

# Research on User Demands for Future Household Refrigerators

Xiaoxiao Wang

School of Design and Architecture, Zhejiang University of Technology, China

2283250634@qq.com

**Abstract.** Refrigerators can provide activity support for users in the kitchen and other areas of the home. However, there is currently a lack of research on the demand for preservation and storage space in other household areas. By conducting semi-structured interviews with participants, we investigated user needs for future preservation and storage space. This research has generated new insights in terms of the intelligence, connectivity, emotional appeal, and ease of use of preservation and storage spaces. Our findings provide valuable insights for the design of refrigerators in future home environments and can also serve as a guide and reference for the design of other smart home appliances.

**Keywords:** Household refrigerator; User experience; User needs.

## 1. Introduction

With the development of technology and production methods, people's lifestyles have changed, and they now seek a better quality of life, with a growing focus on health. As the main product for food preservation and storage, household refrigerators are closely related to healthy eating, and have welcomed new development opportunities. With the gradual increase in national consumption ability, the personalized characteristics of consumers are becoming more apparent, leading to a trend of diversification in the demand for refrigerators.

Firstly, with the impact of changes in family structure due to the two-child and three-child policy, users have varying needs for food preservation, freezing, and storage space. They address these needs through methods such as upsizing, allocating specific portions for certain items, and designating areas for specific uses.

Secondly, with changing consumption trends emphasizing enjoyment, entertainment, quality enhancements, and post-pandemic health care needs, consumers are seeking higher-quality refrigerators. These refrigerators are required to preserve various food ingredients for household meals and non-food items like medicines and skincare products.

Lastly, changes in lifestyle have led to changes in activities related to refrigerators, resulting in a more diversified demand for refrigerators. In family life, the boundaries between work and life, daily activities and entertainment, and public and private domains are no longer strictly separated<sup>[1]</sup>. In the home, users often engage in multiple activities simultaneously, such as watching TV while cooking, playing games while snacking, etc. These activities intertwine in terms of time and space, blurring the boundaries between different areas of the home. As a result, activities related to the refrigerator have become more diverse and complex in family life.

The refrigerator is no longer limited to being a cold household appliance; it has become an integral part of household storage space, bearing the important responsibility of family diet and health. Its new products, functions, technologies, and services are constantly evolving. At the same time, due to changes in people's lifestyles, the demand for refrigerators is also changing. Faced with different application scenarios and user needs, the concept of the refrigerator will be re-evaluated, thereby posing more challenges for interaction between people and the refrigerator.

## 2. The current status of user experience research on refrigerators.

A home is a living space that encompasses various activities such as housework, learning, entertainment, work, communication, and shopping. The refrigerator serves as a convergence point between life and technology, and how to enhance the user experience of refrigerators through smart

technology has become a crucial area of research. For example, Aadhya Bhatt (2020) utilized a Raspberry Pi model to help users identify and manage products in the refrigerator, and notify users remotely via email about the available items in the refrigerator<sup>[2]</sup>. Suhuai Luo (2008) developed a smart refrigerator application and designed a related database. The main functions of this system include recording user information and providing appropriate recipes for different user groups<sup>[3]</sup>. Researchers are also exploring the interactive connection between future refrigerators and smart home products, such as connecting ovens through voice assistants, and generating oven recipes based on the data of food ingredients in the refrigerator<sup>[4]</sup>.

From the perspective of human-computer interaction, studying the preservation and storage space can establish interactive relationships between the refrigerator, users, and dietary health, as well as between users themselves<sup>[5][6][7]</sup>. Manuela Bucci (2010) developed a user-friendly and simple human-computer interface using ethnographic research and participatory design methods, through which family members can write, post, and send messages to improve communication among each other<sup>[8]</sup>.

### **3. User research on the family refrigerator.**

#### **3.1 Identifying the user group**

The target users selected for this study are users aged 19-35. They were born during a period of rapid development in the country, and are very familiar with the digital era, the internet, and technology. They are accustomed to using smartphones, social media, and various online services, and have a high reliance on obtaining and sharing information. They have diverse values, place more emphasis on personal freedom and independence, pursue personalized and diversified lifestyles, and adopt a more open and inclusive attitude towards new things, new technologies, and new products.

#### **3.2 Selection of research methods**

Researchers will use in-depth interviews to engage in deep discussions with users, understand the problems they encounter when using refrigerators, and gather their ideas and needs for future refrigerators. Through in-depth interviews, researchers will obtain more detailed and specific user feedback, providing important insights for the design and improvement of future refrigerators.

#### **3.3 In-depth user interviews**

The interview includes brief exercises, envisioning the future, providing solutions to their own needs, and generating ideas. The interview is divided into two parts.

##### **(1) Current refrigerator**

Participants were asked to describe the organization layout of the fresh storage space, the positioning of the fresh storage space and storage space, express any dissatisfaction, and explain the reasons for it.

##### **(2) A dream day in the home of the future**

Based on previous research<sup>[9][10][11]</sup>, participants were interviewed in semi-structured interviews, focusing on the theme "Home of the Future" with the aim of imagining a "dream day." Participants were asked to draw on a blank sheet of paper what their ideal "Home of the Future" would look like, specifically how various activities would revolve around fresh storage space, and how they would spend a "dream day" in the "Home of the Future."

### **4. User needs for future refrigerators**

Our research not only focuses on the functionality and design of refrigerators, but more importantly on integrating them closely with user behaviors, activities, and scenarios. Research findings have shown that in households, activities related to fresh food storage are not limited to

just the kitchen area; users also engage in a variety of activities in other areas such as leisure, social interactions, personal care, and even engage in cross-area activities. Overall, user needs for future refrigerators can be summarized as follows:

#### **4.1 Connectivity needs**

Participants expect refrigerators to have good connectivity. They believe that refrigerators should have the ability to connect and coordinate well with personal and household smart products or systems, and they hope to achieve this through the following ways:

First, participants believe that the fresh storage space system should be connected to the mobile applications of personal devices. Participants expanded on the data connection between the fresh storage space system and personal devices, mentioning that the fresh storage space system can connect to the mobile applications on personal devices, collect and analyze users' personal data, and facilitate users in managing their fresh storage space.

Second, participants believe that refrigerators should be connected to other smart home devices. By closely integrating with other smart home devices, it assists users in carrying out activities more smoothly.

#### **4.2 Smartification needs**

Participants expressed a unanimous demand for the smartification of refrigerators in various areas of the household. On the one hand, participants hope that refrigerators can achieve personalized monitoring and recommendations through smartification:

Firstly, refrigerators can act as users' personal health managers, timely monitoring the diet and physical condition of each family member.

On the other hand, participants hope that future refrigerators are smart enough to achieve various forms of automation: Firstly, refrigerators can achieve self-management in an automated manner. Secondly, refrigerators can automate item management. Refrigerators can automatically adjust the storage conditions of items to meet the storage needs of different items.

#### **4.3 Emotional needs**

Firstly, refrigerators can help users maintain family emotions. By utilizing the system and associated services, even in situations where family members cannot meet in person, it can increase communication and interaction among family members, strengthen family cohesion and emotional connections.

Secondly, refrigerators should constantly pay attention to users' emotions and activity status, and provide care at appropriate times. This kind of care can make users feel emotional support and attention.

Thirdly, refrigerators should provide a ritualistic usage experience. Refrigerators can recommend activity plans based on the user's leisure activities to enhance the experience.

#### **4.4 Easy to use**

Firstly, they hope that finding and accessing items inside the refrigerator is convenient. Users can quickly locate the needed ingredients or items by using methods such as a mobile app, voice commands, or light indicators to search for the specific location of a particular item.

Secondly, the adjustment of the interior space of the refrigerator should be convenient. Divide the interior of the refrigerator into different modules, each of which can be adjusted and reconfigured as needed. This can maximize space utilization based on different needs and usage patterns.

Thirdly, refrigerators should have a simple and intuitive operating method that is easy for users to understand and use quickly. Users should not require complicated learning processes or tedious operating steps, but rather engage in interaction and operation through simple tactile, gesture-based, and touch-based interactions.

## 5. Summary

This study targets individuals aged 19-35 and focuses on future refrigerators as the research subject. Using user demands for future preservation and storage space as the starting point, in-depth interviews will be conducted to explore users' needs and expectations for future refrigerators. These requirements serve as valuable insights for the design of future refrigerators and provide essential references for other designers in smart home design.

## References

- [1] Allameh E, Jozam M H, de Vries B, et al. Smart Home as a smart real estate: a state of the art review[C]//18th International Conference of European Real Estate Society, Eindhoven, The Netherlands. ERES 2011, 2011.
- [2] Bhatt A, Bhatt A, Fiaidhi J. Next generation smart fridge system using IoT[J]. Authorea Preprints, 2023.
- [3] Luo S, Xia H, Gao Y, et al. Smart fridges with multimedia capability for better nutrition and health[C]//2008 International Symposium on Ubiquitous Multimedia Computing. IEEE, 2008: 39-44.
- [4] Li B, Hathaipontaluk P, Luo S. Intelligent oven in smart home environment[C]//2009 international conference on research challenges in computer science. IEEE, 2009: 247-250.
- [5] Mulay P, Kumar M, Patil S. Child centric food advisory enabled smart system for refrigerators[J]. International Journal of Computer Science and Mobile Computing, 2014, 3(12): 507-513.
- [6] Nguyen V N, Nguyen T H, Huynh T T, et al. Interactive fridge: a solution for preventing domestic food waste[C]//Inclusive Smart Cities and e-Health: 13th International Conference on Smart Homes and Health Telematics, ICOST 2015, Geneva, Switzerland, June 10-12, 2015, Proceedings 13. Springer International Publishing, 2015: 361-366.
- [7] Luo S, Jin J S, Li J. A smart fridge with an ability to enhance health and enable better nutrition[J]. International Journal of Multimedia and Ubiquitous Engineering, 2009, 4(2): 69-80.
- [8] Bucci M, Calefato C, Colombetti S, et al. Fridge fridge on the wall: what can I cook for us all?: an HMI study for an intelligent fridge[J]. 2010.
- [9] Kim H S, Yoon S H, Kim M J, et al. Deriving future user experiences in autonomous vehicle[C]//Adjunct proceedings of the 7th international conference on automotive user interfaces and interactive vehicular applications. 2015: 112-117.
- [10] Ronkainen N J, Ryba T V. Understanding youth athletes' life designing processes through dream day narratives[J]. Journal of Vocational Behavior, 2018, 108: 42-56.
- [11] De Ruyck O, Conradie P, De Marez L, et al. User needs in smart homes: changing needs according to life cycles and the impact on designing smart home solutions[C]//IFIP Conference on Human-Computer Interaction. Cham: Springer International Publishing, 2019: 536-551.