Interface Design for the Mobile Terminal for Furniture Shopping in the Post-epidemic Era: An Empirical Evidence of User Demand Collection

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The Internet economy is flourishing, and the form of consumption has shifted from offline brick-and-mortar shopping to online consumption. At the same time, COVID-19 led to many offline stores being constrained in many ways, accelerating the conversion of shopping. The purpose of the study is to enable users to effectively use mobile products and optimize their service experience during furniture consumption. This study compares the relevant theories and the current state of research. Through qualitative and quantitative methods, user needs are investigated and data analysis is conducted to summarize interface improvement suggestions. The high-fidelity prototype design was conducted, and the interactive prototype was delivered to users for testing to verify the effect and feasibility of interface optimization and to propose improvement suggestions for the mobile terminal of furnishings.

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INTRODUCTION

With the development of the Internet, the online economy emerged and is in a flourishing stage. COVID-19 hit various industries, and the traditional brick-and-mortar economy was adversely affected (Donthu and Gustafsson 2020). Due to the restrictions of the epidemic control system, the consumer base started switching to online consumption more quickly. After several years of development, the online economy is becoming more mature, with contactless purchasing and distribution models creating a closed loop and a maturing model of the Internet empowering traditional brick-and-mortar industries (Sharma *et al.* 2020). Opportunities and challenges coexist, and the growth of the online economy also has revealed the drawbacks of many current online websites, such as an incomplete listing of product information, lack of consumers attention to the main product, *etc*., which on the one hand affects the senses of User Experience (UX), on the other hand, it is not conducive to the benign development of enterprises.

Entering the era of Industry 4.0, the usual information asymmetry weaknesses of traditional industries are improved. Intelligent technology applied to the manufacturing workshop can realize efficient and high-quality production of furniture manufacturing (Gao *et al*. 2023), and when applied to the Internet can enhance the online home

consumption experience (Li *et al*. 2023). More business opportunities will emerge in traditional industries, and home living, as one of the most important areas for the nation, will undergo more profound changes while generating greater commercial profits (Xiong *et al.* 2023). Online shopping and other life service e-commerce continue to grow rapidly, accelerating the digital transformation and upgrading of traditional businesses (Zhang *et al.* 2022). Shopping websites with good usability can make online shopping more liberating than in physical stores. Users tend to make quick decisions to shop online (Xiong *et al.* 2020). Users using online shopping products need an adequate level of interaction and efficient access to obtain needed information. The current research on the mobile shopping interface can be divided into the study of functional requirements to optimize the use of the product and the study of emotional requirements to optimize the UX.

Functional Requirements

The functional requirements mainly include shopping website interface information layout and interface navigation (Zhu and Hou 2021). Interface information layout is a key design attribute of interface design (Pelet and Taieb 2022), and the display layout of product detail pages considerably affects consumers' desire to purchase (Yu *et al.* 2022). The interface information layout of the shopping website has an indirect effect, with the main influencing factors being information quality, visual perception, and interface layout (Patel *et al.* 2020). Li *et al.* (2020), proposed a usability evaluation method for mobile shopping platforms to quantify usability metrics under typical online shopping behavior patterns. Feng *et al.* (2019), used the action research method to interview the UX process and operational interface process, and established an integrated service process summarizing the online and offline integrated interactive services. When optimizing the interface layout of mobile shopping platforms, effective information arrangement can reduce visual tiredness and increase usage efficiency (Li *et al.* 2022).

Interface navigation plays an important role in the usability of mobile shopping. By comparing two online shopping platforms, eBay and Amazon, Cheng (2019) illustrated that efficiency-based user behavior is influenced by navigation and time factors. Hussain *et al.* (2019) designed the Mudah online shopping application, recruited users to perform the tasks of the application, and conducted usability reviews based on user performance and perceptions. Modi and Singh (2022) concluded that part of the graphical interface receives the greatest user attention in terms of first gaze and number of gazes. Jiang and Wang (2018) pointed out that interface design should follow users' visual dynamics and form a sense of unity in shape, size, and direction in layout design. Therefore, a combination of perceptual and rational approaches should be used in the navigation design layout to explore users' real needs (Yu *et al.* 2022).

User Affective Needs

User affective needs mainly include ease of use and UX of mobile shopping (Gulfraz *et al.* 2022). Chopdar *et al.* (2022) investigated the direct and indirect effects of online shopping applications on consumers' shopping desires based on the stimulus-biological-response theory. The results confirmed that the visual appeal, product assortment, and hedonic motivation of the platform had a significant effect on shopping desire. Liu *et al*. (2019), verified through validated factor analysis and structural equation modeling that mobile shopping platform information and visuals have a positive impact on consumers' shopping desires. Muslim *et al.* (2019), evaluated the performance, perception, and behavior of the UX online shopping platform by metrics method, and redesigned the

User Interface (UI) to increase user attractiveness, combined with the evaluated UX elements. Wu *et al.* (2020), used the interview method, observation method, and questionnaire method to analyze and construct a mental model of users in web design. The study considered users' educational background, users' preferences for interface layout, and element placement. Fu *et al.* (2019), obtained design attributes of shopping mobile UI to improve user satisfaction by qualifying user needs through interviews and quantifying qualitative results through experiments. Gao *et al.* (2021), used quantitative features to analyze the layout of mobile interfaces in their study. The optimization of the Korean shopping search engine 1300K (Park and Cho 2021) website analyzed users' catalog browsing behavior and clicking behavior, as well as query search behavior. User emotional needs are an important criterion to verify the usability of a platform. At this stage, most shopping platforms have usability, but users' emotional needs still need active exploration and research.

User Experience

Currently, there is a blossoming theory on the elements of UX. In the field of UX and interaction, Li *et al.* (2022) compiled the UX literature from 1999 to 2019 to study the application, structure, and evaluation methods of UX. Jesse James Garrett (2006), proposed the 5 elements of UX. Regarding the product from abstract to concrete, the layers include a strategic layer, scope layer, structure layer, framework layer, and presentation layer. Martins *et al.* (2021), studied the development of a graphical interface for the online store ALU13. E-commerce was linked to online store design by optimizing the UX, studying and conforming to users' usage and purchasing habits. Gao and Li (2022) developed a personalized recommendation system for an online shopping platform. Quezada *et al.* (2021) systematically reviewed the application of user-centered design techniques in interface design. However, most of the relevant literature focuses on either hardware or software, ignoring the fact that user experience is based on hardware and software coordinating with each other (Zhu and Lv 2023). The size of the device used by users when browsing furniture on mobile also has an impact on user experience and consumer behavior. Consumers who shop using computer web pages (60%) tend to make a quick decision to shop online. Middle-income people prefer to browse and UX buy on e-commerce platforms on mobile devices such as smartphones or tablets, while high-income people and low-income people prefer to shop on computer web pages (Huang *et al*. 2018). However, research, improvement, optimization, and establishment of mobile terminal of furnishings that meet these theoretical requirements are still lacking. Nowadays, consumers' requirements for experience and service quality are getting higher, and the effective integration of high-quality home resources and efficient services through phones will become an opportunity for the future development of the furnishing industry.

Therefore, this paper focuses on optimizing the design of the online furniture consumer experience and improving the ease of use and usability of the mobile terminal of furnishings, mainly addressing the following 3 aspects: 1. exploring the real needs of online furniture consumers; 2. optimizing the functions of the mobile terminal of furnishings; 3. optimizing the information layout of the mobile terminal of furnishings. First, from a theoretical perspective, the classical 5-factor user method was used to analyze the consumer online shopping process and summarize the needs. Secondly, from the perspective of content level, the needs of home-class mobile consumers in producing content were considered, along with experience sharing, brand promotion, and home purchase, *etc.* Interface optimization analysis was carried out. Thirdly, the practice level

perspective, enriched mobile terminal of furnishings, provides a good and convenient platform for people who need to buy home products.

EXPERIMENTAL

Experimental Process

In the analysis phase, the existing mobile terminal of furnishings was compared. The goal was to identify the strengths and weaknesses of the UX through these products and find design opportunities. In the research phase, user research was conducted through qualitative and quantitative methods. Qualitative analysis was carried out for target users, combined with the UX journey map to study the user's emotional experience, pain points, and opportunity points in various possible scenarios to clarify the user demand pain points. User needs and degree of needs were verified through quantitative analysis, making it possible to compile a user needs list. System information architecture was studied, with the goal of building a typical task interaction flow. In the output stage, the research results were used to create a prototype and deliver the interactable prototype to users for testing after pre-testing. In the feedback stage, the UX evaluation was conducted to confirm its value and significance.

Research Subjects

The age, gender, and occupation of the subjects, as well as their economic level and need to purchase household items were considered in the selection of the research subjects. Two groups (the interview group and the questionnaire group) of subjects with current household consumption needs were recruited for this study through in-home shops and online. The interview group consisted of 5 subjects (3 men and 2 women, age range 25 to 35 years old), all of whom were educated and possessed good communication skills, and 3 of them had renovation needs.

The questionnaire group of 204 subjects were randomly recruited from public online platforms, all possessing reading and writing skills. With a larger proportion of participants being female, different genders had different mental models on the UI of mobile shopping apps (Turumugon *et al.* 2018). The main occupations were students and company employees. Their ages were concentrated between 20 and 35 years old. Monthly income was concentrated in 10,000 RMB and below. Those ready to renovate accounted for 27.5%, those in the process of renovation accounted for 12.3%, and those needing renovation accounted for 60.1%.

Research Methods

The study was conducted using observation, interview, contact point experience, and questionnaire methods. The overall study could be divided into two types of research: qualitative and quantitative. Qualitative research was first used to identify user-related needs through qualitative methods, such as interview and contact point analysis, and then quantitative research was conducted based on the results obtained from the qualitative research by designing a questionnaire to confirm the list of end-user needs in conjunction.

After obtaining the quantitative research data, the collected data were analyzed using mathematical methods, using statistical analysis methods such as Excel and SPSS. SPSS software is a set of professional, general-purpose statistical packages, which is also a combined package with data management, statistical analysis, statistical plotting, and statistical reporting functions.

Qualitative research

Qualitative research adopted the interview method, randomly looking for interviewees in the furniture mall, and avoiding interrupting the user during the interview to explain the product. The interviews were conducted in an environment where there were no other people besides the interviewee and interviewer and no noise disturbance. The room was also kept at a suitable temperature and well-lit. The purpose of the interviews was to understand the living conditions of the target users. The interview outline consisted of 4 main parts: (1) Their shopping patterns and paths in the home category. (2) Their usage of the mobile terminal of furnishings. (3) Their real needs and expectations of home category products. (4) Their experience evaluation of mobile terminal of furnishings.

Quantitative research

The quantitative study in this paper used questionnaires, which were randomly distributed through public web platforms. This approach was used to understand the needs and preferences of users and their usage behaviors. The questionnaire was designed and distributed with the previous qualitative analysis and statistical analysis of the data collected. The real needs of users in this regard guided the post-design. A total of 204 questionnaires were received from participants by the web research team. Participants who were confusing, inconsistent, or did not complete the questionnaire were excluded, resulting in 179 effective questionnaires.

The questionnaire design included confirming whether the user is within the target user category, basic information of the user, usage status of the home mobile product and store, and confirming the functional requirements of the home mobile product. The question types were mainly single and multiple-choice questions. In the last part of the questionnaire, the Likert Scale was used to set the headings, each of which has 5 responses: strongly agree, agree, not necessarily, disagree, and strongly disagree, recorded as 5, 4, 3, 2, and 1, respectively.

Research Materials

Typical mobile terminal of furnishings can be divided into the following four categories: user-generated content (UGC) community type, platform type, new retail type, and comprehensive e-commerce type. From these 4 types of mobile terminal of furnishings, representative and frequently used products were selected for user evaluation: Niceliving, Jia.com, Macalline, and Tmall. According to Jesse James Garrett's UX model, which is generally accepted in the industry, UX was divided into 5 levels. Questionnaires were set up according to the 5 levels. In this paper, the focus was placed on analyzing the function and interface layout of the furnishing class mobile terminal, which corresponds to the scope layer and the presentation layer in the 5-layer model. The scope layer includes functional specification and content description. The presentation layer, information layout, and visual design of the interface complete the model (Fig. 1).

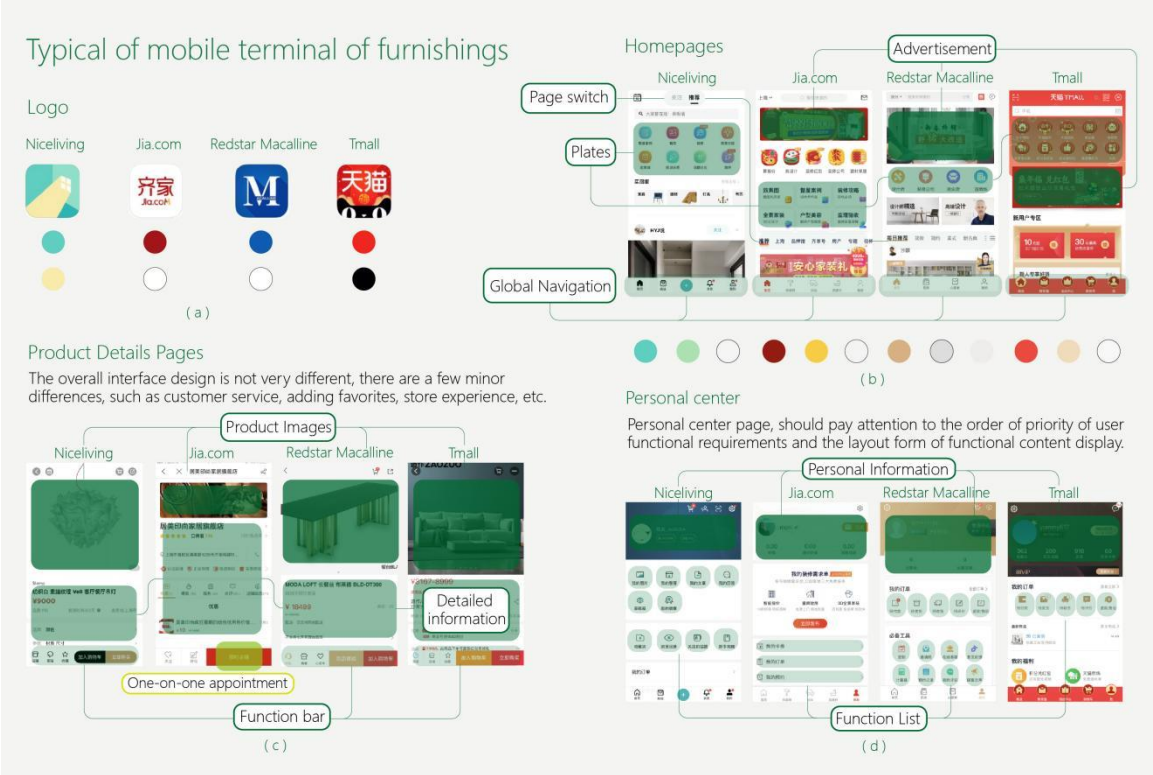


Fig. 1. Interface layout analysis of the framework layer and presentation layer of 4 typical mobile terminals of furnishings. (a) Logo, (b) Homepage, (c) Product Details Pages, (d) Personal center

Qualitative Research: Organization and Analysis of Interview Results

Integrated e-commerce platform was used as the main shopping access, while collecting information in the community-based home platform. Consumers have a high utilization rate of these mobile terminals when they need to purchase furniture. Conversely, consumers tend to choose to uninstall furniture mobile terminals when they have no furniture purchase needs. The main functions are used for searching for products, shopping, recommendations for goodies, recommendations for similar products, inspiration collection, collection, sharing, *etc*. Expectations for online home class mobile are mainly focused on after-sales service, personalized service, better display of product information, *etc*. Respondent users rate the UX of the mobile products they use in the home category. The product shortcomings can be seen in the graph (Fig. 2).

Fig. 2. Interviewed users scored the user experience of the mobile terminal of furnishings they use based on the user experience evaluation framework.

The results of this user interview were analyzed as follows. (1) Platform homogeneity: comprehensive e-commerce with a wide range of user groups adopts a generic design and fails to focus on the design of individual needs. (2) The interface layout is not reasonable; the page style, navigation system, and tagging system are relatively uniform.

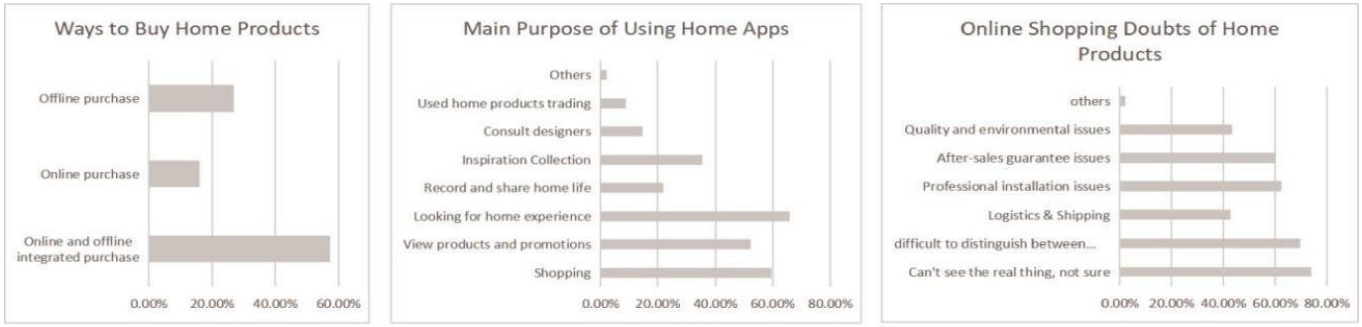
However, the rationality of the interface layout is still debatable and should be optimized and upgraded in conjunction with UX. (3) The consistency of the performance layer is weak; the brand color accounts for the diversity and unity. But the icon style of different panels is different, which is not conducive to the overall sense of the brand.

Quantitative Research: Collation and Analysis of Questionnaire Results

(1) Basic information of research users

The results of the questionnaire research (Fig. 5) included the following: 57.2% of the users combined online and offline purchases; 56.5% of users have used home class mobile products; worries about online shopping mainly come from not seeing the real thing and feeling uneasy (73.9%), information is hard to distinguish between real and fake (69.6%), professional installation problems were encountered (62.3%), and there were after-sales guarantee problems (60.1%).

The main purposes of using online home category mobile were shopping (59.4%), viewing product promotions (52.2%), and viewing home experience and inspiration collection (Fig. 3).



a **b** **c**

Fig. 3. The results of the questionnaire of mobile terminal of furnishings. (a) Main Purpose of Using mobile terminal of furnishings (b) Ways to Buy Home Products (c) Online Shopping Doubts of Home Products

(2) Mobile terminal of furnishings to determine the functional requirements

The requirements were categorized into 4 sections: community, shopping, activities, and other functions, and the key requirements were prioritized (Table. 1).

Based on the above results of the research, reliability, and validity analysis was conducted through SPSS (Statistical Product Service Solutions) data analysis software. Cronbach's coefficient, also known as the reliability coefficient, or Cronbach's alpha, or alpha coefficient, is generally greater than 0.7. The higher the coefficient, the more stable the results of the test. The reliability test yielded an alpha coefficient of 0.994, indicating a high quality of reliability, while the validity test results were positive and the p-value satisfied the condition with validity (Table 2).

Table 1. Prioritize Key Requirements and Summarize Functional Requirements.

Modules	Needs	Mean value	Module Mean Value
Shopping	Commodity rating, effects, color, size, material, warranty, environmental rating, installation details, delivery	4.03	3.77
	Search function, product and brand classification platform regularly selects a list of recommended goodies	3.81	
	Offline with the same product, can provide store information in order to experience the physical product	3.87	
	Quality product usage sharing from quality users	3.85	
	Connect with store staff/customer service to help answer questions about the products you want to inquire about	3.83	
	Personalized recommendations	3.80	
	Set up preferential promotions	3.80	
	Whether the same price online and offline	3.80	
	Similar Products Recommendation	3.74	
	Designer furnishings live and buy on behalf of	3.25	
Community	Users share home life through graphic videos, set comments, set purchase links	3.85	3.74
	Interest tagging module to divide the browsing of recommended community shared content	3.81	
	Selected cases by platform editors	3.78	
	Platform selected home experience	3.77	
	Designer area, providing design cases and experience	3.76	
	Decorating inspiration collection	3.71	
	Designer area, providing consulting services, clear price design services	3.67	
	Topic discussion on a particular furnishings theme	3.55	
Activities	Furnishings brand store offline experience activities	3.70	3.59
	Home exhibition Information	3.66	
	Home theme offline communication activities	3.40	
Others	Support after-sales service online and offline interoperable merchants, are available for after-sales service	4.00	3.8
	Favorites, easy to find by category, including images, products, articles	3.93	
	View personal comments and postings at any time	3.72	

Table 2. Reliability and Validity Test of Questionnaire Data

α factor	KMO and Bartlett's Test of Sphericity		
0.994	KMO value		0.981
	Bartlett spherical calibration	Barth Spherical Value	7447.494
		df	325
		P value	0.001

In the subsequent design practice, the focus is on the following 3 aspects. (1) Try to meet the real needs of users for mobile terminal of furnishings. (2) Simplify the basic functions and add additional functions. (3) Reasonable planning of information layout to improve the efficiency of users' obtaining information.

RESULTS

User Travel Map

Based on the scenarios and descriptions given by users in the qualitative and quantitative surveys, functional requirements were summarized. The objective was to optimize the online home mobile shopping process and create a logical user journey diagram (Fig. 4).

Fig. 4. Mapping a logical user travel map based on qualitative and quantitative research

Functions of Mobile Terminal of Furnishings

Based on the results of the previous study, the functional information analyzed above was prototyped with high fidelity. The user's navigation path through the interface is shown, and the information is displayed graphically. At the same time, the importance of the information and the priority of the content is represented in the high-fidelity prototype at different visual levels. The "Living Specialist" mobile terminal of furnishings was designed with functions divided into necessary basic functions and additional functions after the analysis of the research results.

Basic functions of mobile terminal of furnishings

After the questionnaire results analysis and mobile terminal of furnishings function priority selection, the home page, product details page, product classification, and after-sales service are the basic functions. The home page is the shopping portal and provides sub-portals for other functions. It serves: (1) The 3 categories of furniture, home, and goodies in all product categories are placed in the functional navigation. (2) The purpose of the page is to provide inspiration, brand, experience, and design consultation function entrance. (3) It provides the entrance to a limited time offer. (4) The page recommends products according to user's preferences. There are classified products, recommended products, inspirational graphics, and time-limited offer products, with functions such as shopping cart, message, share, consult customer service, add to wish list, *etc*. The site provides quality product reviews and clear and detailed product details. Regarding commodity classification and selection, all categories include 5 major categories, namely furniture, home, building materials, themes, and products. After entering the sub-categories, the list of products is sorted by new products, sales, and price. The comprehensive, reasonable and orderly selection function helps users to get the target products more efficiently.

Additional functions of mobile terminal of furnishings

Inspiration, Brand, Experience, and Wish are additional features. The inspiration collection page includes daily recommendations, searches, messages, posting graphics, category filtering, and a graphic list. Users can filter by style, space, preference, and source, and the graphic list will be updated after selection. One can slide up and down to view adjacent similar graphic information, and support direct access to product links to facilitate users to more quickly access the relevant information that they need. Experience is the default home page to enter all home page experiences; users can slide horizontally to filter experience types and get a list of responsive experiences. They can enter experience graphic details, support adds wish list, comment, and share. Brands can be added to the wish list for convenient subsequent ownership so that users can check it anytime when they need it. Wishlist includes products, stores, experiences, inspirations, and brands. The Inspiration Wishlist uses the same a Waldo-style graphic list as in the Inspiration function to ensure consistency. It also provides a search function to facilitate quick searches for information.

Usability Testing and Optimization

Usability testing is the typical task of completing the introduction of a product by observing a representative number of users (Bastien 2010). It is the process of defining usability problems and solving them by discovering the efficiency and satisfaction of the product. The main purpose is to observe users' ease of use and task completion. After the problems are organized, they need to be categorized or prioritized. Users perform exploratory testing by manipulating an interactive prototype containing operational logic. Combining the previous scenario analysis and functional requirements, the typical tasks for this test were identified. Typical tasks and task content for the pre-purchase, purchase, and post-purchase sessions.

Based on the information obtained from the analysis, a high-fidelity interface was created, and usability tests were conducted. The mobile interface of the output "Living Specialist" was produced, starting from the part of acquiring experience in the early stage, adding inspiration and wishes, adding the function of home social circle, and integrating the functions of each platform; at the same time, unnecessary operation steps were reduced, simplifying the user's use process and alleviating the original problem of difficulty in acquiring information and collecting home improvement experience (Fig. 5).

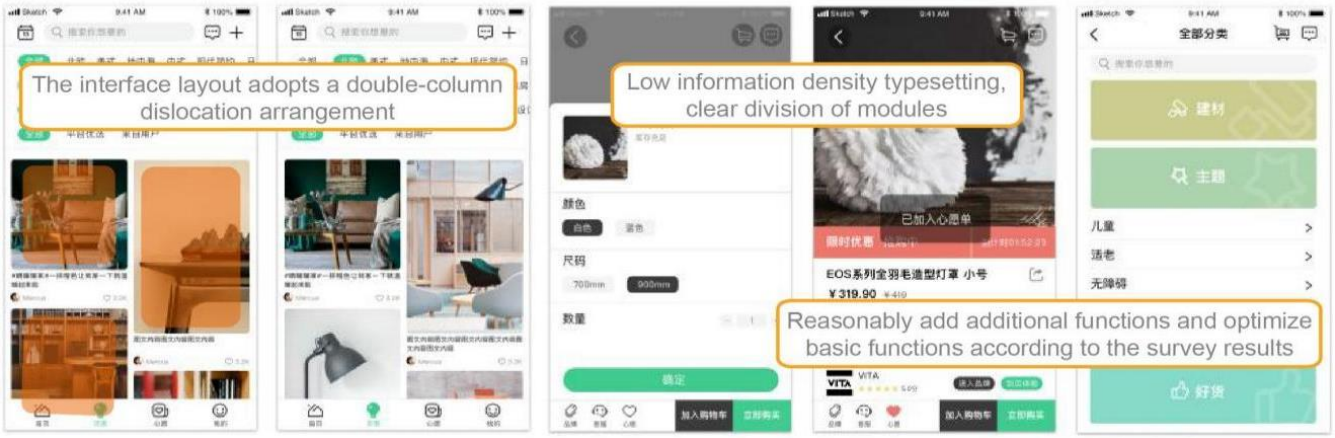


Fig. 5. Improve the problem and complete the high-fidelity prototype design

User Experience Evaluation

In the previous user interviews, five users experienced the task flow through the interactive prototype and rated the UX of the solution. The user test task was to complete a furniture purchase independently. There are various channels for selecting furniture, which can be done through search, personalized recommendations, wish lists, and links below the experience exchange platform for user purchases. The experience was compared with Niceliving and Tmall, to verify the value of this home-class mobile product design. The ratings are all above 8 out of 10 (Fig. 6). Especially for the navigation design, the experience of information design has been significantly improved, and users can get the information they need more efficiently.

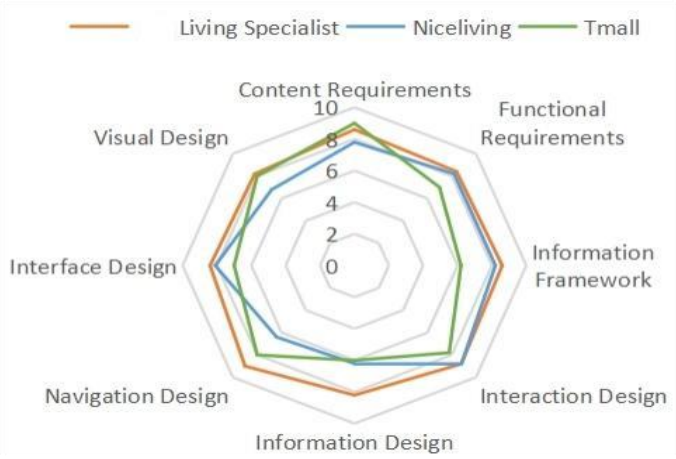


Fig. 6. Scoring the "Living Specialist" app based on the user experience evaluation framework.

DISCUSSION

Compared with previous research, this research provides direction for the optimization of mobile terminal of furnishings based on the current stage demand, which is more targeted. New functional modules are proposed to differentiate from the traditional functional settings. The goal is to derive an information layout and visual presentation that can improve user usability and availability. User demand research was conducted on function setting, navigation arrangement, and information layout. It was found that consumers need to exchange purchasing experience, recommend furniture matching, and improve the quality of after-sales service at this stage.

However, there are still some inadequacies in this research. First, this research on the demand for furniture mobile is from the overall perspective, and it can be further studied in more detail. Second, the use of mobile furniture shopping needs to be considered from a combination of software and hardware, and this research is still lacking in the consideration of the combination with hardware. Third, the sample data is limited, and the actual user group is broader, with different lifestyles and geographical areas, and the demand will be affected.

Combined with the limitations of this study, future research directions can be based on the advantages and characteristics of mobile that distinguish it from the physical market, such as the impact of scientific color schemes and visual presentation on furniture consumers. Based on the hardware presentation, hardware will affect the visual effect and

shopping experience, size, and presentation effect. The sample and the number of subjects should also be expanded, and research should be conducted in different regions to avoid the influence of regional factors. Overall, future research on the mobile terminal of furnishings needs to combine online and offline, hardware and software to optimize the user experience.

CONCLUSIONS

1. The typical representatives of four types of mobile terminal of furnishings were selected as comparison materials, and the interface of furniture mobile terminals was analyzed using five elements of user experience (UX). The aim is to provide insights and directions for optimization in the mobile terminal of furnishings, which include (1) function setting, (2) navigation arrangement, and (3) information layout.
2. Qualitative and quantitative research were conducted, with statistical data, focusing on the real needs of furniture consumers, aimed at providing real and reliable suggestions. According to the results of the study, there are three main influencing factors: (1) Consumers want to get real product trial experience of others before buying, and have a platform to share before buying furniture. (2) Consumers are increasingly focused on the matching and coordination of furniture products, hoping to get matching decorations and matching references. (3) Consumers want to get better delivery service and after-sales return service.
3. Based on the statistical results of the questionnaire, steps were taken to recreate the interface of the mobile terminal of furnishings, re-test it, and finally come up with optimization suggestions: (1) On the scope layer, it is reasonable to add additional functions: inspiration, desire, and experience modules, which can increase usability. In addition, the basic functions can be optimized, which includes product details, delivery service and after-sales *etc.* These functions can be adjusted to improve the UX and increase ease of use. (2) On the structural and framework layers, the interface layout adopts a two-column staggered layout, with a navigation bar-style main navigation at the top of the home page and a combination of auxiliary navigation at the bottom. A low information density layout is adopted to divide the modules. (3) On the presentation layer, the main color uses comfortable colors, and high-saturation color accents are used to highlight key information.

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