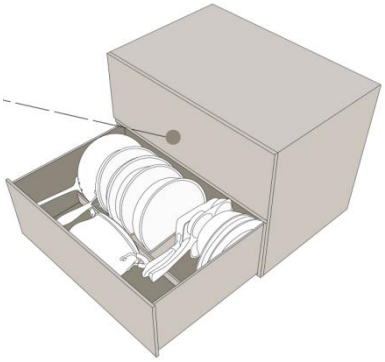

Figure 11: U-shaped kitchen design detail 4

Facing the utilization of the upper space and vertical wall space in the kitchen, installing drop-down storage baskets and cleverly dividing the space on both sides of the hood into cabinets with built-in storage boxes are both practical and beautiful storage solutions. Pull-down storage baskets can elegantly unfold the storage space hidden in the depths of the cabinets, greatly expanding the storage space in the kitchen, ensuring a clean and open kitchen surface, and are suitable for storing infrequently used spare tableware, seasonal baking supplies or bulk food. The space on both sides of the range hood is fully utilized, with built-in organizers to categorize and store spices, cooking tools, cutlery and other kitchen gadgets, and the transparent or translucent design allows items to be seen at a glance, enhancing cooking efficiency. In addition, kitchen corners or wall spaces are also used to store infrequently used kitchen utensils, ingredients and cleaning supplies, using a two-tier structure and incorporating a push-pull design, making it more convenient to access the items, while keeping the space clean and beautiful. For cups and tea utensils, the shelves are sliding down, making full use of the depth of the cabinet, through the slide mechanism to achieve a smooth pull out or push in, easy to operate and save energy, and equipped with a solid load-bearing structure, avoiding the items from squeezing each other and damage, so that each piece of goods can be in its own place to maintain the overall beauty and practicality of the kitchen.

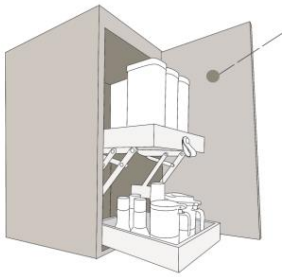

Figure 12: U-shaped kitchen design detail 5

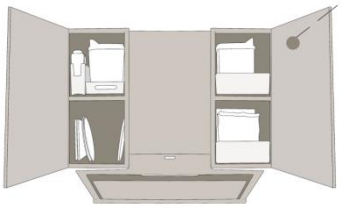

Figure 13: U-shaped kitchen design detail 6

Figure 14: U-shaped kitchen design detail 7

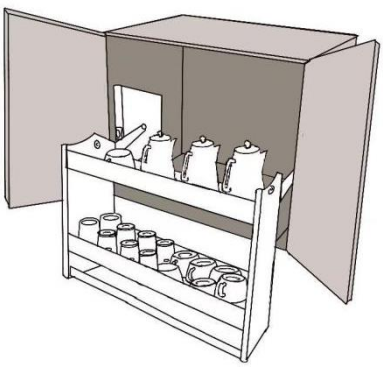

Figure 15: U-shaped kitchen design detail 8

Making the most of the cabinet space above the refrigerator is certainly a clever strategy for optimizing kitchen storage,

especially for those infrequently used clutter, which provides an ideal place to store it. To maximize the value of this high space and keep it organized, we can cleverly place large, perfectly sized transparent or translucent bins inside the cabinets. These bins not only make the most of every inch of space, but also allow us to see what we need at a glance without opening the cabinet doors, thus greatly saving time in searching and improving the smoothness of kitchen operations. In addition, designing some longitudinal long cabinets with sliding drawers can provide tailor-made storage space for commonly used items in the kitchen, such as spices, beverages, foods that are not suitable for refrigeration, and cups and glasses. This design not only saves space for opening and closing, making kitchen operations more convenient, but the drawer interior can also be flexibly adjusted according to the different items stored in the partition pattern to meet the diverse storage needs. At the same time, in order to organize miscellaneous food, cereals, dried fruits and other food, we can choose to use transparent or semi-transparent plastic storage boxes that match the size of the cabinet, these boxes not only have the function of moisture and dust, but also allow us to intuitively see the type of food and the amount of food remaining in the internal storage, so as to reduce the number of unnecessary openings to maintain the freshness of the food. In the overall design of the U-shaped kitchen, according to the cooking process rational layout of the functional areas, so that the preparation, cooking, cleaning and other steps are closely linked to the smooth transfer of items, the entire kitchen space therefore become more practical, efficient and beautiful.

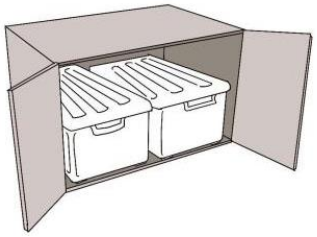

Figure 16: U-shaped kitchen design detail 9

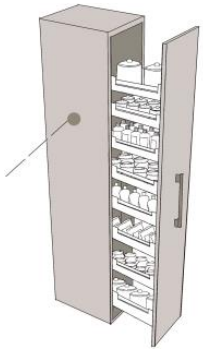

Figure 17: U-shaped kitchen design detail 10

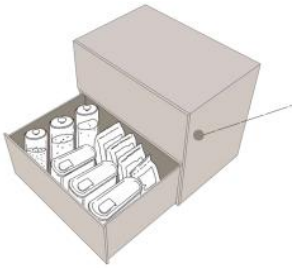

Figure 18: Detail of U-shaped kitchen design 11

The choice of storage materials for a U-shaped kitchen needs to be considered for practicality, aesthetics and durability. Here are some suggested storage materials and their characteristics:

Table 1: Stowage materials and their characteristics

Cabinet material	Cabinet door material	Hardware accessories	Special storage materials	precautions
Ecological multi-layer board: It has good moisture resistance and is suitable for environments such as kitchens that are prone to moisture. Enamel board: easy to clean, and can also use magnetic accessories for wall storage, convenient and practical. Solid wood or composite wood: natural texture, beautiful and generous, but attention should be paid to moisture-proof treatment	Skin feel film: It has a delicate touch, high aesthetic value, and is relatively easy to maintain. As long as the oil stains are wiped off promptly after contact, the good appearance can be maintained. Glass door: made of transparent or semi transparent material, convenient for observing the items inside the cabinet, suitable for storing common items such as seasonings.	Basket: Install a basket inside the cabinet for easy storage of dishes, pots, and seasonings, improving space utilization. Hook: Used on walls or inside cabinet doors to hang cooking utensils, aprons, and other items, saving space. Sliding rails and hinges: Ensure smooth opening and closing of cabinet doors and drawers, improving the user experience.	Magnetic accessories: such as magnetic knife holders, magnetic seasoning boxes, etc., are stored on the wall using magnetic materials such as enamel boards, which is both convenient and space saving. Storage rack: Install a storage rack on the wall or top of a cabinet to store infrequently used kitchen items or decorations.	Material safety: Ensure that all stored materials comply with food safety standards and avoid contamination of food with harmful substances. Moisture proof treatment: If the kitchen environment is humid, it is necessary to choose materials with good moisture resistance and regularly carry out dehumidification treatment. Cleanliness: Choose materials and designs that are easy to clean, reducing the workload of kitchen cleaning.

3.1.3 Space Adaptation Analysis

Through reasonable layout and storage design, the space utilization of the U-shaped kitchen is significantly improved. Walls, countertops and corners are fully utilized, reducing wasted space. The storage design takes full account of the user's operating habits and needs, ensuring that kitchen supplies are within easy reach. Seasonings and kitchen utensils needed for cooking are placed in a reasonable location, reducing walking and operating time. The design solution fully considers the variability of kitchen space, such as the number of family members and cooking habits. Through flexible storage design and detail design, etc., it ensures that the kitchen space can be adapted to different usage needs. Whether it is a small or large home, the kitchen space can be maximized through reasonable layout and storage design. Regularly monitor and evaluate the kitchen space to ensure the effectiveness and adaptability of the design program. Based on the assessment results, design solutions are promptly adjusted and optimized to meet changing usage needs.

3.2 Design Scheme Two

3.2.1 Design Ideas and Objectives

When designing kitchens, we focus on meeting users' actual

needs and application experience as the core, combining users' physiological characteristics, behavioral features, cooking frequency and storage habits to optimize the kitchen space layout and internal storage. The layout ensures smooth functioning, i.e. the order of washing, preparing, processing and cooking is reasonable, and functional areas are divided according to users' habits, such as placing heavy items such as rice, flour and oil in the floor cabinet for easy access, placing pots, pans and chopsticks within reach, and placing condiments according to the frequency of use. In terms of storage design, optimize the layout of drawers, use dividers to adjust the space to suit the size of tableware, use storage boxes, racks, shelves and hooks in corner areas to increase space, and pay attention to vertical storage space, such as the use of hole boards to enhance the storage rate. Reasonable arrangement of cabinet and countertop space, reduce gray space, optimize kitchen operation by planning reasonable storage space and using flexible storage methods, improve dining efficiency and achieve kitchen space diversification and low-carbon.

3.2.2 Functional Module Design and Specific Storage Methods

Cabinet functional modular design with as few as possible unit modules with a hundred different programs to meet the needs of users. Modular design follows the following general principles: combination, adaptability, rationality, flexibility [4]. Our functional division of the cabinet can be divided into three categories: operation area, storage area, and placement of home appliances and equipment area. Through the specific analysis of its function, so as to get a series of cabinet function modular elements. According to the user's behavioral habits of the module split combination, in order to flexible kitchen space.

This design scheme is the L-shaped kitchen flexible space storage design scheme, which is the ideal design scheme. Formed through the kitchen space design and cabinet functional modularization design concept. Combined with the analysis of the user's movement in the kitchen, the following specific storage category classification for each unit cabinet and specific storage for specific storage.

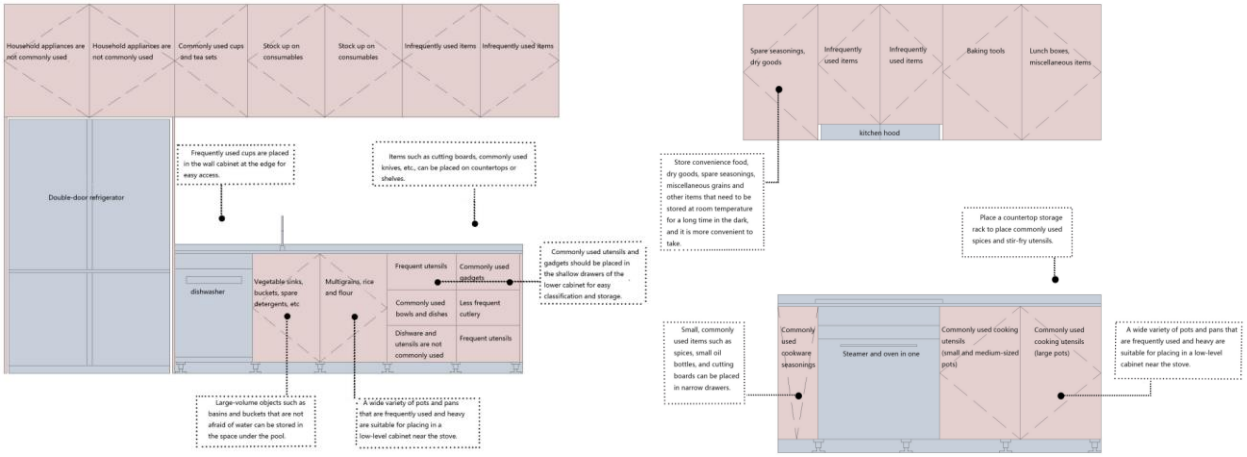

Figure 19: L-shaped kitchen design

(a) Countertops

Countertops require a lot of space to operate should not put too many items, so the items placed on the countertop is the highest frequency of use, storage should be streamlined mode, in addition to the ordinary placement of food trays draining racks, you can also take advantage of the vertical space, the use of hole boards and the corresponding accessories to make commonly used items on the wall to improve the utilization of space at the same time, increase the sense of interaction in the kitchen.

(b) Hanging cabinets

The use of hanging cabinets can make full use of the upper space of the kitchen. Lighter weight consumables and infrequently used items can be placed in the hanging cabinet, where fragile cups and glasses can be placed high up without fear of hurting children in the family. The common internal design of the hanging cabinet is mostly partition, especially the hanging cabinet was high, the upper layer of the hanging cabinet is even higher, so the upper space can store some infrequently used items, such as spare spices, dry goods, lightweight consumables, etc., and the heavier rice, flour and oil can never be placed in a hanging cabinet, first of all, we must consider the load-bearing problem of the hanging cabinet, and secondly, it is not conducive to health when you take it.

Because the upper space of the hanging cabinet is not easy to access, so the storage must pay attention to be able to see from the front of the hidden things [5]. The use of partition boards flexible storage of different categories of items in the hanging cabinet, improve the utilization of space in the cabinet and meet the user's habits. Cabinet shelf height should be strictly in accordance with the size of the items in the cabinet to adjust. Sliding baskets can also be used to improve the visibility of the contents.

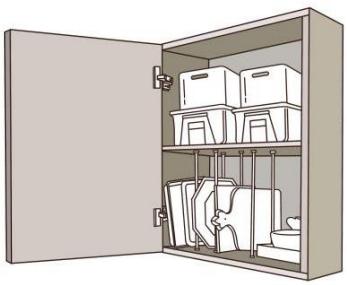

Figure 20: L-Shaped Kitchen Design Detail 1 - Organizers and Dividers

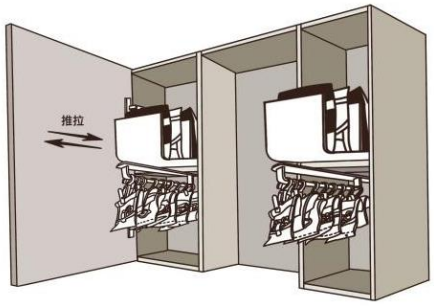

Figure 21: L-shaped kitchen design detail 2-slide pull-outs

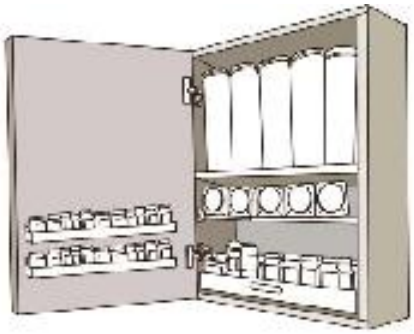

Figure 22: L-Shaped Kitchen Design Detail 3 - Divider Shelves and Shelves on Vertical Face

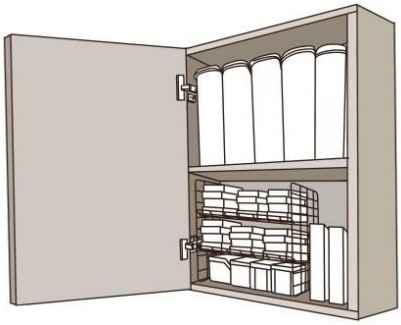

Figure 23: L-Shaped Kitchen Design Detail 4-Shelves

(C) Floor cabinet

In general, the cabinet below the stovetop storage of commonly used seasonings class is most convenient, as well as a variety of pots and pans can also be placed in the vicinity of the pots and pans placed in the floor cabinet must not be scattered flat, overlapping shelves, if you pick up appears to be very cumbersome, so the use of classified storage tools to make it placed vertically. In the storage of seasoning jars should pay attention to the use of small spaces, such as the pull-out cabinet next to the stove, so that when cooking can be pulled out of the pull-out basket to facilitate a clear find the required seasoning, to achieve precise positioning. Can also be placed near the stove on the wall shelves, and can save space, but also enrich the kitchen wall. The cabinet under the sink is more humid than other cabinets, not suitable for placing tableware, and secondly, due to the connection of various water pipes under the sink, taking up part of the cabinet storage space, so you need to place a storage tool with elevation function to store cleaning items or consumables. When the drawer height in the floor cabinet is low, it is suitable for placing cutlery, gadgets and other odds and ends, according to the specific cutlery specific size to create a flexible storage space. When the drawer height is high, the same applies to the storage of dishes by using the appropriate sized dividers.

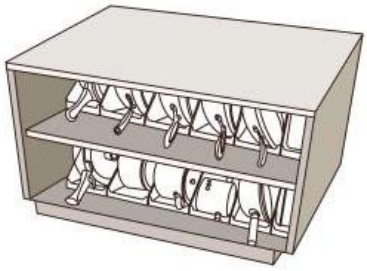

Figure 24: L-shaped kitchen design detail 5

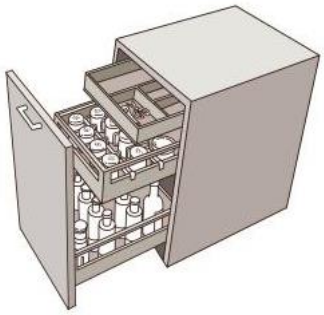

Figure 25: L-shaped kitchen design detail 6

Figure 26: L-shaped kitchen design detail 7

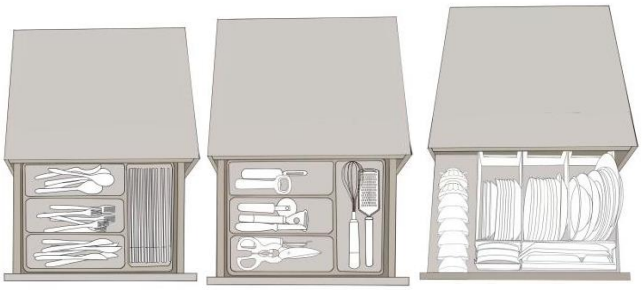

Figure 27: L-shaped kitchen design detail 8

Unconscious storage often leads to clutter, and L-shaped kitchens should be rationally divided into functional areas (e.g., washing area, cooking area) to reduce movement and improve efficiency. Resilient use of cabinet space, layered storage, hanging cabinets for lightweight and infrequently used items. Optimize the lighting design, choose waterproof and fume-proof lamps to reduce energy consumption. Wall space should also be fully utilized by installing shelves to store small items. These designs can improve kitchen efficiency and energy saving.

4. Comparative Analysis of Design Options

L-shaped kitchens and U-shaped kitchens have their own characteristics in terms of space efficiency and sustainability. L-shaped kitchens are suitable for long and narrow spaces, with a simple layout that reduces walking distances and improves work efficiency, and they are economical and

practical with low space requirements, but may not be able to meet the need for a large amount of storage and good ventilation due to the limitations of the kitchen's size and shape. Its simple layout is conducive to reducing material and energy consumption, construction costs and environmental damage, but the need for additional storage equipment and the problem of fumes and odors may affect sustainability. U-shaped kitchens, on the other hand, provide more worktops and storage space and are suitable for large-area kitchens, with a centralized functional area that facilitates quick access to items and collaborative work among multiple people, but with high construction and maintenance costs, high energy consumption, and corner cabinet storage designs that are difficult to utilize. However, the U-shaped kitchen design of the three sides of the work area helps ventilation, conducive to the discharge of fumes and odors. Therefore, kitchen design needs to take into account space dimensions, user needs and sustainability requirements, choose the appropriate layout form, and improve space utilization efficiency and sustainability through optimized design.

5. Empirical Study and Design Optimization

The user survey found that L-type and U-type kitchens each have their own demand characteristics, with L-type kitchen users wanting to increase flexible storage space and optimize the design of the flow line, while U-type kitchen users want to improve the storage in the middle area and the use of corner cabinets. In the actual kitchen environment tests, L-shaped kitchens have the problem of wasted storage due to space mismatch, while U-shaped kitchens face the challenges of large space requirements and insufficient or too bright lighting. Based on this, this study proposes design optimization suggestions: kitchen storage design needs to be integrated with the operation process, such as hidden garbage cans, composite space storage, and the use of aids such as sliding rails; L-shaped kitchens can draw on the Japanese concept of "spatial loops" to optimize the flow and make full use of the corner space; U-shaped kitchens need to formulate an effective storage strategy and rationally plan the middle and corner areas to increase the flexibility of storage. U-shaped kitchens need to develop effective storage strategies, rational planning of the middle and corner areas, increase flexible storage shelves, and optimize equipment, lighting and ventilation design to save energy and improve indoor air quality.

6. Conclusion

This study compares and analyzes L-type and U-type kitchen designs, discusses space utilization and sustainability, and proposes optimization recommendations. Residential storage problems include inappropriate space division, insufficient cabinet storage, irrational setup of large space areas and lack of humanization in the design of movement lines. L-shaped kitchens are simple, low resource consumption and suitable for small kitchens, but are limited by size and shape; U-shaped kitchens are efficient in terms of storage, good operation flow and provide multiple worktops, but with many conditions for realization.

Acknowledgments. This paper is funded by the Innovation and Entrepreneurship Training Program for Undergraduates, and is one of the milestones of the Research on Resilient Kitchen Space Storage Guided by the Concept of Sustainable Development.

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