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User Requirement Matching Model for Distributed Conferencing Systems in the Post-Epidemic Era

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ABSTRACT

The epidemic (COVID-19) has incredibly released the demand for teleconferencing, creating conditions for developing distributed conferencing systems. However, due to the complexity of distributed conferencing systems, there needs to be more clarity regarding matching product supply with user demand. In addition, the currently adopted product evaluation methods are mostly single-view assessments, which do not fully represent the degree of matching between them and user needs. Therefore, this study will take academic conferences as an example and explore and construct a user-demand matching model for distributed conference systems from the perspective of conference organizers. This model's construction can help decision-makers get feedback on user requirements matching degrees quickly and provide design strategies for product system development and iteration.

Keywords: Distributed conferencing system, User requirements, Matching model, Post-Epidemic Era

INTRODUCTION

The development of information technology has broadened the boundaries of the meeting model, and meetings are no longer limited to face-to-face communication in the same space and time but also include distributed communication, including audio conferencing, video conferencing, and telepresence (Standaert et al. 2021; Yankelovich et al. 2004). The outbreak of the epidemic (COVID-19) in 2020 revolutionized people's lives and also drove the growth of the distributed meeting industry. Today, this trend continues and expands. According to Gartner, by 2024, 75% of the world's meetings will be distributed, up from 40% before the outbreak (Standaert et al. 2021).

From traditional offline meetings to distributed meetings, the mode transformation is behind the continuous updating of meeting needs and gradually reveals users' pain points in the meeting process. For example, although video conferencing can meet the synchronous communication needs of participants in different locations, long-time video conferencing makes participants feel physically and mentally exhausted and increases the communication burden of both parties (Xiao, 2021). The technical performance variability of conferencing hardware makes the audio-visual experience of distributed meetings uneven, and people prefer to have multiple people present in the meeting (Berndtsson et al. 2012). These issues have shown a partial dissonance between conferencing systems and user needs. In conclusion, in product innovation, the matching of user needs of distributed meeting systems needs to be considered and evaluated to achieve a good meeting experience. (Zhang and Wang, 2021)

This paper will be divided into seven parts. In the second part, we review the theories related to distributed conferencing and product and user requirements matching. In the third part, we present the basic overview of the study and the research steps. In the fourth section, we detail the source and definition of the matching degree model. Immediately after that, in Part V, we show the data collection, calculation, and analysis process. In Part VI, we discuss this paper's experimental results and research implications and highlight the research conclusions, limitations, and future research directions in Part VII.

LITERATURE REVIEW

Overview of Distributed Conferencing Systems

Distributed conferencing can be defined as the communication of two or more people in different locations by any means of communication. Distributed conferencing systems provide many features and services for this purpose (Yankelovich et al. 2004) and rapidly iterate under the influence of epidemic normalization. However, there is still a gap between its product supply and user needs. For complex products like this (including intelligent products, apps, web pages, etc.), the interaction experience and the definition of the product itself do not fully match due to the diversity of their practical experiences and the complexity of their usage processes. Moreover, not all users can successfully perceive the value of the services provided by the product due to the differential influence of the participants' comprehension ability, the nature of the meeting, and other factors (Chen et al. 2021). Therefore, unilateral product evaluation or performance indicators do not fully represent the degree of matching, and such evaluation mechanisms should also be based on user perception and demand evaluation (Wang et al. 2022; Zhang, 2018).

Product-User Demand Matching Model

The existing literature on product-user needs matching is divided into two main theoretical perspectives: unilateral and bilateral (Gale and Shapley, 1962). The unilateral perspective refers to researchers who focus on a unilateral perspective from the product side or user side to evaluate existing products or service systems comprehensively and propose corresponding evaluation models and strategic approaches (Du, 2018; Berndtsson et al. 2012; Zhou et al. 2013), or to conduct user-needs-centered (Fu and Li, 2021; Zhang and Wang, 2021; Chi, 2020) to derive the corresponding requirement sets from guiding design practice. The bilateral perspective is to match product evaluation with user requirements effectively. Due to the complexity of distributed conferencing systems, the bilateral matching perspective can effectively evaluate and examine users' subjective feedback on objective attributes of existing conferencing systems (Berndtsson et al. 2012). Therefore, it is vital to explore the user requirement matching model with a complete perspective for the future development of distributed conferencing systems.

METHODOLOGY

Research Subjects and Data Sources

In this paper, we will take academic conferences as an example and explore the user requirements matching mainstream conference systems at home and abroad from the perspective of conference organizers. The data for this study comes from two primary sources: first, the user needs to be collected and summarized through online voice interviews; second, quantifiable data collected through an online questionnaire based on preliminary interview findings. Based on the principle of information saturation, a total of seven users participated in the interviews, their ages ranged from 25–40 years old, and they had different professional identities (including associate professor, doctoral student, researcher, etc.). All interviewees had experience in using distributed meeting systems to organize or participate in academic conferences. A total of 266 questionnaires were collected, and the actual number of valid questionnaires was 163 (including 105 females and 58 males) based on time to fill out and consistency and regularity of response scores. The vast majority (about 93%) of the participants were between 18 and 40, covering different professional identities (about 66% were students or teachers, while the rest included technical developers, managers, professionals, etc.).

Research Steps

Given the advantages of the Grey Relation Analysis(GRA) in evaluating objectivity and the strengths of the Coupling Coordination Analysis(CCA) in analyzing the matching degree of things, this paper will combine the above two methods (Zhang et al. 2020; Hao, 2016) to quantify the user demand matching degree of distributed meeting systems. The specific research steps are shown in Table 1.

EVALUATION INDEX SYSTEM CONSTRUCTION

Distributed Meeting System Product Evaluation Index

A combination of literature research, general generalization, and screening construct the product evaluation index system of the distributed conference system. Furthermore, considering the quantitative balance among the indicators on the product side and the difficulty of setting up the questionnaire at the later stage, it was finally summarized into three primary indicators (A) and 16 secondary indicators (a), as shown in Table 2.

Table 1. Study steps and methods.

Stage	Research methodology	Specific content
Determine metrics	Literature Research General Induction Qualitative Interview	Form product evaluation index system and user requirements index system.
Data acquisition	Quantitative Questionnaire	Obtain product evaluation satisfaction score and user demand importance score.
Data calculation	Entropy Weighting Method	Determine the weights of each index for product evaluation and user needs.
	Grey Relation Analysis	Derive the grey rational degree of each conferencing system and analyze it.
	Coupling Coordination Analysis	Derive the coupling coordination degree of each conferencing system and analyze it.

Table 2. Distributed meeting system product evaluation index system.

Primary Indicators (A)	No.	Secondary indicators (a)	References
Presenting Effect A1	a1	Dynamic display effect	Berndtsson et al. 2012; Zhou et al. 2013; LeRouge et al. 2002; Vucic and Skorin-Kapov, 2015
	a2	Static display effect	Berndtsson et al. 2012; Zhou et al. 2013; LeRouge et al. 2002
	a3	Sound effects	Berndtsson et al. 2012; Zhou et al. 2013; LeRouge et al. 2002
	a4	Interface aesthetics	Kong et al. 2019; LeRouge et al. 2002
Technology Performance A2	a5	Operational reliability	Du, 2018; Li, 2014; Zhou et al. 2013; LeRouge et al. 2002; Vucic and Skorin-Kapov, 2015
	a6	Interoperability	LeRouge et al. 2002; Vucic and Skorin-Kapov, 2015
	a7	Security	Kong et al. 2019; LeRouge et al. 2002
	a8	Load force	Du, 2018; Li, 2014; Kong et al. 2019
	a9	Synchronization	Berndtsson et al. 2012; Li, 2014; LeRouge et al. 2002
Function Using A3	a10	Ease of use	LeRouge et al. 2002; Townsend et al. 2001; Khalid and Hossan, 2016
	a11	Convenience	Kong et al. 2019; LeRouge et al. 2002; Vucic and Skorin-Kapov, 2015
	a12	Practicality	Kong et al. 2019; LeRouge et al. 2002; Townsend et al. 2001; Khalid and Hossan, 2016
	a13	Integrity	CSUQ, 1995
	a14	Comprehensibility	CSUQ, 1995
	a15	Reasonableness	Vucic and Skorin-Kapov, 2015
	a16	Controllability	Li, 2014; Khalid and Hossan, 2016

Distributed Meeting System User Requirements Evaluation Index

The distributed conference system user requirement evaluation index system was constructed from literature research and qualitative interviews. Also,

Table 3. Distributed meeting system user requirements index system.

Primary indicators (B)	No.	Secondary indicators (b)	References
Experiential Demand B1	b1	Multimodal participation experience	Berndtsson et al. 2012; Interviews
	b2	Visual quality	Li, 2014; Zhou et al. 2013; Interviews
	b3	Sound quality	Li, 2014; Zhou et al. 2013; Interviews
	b4	Sense of reality	Interviews
	b5	Communication atmosphere	Berndtsson et al. 2012; Interviews
	b6	Communication effectiveness	Interviews
Technical Demand B2	b7	System reliability	Li, 2014; Interviews
	b8	Network Signal	Li, 2014; Zhou et al. 2013; Interviews
	b9	Confidentiality	Interviews
Functionality Demand B3	b10	Immediate feedback visibility	Interviews
	b11	Fun	Interviews
	b12	Adaptability	Interviews
	b13	Fault Tolerance	Interviews
	b14	Controllability	Interviews; Li, 2014; Khalid and Hossan, 2016
	b15	Ease of use	Interviews; LeRouge et al. 2002; Townsend et al. 2001; Khalid and Hossan, 2016
	b16	Programmatic	Interviews

considering the balance of quantity among the indicators on the demand side and facilitating data statistics and calculations at a later stage, it was finally determined as three primary indicators (B) and 16 secondary indicators (b), matching the number of indicators on the product side, as shown in Table 3. After the indicator system's construction, the indicators' names and definitions were adjusted and improved by professionals' evaluation and suggestions.

DATA ANALYSIS AND DISCOVERY

Data Calculation and Analysis

Conference system evaluation feedback is collected utilizing subjective satisfaction scoring (extremely dissatisfied - extremely satisfied), and user demand feedback is collected utilizing subjective importance scoring (extremely unimportant - essential). Taking into account the influence of the level setting on the calculation results, the final questionnaire is issued in the form of a ten-point Likert scale and combined with personal information, participation, and other fundamental questions. (The amount of data in some meeting systems is too small for statistical purposes, so the data analysis and conclusions later take Tencent Meeting, Ding Talk, and ZOOM meeting systems as examples)

According to the scores of each index, the collected data were analyzed using SPSS (Statistical Package for Social Sciences). Firstly, the entropy weight method was used to determine the weight of each indicator. Secondly, the total grey rational degree of the three meeting systems and the grey rational degree of each level indicator was measured by the GRA, and then the final grey rational degree was obtained by weighting and summing, as shown in Table 4. The larger the value is, the stronger the correlation with the parent series (composite score), which means the higher the rating. As we can see, the total grey rational degree of product evaluation after weighted summation is from highest to lowest: Tencent Meeting (0.82887), ZOOM (0.77984), and Ding Talk (0.77164), and the total grey rational degree of user demand is also ranked in the same order. In the grey rational degree of product evaluation level 1 index (A1-A3), Tencent Meeting still maintains the leading position. Compared with Ding Talk, ZOOM scores lower in presentation effect. Regarding the grey rational degree of user requirements (B1-B3), Tencent Meeting, ZOOM, and Ding Talk continue to lead from the highest to the lowest.

Matching Results Display

The above calculation can only highlight the comprehensive evaluation and score from a unilateral perspective. In order to better understand whether the product evaluations of distributed conferencing systems and user needs match, a final step is required in this study. The coupling coordination degree (D-value) is calculated using the standardized grey rational degree between product evaluation and user needs, and the above three meeting systems and their first-level indicators are ranked separately. The degree of matching is

Table 4. GRA results for distributed meeting systems.

Conference System	Total grey rational degree of product evaluation	Total grey rational degree of user needs	Grey rational degree of each level of product evaluation indicators (A1-A3)	Grey rational degree of each level of user demand indicators (B1-B3)
Tencent Meeting	0.82887	0.83065	0.814	0.823
			0.812	0.845
			0.845	0.830
ZOOM	0.77984	0.77975	0.735	0.771
			0.778	0.793
			0.798	0.777
Ding Talk	0.77164	0.76592	0.789	0.763
			0.768	0.761
			0.767	0.769

Note: The total grey rational degree is retained to five decimal places due to the slight difference in values compared according to the results, as shown in Tables 5 and 6. In this paper, the D-values are divided by referring to the decile interval method (Liao, 1999), and 0–1 is divided into ten intervals on average.

From the total matching results, Tencent Meeting is significantly higher than ZOOM and Ding Talk, and its product evaluation and user needs have the highest matching degree, which is at the level of quality matching. In terms of the matching degree of the first-level indicators, Tencent Meeting still maintains a high level of matching. At the same time, ZOOM, as a similar competitor to Tencent Meeting, has the lowest matching degree in terms of presentation effect and experiential demand (A1-B1), and the remaining two dimensions maintain a high level of coordination. Due to its product positioning and nature, Ding Talk is at a lower matching level in all indicators.

Table 5. Results of user requirements matching for distributed conferencing systems.

Conference System	Coupling degree (C- value)	Coordination (T-value)	Coupling coordination (D-value)	Matching level	Matching degree
Tencent Meeting	1.000	0.990	0.995	10	Quality Match
ZOOM	0.982	0.185	0.426	5	Close match
Ding Talk	1.000	0.010	0.100	2	Serious mismatch

Table 6. Results of user requirement matching for primary indicators.

Conference System	No.	Coupling degree (C-value)	Coordination (T-value)	Coupling coordination (D-value)	Matching level	Matching degree
Tencent Meeting	A1-B1	1.000	0.725	0.851	9	Good Match
	A2-B2	0.985	0.846	0.913	10	Quality Match
	A3-B3	0.995	0.903	0.948	10	Quality Match
ZOOM	A1-B1	0.528	0.066	0.187	2	Serious mismatch
	A2-B2	1.000	0.389	0.624	7	Primary Matching
	A3-B3	0.873	0.385	0.580	6	barely match
Ding Talk	A1-B1	0.455	0.260	0.344	4	Mild mismatch
	A2-B2	0.350	0.158	0.235	3	Moderate mismatch
	A3-B3	0.872	0.196	0.413	5	Close match

DISCUSSION

Focusing on product evaluation or data calculation from a unilateral perspective, especially when analyzing a complex product like a distributed meeting system, may make the results biased. In this paper, we explore the relationship between product evaluation and user requirement matching from a bilateral perspective and aim to find a more comprehensive evaluation model for distributed meeting systems through qualitative and quantitative research. In the process of data processing, we have the following findings.

First, the meeting system with the highest satisfaction level is not necessarily the highest in user requirement matching. According to the preliminary scores after data collection, the highest to lowest order is Ding Talk (7.419), ZOOM (7.220), and Tencent Meeting (6.965). After the GRA and the CCA, the ranking of the three meeting systems was switched, and the highest matching degree was Tencent Meeting. Although the functions of Ding Talk are powerful, the overly elaborate design in academic meetings will instead make users feel confused or bewildered. Moreover, from the perspective of product positioning, Ding Talk is more suitable for internal corporate communication. As a local meeting system, Tencent Meeting is similar to ZOOM in terms of presentation effect, technical performance, or functional experience, but it is better than the other in terms of user scale, promotion and dissemination, and economic burden.

Second, in academic conferences, users are still more concerned about indicators such as sound quality, controllability, immediate visibility of feedback, especially network signal and system reliability. Although the interviewees have mentioned several times in the interviews about the multimodal participation experience or the need for authenticity and presence in the conference, we were able to find low scores in the follow-up questionnaire for the indicators of fun (6.773), multimodal participation experience (7.110), and authenticity (7.221).

Finally, from the interviews, we uncovered some neglected details. Some respondents would like a more interactive sense of scholarly communication, e.g., politely interrupting each other and joining in heated discussions more comfortably. Other respondents mentioned that long listening to the lectures at the academic conference might lead to inattentiveness and the possibility of having real-time content captioning. Although the matching metric model is a more objective and intuitive way to evaluate, talking directly with users can help us to obtain more in-depth value.

CONCLUSION

In this paper, a quantitative model of user demand matching is constructed by collecting the product satisfaction and demand importance of each distributed meeting system and combining the GRA and the CCA. Moreover, taking academic conferences as an example, three mainstream meeting systems at home and abroad are calculated and evaluated, and a primary reason analysis is conducted. The study's conclusion shows that in the evaluation method of distributed conference systems, the degree of matching between product supply capability and user demand needs to be considered, and the evaluation results from a unilateral perspective are not entirely accurate. The construction of the model helps decision-makers clarify the matching relationship between the product supply side and the demand side and provides development directions for the iteration of distributed meeting systems.

Although most of the research in this study adopts the method of targeted questioning and targeted questionnaire distribution, there are still many shortcomings and areas for improvement due to the realistic conditions. For example, increasing the sample size and diversity including combined hardware and software conferencing systems). At the same time, the categories and classification of evaluation indicators are still open to discussion if hardware and software combined conferencing systems are involved. In addition, the follow-up study should also consider the bias effects of factors such as geographic scope, user size, and the number of measured samples on the results.

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