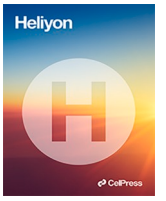
Heliyon 10 (2024) e30050

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon



Research article

A study on satisfaction evaluation of Chinese mainstream short video platforms based on grounded theory and CRITIC-VIKOR

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ARTICLE INFO

Keywords:
Short video platforms
Grounded theory
CRITIC
VIKOR
User satisfaction

ABSTRACT

In recent years, Chinese short video platforms have experienced vigorous development, accompanied by increasing expectations and demands from users. This study aims to explore the factors influencing user satisfaction on mainstream Chinese short video platforms and provide a scientific and objective evaluation framework to support the enhancement of user satisfaction and the development of short video platforms. Through a combination of qualitative and quantitative research methods, multiple mainstream Chinese short video platforms were evaluated and analyzed. Firstly, semi-structured interviews with users were conducted using Grounded Theory to delve into the key factors shaping users' expectations, needs, and satisfaction towards short video platforms. Secondly, the CRITIC-VIKOR method was employed to assign comprehensive weights to various factors and to evaluate the satisfaction levels of the mainstream platforms. The study revealed that the core categories affecting user satisfaction include content quality and interaction, trust and values, and user experience. The weighted values of the main categories are as follows: interface and interaction design 0.124, personalized experience 0.115, platform stability and performance 0.075, privacy and security 0.133, user service and communication 0.060, social impact and values 0.124, content quality and diversity 0.088, social interaction 0.094, and advertising experience 0.186. Furthermore, the satisfaction evaluation of mainstream short video platforms indicated that bilibili platform garnered the highest user satisfaction among surveyed users. This study provides specific directions for improving user experience and enhancing user satisfaction for short video platforms, while also offering a evaluation framework based on Grounded Theory and CRITIC-VIKOR method for similar studies, thus expanding the theoretical and practical fields of user satisfaction research.

1. Introduction

As a result of the quick advancement of communication and information technologies, social media and digital entertainment have become integral components of individuals' everyday routines [1]. In the digital age, the concise video platform has become a beloved form of digital amusement for users due to its simplicity and vividness. Additionally, it has become a crucial tool for online content production [2]. The emergence of short video platforms has not only altered the way individuals consume entertainment but has also

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https://doi.org/10.1016/j.heliyon.2024.e30050
Received 24 December 2023; Received in revised form 16 April 2024; Accepted 18 April 2024
Available online 24 April 2024

presented a novel platform for content creators to utilizeUsers participate both as consumers and uploaders within short-form video platforms [2]. These platforms enable users to share their lives, access information, and enjoy a variety of content, utilizing digital entertainment through social media [3]. Currently, the short video market in China has achieved tremendous success and growth, multiple mainstream short video platforms have emerged in China, including but not limited to Douyin, Kuaishou, Bilibili, etc. These platforms have attracted billions of users with their unique content creation, user interaction, and business models [4]. Scholar Sharabati A A A proposed that the use of social media is not only for social purposes but also for business purposes. Attracting users to use it requires leveraging a multitude of factors that influence user satisfaction to increase users' willingness to continue using it [5]. CHU proposed that user-centered short video platforms are a platform model that focuses on meeting user needs and emphasizing user experience [6]. This indicates that in a fiercely competitive market environment, user satisfaction is a key factor in measuring whether a platform can sustain development and attract more users.

Currently, many scholars have conducted research and evaluation on the construction of short video platforms and user satisfaction. Among them, in the analysis and evaluation research focusing on meeting user needs, Mou X studied the factors influencing the intention of continued use of short video platforms. It was suggested that in commercial practice, developers of short video platforms should pay attention to their own brand building, continuously establish a product image that respects user privacy and protects user data [7]. Wu S constructed a model of influencing factors on mobile short video platform user's intention of continued use based on the Technology Acceptance Model (TAM) and the Extended Continuance Intention to Use Model (ECM-IT). This model explores the factors influencing users' intention of continued use on mobile short video platforms [8]. This indicates that by gaining a deeper understanding of user behaviors, preferences, and interaction patterns, providing personalized, user-friendly, and engaging content can effectively promote user participation, interaction, and creation. Currently, the short video market in China has achieved tremendous success and growth, multiple mainstream short video platforms have emerged, including but not limited to Douyin, Kuaishou, Bilibili, etc. These platforms have attracted billions of users with their unique content creation, user interaction, and business models [4]. Furthermore, in the aspect of analyzing user satisfaction evaluation of short video platforms, Yaqi Z conducted a study on the usage and satisfaction of Douyin short video platform, dividing Douyin video content into 10 categories, and proposed the concept that Douyin user motivations have a positive impact on user satisfaction and user attention intentions [9]. Zheng C utilized the theory of mind-flow experience to investigate the attraction to viewing and sharing brief online videos among users. The study found that three sets of mediating relationships exist: mind-flow experience, social norms, and perceived critical mass, all of which are influenced by engagement and sharing behaviors [10]. Li H discusses the optimization of its industry content based on the theory of user profiling, combined with the example of Racer APP [11]. ZHANG WANGNAN conducted a study on improving user satisfaction with the Racer app. Five strategies were identified to enhance satisfaction and mitigate the risk of declining user satisfaction. These strategies will enhance the app's user experience for improved satisfaction [12]. Liu W et al. conducted an empirical study on the factors that affect the user experience of pop-up videos, using the Bibili short video platform as an example. Their findings suggest that user emotion partially mediates the relationship between content and user experience, while it fully mediates the relationship between function and user experience [13]. Zhuhua W U et al.conducted an assessment of scientific and technical journal paper short videos available on popular video media platforms in China. Their study resulted in the identification of an evaluation system comprising four levels: content production, overall effect, video elements, and dissemination channel [14]. This indicates that by studying user satisfaction, we can gain insights into users' evaluations of platform features, content quality, interaction experience, and other aspects, providing guidance for improving user satisfaction.

However, currently, most scholars only conduct research on individual short video platforms or cases, without integrating corresponding theories to comprehensively assess multiple mainstream platforms. China's short video platform user base is massive, and each platform has formed fierce market competition. There are significant differences between different platforms, which involve multiple aspects such as user experience, content quality, and business models [15]. In this context, conducting research and analysis on a single case alone cannot provide sound advice for the development of short videos [16]. Furthermore, existing research tends to focus more on qualitative analysis, with limited exploration into quantitative studies. Additionally, the few quantitative studies often only consider a few indicators, neglecting the multidimensional nature of user satisfaction. In summary, current research is mostly confined to the analysis of user satisfaction on individual short video platforms, with methods primarily centered on qualitative analysis and limited exploration into quantitative research. Therefore, to comprehensively understand and evaluate these differences, it is necessary to conduct in-depth research.The main purpose of this study is to conduct a comprehensive analysis, investigating user satisfaction with different short video platforms in the Chinese market environment. This aims to identify directions for improvement and optimization of short video platforms, thereby enhancing market competitiveness and supporting the sustainable development of the digital entertainment industry. Through a comprehensive understanding of the current status of short video platforms and user expectations and behaviors, combined with the quantitative research method of CRITIC-VIKOR, a scientific and objective evaluation framework is established to comprehensively assess the user satisfaction performance of different short video platforms.A comprehensive user satisfaction assessment of representative short video platforms in China is conducted to clarify the key factors affecting user satisfaction and their respective weights. Finally, through the discussion of the evaluation results, powerful references are provided for the future direction, innovation points, and optimization strategies of the industry, promoting the prosperity and progress of the short video digital entertainment industry.

2. Research modeling

2.1. Theoretical overview

The study utilized Rooted Theory, CRITIC, and VIKOR to construct a model for the evaluation of short video platform user satisfaction. Rooted Theory (GT) was developed by American sociologists Barney Glaser (1930-) and Anselm Strauss (1916–1996), who published "The Discovery of Rootedness Theory: A Qualitative Research Strategy" in 1967, a seminal work in qualitative research strategy [17]. Grounded theory emphasizes understanding the nature of issues by analyzing individuals' perspectives and experiences [18]. Grounded theory originated in sociology and now serves as a primary methodology for many other fields, including nursing, physical therapy, healthcare, education, anthropology, psychology, management, information systems, and software engineering [19]. Rooted theory is a qualitative research analysis that systematically collects and analyzes data to develop new theories about human behavior in the perception of social welfare [20]. It is valuable for both expert and novice researchers to create new explanatory theories. The aim of classical grounded theory is to theorize and advance the comprehension of valid knowledge regarding the occurrences in society that impact individuals' lives [21]. Currently, scholars in multiple fields have constructed theoretical frameworks employing the research of rootedness theory. Sun S. and other scholars have generated a theoretical framework by coding results for gym users, featuring the core variable of "perceived continuous value" [22]. Adopting a qualitative research methodology based on rootedness theory, Tian Y systematically identified the factors that influence consumers' brand preferences by conducting in-depth interviews with 60 mothers in the Beijing-Tianjin-Hebei region of China [23].Hu et al.utilized rootedness theory to investigate the essential elements impacting the user experience of a combined sports and healthcare platform. The study identified usefulness, interactivity, usability, trustworthiness, and findability as key determinants of user satisfaction, which all exhibited a significant positive effect on user satisfaction [24]. These studies indicate that Grounded Theory has a wide range of applications in research fields and can provide a solid theoretical foundation for related studies. This method is primarily suitable for exploratory research, allowing for the discovery of new theories or patterns through in-depth data collection and analysis. Additionally, it offers considerable flexibility, enabling researchers to adjust the research direction and theoretical construction process based on the actual data, thus better adapting to the characteristics of the research subjects [25]. However, the Grounded Theory approach emphasizes the subjective interpretation of data and theoretical construction by researchers, which may be influenced by personal experiences and perspectives, potentially leading to subjectivity and bias in research results. Therefore, in order to provide a structured method for handling and analyzing data, ensuring both theoretical depth and scientific data support while balancing subjectivity and objectivity, it is necessary to integrate other quantitative research methods for assistance.

CRITIC-VIKOR is a multi-criteria decision-making approach for resolving problems involving multiple evaluation metrics and decision objects. The method blends the CRITIC (Criteria Importance Through Intercriteria Correlation) and VIKOR (VlseKriterijumska Optimizacija I Kompromisno Resenje) techniques to aid the decision maker in making optimal choices in intricate environments for multidimensional and multifactorial issues [26]. The CRITIC method is used to determine the correlation between evaluation indicators, and by calculating the correlation matrix between evaluation indicators, it is possible to determine the importance of each indicator for the overall decision [27]. VIKOR is a multi-criteria decision methodology that aims to find the best solution for all decision objects by calculating the distance between each decision object and the ideal solution and then determining the overall ranking of each object [28]. The combination of CRITIC-VIKOR provides a comprehensive decision support framework that considers the importance of different metrics and evaluates multiple scenarios in an integrated manner [29]. Liu Chang et al. used the CRITIC method to determine the subjective and objective weights of evaluation indexes, and adopted the combination weight method based on the ideal point method to determine the combination weights. On this basis, the VIKOR method is used to calculate the comprehensive evaluation value of the suppliers to be selected, and the advantages and disadvantages are ranked. Finally, an arithmetic example is given to verify the practicality and scientificity of the method [29]. Liang Peiyun used the improved CRITIC-VIKOR method to comprehensively evaluate the service innovation capacity of the science and technology service industry, and the study concluded that there are significant differences in the service innovation capacity of the four economic regions [30]. Liu Zuwei et al. used the CRITIC model to calculate the weights of each evaluation index of suppliers, and then combined it with the VIKOR method to make selection decisions of precast suppliers. The flexibility and feasibility of the method is verified by obtaining the ranking of potential suppliers through a case study [31].

The research suggests that the combined research methodology of CRITIC-VIKOR is applicable to multi-criteria decision-making problems. It can consider the interrelationships and weights of different indicators, aiding in comprehensive evaluation and ranking. Furthermore, this method employs mathematical models and quantitative analysis, which are relatively objective and can mitigate the influence of subjective judgment and bias [32]. Consequently, it provides decision-makers with comprehensive assessments and comparisons, facilitating holistic decision-making and enhancing the scientificity and accuracy of decisions. However, the analysis results may be influenced by the selection of criteria and weight assignments, leading to certain theoretical biases and limitations. There are limitations regarding data dependency, model assumptions, and subjectivity, necessitating comprehensive consideration and handling in practical applications.

2.2. Research process

To summarize, in the satisfaction evaluation of short video platforms, the rooted theory can help researchers dig deeper into users' perceptions, feelings, and expectations, so as to understand the formation mechanism of user satisfaction more comprehensively. CRITIC-VIKOR is a multi-criteria decision-making method that is applicable to multi-dimensional and multi-factor problems. When

evaluating the satisfaction of short video platforms, considering that there may be multiple evaluation indicators, CRITIC-VIKOR can help synthesize these indicators and provide more comprehensive information for decision-making [26]. However, during the research process, when the three methods are combined, researchers need to ensure effective acquisition, integration, and processing of different types of data, which may increase the difficulty of the study. This study combines the qualitative theoretical study of rootedness theory with the quantitative study of the CRITICAL-VIKOR decision-making methodology to create a scientific evaluation model that combines qualitative and quantitative aspects.In this study, firstly, we adopt the rooted theory to conduct user-centered interviews to obtain users' general needs, expectations, and shortcomings of the short video platform, and then construct users' representative category concepts of the short video platform. Second, the CRITIC research method is used to assign weights to users' category concepts to clearly understand the importance of each category. Finally, the VIKOR evaluation method is used to conduct a comprehensive evaluation study of mainstream short video platforms in the Chinese market, and the research process is shown in Fig. 1. Based on the combination of qualitative and quantitative research methods, we can not only accurately evaluate the user satisfaction of each short video platform in the Chinese market, but also provide a more accurate category concept for the development direction of short video platforms, and provide evaluation methods and substantive suggestions for the development of short video platforms in the future. This kind of research also helps scholars to verify and explore the effects of rooted theory and multi-criteria decision-making methods in practical applications, and promote the development of related theories.

3. Grounded theory user satisfaction research

3.1. Data collection

Grounded theory consists of four main steps: primary coding (open coding), secondary coding (spindle coding), tertiary coding (axial coding), and theory saturation testing [33]. In terms of data collection, it was conducted using semi-structured interviews, which are appropriate for delving deeper and understanding complex social phenomena, behavior patterns, or problems in a particular area, especially in the early stages of the study when the researcher may not have enough knowledge about the nature of the problem and its relationships [34].This interview method emphasizes the open exploration of participants' perspectives, allowing the researcher to continuously adjust the questions during the interview process to better understand the phenomenon under study. The interview outline was prepared by searching the literature in related research fields, and the outline was set to include the basic information of the interviewees, the application of the short video platform, and the experience of using it, etc. The questions were set according to the basic principle of "first easy, then difficult" to guide the interviewees to discuss the details of the process of using them in depth from the perspective of the overall experience [35]. Some of these questions are listed in. In this study, the interviewees comprised users of short video platforms and relevant content creators. Relevant users were obtained through random sampling and expert recommendations. The interview process was conducted using a progressive recruitment approach until thematic saturation was achieved, ensuring sample adequacy. A total of 11 research subjects were interviewed in this study, with their demographic characteristics detailed in Table 1. Interviews were conducted through a combination of online and offline dialogues. During the interview process, participants were informed in advance about the possibility of recording and the handling of recordings. This ensured accurate recording and storage of interview content for subsequent data analysis and utilization. The study duration spanned from September 2023 to November 2023. In Table 2accordance with the nature of grounded theory research [35], each interviewee engaged in a 20–30 min conversation focusing on the interview outline, with encouragement for participants to describe and evaluate relevant content beyond the outline as deemed appropriate.

The grounded theory coding process comprises three aspects. Firstly, the open coding phase involves carefully reading and analyzing the raw data, segmenting it into small pieces, and assigning a descriptive label or code to each segment [36]. These codes are typically based on the characteristics and content of the data itself, without being limited by pre-existing theoretical frameworks or assumptions. Secondly, the axial coding phase involves integrating and categorizing the results of open coding to form broader and more systematic concepts [37]. This entails grouping codes with common themes or connections into larger concepts or categories, and exploring the relationships and connections between these categories. Lastly, the selective coding phase requires further refining and developing a set of core concepts or categories to explain the key patterns and themes in the data [38]. During this phase, researchers may emphasize some of the most important categories and explore the relationships between them to construct a more complete and

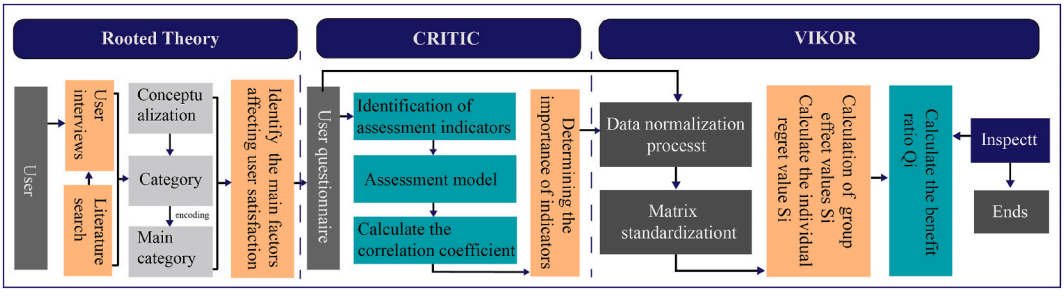

Fig. 1. Research process system.

Table 1
Respondent information.

Number	Gender	Age	Education level	Occupation	Number of uses	Most used applications	User Type
A1	Female	25	Master's Degree	Students	2	TikTok/Bilibili	Viewer、Creator
A2	Male	28	Doctoral Degree	Students	3	TikTok/Bilibili/Kuaishou	Viewer
A3	Male	28	Doctoral Degree	Worker	3	TikTok/Bilibili/RED	Viewer、Creator
A4	Male	23	Bachelor's Degree	Students	2	TikTok/Kuaishou	Viewer
A5	Male	25	Master's Degree	Students	2	Bilibili/RED	Viewer、Creator
A6	Female	26	Specialized education	Housewife	2	TikTok/Kuaishou	Viewer
A7	Male	26	Master's Degree	Students	2	TikTok/Bilibili	Viewer、Creator
A8	Male	27	Doctoral Degree	Students	2	TikTok/Kuaishou	Viewer
A9	Female	24	Master's Degree	Students	2	WeChat/RED	Viewer
A10	Female	30	Master's Degree	Worker	2	TikTok/RED	Viewer
A11	Female	16	Master's Degree	Worker	2	TikTok/RED	Viewer、Creator

Table 2
Questions for semi-structured interviews.

Number	Content of the interviews
1	Have you used Short Video Platform? Please tell us about your experience.
2	Is there anything you are dissatisfied and concerned about the short video platform you are using now?
3	What is your favorite feature set when using various short video platforms?
4	Do you ever get involved in the process of producing content for short video platforms? What types of videos have been produced, and please share your specific production ideas? What are the reasons for not sticking to the production?
5	Did anything memorable happen while using the current short video platform, positive or negative.
… …	… …

accurate theoretical framework.

3.2. Open encoding

In order to ensure the reliability and validity of the coding results of grounded theory, this paper mainly adopts the following data analysis strategies: First, members coded individually. Under the premise that the concepts and categories of the interview texts were agreed upon, several authors coded together and each was responsible for labeling the interview texts. Second, memo cross-checking, creating a memo for each interview transcript to cross-check the coding and revision process. Third, repeated comparative analysis. In response to the emergence of new or difficult to categorize concepts and attributes, the concepts and categories formed were used as the basis for analyzing and comparing the concepts and attributes for continuous revision and improvement [39]. In the first step of content textualization [39], initial concepts are conceptualized through cluster analysis and associations and logical relationships are established according to certain rules or paths to form the initial category [40]. By organizing the data from the 11 user interviews, 49 representative raw materials were summarized. Subsequently, subordination analysis was performed to obtain 39 concepts, and raw data statements with the same concepts were collected and merged to obtain 30 initial categories, which are shown in Table 3. These initial categories are the direct factors influencing users' satisfaction with short video platforms.

3.3. Axial coding

Axial coding builds upon open coding, further exploring the connections between initial categories [41]. First, identify important initial categories or concepts from the open coding stage [42]. Second, identify the relationships and patterns among these categories and record them [42]. Then, establish a core category as a central concept connecting other categories. In this study, the 30 initial categories were traced back to the original textual data, relationships between categories were established, and they were refined into 9 more representative main categories, namely "Interface and Interaction Design," "Personalized Experience," "Platform Stability," "Privacy and Security," "User Service and Communication," "Social Impact and Values," "Content Quality and Diversity," "Social Interaction," and "Advertising Experience," as shown in Table 4 for the specific extraction process.

3.4. Selective encoding

This coding was done by obtaining the main category with an overarching role from the spindle coding, as shown in Table 4. Through multilevel coding and in-depth analysis, the main category was linked with other categories to form a theoretical model of users' satisfaction with short video platforms [41]. During the selective coding phase, it is first necessary to review the established categories or concepts and determine which ones are the most important and representative. These selected core concepts should effectively explain the key patterns and themes in the data [43]. As shown in Fig. 2, the main categories are user experience, trust and values, content quality, and interaction. User Experience represents the overall experience that users have when interacting with a short video platform. It focuses not only on the functionality of the platform or service, but also includes the emotional, sensory,

Table 3
An open coding process based on user satisfaction with short video platforms.

Representative statement information	Conceptualization	Category
Some of the short video platforms have very beautifully designed interfaces that are a pleasure to use.	Beautifully designed interface is a pleasure to use	Clear and beautiful interface
The interfaces of the various short video platforms are different, preferring clear interactions.	Clear Interaction	Usability
The interface for friend interaction would like to be optimized.		
I often need to go back and watch some clips and the fast forward and rewind feature of this app works well.	Smooth front and back playback	Smooth and clear video
The picture quality of video playback is crisp and clear, with no lagging or blurring.	Clarity Video Quality	
Short video platforms will have recommendation algorithms behind them that will recommend appropriate videos based on their level of preference.	Intelligent Recommendations for Video	Accuracy of recommendation algorithms
It is required that the platform does not recommend videos that are not of interest.		
I like that the recommendations of short video platforms don't stay the same and recommend different things based on my changing interests.	Content alone is a repeat recommendation with appropriate diversity	Personalization of Recommendation Algorithms
For short video platforms, I hope that the recommendation function will be improved, as most of the short video platforms have been pushing repetitive content over and over again, and I hope that fresh content will be accepted.		
The app collects the behavior at the time of use and then gives some push messages, videos, etc. that suit me.	User behavior records	Usage behavior monitoring
You can customize the interface skin, which costs money to buy, but I kinda think it's fun.	Interface personalization	Customized settings
You can define to turn on and off the sound to avoid opening it with a loud and embarrassing sound.	Mute when turned on	
The platform fixes bugs, which allows me to use the app smoothly after each update.	Platforms are updated from time to time	Stability of the platform
Having tried several short video platforms, this one loads the fastest I've ever used.	Efficient playback	Video loading speed
That's a pretty good loading speed compared to other platforms.		
The platform crashed during the last XXX event, but it was still back up and running in a very timely manner.	Timely repair	Speed at which issues are addressed
I hope that the process of using the short video platform is absolutely private, and I hope that I go through the videos quietly.	Privacy of use	Speed of problem solving
There is a concern about privacy, looking up some content in a shopping app and immediately promoting the item in question on a short video platform.		
I get notified if there are places I don't recognize logging in, which I think is pretty sweet.	Offsite Login Notification	Speed of problem solving
The user agreement will be bold or color-coded with key terms and conditions, this is a good design.	Clear terms	Clear privacy policy and user agreement
Before I have a problem, I often visit the help center, which is clearly written and easy to understand.	Friendly customer service	Good user service
Found that sometimes you can just ask questions online and the responses are prompt.		
When I encountered errors, the platform gave clear error alerts with suggestions on how to resolve them so that I could try to resolve them on my own.	Tips on errors	Timely feedback
I found the user guide provided by the platform to be very detailed, with clear guidelines for some of the operations and features.	Functional guidelines	Clear guidelines for use
There are notes in the user guide about the latest updates and new features so I can keep up to date with what's new.		
I think the platform does a pretty good job of filtering and policing bad content with a strong sense of social responsibility.	Removal of undesirable content	Social responsibility of the platform
The platform is open to different groups of people, regardless of age, gender or cultural background.	wide range of user groups	The concept of sustainable development
The platform is not just an entertainment platform, but should also have socially responsible activities that give back to the community and promote positive social development.	Promotion of social activities	
There are many creators from different cultural backgrounds on the platform, which demonstrates the platform's respect and tolerance for multiculturalism.	cultural inclusion	Respect for the user
I like the fact that the platform is able to provide users with a platform to discuss social issues so that people can share their views and promote understanding.	Hot Social Discussions	Attitudes and behaviors of the Platform towards social issues
Some of the video ideas are so hilarious and the creators really have a sense of humor.	Interesting video content	Video Creativity
Creative approach to video production.	Creative approach to video production	

(*continued on next page*)

Table 3 (*continued*)

Representative statement information	Conceptualization	Category
In the process of brushing up on videos, you will see a lot of nutritious videos that are very rewarding to watch.	Content is rewarding	High video quality
I'm concerned about the accuracy of the video content, and if it's not accurate it reduces my desire to watch it.	Accuracy of information	
If the videos on this platform are comprehensive, I will continue to use it and will recommend it to my close friends.	Diversity of video subject matter	Diversity of content
In addition to swiping short videos I also do chatting, shopping, and live streaming viewing in the app, which meets most of my needs in my daily life.	Diversity of content forms	
It's usually easy and simple to post videos, which makes me willing to upload them.	Ease of uploading videos	Ease of content generation
The complexity of the creator interface, the complexity of collapsing features, and not being able to get to the target quickly is really giving me a headache.	Ease of feedback after uploading	
I love the beauty features of this platform, so I often take videos and upload them.	Video content beautification	
It's easy to chat and share videos with friends.	positive interaction	Good social interaction mechanism
The ability to hack and delete comments is really nice, there are some people who will give me some bad comments and the comment section clears up after hacking.	negative interaction	
I use short video apps when I'm resting and bored.	Occupy users for a longer period of time	User adhesion
Brush up on videos every morning and evening.		
I'm a fan of the sharing feature, it's very convenient.	It's easy to share within the app	Easy to share
There are restrictions on sharing with other social software and sharing is not convenient.		
Can't tolerate ad promotions, too many implanted ads in short video apps.	Too many ads cause user offense	Number of advertisements
The reason for the poor experience is too many ads.		
Very strong ads I would be offended by, breaks the immersive feeling I get from swiping through videos.	Non-interference with users	Relevance of ads to content
That kind of high quality implantation is still acceptable.	Funny ads	Quality of advertising

Table 4
Core scope coding refinement process.

Content	Category	Main Category
Clear and beautiful interface	User Interface and User Experience	User Experience
Usability		
Smooth and clear video		
Accuracy of recommendation algorithms	Personalized Experience	
Personalization of Recommendation Algorithms		
Usage behavior monitoring		
Customized settings		
Stability of the platform	Platform Stability	
Video loading speed		
Speed at which issues are addressed		
Secure privacy protection	Privacy and Security	Trust and Values
Account security		
Clear privacy policy and user agreement		
Good user service	User Services and Communication	
Timely feedback		
Clear guidelines for use		
Social responsibility of the platform	Social Influence and Values	
The concept of sustainable development		
Respect for the user		
Attitudes and behaviors of the Platform towards social issues		
Video creativity	Quality and Diversity of Content	Content Quality and Interaction
Good quality of the video		
Diversity of content		
Ease of content generation		
Good social interaction mechanism	Social Interaction	
User adhesion		
Easy to share		
Number of advertisements	Advertising Experience	
Relevance of ads to content		

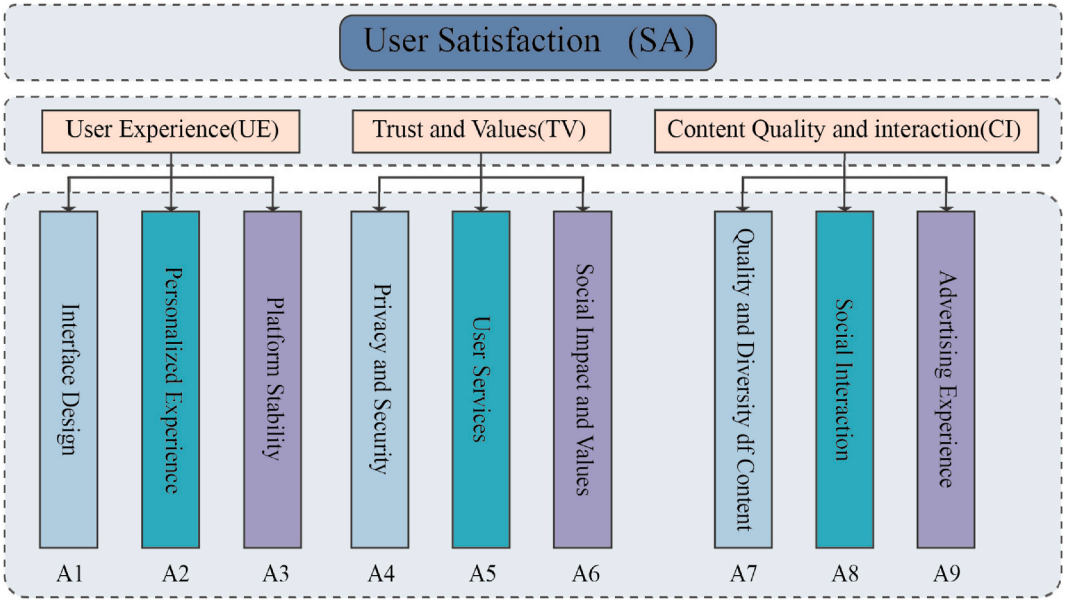

Fig. 2. Short video platform satisfaction evaluation index.

attitudinal, and cognitive aspects of the user's experience during use. The goal of UX design is to create a process that is satisfying, enjoyable, efficient, and meaningful. Trust and values represent the level of trust in the platform and the alignment of values between the user and the platform. Both concepts play an important role in building and maintaining user relationships, promoting user engagement, and enhancing the user experience. Content quality and interaction are two key aspects that directly affect user experience, user engagement, and platform development. Content quality depends primarily on the creativity and interest of the short videos. The ability of creators to present content in a unique way that attracts users' attention is a key aspect of content quality. User interaction is mainly reflected in social interaction behaviors such as liking, commenting, and sharing. These interactions not only increase the exposure of the content, but also create a community atmosphere and increase user stickiness. These two aspects are interrelated, as high-quality content tends to generate more interactions, and positive interactions in turn help increase the visibility and reach of the content. Finally, based on standard grounded theory procedures, a saturation test is required to ensure that the conceptual model explored has good validity [39]. This study attempted to re-extract new categories for the data coding phase and conducted more than three original interviews as well as validation data, and no new categories were found that would indicate theory saturatio [24].

4. Application of the CRITIC-VIKOR methodology

4.1. Weighting analysis of categories influencing user satisfaction

This section utilizes CRITIC to quantitatively analyze the main categories and core categories obtained from grounded theory, providing a more detailed weight relationship for the satisfaction evaluation of short video platforms. In this study, the team conducted surveys on representative short video platforms in the Chinese market. Eight platforms were selected, with S1 representing Douyin, S2 representing Kuaishou, S3 representing Xiaohongshu, S4 representing WeChat, S5 representing Bilibili, S6 representing Huoshan Short Video, S7 representing Xigua Video, and S8 representing Weishi. These platforms were evaluated using a questionnaire based on the

Table 5
Matrix of correlation coefficients between main categories.

	A1	A2	A3	A4	A5	A6	A7	A8	A9
A1	1.00	0.31	0.86	0.36	0.76	0.16	0.41	0.37	−0.01
A2	0.31	1.00	0.23	0.61	0.42	−0.31	0.07	0.00	−0.22
A3	0.86	0.23	1.00	0.39	0.81	0.28	0.65	0.64	−0.23
A4	0.36	0.61	0.39	1.00	0.40	−0.25	0.27	0.12	0.11
A5	0.76	0.42	0.81	0.40	1.00	0.56	0.75	0.51	−0.17
A6	0.16	−0.31	0.28	−0.25	0.56	1.00	0.65	0.36	−0.26
A7	0.41	0.07	0.65	0.27	0.75	0.65	1.00	0.88	−0.39
A8	0.37	0.00	0.64	0.12	0.51	0.36	0.88	1.00	−0.52
A9	−0.01	−0.22	−0.23	0.11	−0.17	−0.26	−0.39	−0.52	1.00

nine main category indicators shown in Fig. 2. Among these indicators, B9 is a minimal indicator, meaning that the fewer advertisements, the higher the user satisfaction with the short video platform, while B1–B8 are maximal indicators, indicating that higher values lead to higher user satisfaction. A total of 236 questionnaires were distributed, of which 216 were valid. The gender distribution of respondents showed that 53.7 % were male and 46.3 % were female. The age range of respondents was wide, primarily concentrated between 23 and 47 years old. In terms of geographical distribution, respondents were mainly from cities in the central and eastern regions of China, with fewer respondents from western cities. Regarding occupational distribution, respondents covered various fields, including students, company employees, self-media workers, teachers, and others. This diversity to some extent represents different groups in society, contributing to the breadth and representativeness of the study.

The steps for solving the weights of each category based on CRITIC are as follows:

There are 8 platforms and 9 indicators in this study, and the matrix $A = [a_{ij}]m * n$, $a_{ij}a_{ij}$ was established to represent the value of the jth indicator of the ith program.

Data processing: To eliminate differences between different indicators, formulas (1) and (2) are applied to perform forward normalization of the minimal indicators, resulting in a standardized matrix. That is, as shown in Table 5, the differences between A1, A2, etc., and A1, A2, A3, etc., are compared with each other. The extreme variance normalization procedure was then applied [44]. Normalization was performed and the correlation coefficient matrix was obtained by correlation coefficient calculation as shown in Table 5.

$$X_{ij} = \frac{X_{ij} - Min \le i \le nX_{ij}}{Max \le i \le nX_{ij} - Min\, X_i \le i \le nX_{ij}} \tag{1}$$

$$X_{ij} = \frac{Min \le i \le nX_{ij} - X_{ij}}{Max \le i \le nX_{ij} - Min\, X_i \le i \le nX_{ij}} \tag{2}$$

Comparability: Indicator variability measures whether there is a large difference between users' ratings of a criterion in a paired comparison. If there is a large difference in how users rate a criterion, it indicates that the criterion has a high degree of variability [45]. This may reflect the fact that different users have different perceptions of the importance of the criterion [29]. Calculation is conducted using Formula (3), σ_j is the amount of information in the i th upper condition.

$$\sigma_j = \sqrt{\frac{\sum_{i=0}^{n} \left(X_{ij} - X_j\right)^2}{n-1}} \tag{3}$$

Contradiction: Indicator conflict is concerned with whether there is a contradiction or conflict between different criteria [44,45]. If users have conflicting ratings between different criteria in a two-by-two comparison, this indicates that there is a conflict between these criteria. The existence of indicator conflict can increase the complexity of decision making, as more compromises may be required in balancing the different criteria. Using Formula (4) to address the conflict of this indicator, where r_{ij} is the correlation coefficient between two indicators, and there is an indicator j with its indicator conflict magnitude S_j, and finally the total conflict value of each category is derived by summation.

$$S_j = \sum_{j=1}^{m} \left(1 - r_{ij}\right) \tag{4}$$

Information Carrying Capacity: Using Formula (5) to perform calculations, where C_j is the amount of information contained in the condition above i. A higher information carrying capacity usually means that the user provides a clearer and more consistent comparison, which is more helpful in determining the relative weights of the criteria.

$$C_j = \sigma_j \sum_{i=1}^{m} \left(1 - r_{ij}\right) \tag{5}$$

Weighting solution: When determining the weights of each category, the standard deviation of the criteria and the correlation between the categories are also taken into account. The calculation formula for the W_j of the jth category is shown as Formula (6).

Table 6
Ratio of weights of main categories to core categories.

	SIGMA	SUM	C_j	W_j	Total	Main Category
A1	0.36	6.80	2.448	0.124	0.314	UE
A2	0.33	6.89	2.274	0.115		
A3	0.34	4.36	1.482	0.075		
A4	0.44	5.99	2.636	0.133	0.318	TV
A5	0.3	3.97	1.191	0.060		
A6	0.36	6.80	2.448	0.124		
A7	0.37	4.71	1.743	0.088	0.369	CI
A8	0.33	5.63	1.858	0.094		
A9	0.38	9.69	3.682	0.186		

$$W_j = \frac{C_j}{\sum_{k=1}^{m} C_j} \tag{6}$$

Finally, the weight values of the nine main categories were calculated, and by assigning the core categories to the main categories, the weight shares of the three core categories were calculated as UE:0.314,TV:0.318,CI:0.369, as shown in Table 6. Through CRITIC analysis of the categories derived from grounded theory, the weights of the main categories of user satisfaction with short video platforms were determined, helping to ascertain the importance of each evaluation criterion in the overall assessment. Such weight allocation is based on data and analysis, enabling a more accurate reflection of user preferences and priorities, thus enhancing the objectivity and credibility of the evaluation results. This also provides the weight proportions for scoring Chinese mainstream short video platforms later on.

4.2. Satisfaction rating of short video platforms

The CRITIC method calculates the weight ratio of each Main Category and Core Category, and VIKOR can be used to find out the satisfaction evaluation of representative short video platforms in China. The original data of the research is still used in the CRITIC research process, and the user questionnaire plays an important role in obtaining the weights of the main categories that affect users' satisfaction with short video platforms and the satisfaction evaluation of representative platforms. Firstly, the original matrix is normalized, and all indicator types are unified into very large indicators, which are calculated by using formula (7), as shown in.

$$Max(x) - x \tag{7}$$

Second, the matrix is standardized with the aim of eliminating the influence of different indicator scales, assuming that there are n evaluation objects and m evaluation indicators, the matrix x that has completed the forwarding is shown in Table 7, and the results are calculated by applying equation (8) as shown in Table 8 Table 9.

$$Z_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i-1}^{n} X_{ij}^2}} \tag{8}$$

Determine the positive ideal solution and the negative ideal solution as shown in Table 9, where the positive ideal solution consists of the maximum value of each column element and the negative ideal solution consists of the minimum value of each column element. Based on the resulting ideal solution, calculate the group effect value S_i and the individual regret value R_i as shown in Equations 9 and 10, where W_j is the weight ratio of each category derived from the CRITIC method, and Z_{ij} is the normalized value of X_{ij} based on Equation (8).

$$S_i = \sum_{j=1}^{m} \frac{W_j\left(Z_j^+ - Z_{ij}\right)}{\left(Z_j^+ - Z_j^-\right)} \tag{9}$$

$$R_i = Max_i\left(\frac{W_j\left(Z_j^+ - Z_{ij}\right)}{Z_j^+ - Z_j^-}\right) \tag{10}$$

Finally, the compromise value Q_i is calculated, see equation (11). v in the formula is the compromise coefficient, which takes the value of [0,1], and generally takes the value of 0.5, indicating that a balanced approach is taken to consider both the group benefits and individual regrets at the same time. Finally, through the S_i, R_i, Q_i three values of the nine platforms for satisfaction evaluation, in accordance with the Q_i from small to large sorting, get the sorting results as follows: S5,S4 …. .S8, the platform with the smallest value is the highest satisfaction, as shown in Table 10.

$$Q_i = \frac{v(\mathrm{sj} - S^+)}{S^- - S^+} + \frac{(1-v)(R_i - R^+)}{R^+ - R^-} \tag{11}$$

In the test part, if Scheme A1 satisfies the following two evaluation conditions at the same time, then it is the optimal scheme [31].

Condition 1: $Q_2 - Q_1 \geq \frac{1}{n-1}$.

Condition 2: A1 is optimal in at least one of the orders S_i or R_i.

The test shows that S5 satisfies both conditions, indicating that S5 is the best of the nine platforms in terms of user satisfaction.

Table 7
Original evaluation matrix.

x =	x_{11}	x_{12}	… …	x_{1m}
	x_{21}	x_{22}	… …	x_{2m}
	… …	… …	… …	… …
	x_{n1}	x_{n2}	… …	x_{nm}

Table 8
Raw data normalization processing.

	A1	A2	A3	A4	A5	A6	A7	A8	A9
S1	9	6	9	8	9	8	9	8	0
S2	9	6	8	7	6	4	5	6	1
S3	8	6	8	6	7	6	8	9	3
S4	7	5	8	6	7	9	8	8	5
S5	7	8	7	8	7	5	7	7	4
S6	6	5	5	6	5	7	6	6	1
S7	5	5	6	7	4	4	6	7	1
S8	6	6	6	6	6	6	5	5	0

Table 9
Relevant values after standardized calculations.

	A1	A2	A3	A4	A5	A6	A7	A8	A9
S1	0.439	0.357	0.440	0.416	0.487	0.445	0.462	0.398	0.000
S2	0.439	0.357	0.391	0.364	0.325	0.223	0.256	0.299	0.137
S3	0.390	0.357	0.391	0.312	0.379	0.334	0.410	0.448	0.412
S4	0.341	0.297	0.391	0.312	0.379	0.501	0.410	0.398	0.687
S5	0.341	0.476	0.342	0.416	0.379	0.278	0.359	0.348	0.549
S6	0.292	0.297	0.244	0.312	0.271	0.389	0.308	0.299	0.137
S7	0.244	0.297	0.293	0.364	0.217	0.223	0.308	0.348	0.137
S8	0.292	0.357	0.293	0.312	0.325	0.334	0.256	0.249	0.000

Table 10
Ranking of short video platform satisfaction.

	A1	A2	A3	A4	A5	A6	A7	A8	A9	S_i	R_i	Q_i	Sorted
S1	0.000	0.077	0.000	0.000	0.000	0.025	0.000	0.024	0.186	0.311	0.186	0.500	4
S2	0.000	0.077	0.019	0.067	0.036	0.124	0.088	0.071	0.149	0.629	0.149	0.588	5
S3	0.031	0.077	0.019	0.133	0.024	0.074	0.022	0.000	0.074	0.454	0.133	0.331	3
S4	0.062	0.115	0.019	0.133	0.024	0.000	0.022	0.024	0.000	0.398	0.133	0.278	2
S5	0.062	0.000	0.038	0.000	0.024	0.099	0.044	0.047	0.037	0.351	0.099	0.038	1
S6	0.093	0.115	0.075	0.133	0.048	0.050	0.066	0.071	0.149	0.799	0.149	0.749	6
S7	0.124	0.115	0.056	0.067	0.060	0.124	0.066	0.047	0.149	0.808	0.149	0.757	7
S8	0.093	0.077	0.056	0.133	0.036	0.074	0.088	0.094	0.186	0.837	0.186	1.000	8

VIKOR is a multi-criteria decision-making method that helps analyze and address multidimensional and multifactorial issues. In the study, the VIKOR method was utilized to comprehensively assess various evaluation indicators, thereby deriving the comprehensive evaluation results for eight mainstream platforms.

5. Results and discussion

This study initially applied Grounded Theory as the theoretical framework to explore the primary factors influencing user satisfaction in mainstream Chinese short video platforms. Grounded Theory emphasizes understanding the fundamental factors behind user experience deeply. This study delved into users' perceptions, emotions, and behaviors regarding short video platforms, categorizing these factors into three main aspects: user experience, trust and values, and content quality and interaction. Through CRITIC analysis, the study weighted these three factors and found that content quality and interaction had the highest weight ratio of 0.369. This indicates that content quality and interactivity directly impact user viewing experience. High-quality content can attract users and provide valuable, interesting, and inspiring viewing experiences, while interactivity can increase user engagement, making users more involved and enjoying the viewing process [46]. Next, utilizing the factors derived from Grounded Theory that influence user satisfaction, the VIKOR method was employed to investigate and analyze mainstream Chinese short video platforms. This yielded overall satisfaction scores for these platforms, with the S_i、 R_i、 Q_i values for eight platforms distributed as shown in Fig. 3. Smaller values indicate higher satisfaction. Bilibili platform emerged with the highest user satisfaction, indicating its alignment with users' core needs across various categories. However, Bilibili also exhibits shortcomings. Firstly, the platform features relatively fewer commercial advertisements and promotional content, potentially impacting its revenue streams, profitability, and sustainability. Secondly, the platform's content quality and diversity scores are comparatively lower. This is attributed to Bilibili's user-generated content (UGC) focus, resulting in relatively fewer offerings in areas like local news and informational content [47]. In conclusion, it can be said that each platform possesses its unique strengths and characteristics. Platforms need to continually optimize and enhance their competitiveness and service levels. Combining the core influencing factors of user satisfaction identified in this study and their respective sub-factors provides insights into the future development of platforms. The following is a more detailed discussion and analysis of these

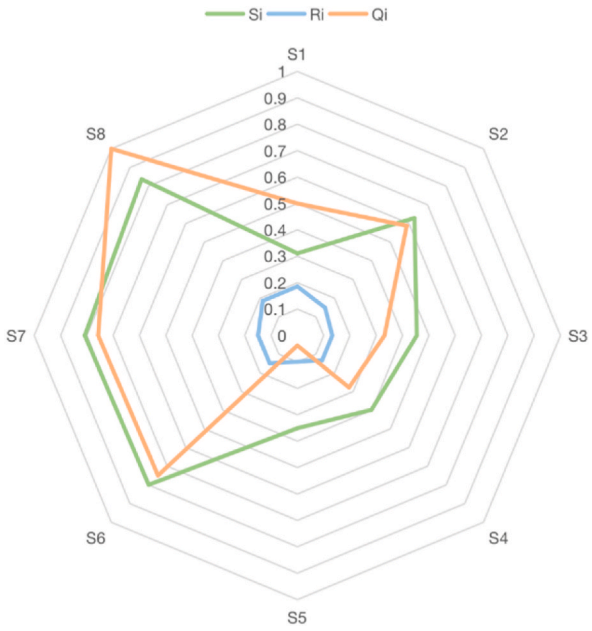

Fig. 3. Values of each indicator for short video platforms.

key factors, aiming to provide constructive suggestions for the development of short video platforms.

In terms of user experience, it encompasses three main categories: interface and interaction design, personalized experience, and platform stability. In terms of weight distribution, interface and interaction design scored the highest. As mentioned by Tidwell J in the study, effective interface and interaction design can fulfill users' habits and psychological needs [48]. Jin Y also proposed the concept that effective interaction feedback mechanisms contribute to improving user satisfaction [49]. Many products are well-known for having this characteristic, for example, products like Apple's iPhone, iPad, MacBook, etc., are renowned for their simple, intuitive, and smooth interface and interaction design [50]. The design styles of its operating systems, iOS and macOS, are widely regarded as epitomes of user experience. This demonstrates that clear and concise interface designs can reduce user learning curves and usage difficulties, while smooth and efficient interaction methods can enhance user operational experiences, meeting their demands for convenience, speed, and intuitiveness [51]. In short video platforms, users can perceive the platform's dedication and professionalism through interaction design, thereby establishing trust and likability towards the platform, promoting user loyalty and satisfaction. Scholar Semerádová T summarized that website interaction design mainly includes six aspects: background, content, community, personalization, communication, and transactions [52]. In order to accurately obtain user demand information, platforms can also gather user feedback and opinions through surveys, user interviews, behavioral analysis, etc., to provide references for interface and interaction design. Research by scholar Zhang M indicates that sequential layout effectively improves user efficiency and satisfaction, while reducing cognitive burden [53]. With the continuous development and innovation of technology, the introduction of new technological means and design concepts, continuous improvement of interface and interaction design, adoption of consistent design elements and layouts, and reducing users' learning curves, enhancing overall user experience, and adhering to the concept of continuous optimization to adapt to changes in user needs and enhance user experience requirements.

Trust and values consist of three main categories: privacy and security, user service and communication, and social impact and values. Among them, the weight ratio of privacy and security is the highest at 0.133, indicating that users are increasingly concerned about the use and protection of their personal information and data on the platform. Bandara R found in the study that for internet users, privacy may psychologically feel distant and may negatively impact their decisions [54]. In other words, the privacy and security factors influence users' trust in the platform, thereby affecting their satisfaction. During the interview process of this study, one user mentioned that while using short video platforms, if they feel that their personal information is effectively protected, they would be more willing to create content, engage in interactions, and recommend the platform to others. Users desire to use short video platforms in a secure and trustworthy environment. Wang's research indicates that privacy concerns on short video platforms consist of three dimensions: collection concern, awareness concern, and use concern [55]. In terms of collection and awareness concern, short video platforms can provide clear privacy policies, which will help users easily access these documents. This will facilitate the establishment of trust with users, thereby positively influencing satisfaction [56]. At the same time, establishing proactive monitoring systems to promptly identify and prevent potential threats such as user data leaks and fraudulent account logins is essential. Effective interaction feedback mechanisms are equally crucial for user satisfaction [57]. In terms of usage concern, platforms conduct regular security vulnerability scans and assessments to promptly address identified vulnerabilities and security risks. Additionally, they establish dedicated complaint channels and customer service teams to promptly address privacy and security issues reported by users, ensuring the protection of user rights.

Content quality and interaction consist of three main categories: diversity of content quality, social interaction, and advertising experience. Among them, the weight value of advertising experience is the highest at 0.186. Advertising is one of the primary sources of revenue for short video platforms and is also a significant factor influencing user satisfaction with the platform. This is because of the large user base of short video platforms, leading advertisers to be willing to pay for advertising placements on these platforms [58]. However, if the advertisements are frequent, highly intrusive, and not aligned with users' interests, users may feel dissatisfied and even choose to leave the platform as a result. Therefore, advertisements to a certain extent impact the user viewing experience. Users are relatively tolerant when the duration of advertisements is moderate; however, when advertisements are excessively long and frequent, the user experience is significantly negatively affected [59]. Li found in the study of new media advertising implantation strategies that short and creative advertisement videos are effective marketing tools [60]. Therefore, incorporating different emotional elements such as humor, warmth, and sentimentality, or combining interactive and suspenseful techniques, makes the advertising content more appealing and engaging [61]. Platforms can provide personalized advertising experiences based on users' interests and preferences. By analyzing users' behavioral data and interest tags through algorithms, platforms can recommend advertising content relevant to users' interests, thereby enhancing the relevance and attractiveness of advertisements. Of course, it is also important to control the duration of advertisements reasonably and provide options for users to skip advertisements, reducing users' aversion to advertisements. Lastly, establishing a good feedback mechanism allows users to express their opinions and suggestions regarding advertisements.

In summary, platforms can enhance user satisfaction, increase user loyalty, and promote sustainable development by further optimizing content quality, improving user experience, and managing advertising placements reasonably. In terms of technological development, with the continuous maturation and popularization of technologies such as artificial intelligence, augmented reality, and virtual reality, short video platforms will face more innovative opportunities and challenges. Short video platforms should always pay attention to the potential impact of technological development, market dynamics, and changes in user behavior on user satisfaction. As user demands and preferences continue to evolve, short video platforms need to continuously adjust their content and services to meet diverse user needs. The research findings provide valuable insights for the management and development of short video platforms, but it is also necessary to acknowledge some limitations. Firstly, this study only covers a portion of users from mainstream Chinese short video platforms and data from specific time periods, which may lead to insufficiently random samples. Therefore, future policy changes, technological trends, etc., may result in significant differences. Secondly, the study is also subject to methodological limitations. Firstly, although the theoretical framework of Grounded Theory involves coding by individual group members followed by discussion and cross-checking to reduce the impact of subjective judgments, some degree of subjective judgment may still exist. Additionally, the calculation process of the CRITIC-VIKOR method is complex, involving multiple steps and indicators for comprehensive evaluation, which requires high computational resources and time costs. This may limit the applicability and practical feasibility of the method for other scholars.

6. Conclusions and outlook

Against the backdrop of prevalent social media and digital entertainment, this study adopts a qualitative approach from the perspective of user satisfaction to investigate mainstream Chinese short video platforms, utilizing Grounded Theory. Through semi-structured interviews, literature review, and considering current societal, cultural, and experiential factors, the relevant theoretical domains are redefined. Consequently, influencing factors are summarized and categorized into three core domains and nine primary categories. Subsequently, the CRITIRC model is employed to determine the weight ratios of each main factor, revealing that user experience (0.314), trust and values (0.318), and content quality and interaction (0.369) are the core factors influencing user satisfaction. The nine categories include interface and interaction design, personalized experience, platform stability and performance, privacy and security, user service and communication, social impact and values, content quality and diversity, social interaction, and advertising experience. Finally, the VIKOR model evaluates user satisfaction with mainstream Chinese short video platforms, with Bilibili receiving the highest overall satisfaction. Quantitative analysis reveals the impact degree of various factors on short video platforms, aiding in better understanding the data structure and relationships, helping designers overcome subjective biases, and objectively improving platforms with higher user satisfaction. The study identifies user interface design, privacy and security, and advertising experience as pivotal factors affecting user satisfaction. Accordingly, recommendations are proposed: introducing new technological means and design concepts to continuously enhance interface and interaction design, ensuring user privacy security from three levels of privacy concerns, and adjusting the advertising placement ratio to provide personalized advertising experiences based on user interests and preferences. Nevertheless, the study is subject to limitations. Firstly, due to limited sample size, further exploration and collation of user demands cannot be achieved. Secondly, the CRITIC-VIKOR model insufficiently considers the interrelationships between some evaluation factors and platform-specific variations. Additionally, user feedback in the survey is often subjective, influenced by personal experiences and emotions. Future research could explore more objective data sources, such as behavioral analysis and eye-tracking methods. Furthermore, with continuous technological advancements, future studies can explore the impact of emerging technologies like artificial intelligence, augmented reality, and virtual reality on user experience and satisfaction with short video platforms, and how to utilize these technologies to enhance service quality. Research on the application effects of artificial intelligence technology in content recommendation and personalized services, as well as innovative applications of augmented reality technology in advertising display and interactive experiences, will help discover and leverage new technologies to enhance the service level and competitive advantages of short video platforms.

Ethical statement

The research has been reviewed and approved by the Faculty Ethics Committee to ensure the ethicalsoundness and safety of the research. In order to ensure the ethicality and safety of the study, the research team began recruiting study participants in September 2023 and completed all questionnaire collection in December 2023. Subjects who agreed to participate in the study completed the appropriate learning tasks and simulation exercises in accordance with the teaching requirements and completed the anonymous questionnaire at the end of the course. Meanwhile, the research team obtained consent from the research subjects and conducted personal interviews.

Data availability statement

The data used to support the findings of this study are all in the manuscript.

CRediT authorship contribution statement

YuZhe Qi: Conceptualization, Data curation, Formal analysis, Investigation, Visualization, Writing – original draft, Writing – review & editing, Methodology, Validation. **JiangYue Han:** Formal analysis, Data curation, Writing – review & editing, Investigation. **XiaoNing Lu:** Visualization, Project administration, Investigation, Data curation, Writing – review & editing. **ZiXiang Wang:** Investigation, Data curation, Writing – review & editing. **HongYan Ren:** Data curation, Resources, Supervision. **Xiang Zhang:** Investigation, Conceptualization, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgement

This study received no funding.

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