



On the Evaluation of the Usability of E-commerce UI Design

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Abstract. **Aim** The study aims to establish a system for evaluating the usability of e-commerce UI design to offer insights for future studies concerning e-commerce UI design and the evaluation of its usability. **Methods** After a review of the existing literature, the study establishes a system for evaluating the usability of e-commerce UI design by matching the usability evaluation methods, the existing problems concerning usability, and the indicators of usability, which are all taken from the existing literature, with the five elements of user experience design. The study then explores the ways the indicators measure usability and works out the specific issues covered by the indicators. Then the weight of the indicators is calculated using expert grading and the analytic hierarchy process. **Conclusion** Effectiveness, efficiency, and satisfaction are the usability indicators most frequently used and spanning the greatest number of elements of user experience design, and that questionnaires, interviews, user testing, and thinking aloud are the most frequently used methods for evaluating usability. By establishing an evaluation system and working out the weight of each indicator, finds that satisfaction with navigation, satisfaction with visual effects, satisfaction with structure, and satisfaction with functions carry the highest weights.

Keywords: E-commerce platforms · User Interface (UI) design · Usability evaluation · Evaluation system

1 Introduce

E-commerce platforms serve as bridges connecting different users and linking users with businesses. With trade in brick-and-mortar businesses hindered by the Covid-19 pandemic, buying from e-commerce platforms has gradually become the major way people shop. The user interface (UI) design of e-commerce platforms has gained increased attention.

The fundamental aim of a user interface is to facilitate the use of products, and usability is hence an issue that cannot be ignored. Research on the system for evaluating the usability of e-commerce UI design is significant for the development of e-commerce platforms as it helps improve the overall usability of e-commerce platforms and enhance user satisfaction and engagement.

2 An Introduction to the Usability of UI Design

2.1 The Conception of Usability

Usability is a quality indicator for assessing whether the user interface of a product suits its target users. It is meant to figure out whether a system can satisfy the basic needs of its users. Below are two commonly used indicators of usability.

- (1) ISO 9241-11 points out that indicators of usability include effectiveness, efficiency, and satisfaction [1].
- (2) The indicators of usability proposed by Nielsen include learnability, the efficiency of use, memorability, errors, and satisfaction [2].

When it comes to the study of users, Nielsen categorized users into three types, namely inexperienced users, less frequent users, and experienced users, the indicators proposed by Nielsen are more targeted, It is more suitable for research on a certain type of users.

2.2 The Conception of Usability Evaluation

Research and application featuring usability in the entire process of product development are called usability engineering, which refers generally to a series of processes, methods, technologies, and standards for improving and evaluating product usability. The process of collecting problems and finding solutions in a certain stage of usability engineering is called usability evaluation. Usability evaluation is how research on usability is conducted [3].

2.3 Evaluation of the Usability of Interface Design

The evaluation of the usability of an interface refers generally to the research on the results of interface design [3]. The main purpose is to spot the problems with an interface after analyzing the usability of all the elements the interface design. The evaluation of the usability of interface design features two aspects. For one thing, it means conducting a usability analysis for all the elements of interface design. For another, it runs across the entire process of interface design.

2.4 Usability Evaluation Methods

Some specific technologies, methods, and tools are required in the evaluation of usability to measure tasks, and these technologies, methods, and tools are called usability evaluation methods. For the two commonly used sets of indicators of usability mentioned above, the usability evaluation methods required include questionnaires, interviews, user testing, observation, log file analysis, focused conversations, heuristic evaluation, cognitive walkthrough, thinking aloud, physiological analysis, and motion analysis. Scholars have got used to classifying the above-mentioned usability evaluation methods into two types, namely subjective evaluation methods and objective evaluation methods; Hix

and Hartson [4] (1993) categorized usability evaluation methods as experimental methods and format methods; Gray [5] (1998) categorized the above-mentioned methods as experimental methods and analytical methods; Xiaobin Huang [6] (2002) classified it into three groups, namely usability-survey-related methods, usability-check-related methods, and usability-testing-related methods; Liting Fan [7] (2017) separated it into three categories, namely expert evaluation, user evaluation, and theoretical evaluation.

3 Usability Analysis of the Elements of E-commerce Interface Design

Due to the fast development of mobile devices, e-commerce platforms have evolved from websites to mobile apps. The elements of design involved in the two forms of e-commerce platforms are generally similar [8].

Strategy: Strategy concerns user needs and product orientation, and that represents is fundamental for improving the usability of e-commerce user interfaces. The ability to satisfy the needs of target users and proper product orientation are essential for e-commerce platforms to gain public attention.

Scope: Scope concerns functional specification and content requirements. Whether an e-commerce platform is fully functional and whether it has reasonable content requirements also matters a lot to the usability of its user interface. As some mobile apps are synchronized, the user retention rate will be higher for e-commerce apps that align their functions well with voice recognition systems, cameras, and mobile payments.

Structure: Structure concerns information architecture and interactive design. It influences the usability of a user interface by influencing the functions of the interface and the way information is presented. The design of e-commerce user interfaces should involve the structure of the information presented, which features the design of structures for categorization and navigation as well as the establishment of a categorizing system. Such design is manifested in the organization, labeling system, navigation system, and search system of e-commerce user interfaces. The information architecture of an e-commerce user interface should be in line with the purposes and user needs that Strategy and Scope cover. When it comes to interactive design, the processes and forms of interfacial interactions are the keys.

Skeleton: Skeleton concerns interface design, navigation design, and information design. In e-commerce UI design, selecting proper interface elements to facilitate use and help clinch deals is one of the issues that cannot be ignored. Navigation design involves the design of the style, mode, and information of navigation and helps users figure out which stage of shopping they are in and the steps they can take next. Navigation design combined with information design helps to guide users with signs and instructions. Information design involves not only collecting user information but providing users with information including product information (such as the name, specification, and producer of a product) and system information (such as error prompts). Designers must ensure the information provided is arranged in proper order.

Surface: Surface concerns the visual effect of an e-commerce platform as well as how it can be perceived by users with their five senses (sight, hearing, touch, smell, and taste). The visual effect is manifested in the layout, colors, patterns, and icons of

e-commerce user interfaces, and good visual effects can improve greatly the usability of e-commerce user interfaces.

4 Existing Studies on the Evaluation of the Usability of E-commerce UI Design

4.1 Existing Studies on the Usability of E-commerce UI Design

Existing studies on the evaluation of the usability of e-commerce UI design are relatively few both in China and around the world. Below is a review of the existing studies.

Taking Jingdong Mall and COFCO I Buy Nets as research subjects, Congcong Chen [9] conducted a questionnaire survey after the participants were asked to use the platforms. The study then obtained the scores the platforms got in five dimensions which were in line with the five indicators of usability, namely memorability, ease of use, efficiency, interactive experiences, and satisfaction. The study found that in terms of interactive experiences, the ways users could interact with the platforms were limited. By giving out questionnaires and conducting interviews, the scholar then delved deeper into touch interactions and natural gesture interactions, which constituted interactive experiences, and found out that gesture-based interactions were more in line with users' habits and that users wanted the apps to replace touch interactions with natural gesture interactions.

By observing and interviewing elderly users, Fu Guo [10] collected data on the feelings the participants got when using e-commerce platforms. By transcribing, coding, classifying, and identifying the data, the scholar figured out six indicators and the problems with the usability of the platforms faced by elderly users, that are as follows: Standardization: The information the user interface presented was not neatly organized; there was a lack of a uniform format for each interface; The interface lacked a clear structure. Readability: text sizes were improper; icons and the information provided by images and text were hard to understand; the amount of text was disproportionate to the number of images. Learnability: Buttons, icons, and links were complex and hard to understand while providing few instructions. Navigation: The navigation bar was not prominent; the structure of the navigation system was not proper; vital information was not highlighted; the classification of information was incomplete; ways to interact with the interface were limited. Effectiveness: Responses were not prompt; the classification of information was inaccurate; some links on the interface were invalid; fuzzy lookup was unavailable when users typed things in the search box. Attractiveness: Images, text, and interactive elements on the interface were not aesthetically pleasing; the background color of the interface was overly dark.

Jiao Song [11] took the user interfaces of e-commerce platforms for home appliances (Suning, Changhong, and Xiaomi) as research subjects. On the basis of Junhua Hao [12]'s review of a variety of studies on the usability of website UI design, the scholar took satisfaction and efficiency as two important indicators of the usability of website UI design. After analyzing the participants' performance, making observations, and carrying out interviews, the scholar figured out the problems facing the usability of the platforms: The submenu of Changhong presented only the main product types and was

not rich in content; the interface of Suning lacked eye-catching visual effect, and the navigation page contained too much information, which was liable to cause confusion; the “cart” icon was not conspicuous on the interface of Suning, and the response after clicking the icon lacked immediacy: key functions were missing from the home page of Suning, which prolonged use; the different parts of the navigation page of Changhong lacked distinguishing features, making it hard for users to distinguish between different information and hence reducing efficiency. With the help of SUS (System Usability Scale), questionnaires, and interviews, the scholar finally measured users’ satisfaction with the user interfaces of the e-commerce platforms for home appliances and found that the participants expressed the highest satisfaction with Xiaomi, that the background color of the interface of Changhong was perceived as overly cool and monotonous, and that the styles of the three platforms involved in the study were similar to those of other e-commerce platforms.

Goh [13] took the e-commerce platform of a Malaysian gift shop as the research subject. Being aware that cultural factors and language barriers might have an impact on the results of thinking aloud, the problems spotted through the combination of post-task feedback capturing, retrospective thinking aloud, and retrospective eye-tracking thinking aloud, and the corresponding indicators of usability were Language and content: Some products were often in short supply (The products were handcrafted and came out in small batches). User guide and support: The registration system was not separated from the login system, which was liable to cause confusion. Flexibility and control: A tool for comparing various products was missing. Visual clarity: The text was too small and caused difficulties in reading. The problems spotted through observation were: The products were not categorized; product details including the date of manufacture as well as the date of delivery were missing; there was a lack of a product comparison button; some purchasing information was redundant; the login state was not clearly shown; personalization settings were unavailable; some text was blocked by the username; a logout confirmation panel was missing.

Taking Yahoo Kimo as the research subject, Hui-Jiun Hu [14] collected data by asking the participants to think aloud. After transcribing, splitting, and coding the data, the scholar figured out 121 problems concerning usability. The problems were then classified into nine groups and matched respectively with five indicators of usability, namely satisfaction, efficiency, effectiveness, navigation, and help. Among the 121 problems, 39 were matched with satisfaction, among which the most important ones were: Modes of interaction were not user-friendly; mistakes could be easily made; bad user experiences were frequently reported. 36 problems were matched with efficiency, among which the major ones were: The shopping process was not simple enough to rival offline shopping; the “buying together” function was unavailable; the shopping links were not neatly arranged and were liable to cause confusion; the refund procedure was flawed; there were delays in the display of purchasing information. 28 problems were connected with effectiveness, among which the major ones were system delays, faulty information, and problems with the scope and categorization of products. 11 problems were connected with navigation, among which the major ones were: The content was not neatly organized and caused inconvenience; content recognition took a long time; the function buttons were improper; the text, images, and ads were not neatly arranged. Problems concerning

help include: The terms “cash flow” and “logistics” were involved in the design of an e-commerce platform; there was no alternative to the existing mode of customer service; help could not be offered immediately when needed.

4.2 Studies on the Evaluation of the Usability of User Interface Design Based on the Five Elements of User Experience Design

Based on the existing literature on the evaluation of the usability of e-commerce UI design, the usability evaluation methods and the existing problems concerning usability are matched with the corresponding indicators of usability. Considering that the design strategies inspired by the problems concerning the usability of UI design can in turn guide UI design, the above-mentioned methods, problems, and indicators are then matched with the five elements of user experience design. Details are presented in Table 1.

It can be found that few problems relate to Strategy, and the only problem presented is about post-sales. Scope is connected mainly with the absence of auxiliary functions, which serve to distinguish one platform from another and help to bulk out a platform. The problems connected with Structure mainly concern interaction processes and ways of interaction. Skeleton is the element connected with the largest number of problems of usability, which mainly include problems with the information on a user interface, the layout of a user interface, product classification, product description, signs, instructions, and the navigation system. The problems connected with Surface are mainly about the sizes and visual effects of images, icons, and text. When a platform is used by elderly users, the images, icons, and text should be larger in size and more conspicuous.

When it comes to the indicators of usability, effectiveness, efficiency, and satisfaction span almost all the five elements of user experience design and are the most frequently

Table 1. A correspondence table for studying the evaluation of e-commerce UI design [Self-Drawing]

Elements of user experience design	Number of problems concerning usability	Indicators of usability
Strategy	1	Help
Scope	7	Efficiency, Flexibility and control, Help
Structure	11	Interactive experiences, Navigation, Learnability, Effectiveness, Efficiency, Satisfaction
Skeleton	17	Standardization, Learnability, Navigation, Effectiveness, Language and content, User guide and support, Navigation
Surface	6	Learnability, Attractiveness, Efficiency

used indicators that cannot be ignored. When it comes to usability evaluation methods, the most frequently used ones are questionnaires, interviews, user testing, observation, and thinking aloud. The problems concerning usability spotted through these five methods span all the five elements of user experience design, which in turn proves the effectiveness of these methods.

5 The Construction of a System for Evaluating the Usability of E-commerce UI Design

5.1 Constructing a System for Evaluating the Usability of E-commerce UI Design

The problems concerning usability, the indicators of usability, and the usability evaluation methods, which are all taken from the above-mentioned studies, have been matched with the five elements of user experience design. Given the status quo of the research on the evaluation of e-commerce UI design, the study takes effectiveness, efficiency, and satisfaction as the primary indicators of usability for the system for evaluating the usability of e-commerce UI design.

The secondary indicators of usability are selected according to the corresponding problems of usability linked with effectiveness, efficiency, and satisfaction. When it comes to effectiveness, information effectiveness is followed by interaction effectiveness and navigation effectiveness. The secondary indicators aligned with efficiency are the efficiency of use, interaction efficiency, and navigation efficiency, and the secondary indicators linked with satisfaction are the satisfaction of use and satisfaction with service. With the help of the analysis of the elements of user experience design presented above, more details are added to the above-mentioned problems concerning the usability of UI design. The tertiary indicators of usability are hence selected based on the five elements of user experience design, and a system for evaluating the usability of e-commerce UI design is thereby established. Details are presented in Table 2.

Attention should be paid to the ways each primary indicator is measured. Among the three primary indicators mentioned above, effectiveness and efficiency are usually measured by collecting data on user behavior, which is called performance evaluation. Satisfaction, however, is usually measured through interviews and questionnaires, with the help of which problems concerning satisfaction can be spotted [15].

As effectiveness and efficiency are finally measured through data comparison, the corresponding secondary and tertiary indicators cannot be used to evaluate the usability of e-commerce UI design. What these indicators serve to do is to offer insights concerning interface design for future studies. Hence in the establishment of the evaluation system, there is no need to calculate the weight of each secondary and tertiary indicator connected with effectiveness and efficiency. But as the secondary and tertiary indicators linked with satisfaction span all the five elements of user experience design and cover a wide range of issues, calculating the weight of each of the indicators can help accentuate the key issues in the evaluation of the usability of e-commerce user interface and facilitate exploration of problems concerning satisfaction faced by users of e-commerce platforms.

Table 2. A system for evaluating the usability of e-commerce UI design [Self-Drawing]

Primary indicators	Secondary indicators	Tertiary indicators	Elements of user experience design	
Effectiveness	Information effectiveness	Organization and structure	Structure	
		The tag system		
		The search system		
		Content of information	Skeleton	
		Arrangement of information		Surface
	Interaction effectiveness	Interaction processes	Structure	
		Ways of interaction		
	Navigation effectiveness	Style of navigation	Skeleton	
		Mode of navigation		
Navigation information				
Efficiency	Efficiency of use	Functional elements	Scope	
		Organization and structure	Structure	
		The tag system		
		The search system		
		The layout of the interface	Surface	
		Arrangement of information		
		Icons and patterns		
	Interaction efficiency	Interaction processes	Structure	
		Forms of interaction		
	Navigation efficiency	Style of navigation	Skeleton	
Mode of navigation				
Satisfaction	Satisfaction with service	Learner guide service	Strategy	
		After-sales service		
	Satisfaction of use	Satisfaction with information	Skeleton, Surface	

(continued)

Table 2. (continued)

Primary indicators	Secondary indicators	Tertiary indicators	Elements of user experience design
		Satisfaction with functions	Scope
		Satisfaction with structure	Structure
		Satisfaction with interactions	
		Satisfaction with navigation	Skeleton
		Satisfaction with visual effects	Skeleton, Surface effects

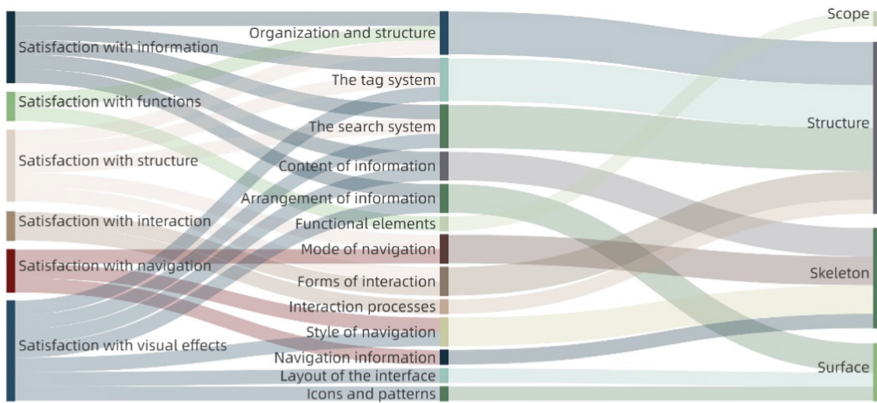


Fig. 1. The specific issues connected with concerning satisfaction of use [Self-Drawing]

Then the tertiary indicators connected with the satisfaction of use are matched with the corresponding elements of user experience design. By delving further into each of the tertiary indicators, the specific issues concerning satisfaction are made clear. This helps explain the calculation of the weight of each tertiary indicator, which is about to be introduced and improve the accuracy of the study. Details are presented in Fig. 1.

5.2 Calculation of the Weights of the Tertiary Indicators Concerning Satisfaction

In the evaluation of e-commerce UI design, the relative importance of each indicator of satisfaction in the whole evaluation system, or the degree to which an indicator can influence the overall evaluation, can be measured through the analytical hierarchy process [16]. Then expert grading is employed. Based on the rule of “1 to 9 ranking”, seven experts, among which three are professors, two are postgraduate students in design, and two are ordinary users of e-commerce platforms, are invited to grade the indicators. Then a judgment matrix is created, a consistency check is performed, and the weight of

Table 3. Weights of the tertiary indicators concerning satisfaction [Self-Drawing]

Primary indicator	Secondary indicator	Tertiary indicator	Weight	Ranking
Satisfaction	Satisfaction with service	Learner guide service	0.0681	8
		After-sales service	0.0910	6
	Satisfaction of use	Satisfaction with information	0.0734	7
		Satisfaction with functions	0.1155	4
		Satisfaction with structure	0.1394	3
		Satisfaction with interaction	0.0986	5
		Satisfaction with navigation	0.2149	1
		Satisfaction with visual effects	0.1990	2

each of the tertiary indicators is worked out. The details of the procedure can be found in an existing paper [17], and the weight of each indicator is shown in Table 3.

It can be seen from Table 3 that the weights of the tertiary indicators including satisfaction with navigation, satisfaction with visual effects, satisfaction with structure, and satisfaction with functions rank high, and the weight of each of the indicators is 0.2149, 0.1990, 0.1394, and 0.1155, respectively.

6 Conclusion

Matched usability evaluation methods, problems concerning usability, and indicators of usability with the five elements of user experience design. It can then be found that Skeleton is the element of user experience design connected with the largest number of problems concerning usability, which means in future studies on interface design and evaluation of usability, more attention should be paid to issues concerning Skeleton. Strategy is the element has the smallest number of problems concerning usability, which implies that e-commerce platforms should have a clear knowledge of their target users and a strong orientation towards the services they provide to be popular among scholars as well as the public.

When it comes to usability evaluation methods, most of the existing studies collect relevant data through user testing combined with observation and thinking aloud and then gather information about user satisfaction through interviews and questionnaires. When it comes to the indicators of usability, effectiveness, and efficiency span almost all the five elements of user experience design, which serves as an important guide for the choice of primary indicators in this study.

By matching the indicators of usability employed by existing studies with the five elements of user experience design and delving into the elements of e-commerce UI design, the study figured out proper indicators of usability and established a system for evaluating the usability of e-commerce UI design. After the effectiveness and efficiency of e-commerce platforms are measured, what matters is to improve design under the guidance of the tertiary indicators and thereby improve usability. When it comes to satisfaction, which is measured through questionnaires and interviews, the weights of the corresponding tertiary indicators should be measured to figure out priorities and spot specific problems concerning usability which can guide design.

In studies on the evaluation of the usability of user interface design, problems concerning usability, usability evaluation methods, indicators of usability, and elements of user experience design are interconnected. Hence in studies on the evaluation of the usability of user interface design, the relationship between these distinct parts should be taken into consideration to make for effective design and evaluation.

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