Service Quality in Cloud Gaming: Instrument Development and Validation

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Abstract

Purpose - The global market for cloud gaming is growing rapidly. How gamers evaluate the service quality of this emerging form of cloud service has become a critical issue for both researchers and practitioners. Building on the literature on service quality and software as a service, this study develops and validates a gamer-centric measurement instrument for cloud gaming service quality.

Design/methodology/approach - A three-step measurement instrument development process, including item generation, scale development, and instrument testing, was adopted to conceptualize and operationalize cloud gaming service quality.

Findings - Cloud gaming service quality consists of two second-order constructs of support service quality and technical service quality with seven first-order dimensions, namely rapport, responsiveness, reliability, compatibility, ubiquity, smoothness, and comprehensiveness. The instrument exhibits desirable psychometric properties.

Practical implications - Practitioners can use this new measurement instrument to evaluate gamers' perceptions toward their service and to identify areas for improvement.

Originality/value - This study contributes to the service quality literature by utilizing qualitative and quantitative approaches to develop and validate a new measurement instrument of service quality in the context of cloud gaming and by identifying new dimensions (compatibility, ubiquity, smoothness, and comprehensiveness) specific to it.

Keywords: cloud gaming, software as a service, service quality, SERVQUAL, instrument development, scale development

1. Introduction

Cloud gaming, also known as gaming on demand or gaming as a service, is a new gaming mode that runs games on cloud servers. It allows sophisticated and large-scale games to be played on thin clients (Hong *et al.*, 2015). Cloud gaming has become an emerging gaming trend with a growing market size. It is expected to reach US $6.3 billion at a compound growth rate of 75.05% in 2024 (Newzoo, 2022), exerting a formidable force to replace conventional video gaming. The prospect of such an emerging cloud service has drawn the attention of not only incumbents such as NVIDIA and Microsoft but also new entrants such as Shadow and Vortex (De Giovanni *et al.*, 2022).

While cloud gaming can overcome major bottlenecks in a typical gaming journey, such as stringent hardware requirements for playing graphics-intensive and sophisticated games, it is not exempt from constraints. For instance, response latency has been recognized as one of the biggest challenges in cloud gaming service provision, especially in video games featuring high degrees of synchronous interaction (e.g., Shea *et al.*, 2013, Shirmohammadi *et al.*, 2015). In addition, developers have strived to achieve smooth video streaming to provide exceptional gaming experiences (e.g., Xu *et al.*, 2018, Zhang *et al.*, 2015). It is, therefore, critical for cloud gaming operators to understand the salient attributes contributing to the overall evaluation of cloud gaming service quality to retain cloud gamers.

Research on service quality has gained prominence over the past decades. Context-specific measurement instruments have been advocated and developed to capture the unique dimensions that manifest service quality in their respective contexts (Benlian *et al.*, 2011, Gefen, 2002, Parasuraman *et al.*, 1991), such as e-government (Nishant *et al.*, 2019), e-commerce (Kao *et al.*, 2020, Shi *et al.*, 2018, Suryani *et al.*, 2022), online healthcare (Gao *et al.*, 2022), cloud computing (Chou and Chiang, 2013), air transport (Mahapatra and Bellamkonda, 2023), artificial intelligence (Noor *et al.*, 2022, Prentice and Nguyen, 2021), and education (Goumairi *et al.*, 2020).

Although there are service quality measurement instruments available for evaluating cloud computing services (e.g., SaaS-Qual), the unique characteristics of cloud gaming, including real-time interaction, high frame rates, low latency requirements, and diverse gaming requirements (Carrascosa and Bellalta, 2022, Laghari *et al.*, 2019, Zhang *et al.*, 2019), present unique challenges in assessing service quality within this emerging context (Carrascosa and Bellalta, 2022). Existing service quality scales in the realms of cloud computing and SaaS are insufficient to encompass the above unique dimensions of cloud gaming and capture its service quality. To the best of our knowledge, there exists no gamer-centric measurement instrument to capture gamers' evaluation of cloud gaming service quality and the attributes that hold significance to them. A rigorously developed and gamer-centric measurement instrument of cloud gaming service quality is imperative to advance the service quality literature and provide practitioners with insights into service improvement.

Against this backdrop, this study aims to systematically develop and validate a measurement instrument of service quality in the context of cloud gaming and demonstrate its nomological validity by testing how it affects gamers' continuance intention. Specifically, this study addresses the following two research questions: (1) What are the key dimensions of cloud gaming service quality? and (2) Does cloud gaming service quality influence gamers' continuance intention?

The newly developed cloud gaming service quality instrument exhibits adequate psychometric properties in terms of reliability, convergent validity, discriminant validity, and nomological validity. Accordingly, our study makes key contributions to both research and practice. On the research ground, we revealed two aspects of cloud gaming service quality: support service quality and technical service quality, and identified their corresponding dimensions, advancing our theoretical understanding of service quality in the context of cloud gaming. Furthermore, we tested the nomological network of cloud gaming service quality and revealed its effects on gamers' satisfaction, enjoyment, and continuance intention to use cloud gaming services. On the practical ground, cloud gaming operators can use this new measurement instrument to evaluate gamers' perception toward their services and to identify areas for improvement, thereby providing targeted recommendations for service enhancement. Moreover, by understanding gamers' evaluations of different service quality dimensions, cloud gaming operators can use resources more effectively to address areas that negatively impact cloud gaming experience and satisfaction.

The subsequent sections are structured as follows. In the next section, we leverage prior research on service quality from marketing and information systems literature, along with insights from cloud gaming research, to establish the theoretical foundation of this study and elucidate the necessity for a dedicated service quality measurement tool tailored to the context of cloud gaming. Then, we delve into the development and validation of the service quality measurement tool specifically designed for cloud gaming. Finally, we discuss the findings, highlight the implications for research and practice, and acknowledge the limitations, and propose potential avenues for future research.

2. Literature Review

2.1. Research on Service Quality

Service quality is intricately shaped by the interactions between the customers and the service organizations (Lehtinen and Lehtinen, 1982). Service quality is different from general commodity quality, as customers' perception of commodity quality is often undifferentiated due to its standardized specifications and uniform quality. On the contrary, the service quality concept is fluid and contingent on the specific types of services being provided as well as the particular customer groups being served (Crosby and Free, 1979). The complex nature of service quality underscores the importance of continuously developing service quality instruments tailored to emerging service contexts.

Early studies have identified broadly three dimensions of service quality, including material, facility, and personnel (Earl Jr *et al.*, 1978). Later, these three dimensions were consolidated into two, comprising technical quality (which pertains to the actual content or output of the service provided to the customer) and functional quality (which encompasses how the service is delivered) (Grönroos, 1978). In their seminal work, Parasuraman *et al.* (1988) developed a 22-item measurement instrument called SERVQUAL to evaluate customers' views on service and service quality in the context of retail organizations. The tool has laid a robust theoretical foundation for the subsequent studies of service quality. It consists of five dimensions (Parasuraman *et al.*, 1985), including *Tangibles,* which refers to physical facilities, equipment, and appearance of personnel; *Reliability,* which refers to ability to perform the promised service dependably and accurately; *Responsiveness,* which refers to willingness to help customers and provide prompt service; *Assurance,* which refers to knowledge and courtesy of employees and their ability to inspire trust and confidence; and, *Empathy,* which refers to caring, individualized attention the firm provides to its customers.

2.2. Research on e-Service Quality and Cloud Gaming

With the advancement of information technologies, digital services have become more prevalent in the past decade (Corkindale *et al.*, 2019). The study of service quality across digital contexts has received increasing scholarly attention in the information systems (IS) discipline (Saha and Mukherjee, 2022, Tabaeeian *et al.*, 2023, Tam *et al.*, 2020, Wahid and Afifah, 2023).

IS practitioners have expanded their roles beyond being solely developers and managers of information systems and technologies, assuming the role of service providers (Pitt *et al.*, 1995). The introduction of the concept of "service quality" into the field has enabled partitioners to better understand the needs and expectations of their users. This, in turn, allows them to better cater to the requirements of their user base. The SERVQUAL instrument has offered a solid foundation to further the understanding of service quality in online contexts. There are, however, fundamental differences between offline and online service provision and thus the evaluation of service quality (Grover *et al.*, 1996, Jiang *et al.*, 2002, Watson *et al.*, 1998). For instance, Van Dyke *et al.* (1997) questioned the interpretation and operation of SERVQUAL expectation structure, reliability, and validity in e-services.

In light of such need for continuous development and adaptation of service quality instruments, IS researchers have developed new instruments to capture service quality across a wide array of online services. For example, Gefen (2002) built on the conceptualization of SERVQUAL and developed an online service quality scale consisting of three dimensions:

tangibles, empathy, and a combined dimension of responsiveness, reliability, and assurance. Benlian *et al.* (2011) built upon the conceptualization of SERVQUAL and proposed six dimensions of service quality in the context of software as a service: rapport, responsiveness, reliability, flexibility, features, and security. In the same vein, different context-specific measurement instruments for e-service quality have been developed and validated across digital service contexts, including website (e.g., Nishant *et al.*, 2019, Tan *et al.*, 2013), AI service (Chen *et al.*, 2022, Noor *et al.*, 2022, Prentice and Nguyen, 2021), cloud computing (e.g., Benlian *et al.*, 2011, Chou and Chiang, 2013), e-commerce (e.g., Barfar *et al.*, 2017, Hsieh *et al.*, 2012), and mobile communication (e.g., Kim and Park, 2012, Zhao *et al.*, 2012).

Furthermore, there have been measurement instruments developed and validated specifically and purposively to capture service quality across cloud computing service contexts, including infrastructure as a service (IaaS) (Taghavi *et al.*, 2020), platform as a service (PaaS) (Hu and Zhang, 2013), and software as a service (SaaS) (Mell and Grance, 2011, Ojala and Tyrvainen, 2011), which are all utilitarian in nature. IaaS provides users with access to infrastructure and alternative computing resources in the cloud; PaaS provides users with a cloud-based environment for building and delivering applications; and SaaS delivers software and applications to users through the cloud (Mohammed and Zeebaree, 2021). Specifically, these three service models encompass distinct functionalities tailored to various utilitarian environments and requirements. IaaS focuses on the bottom layer services, providing users with the cloud computing infrastructure and enabling them to deploy and execute any desired software. PaaS offers a higher-level service layer, granting users direct access and control over applications without the need to manage and oversee the bottom layer of cloud computing infrastructure. SaaS, which represents the highest service layer, allows users to directly utilize cloud computing services through lightweight clients, without necessitating the management of any hardware or software.

Cloud gaming, also known as gaming as a service (GaaS) (Cai *et al.*, 2014), is most akin to SaaS. Cloud gaming delivers gaming services as the form of software service, allowing users to play games and interact with others using thin devices and through the cloud (Hong *et al.*, 2015, Hossain *et al.*, 2015, Li *et al.*, 2015, Shea *et al.*, 2013). However, cloud gaming services differ from traditional SaaS offerings as they primarily cater to users' hedonic needs rather than utilitarian needs. As a result, users may evaluate the service quality of cloud gaming differently than those of its utilitarian counterparts.

The distinction in evaluation arises not only from the contrasting hedonic and utilitarian purposes but also from the unique delivery models and technical requirements associated with cloud gaming services. These requirements include real-time high-definition video streaming, low-latency interaction, and compatibility with thin client devices (Carrascosa and Bellalta, 2022, Laghari *et al.*, 2019, Zhang *et al.*, 2019). In contrast, traditional SaaS services typically involve providing software functionality through a web browser, prioritizing data processing, storage, data security, privacy, and seamless integration with other software tools (Sharma *et al.*, 2020, Xiao *et al.*, 2020, Yang *et al.*, 2020). Appendix A summarizes existing measurement instruments of e-service quality and discusses their applicability in the cloud gaming context.

These differences in delivery models and requirements make a dedicated measurement instrument for assessing the service quality of cloud gaming essential. Therefore, developing a specific service quality measurement instrument for cloud gaming, accurately reflecting gamers' expectations and satisfaction, will aid cloud gaming service providers in better understanding gamer needs and optimizing their services.

3. Instrument Development Process

Following the systematic and rigorous approach of instrument development advocated in the IS literature (Boudreau *et al.*, 2001, Moore and Benbasat, 1991, Segars, 1997), we developed the measurement instrument of cloud gaming service quality in three steps, including dimension identification and item generation, scale development, and instrument testing. This approach has been widely adopted by IS researchers and enabled the development of measurement instruments with desirable psychometric properties (Moore and Benbasat, 1991, Lee *et al.*, 2015, Cheung *et al.*, 2021). Figure 1 depicts the overview of the process.

<<< INSERT FIGURE 1 HERE >>>

3.1. Dimension Identification and Item Generation

The first step of the instrument development process identifies and consolidates potential dimensions of the cloud gaming service quality construct and generates the initial pool of candidate items for the dimensions. These were accomplished through a comprehensive literature review of related studies and interviews with gamers of cloud gaming services. We first reviewed prior studies on service quality, e-service quality, cloud computing, and cloud gaming. We also reviewed practitioner-oriented publications and examined the contents of emerging cloud gaming services to ensure that no potential dimensions were overlooked. The measurement instrument of service quality in software as a service (SaaS-Qual) developed by Benlian *et al.* (2011) is most akin to our study on developing a new service quality measurement for cloud gaming. Therefore, when reviewing the concerning literature, we referred primarily to the SaaS-Qual scale and the cloud computing and cloud services literature for identifying and classifying dimensions that are most relevant to the cloud gaming service context.

Cloud gaming service quality can be assessed largely from two different aspects, support service quality and technical service quality. The former focuses on the quality of support services offered to gamers by service providers and the interactions between them; the latter focuses on the quality of the technological application services delivered to gamers by the cloud gaming platforms (Watty, 2019). In other words, support service quality is human-facing whereas technical service quality is technology-facing. During the provision of cloud gaming services, gamers typically encounter interactions with both the supporting staff and the cloud gaming platform itself. For example, similar to traditional physical and online services, there are human-facing aspects of cloud gaming services in which staff are needed to offer effective customer support and problem-solving services to ensure gamers can fully utilize their cloud gaming services.

Additionally, the technical aspects of cloud gaming, such as the compatibility between platforms and client devices, exert direct impacts on gaming experiences (Cai *et al.*, 2015, Hong *et al.*, 2015, Nan *et al.*, 2016). Such a configuration of a two-factor structure of the cloud gaming service quality construct is not only meaningful and appropriate but also helps gamers and cloud gaming service operators and developers to systematically evaluate the services from different perspectives (Howell *et al.*, 2020).

Established dimensions of e-service quality and SaaS-Qual scales related to support service quality, namely rapport, responsiveness, and reliability, were adopted to form the beginning set of dimensions. The existing literature on cloud gaming and the examination of emerging cloud gaming services have suggested new dimensions capturing the technical service quality, including compatibility, ubiquity, smoothness, and comprehensiveness, that tap into the characteristics of cloud gaming services (Cai *et al.*, 2015, Di Domenico *et al.*, 2021, Nan *et al.*, 2016, Tian *et al.*, 2015, Wu *et al.*, 2017, Zhang *et al.*, 2019). Therefore, we extended the flexibility and features dimensions in the SaaS-Qual scale and replaced them with the four dimensions of technical service quality identified above to capture the characteristics of cloud gaming services. Security was a generic but salient dimension in many existing e-service quality scales and was thus kept in the beginning set. In total, there were eight proposed dimensions of cloud gaming service quality to be further evaluated.

Next, we conducted semi-structured interviews to evaluate the beginning set of dimensions. Semi-structured interviews were conducted with 30 cloud gamers. A majority of the respondents (83%) were male, and a significant portion (73%) were aged between 18 and 29, with the remainder aged 30 or above. Respondents are required to have had at least two months experience of using cloud gaming services to provide insights into the salient attributes of cloud gaming service quality. Specifically, the semi-structured interviews helped consolidate overlapping dimensions, screening out inadequate and irrelevant dimensions, and identifying additional dimensions not covered in the existing literature to capture the breadth and depth of cloud gaming service quality dimensions.

As the results of the semi-structured interviews, rapport, reliability, and responsiveness were kept because they were consistently highlighted by the majority of respondents as important dimensions for evaluating the support service quality of cloud gaming services. Considering the proposed dimensions under technical service quality, smoothness was highlighted by the majority as the most important dimension, followed by and in the order of importance, compatibility, ubiquity, and comprehensiveness. However, less than one-third of respondents considered security to be an important dimension and it was thus removed from the subsequent instrument development. Two additional dimensions, namely community and personalization, were mentioned by less than one-third of the respondents and were thus not considered salient dimensions to be included. In sum, seven dimensions, including rapport, responsiveness, reliability, compatibility, ubiquity, smoothness, and comprehensiveness were retained for subsequent instrument development. Table 1 summarizes the definitions of these seven dimensions. Appendix B presents the mapping of these dimension definitions against those from service quality scales in the literature.

<<< INSERT TABLE 1 HERE >>>

These seven dimensions provided the basis for generating candidate items of cloud gaming service quality. Measurement items from existing instruments of service quality and e-service quality that have been empirically tested and validated were considered and adapted primarily whenever appropriate. We conducted a comprehensive and iterative literature review to identify existing service quality and e-service quality instruments and to generate the initial pool with 79 items of candidate items for the seven dimensions. Multiple items were generated for each dimension (Allen and Yen, 2001). We then evaluated the item pool to eliminate seemingly redundant and overlapping candidate items. This culling process resulted in a total of 43 items for the seven dimensions as summarized in Table 2.

<<< INSERT TABLE 2 HERE >>>

3.2. Scale Development

The scale development stage aims to assess the construct validity of the instrument being developed and to identify the ambiguous items (Moore and Benbasat, 1991). We invited panels of judges to evaluate the candidate items and sort them into potential dimensions (Moore and Benbasat, 1991). The panel members either held Ph.D. degrees, were pursuing Ph.D. studies, or were gamers of cloud gaming services.

3.2.1. Card sorting procedures

We conducted two rounds of card sorting. Different judges were used for each round of card sorting. Before the card sorting exercise, we provided the judges with a standard set of instructions. These instructions, designed to guide the sorting process, included details on how to interpret the definitions of the proposed dimensions, how to assign each item to the appropriate dimension, and how to handle items that could be considered ambiguous. To ensure the comprehensiveness and understandability of these instructions, we previously had them reviewed and refined by a separate judge who was not part of the sorting exercise. To further ensure clarity of the procedure, we encouraged the judges to ask any questions about the instructions or the sorting process, and we addressed their queries promptly. In each round of card sorting, six judges were given the definitions of the seven proposed dimensions of cloud gaming service quality and were asked to carefully read each item and sort it to its corresponding dimension. Each item could be sorted into only one dimension. Items that were considered ambiguous could be placed in the unclassifiable category. Judges were invited to provide additional feedback to improve the items after the card sorting procedures.

3.2.2. Inter-rater reliabilities

The reliability of card sorting procedures was assessed using two metrics, Cohen’s Kappa and item placement ratios. First, Cohen’s Kappa assesses the agreement between two raters. Although there are no golden rules of thumb on the required scores for Cohen’s Kappa (Moore and Benbasat, 1991), values higher than 0.6 are considered to be desirable (Fleiss and Cohen, 1973, Todd and Benbasat, 1991). Besides, item placement ratios assess the reliability of the classification scheme and the validity of the items. Item placement ratios demonstrate the overall frequency with which all of the judges placed the items into the intended dimensions. The higher the percentage of items placed in the intended dimension, the higher the degree of inter-judge agreement across the panel (Moore and Benbasat, 1991). Similarly, there are no established standards for determining good levels of item placement ratios while higher item placement ratios are typically considered to be better.

In the first round of card sorting, six judges were invited to sort the candidate items into seven dimensions of cloud gaming service quality based on the definitions given (Moore and Benbasat, 1991). The results showed a generally high degree of agreement among judges with Cohen’s Kappa ranging between 0.70 and 0.86 and averaging 0.77 (see Table 3), indicating high levels of agreement among raters (Fleiss and Cohen, 1973). The average placement ratio of items within the target dimensions was 87%, indicating that the items were generally sorted into their intended dimensions (see Table 4). Following the card sorting results and the feedback from judges, two items for *rapport* were dropped and one item was dropped from *responsiveness, reliability,* and *compatibility* each. Besides, one item was dropped, and one item was revised from *ubiquity*. As a result, 37 items thus remained for the second round of card sorting.

In the second round of card sorting, another six new judges were invited to sort the remaining items based on the definitions provided. The results revealed further improvements to both the degrees of agreement among judges and the item placement ratios. The Cohen's Kappa ranged between 0.92 and 0.99 (see Table 3). The average placement ratio of items within the target dimensions was 97.5% and each item placement ratio was equal to or greater than 92% (see Table 5). The results indicated that the candidate items were largely sorted into the intended dimensions of cloud gaming service quality. One item from *compatibility* and *uniquity* each was revised based on the feedback from judges. No item was dropped, leaving 37 items for the subsequent instrument testing. We concluded that the development process had resulted in an instrument that demonstrated construct validity and had a high potential for good reliability.

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<<< INSERT TABLE 4 HERE >>>

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3.3. Instrument Testing

We collected data from two countries, China and the United States. These two countries represent the two largest markets of cloud gaming services. We employed a forward-backward translation to ensure semantic equivalence between the two language versions (Beaton *et al.*, 2000, Mokhtarinia *et al.*, 2020).

3.3.1. Pilot test

A pilot test using a self-administered online survey was conducted to ensure that the mechanics of compiling the questionnaire were adequate, by having respondents first complete the questionnaire, and then comment on its length, wording, and instruction. Data were collected from 50 gamers of cloud gaming services. Incentives were offered to compensate for the time of the respondents.

Cronbach's alphas and the item-total correlation were calculated to assess the reliability of the instrument. The reliability met the conventional standard of internal consistency, with Cronbach's alphas for all of the dimensions ranging between 0.90 and 0.95 and exceeding the recommended level of 0.7. The questionnaire was then refined based on the results and feedback.

3.3.2. Field test

The refined online questionnaire was then distributed to cloud gamers for the field test. An online data collection service was used. Incentives were administered by the data collection firm to compensate for the time of respondents. A total of 1042 respondents attempted the online survey, and 269 complete and valid responses were collected, giving a response rate of 25.82%. Of these respondents, 68.77% were male. More than 88% of the respondents were young adults, aged between 18 and 45.

3.3.3. Confirmatory factor analysis

Given the theory-driven approach used for the development of the measurement instrument, we used confirmatory factor analysis (CFA) to validate the instrument. CFA is a combination of empirical data and prior theoretical expectations to validate the factor structure and is therefore a preferred statistical method in the development of theory-driven instruments (Bhattacherjee, 2002). The visual inspection of histograms, box plots, and Kolmogorov-Smirnov test results suggested that there is no significant deviation from the assumption of normality (Chin, 1998).

CFA was performed on all first-order dimensions, which are rapport, responsiveness, reliability, compatibility, ubiquity, smoothness, and comprehensiveness. Six items across the dimensions were dropped due to low factor loadings (< 0.7). In performing the model fit analysis of first-order dimensions, most dimensions demonstrated a reasonably good fit, except that the CMIN/DF and RMSEA values of ubiquity both exceeded the suggested thresholds (CMIN/DF < 3, RMSEA < 0.1). M.I. values of each observed variable for ubiquity were checked and one with the largest M.I. value was removed. The revised ubiquity exhibited a good model fit. Consequently, 30 items were retained for instrumental testing, as shown in Appendix C.

3.3.4. Estimation of competing models

Analyses of competing models were performed to identify the preferred construct structure. Building on the service quality literature, four models of plausible construct structure of cloud gaming service quality were proposed. Figure 2 shows the representative items for constructs from each of these plausible models.

Models 1 and 2 present non-hierarchical structures with only first-order constructs. Model 1 is a first-order construct model. In this unidimensional model, one construct, cloud gaming service quality, was hypothesized to account for all the common variance among the 30 observable variables. Model 2 is a first-order construct model with seven constructs correlating with each other to represent the different dimensions of the cloud gaming service quality construct overall. By assuming that the 7 constructs are correlated, the multiple dimensions are associated with one another, capturing the common variance in the model.

Models 3 and 4 present two different composite latent variable models with different hierarchical structures, highlighting the different facets of cloud gaming service quality. Model 3 comprises a second-order construct onto which the seven first-order constructs are loaded. Model 3 tests the extent to which the correlations among the seven first-order constructs are accentuated by the second-order construct, cloud gaming service quality, which is consistent with plausible hierarchical structures as suggested in the cloud services literature (e.g., Benlian *et al.*, 2011). Referencing the theoretical framework of e-service quality from Tan *et al.* (2013) and Xu *et al.* (2013), Model 4 presents an alternative hierarchical structure in which two second-order constructs (i.e., support service quality and technical service quality) and seven first-order constructs (i.e., rapport, responsiveness, reliability, compatibility, ubiquity, smoothness, and comprehensiveness) capture cloud gaming service quality.

The fit indices of the four competing models are summarized in Table 6. The null model stated that no latent constructs had underlain the observed items and that the correlations between the items were zero in the population (Muylle *et al.*, 2004). The null model was included to establish a zero point for the NFI (Doll *et al.*, 1994). The null model resulted in inadequate fit indices as expected. Model 1 demonstrated substantial improvements over the null model. This model, however, had an unreasonable fit with the empirical data. Although part of the fit indices of Model 3 met the suggested thresholds, given that its RMR, GFI, and NFI had only marginal fits, it was not considered. Models 2 and 4 provided substantial improvements over their alternatives. The majority of the fit indices in Models 2 and 4 met the recommended thresholds, except for GFIs that had marginal fits. Therefore, Models 2 and 4 were both regarded as adequate for representing the underlying construct structure of cloud gaming service.

A higher-order construct model can explain the covariation more parsimoniously than its corresponding first-order construct models. However, even if a higher-order model can well describe the component covariations, its goodness-of-fit seldom exceeds that of its first-order model which requires fewer degrees of freedom (Doll *et al.*, 1994). As shown in Table 6, the fit indices of Model 2 were slightly superior to those of Model 4, implying that Model 2 might provide an optimum fit. However, the target coefficient (T) of 0.924 (the ratio of the CMIN between Model 2 and Model 4) suggested the existence of the second-order model, indicating that 92.4% of the variation was explained by the second-order model (Doll *et al.*, 1994). Therefore, the construct covariance in Model 2 can be represented in a more parsimonious way with the existence of second-order constructs. Aligning with the cloud gaming literature that suggested the existence of *support service quality* and *technical service quality* underlying the overall cloud gaming service quality, Model 4 is of greater theoretical interest than Model 2. Therefore, Model 4 was chosen for the subsequent analysis in this study.

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3.4. Psychometric Property Tests

We collected a new dataset to test the psychometric properties, including the reliability, convergent, discriminant, and nomological validity, of the newly developed measurement instrument of cloud gaming service quality. Focal constructs of the cloud gaming service quality instrument and other constructs to test the nomological validity (e.g., satisfaction, enjoyment, and continuance intention from the IS continuance model (Bhattacherjee, 2002) were measured on a 7-point Likert scale. A self-administered online questionnaire was delivered with the aid of a data collection service. A total of 2,183 respondents attempted the survey, and 436 valid responses were obtained, giving a response rate of 19.97%. In terms of the respondent demographics, 70.87% of the respondents were male; 69.27% of the respondents were aged between 18 and 35. Table 7 summarizes the details of the respondent demographics.

3.4.1. Assessment of reliability and validity

Cronbach's alphas and the item-total correlations were calculated to examine the reliability of the instrument. The reliability met the conventional standard of internal consistency (Hair *et al.*, 2009). Specifically, with Cronbach's alphas falling between 0.88 and 0.94 and the item-total correlations for all of the items ranging between 0.67 and 0.87, all exceeded the recommended thresholds.

Convergent validity refers to the extent to which the items in an instrument appear to be indicators of a single underlying construct. The evaluation of convergent validity in this study was based on several criteria. Firstly, all measurement factor loadings were required to be significant and exceed 0.7. Secondly, the construct reliabilities needed to exceed 0.7. Lastly, the average variance extracted (AVE) was expected to exceed 0.5. As evident in the measurement model results in Table 8, the factor loadings of all the items were above the threshold value of 0.7 and were all significant ($p < 0.05$). Composite reliability of all the dimensions ranged between 0.88 and 0.94, AVE ranged from 0.67 to 0.78. The results suggested that the instrument demonstrated convergent validity. Discriminant validity refers to the degree to which the measures of distinct constructs differ. Discriminant validity is demonstrated when the square root of the AVE for each construct is higher than the correlations between itself and the rest of the constructs. The square root of the AVE for each construct is shown in Table 9, displayed in bold on the diagonal of the table. The value for each construct was higher than the correlations between itself and the other constructs, denoting the discriminant validity of the instrument. Together, the completed dimension identification and item generation, scale development, and instrument testing processes addressed the first research question by identifying and validating the dimensions and the structure of cloud gaming service quality construct.

3.4.2. Nomological validity test

The ability of a new measure to behave as expected in a network of known causal relations and well-established measures is known as nomological validity (Straub *et al.*, 2004). We placed the new measure of cloud gaming service quality into a nomological network built in the research field of IS continuance (Bhattacherjee, 2002) to evaluate its nomological validity. The IS continuance model depicts salient factors influencing IS continuance intention, including satisfaction and usefulness/enjoyment (e.g., Blut *et al.*, 2015, Dabholkar *et al.*, 1996). Service quality has been widely modeled and validated to be important in influencing users' continuance intention of IS/IT in previous studies (Blut, 2016, Blut *et al.*, 2015). Following Benlian *et al.* (2011) study on SaaS, we modeled cloud gaming service quality, in the form of support service quality and technical service quality as antecedents to enjoyment and satisfaction that lead to continuance intention in the IS continuance model.

Structural equation modeling (AMOS version 26) was used to examine the relationships between the cloud gaming service qualities and the other constructs. In general, the hypothesized research model was supported, indicating satisfactory nomological validity. Specifically, an R^2 greater than 0.19 is generally considered an acceptable level of explanation of the dependent variable by the independent variables, and that greater than 0.33 equates to a medium level of explanation (Chin, 1998, Urbach and Ahlemann, 2010). As shown in Figure 3, the support service quality and technical service quality together explained 64% of the variance in enjoyment and 55% in satisfaction, and then 43% of the variance in continuance intention, indicating satisfactory nomological validity of the new measurement instrument of cloud gaming service quality and addressing the second research question.

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4. Discussion

This study aims to develop a context-specific measurement instrument that captures cloud gaming service quality. By synthesizing the literature on service quality, e-service quality, and cloud gaming, we developed and validated a measurement instrument for cloud gaming service quality. The newly developed measurement instrument not only draws from the existing service quality literature but also captures the unique characteristics of this novel digital service. This new instrument on cloud gaming service quality distinguishes between support service quality and technical service quality in the context of cloud gaming. The development process followed rigorous and systematic procedures, and the newly developed and validated instrument demonstrates satisfactory psychometric properties for assessing cloud gaming service quality.

4.1. Implications for Research

Our study has several important implications for research. First, it adds to the cloud gaming literature by developing a new measurement instrument that captures the evaluation of service quality from the gamers' perspective. Specifically, most of the existing studies on cloud gaming were from the computer science discipline, focusing on the infrastructure and the technical aspects related to this emerging digital technology and service. Our study represents one of the first attempts to develop a gamer-centric measurement instrument for cloud gaming service quality.

Second, our study contributes to and advances the service quality literature by developing a new instrument that specifically captures the unique characteristics of cloud gaming. There have been consistent calls for advancing service quality measurement instruments by taking into context-specific characteristics of emerging services, rather than applying the original scale for all offline and online services (Benlian *et al.*, 2011, Gefen, 2002, Parasuraman *et al.*, 1991).

Furthermore, our study contributes to the existing literature by distinguishing between support service quality and technical service quality in the context of cloud gaming. Our classification of the seven identified dimensions of cloud gaming service quality into these two broad categories offers a more concise framework for future research, enabling researchers to systematically investigate the factors influencing and resulting from these two aspects of cloud gaming service quality. By offering a nuanced understanding of cloud gaming service quality, we believe our study has established a theoretically sound measurement tool that captures the distinct attributes of evolving cloud gaming services, thus expediting future research in this domain.

4.2. Implications for Practice

Our research offers practical implications for cloud gaming platform owners and operators. By utilizing our developed measurement instrument of cloud gaming service quality, they can identify the key dimensions of service quality that matter most to gamers. This enables them to allocate resources and efforts effectively, addressing the most critical aspects of service quality and ultimately enhancing the overall gaming experience.

Specifically, our findings showed that technical service quality, compared with support service quality, exerted strong effects on enjoyment and satisfaction. It indicates that cloud gaming operators should allocate their organizational resources to improving service attributes related to technical service quality. It includes providing ubiquitous access to cloud gaming services (i.e., ubiquity), ensuring smooth video streaming and running of games (i.e., smoothness), enriching the comprehensiveness of gaming contents (i.e., comprehensiveness), and enhancing the compatibility of cloud gaming services to different thin devices (i.e., compatibility). These dimensions are all salient attributes influencing gamers' perception of technical service quality of cloud gaming services that lead the positive outcomes of continuance use.

Additionally, the support service quality of cloud gaming cannot be overlooked. As revealed in the semi-structured interviews with cloud gamers, they reported negative feelings of not being valued when they deemed the support service quality to be inadequate, such as the perceived unfriendliness, irresponsiveness, and unreliability of the staff handling their inquiries and problems. Despite focusing on the technical aspect of the cloud gaming service, it is also crucial for the cloud gaming operators to address the human support aspect in this novel context, such as establishing empathetic communication with gamers.

4.3. Limitations and Future Research Directions

Our research has several limitations that should be acknowledged. First, despite our attempts to cover all dimensions crucial to the evaluation of cloud gaming service quality, we discarded some that were considered by cloud gamers to be relatively less salient. For example, although security has been included in existing e-service quality scales (Benlian *et al.*, 2011), our respondents emphasized salient attributes such as compatibility and ubiquity instead. Future studies could explore the inclusion of these dimensions to further validate the measurement instrument of cloud gaming service quality.

Second, our study examined the nomological validity of the new measurement instrument of cloud gaming service quality with the IS continuance model. It would be valuable for future research to investigate the instrument's validity in other research domains beyond IS continuance, expanding its applicability to different contexts and theoretical frameworks.

Third, we validated the new measurement instrument of cloud gaming service quality with data collected from China and the United States. However, the generalizability of the instrument to other cultures and regions may be limited. Considering that a significant portion of the global cloud gaming market resides outside these two countries (Newzoo, 2021), it is essential to replicate the study in diverse cultural and geographical contexts to enhance the generalizability of the cloud gaming service quality measurement instrument. Furthermore, technological disparities, such as the deployment of infrastructure and availability of high-speed networks, should also be considered in future studies to account for their potential influence on cloud gaming experiences.

Finally, while we have conducted preliminary psychometric property evaluations for our newly developed scale for cloud gaming service quality, we have not assessed its test-retest reliability. Given that the two sets of data were not collected from the same group of respondents, we are unable to ascertain the consistency of the scale's measurements over time within the same group. Future research could collect multiple waves of data from the same group of respondents to provide a more comprehensive evaluation of the psychometric properties of this new measurement instrument.

5. Conclusion

The rapidly growing cloud gaming market has attracted increasing attention from both the industry and academics. While efforts have been made to enhance the technical aspects and infrastructure of the provision of cloud gaming services, research on gamer-centric evaluation of cloud gaming service quality remains scarce. Our study developed and validated a new measurement instrument of cloud gaming service quality, offering valuable implications for both research and practice in the field of cloud gaming. It represents a valuable tool to assess gamers' cloud gaming experience with the services and can be used in future cloud gaming studies to further examine the antecedents and consequences of cloud gaming service quality, extending and accelerating this research stream. Moreover, it provides cloud gaming practitioners with insights into assessing gamers' evaluation of cloud gaming services and allocating organizational resources to enhance service provision and quality. We hope it serves as a springboard and provides a validated and solid theoretical reference for future cloud gaming and digital service research.

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Table 1. Definitions of Proposed Dimensions

Dimensions	**Definitions**
Support Service Quality	It refers to the caliber of supplementary services offered by cloud gaming service operators, emphasizing interpersonal communication aspects including rapport establishment, responsiveness, and reliability in addressing gamer needs.
Rapport	It refers to gamers' perceived extent of cloud gaming service operators' ability to provide knowledgeable, courteous, and caring supporting services.
Responsiveness	It refers to gamers' perceived extent of cloud gaming service operators' ability to respond to inquiries and to provide prompt supporting services.
Reliability	It refers to gamers' perceived extent of cloud gaming service operators' ability to resolve the issues that gamers encounter during the gaming dependably and accurately.
Technical Service Quality	It refers to the excellence of cloud gaming service operators' technological applications furnished to gamers, encompassing dimensions of compatibility, ubiquity, smoothness, and comprehensiveness in performance and gaming experiences.
Compatibility	It refers to gamers' perceived extent to which a cloud gaming service is adaptable across client devices, accessories, and game distribution platforms.
Ubiquity	It refers to gamers' perceived extent to which a cloud gaming service can be used anytime and anywhere.
Smoothness	It refers to gamers' perceived extent to which the streaming of a cloud gaming service is fluid and without noticeable jitters.
Comprehensiveness	It refers to gamers' perceived extent to which a cloud gaming service offers an all-encompassing selection of game contents.

Table 2. The Dimensions and the Corresponding Numbers of Items

Dimensions	**No. of Items**
Rapport	9
Responsiveness	6
Reliability	6
Compatibility	5
Ubiquity	6
Smoothness	5
Comprehensiveness	6

Table 3. Degree of Agreement (Cohen's Kappa)

	Judge	**1**	**2**	**3**	**4**	**5**	**6**	
Card Sorting Round 1	**1**		0.98	0.92	0.99	0.99	0.97	Card Sorting Round 2
	2	0.86		0.94	0.98	0.98	0.96	
	3	0.70	0.72		0.95	0.95	0.93	
	4	0.72	0.78	0.75		0.99	0.97	
	5	0.70	0.75	0.80	0.83		0.97	
	6	0.86	0.86	0.73	0.72	0.75		

Table 4. Results of the First Round of Card Sorting (Item Placement Ratio)

Target dimension	**Actual placement**								**Total items**	**Hit ratio**
	1	2	3	4	5	6	7	UN		
1. Rapport	43	1	9					1	54	80%
2. Responsiveness	2	32	2						36	89%
3. Reliability		4	32						36	89%
4. Compatibility				27			3		30	90%
5. Ubiquity	1		1	2	27	2	2	1	36	75%
6. Smoothness		1				28	1		30	93%
7. Comprehensiveness							36		36	100%
Average hit ratio: 87%										
Note: UN = Unclassifiable										

Table 5. Results of the Second Round of Card Sorting (Item Placement Ratio)

Target dimension	Actual placement								Total items	Hit ratio
	1	2	3	4	5	6	7	UN		
1. Rapport	41		1						42	98%
2. Responsiveness		30							30	100%
3. Reliability			30						30	100%
4. Compatibility				22	1		1		24	92%
5. Ubiquity					28	1		1	30	93%
6. Smoothness						30			30	100%
7. Comprehensiveness							36		36	100%
Average hit ratio: 97.5%										
Note: UN = Unclassifiable										

Table 6. Model Fits of Competing Models

Indicators	Threshold	Null Model	Model 1	Model 2	Model 3	Model 4
CMIN	Smaller is better	5979.62	3787.75	647.86	831.78	701.32
DF		435.00	405.00	384.00	398.00	397.00
P	> 0.05	0.00	0.00	0.00	0.00	0.00
CMIN/DF	< 3	13.75	9.35	1.69	2.09	1.77
RMR	< 0.1	0.44	0.18	0.05	0.11	0.07
GFI	> 0.9	0.17	0.37	0.87	0.83	0.86
AGFI	> 0.9	0.12	0.28	0.84	0.80	0.83
NFI	> 0.9	/	0.44	0.90	0.88	0.90
IFI	> 0.9	/	0.47	0.96	0.93	0.95
CFI	> 0.9	/	0.46	0.96	0.93	0.95
RMSEA	< 0.1	0.23	0.18	0.05	0.06	0.05

Table 7. The Respondent Demographics

Category	Percentage	Frequency	
		CHINA	US
Age			
18-25	36.24%	81	77
26-35	33.03%	65	79
36-45	20.64%	36	54
46-55	6.19%	10	17
56-65	1.84%	2	6
66 and above	2.06%	1	8
Gender			
Male	70.87%	143	166
Female	25.69%	51	61
Prefer not to say	3.44%	1	14
Educational background			
Less than high school	0.69%	3	0
High school graduate	2.75%	6	6
Some college	9.40%	12	29
Undergraduate	66.06%	131	157
Postgraduate and above	21.10%	43	49
Annual Income (USD)			
Less than $29,999	31.42%	107	30
$30,000 - $60,000	44.27%	51	142
More than $60,000	24.31%	37	69
Cloud gaming platform in use			
Tencent-Start	11.01%	48	0
Sony-PlayStation Now	15.83%	21	48
NetEase Cloud Gaming Platform	6.19%	27	0
Nvidia-GeForce Now	7.11%	10	21
Taptap	1.61%	7	0
Blade-Shadow	4.13%	0	18
Migukuaiyou	2.98%	13	0
Google-Stadia	17.89%	29	49
Caiji	1.83%	8	0
Microsoft-Xbox (XCloud)	15.14%	15	51
Shunnet	2.29%	10	0
Amazon-Luna	13.99%	7	54
Frequency of Cloud Gaming Usage			
Once a week	3.21%	8	6
2-3 times a week	25.00%	62	47

4-5 times a week	41.06%	91	88
6-7 times a week	20.87%	20	71
More than 7 times a week	9.86%	14	29
Duration of Cloud Gaming Usage per Time			
Less than 1 hour	2.98%	3	10
1-2 hours	23.85%	42	62
3-4 hours	37.16%	78	84
5-6 hours	22.02%	41	55
More than 7 hours	13.99%	31	30

Table 8. Confirmatory Factor Analysis (CFA) Result of Testing Model

Constructs	**Number of items**	**Range of loadings**	**Cronbach's alpha**	**Composite reliability**	**AVE**
Rapport	5	0.81-0.89	0.93	0.93	0.72
Responsiveness	5	0.76-0.88	0.91	0.91	0.67
Reliability	4	0.85-0.88	0.91	0.92	0.73
Compatibility	4	0.81-0.85	0.90	0.90	0.70
Ubiquity	4	0.71-0.91	0.89	0.89	0.68
Smoothness	3	0.82-0.86	0.88	0.88	0.71
Comprehensiveness	5	0.76-0.91	0.94	0.94	0.75
Enjoyment	4	0.84-0.90	0.92	0.92	0.75
Satisfaction	4	0.86-0.90	0.93	0.93	0.77
Continuance Intention	3	0.87-0.90	0.91	0.91	0.78
Note: All factor loadings are significant at least at $p < 0.05$ level.					

Table 9. The Correlation Matrix of Psychometric Property Tests

	Mean	SD	**RAP**	**RES**	**REL**	**CPA**	**UBI**	**SMO**	**CPR**	**ENJ**	**SAT**	**INT**
RAP	5.39	0.87	**0.85**									
RES	5.18	0.85	0.67	**0.82**								
REL	5.10	0.80	0.50	0.50	**0.85**							
CPA	4.86	0.99	0.28	0.28	0.21	**0.84**						
UBI	4.88	0.97	0.33	0.33	0.24	0.40	**0.82**					
SMO	4.79	1.01	0.30	0.29	0.22	0.36	0.42	**0.84**				
CPR	4.67	0.98	0.30	0.30	0.22	0.36	0.42	0.38	**0.86**			
ENJ	4.93	0.92	0.47	0.47	0.35	0.46	0.54	0.48	0.49	**0.87**		
SAT	4.95	0.88	0.46	0.46	0.34	0.42	0.50	0.44	0.44	0.59	**0.88**	
INT	4.82	0.85	0.34	0.34	0.25	0.32	0.38	0.34	0.34	0.59	0.59	**0.88**

Note: Diagonal elements (in boldface) are the square root of average variance extracted (AVE). These values should exceed inter-construct correlations (off-diagonal elements) for adequate discriminant validity. RAP = Rapport, RES = Responsiveness, REL = Reliability, CPA = Compatibility, UBI = Ubiquity, SMO = Smoothness, CPR = Comprehensiveness, ENJ = Enjoyment, SAT = Satisfaction, INT = Continuance Intention

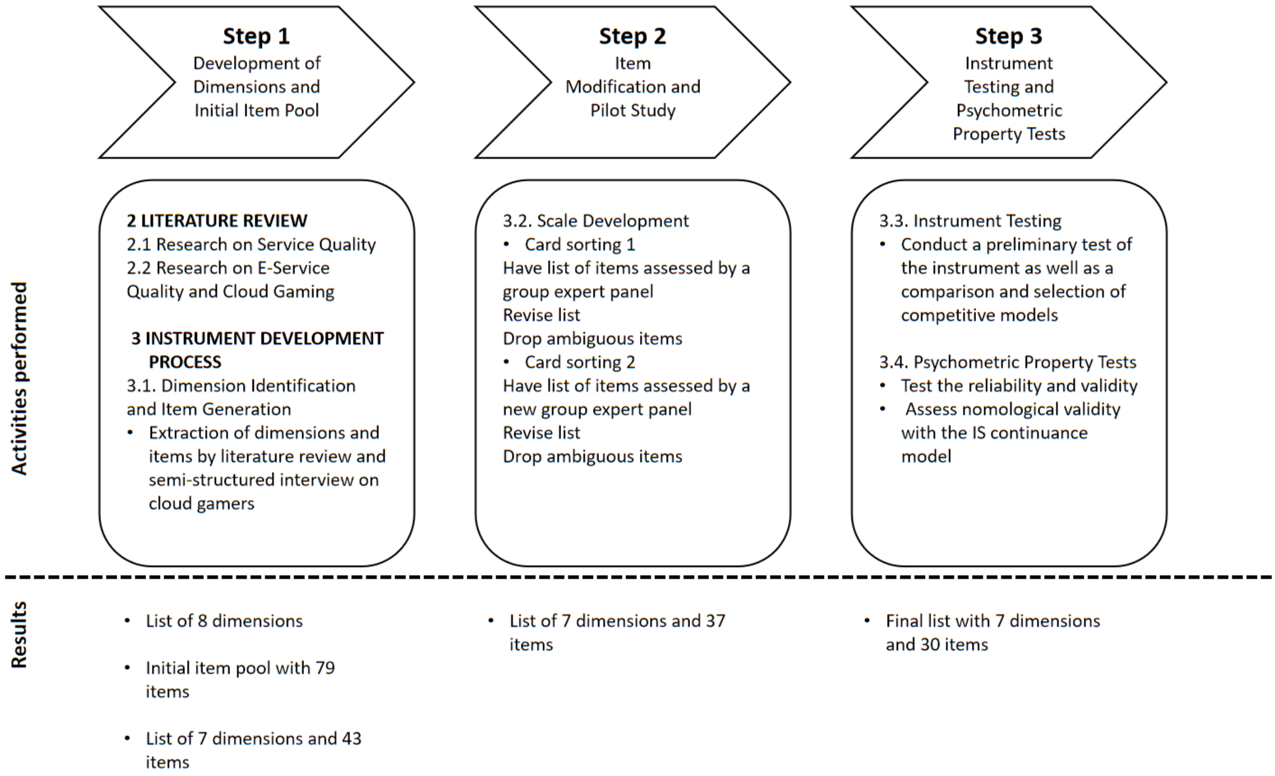

Figure 1. The Overview of the Instrument Development Process.

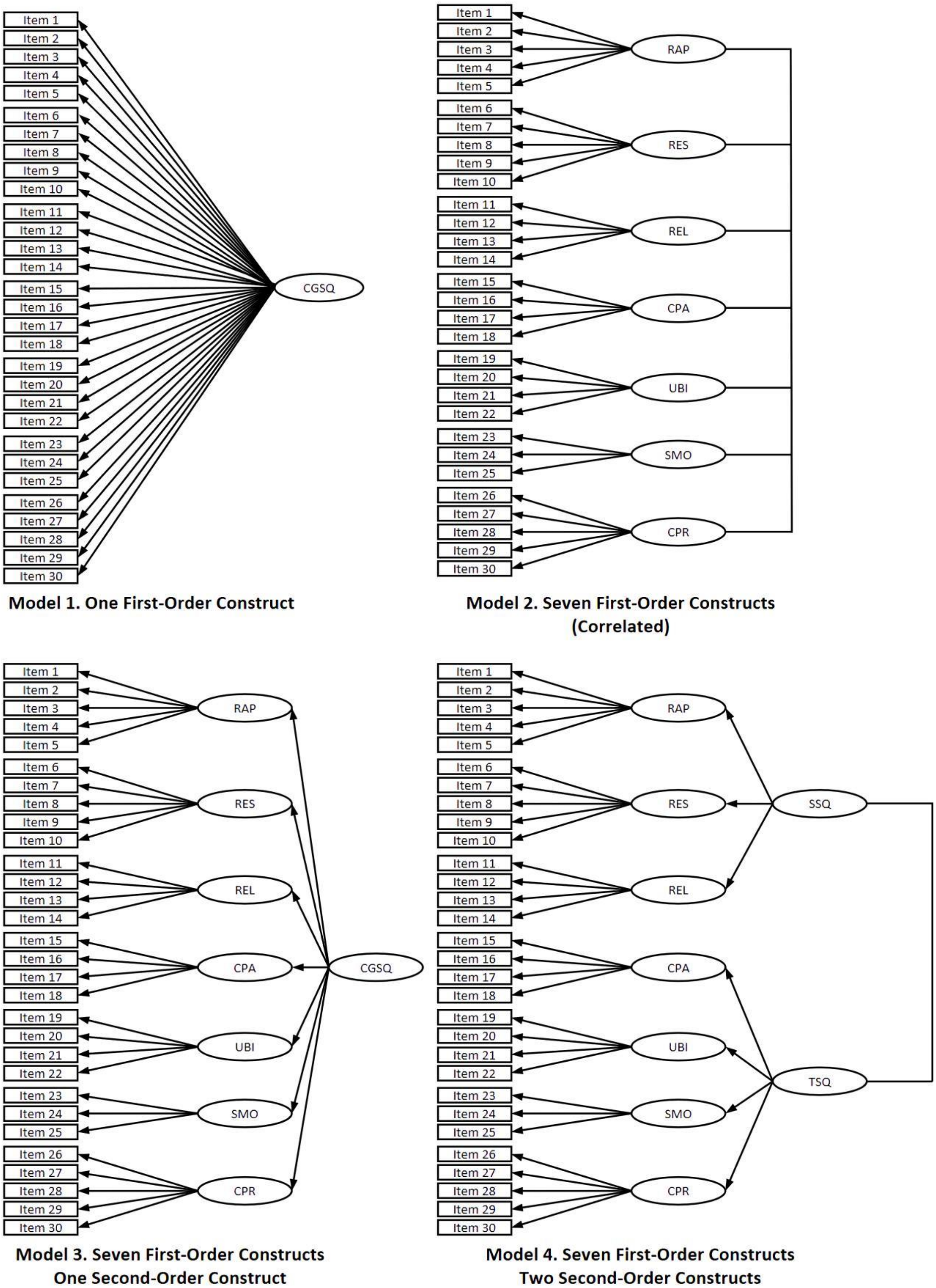

Figure 2. The Competing Models for Cloud Gaming Service Quality Measurement Instrument.

Note: RAP = Rapport, RES = Responsiveness, REL = Reliability, CPA = Compatibility, UBI = Ubiquity, SMO = Smoothness, CPR = Comprehensiveness, CGSQ = Cloud Gaming Service Quality, SSQ = Support Service Quality, TSQ = Technical Service Quality

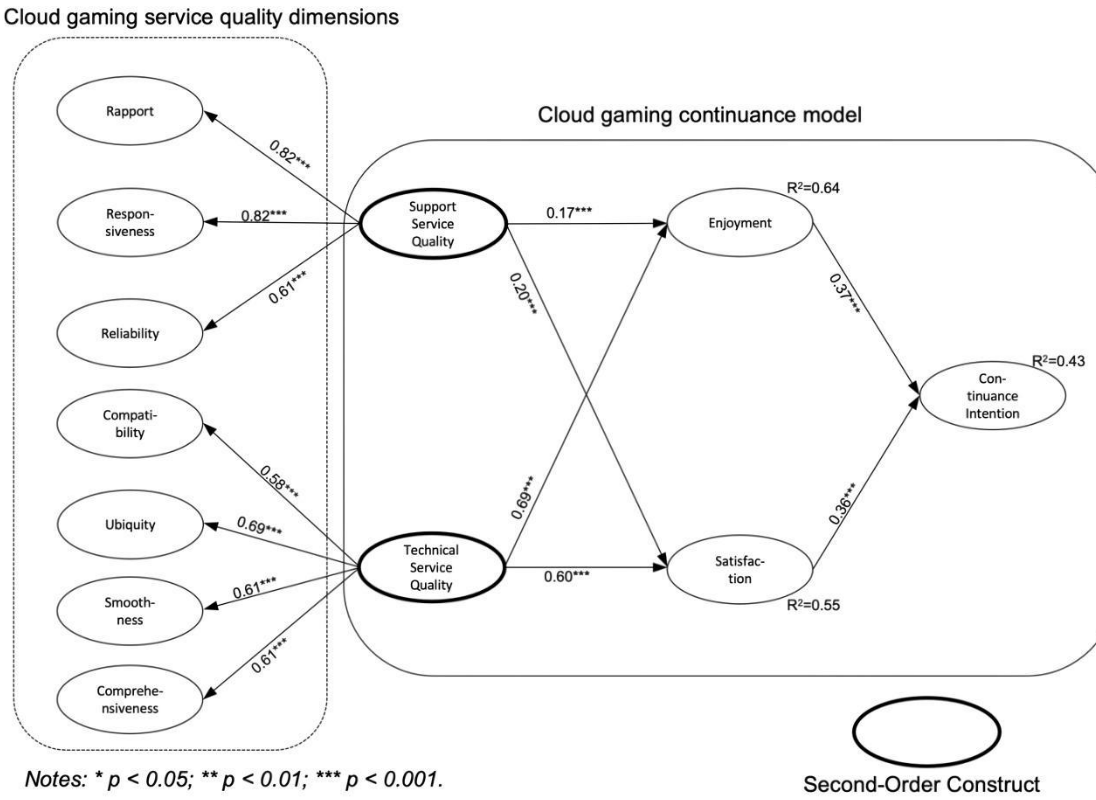

Figure 3. The Results of Nomological Validity Test.

Appendix A. Measurement Instruments of e-Service Quality and Applicability in the Cloud Gaming Context

Study	Dimensions and Sub-Dimensions	Context	Theoretical Frameworks	Conceptual vs. Empirical	Applicability to Cloud Gaming Service Quality
Barnes and Vidgen (2001)	Aesthetics, Navigation, Reliability, Competence, Responsiveness, Access, Credibility, Security, Communication, Understanding the Individual	Websites	SERVQUAL	Empirical	This scale contains an array of dimensions, sub-dimensions, and associated indicators, rendering it lengthy and difficult to apply.
Benlian *et al.* (2011)	Rapport, Responsiveness, Reliability, Flexibility, Features, Security	Cloud Service/ Computing	SERVQUAL	Empirical	This instrument, while optimally aligned with cloud gaming, necessitates refinement due to the functional and purposive distinctions between SaaS and cloud gaming.
Blut (2016)	Website Design, Fulfillment, Customer Service, Security/Privacy	Websites/ E-Service	Means-Ends-Chain Theory	Empirical	This measurement tool encompasses a comprehensive range of attributes, tailored to accommodate various information systems contexts. While it serves as a valuable reference, its application in cloud gaming is hindered by conceptual ambiguity.
Gefen (2002)	Tangibles, Reliability, Responsiveness, Assurance, Empathy	Websites/ Online Shopping	SERVQUAL	Empirical	This study represents a pioneering effort in applying service quality dimensions to information systems, employing SERVQUAL's framework directly.

					While it successfully adapts to certain general dimensions pertinent to cloud gaming, such as responsibility and reliability, it falls short in addressing the distinctive elements of cloud gaming service quality, like ubiquity and compatibility
Parasuraman *et al.* (2005)	Efficiency, Fulfillment, System Availability, Privacy	B2C/E-Commerce Websites	SERVQUAL	Empirical	The scale items were specifically developed for a B2C e-commerce setting and miss important aspects of cloud gaming service quality (e.g., data/network security and resilience).
Raza *et al.* (2019)	Security, Availability, Scalability, Resilience, Management	Cloud Service/ Computing	Multi-Criteria Decision Making (MCDM)	Empirical	This scale, grounded in Microsoft's context, pertains to cloud services and offers some referential dimensions. However, its full applicability to cloud gaming is limited due to divergent backgrounds and objectives.
Semeijn *et al.* (2005)	Assurance, Navigation, E-Scape, Accuracy, Responsiveness, Customization	Online Shopping	SERVQUAL	Empirical	Although this scale succeeds in capturing antecedents related to the service quality of online shopping, it does not capture essential factors in cloud services (e.g., ubiquity).
Sigala (2004)	Tangibles, Reliability, Responsiveness,	ASP/ B2B	SERVQUAL	Empirical	The tangibles dimension requires refinement for

	Assurance, Empathy, Trust, Business Understanding, Benefit and Risk Share, Conflict, Commitment				effective application in cloud gaming contexts, emphasizing aspects such as availability and adaptability. Moreover, the commitment dimension appears to replicate aspects of Assurance.
Tan *et al.* (2013)	Service Content Quality: Needing Function, Service Acquisition Functions, Service Ownership Functions Service Delivery Quality: Efficient IT-Mediated Service Delivery	Websites	The Customer Service Life Cycle (CSLC)	Empirical	While this paper offers an in-depth reference to IS service quality research, its focus predominantly on antecedent analysis results in an incomplete coverage of factors pertinent to cloud gaming, including specific components.
Xu *et al.* (2013)	**System Quality:** Reliability, Flexibility, Accessibility, Timeliness **Information Quality:** Completeness, Accuracy, Format, Currency **Service Quality:** Responsiveness, Empathy, Service Reliability, Assurance	Websites/ Online Shopping (B2C)	Wixom and Todd Model	Empirical	This represents an alternative design perspective that may be perceived as overly complex and inflexible. Notably, both system quality and information quality can be subsumed under the service quality dimension in the SERVQUAL framework.

Appendix B. Mapping of the Dimension Definitions of Cloud Gaming Measurement Instrument

Dimensions	Reference source and definitions			Our Definitions
Rapport	Includes all aspects of a SaaS provider's ability to provide knowledgeable, caring, and courteous	Rapport focus on an IS service provider's ability to convey a rapport of knowledgeable,	Knowledge and courtesy of employees and their ability to inspire trust	It refers to gamers' perceived extent of cloud gaming service

	support (e.g., joint problem solving or aligned working styles) as well as individualized attention (e.g., support tailored to individual needs). Benlian *et al.* (2011)	caring, and courteous support. Kettinger and Lee (2005)	and confidence. Caring, individualized attention the firm provides its customers. Parasuraman *et al.* (1988) (SERVQUAL)	operators' ability to provide knowledgeable, courteous, and caring supporting services.
Responsiveness	Consists of all aspects of a SaaS provider's ability to ensure that the availability and performance of the SaaS-delivered application (e.g., through professional disaster recovery planning or load balancing) as well as the responsiveness of support staff (e.g., 24-7 hotline support availability) is guaranteed. Benlian *et al.* (2011)	Responsiveness is a key consumer issue when shopping on the Web. Responsiveness is defined as the presence of feedback to users and the availability of response from the site managers. Palmer (2002)	Willingness to help customers and provide prompt service. Parasuraman *et al.* (1988)) (SERVQUAL)	It refers to gamers' perceived extent of cloud gaming service operators' ability to respond to inquiries and to provide prompt supporting services.
Reliability	Comprises all features of a SaaS vendor's ability to perform the promised services timely, dependably, and accurately (e.g., providing services at the promised time, provision of error-free services). Benlian *et al.* (2011)	The extent to which the site's promises about order delivery and item availability are fulfilled. Parasuraman *et al.* (2005)	Ability to perform the promised service dependably and accurately. Parasuraman *et al.* (1988) (SERVQUAL)	It refers to gamers' perceived extent of cloud gaming service operators' ability to resolve the issues that gamers encounter during the gaming dependably and accurately.

Compatibility	The degree to which the website adapts to different tasks and needs. Xu *et al.* (2013)	Extent to which an e-government website reflects revised service content and accommodates fluctuations in citizens' usage patterns (e.g., having a dynamic content section within an e-government website that updates citizens on new services without causing disruptions to the rest of the pages). Tan *et al.* (2013)	The ability of a system to handle increased workloads. Raza *et al.* (2019)	It refers to gamers' perceived extent to which a cloud gaming service is adaptable across client devices, accessories, and game distribution platforms.
Ubiquity	The availability and accessibility of cloud computing services can be possible anywhere and anytime and this particular characteristic represents the ubiquitous nature of cloud computing. Tripathi and Mishra (2019)	The degree of which the information system is accessible from various client platforms and locations. Zhong and Rohde (2014)	Ability to provide services anytime, anywhere. Lai and Wang (2015)	It refers to gamers' perceived extent to which a cloud gaming service can be used anytime and anywhere.
Smoothness	The clarity of the graphics quality and the frame rate. Fassnacht and Koese (2006)	The speed of access and display rate within the Web site. Palmer (2002)	The response delay refers to the time difference between the time when a gamer triggers an input and the time when the client renders the corresponding	It refers to gamers' perceived extent to which the streaming of a cloud gaming service is fluid and without noticeable jitters.

			effect. Hong *et al.* (2015)	
Comprehensiveness	Useful information. Information should be interesting, easy to understand and attractive rather than boring words. Santos (2003)	The information provided is accurate, updated, and appropriate. Good selection/diversity of product offerings on website. Blut (2016)	Ability to provide comprehensive and up-to-date information for customer needs. Xu *et al.* (2013)	It refers to gamers' perceived extent to which a cloud gaming service offers an all-encompassing selection of game contents.

Appendix C. Items of Cloud Gaming Measurement Instrument

Dimensions	Items
Rapport	• The cloud gaming support service staff have the knowledge to answer my questions. • The cloud gaming support service staff have my best interest at heart. • The cloud gaming support service staff are courteous. • The cloud gaming support service staff give me individual attention. • In general, the cloud gaming support service staff have a good rapport with me.
Responsiveness	• The cloud gaming support service staff are never too busy to respond to my requests. • The cloud gaming support service staff respond to my inquiries in quick. • The cloud gaming support service staff are always ready to respond to my inquiries. • The cloud gaming support service staff handle my inquiries quickly. • In general, the cloud gaming support service staff are responsive.
Reliability	• The cloud gaming support service staff make no errors in their support service provision. • The cloud gaming support service staff dependably handle my inquiries. • The cloud gaming support service staff offer a guarantee to its support services. • The cloud gaming support service staff offer support services as promised.
Compatibility	• The cloud gaming service can be used seamlessly across devices (e.g., laptops, desktops, smart phones, and tablets) I have. • The cloud gaming service supports different gamepads. • The cloud gaming service can launch games from different distributors/distribution platforms. • In general, the cloud gaming service has a high level of compatibility.
Ubiquity	• The cloud gaming service can be used anytime. • The cloud gaming service can be used anywhere.

	• The cloud gaming service launches and runs right away without any waiting or downloading. • In general, the cloud gaming service exhibits ubiquity.
Smoothness	• The streaming of the cloud gaming service is without any noticeable latency. • The streaming of the cloud gaming service has seldom been laggy. • In general, the cloud gaming service demonstrates smoothness in streaming.
Comprehensiveness	• The cloud gaming service provides up-to-date games. • The cloud gaming service offers a good variety of games. • Most games that I want to play can be found in the cloud gaming service. • The cloud gaming service incorporates new games regularly. • In general, the game contents of the cloud gaming service are comprehensiveness.

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