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A Study on Immersion and Intention to Pay in AR Broadcasting: Validating and Expanding the Hedonic Motivation System Adoption Mode

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Abstract: With the rapid growth of online entertainment live streaming, how to continuously innovate and achieve long-term sustainability has become a major challenge for the industry. Augmented reality (AR) technology offers users immersive interactive experiences and potentially addresses this challenge. The aim of this study is to explore how AR technology influences key components of user online experience—immersion and intention to pay—using survey data. Building upon the Hedonic Motivation System Adoption Model (HMSAM), this research incorporates aesthetic variables to theoretically expand the model in order to gain a deeper understanding of the mechanisms influencing user behavior. A questionnaire survey was conducted to collect 450 valid samples. Detailed analysis was conducted using structural equation modeling. The findings confirm that aesthetic design significantly impacts users' judgments of content value and perceived ease of use, generating positive effects at the perceptual level. Additionally, AR applications enhance the quality of user experience, thereby stimulating intrinsic motivations such as curiosity and joy. Further analysis indicates that users' curiosity and perceived behavioral control directly influence the level of immersion and intention to pay. Overall, the research results offer important insights into industry applications. This study successfully expands the HMSAM theoretically by incorporating aesthetic variables to enhance the explanatory power of user judgment mechanisms. The analytical framework proposed aids in understanding the potential mechanisms of new technologies on customer experience and commercial value creation. The research findings provide guidelines for technological design and marketing strategies of streaming platforms.

Keywords: online entertainment; live broadcasting; immersion; intention to pay; augmented reality

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1. Introduction

1.1. Background

With the stride of network advancement, online communities have thrived as pivotal venues for public engagement and exchange, creating novel avenues for individuals' learning, socializing and collective pursuits [1,2]. Integrated deeply into these cyberspaces, webcasting has attracted growing users with its real-time interactivity to shape a distinctive cultural phenomenon [3,4]. In China, the webcast market reached $18 billion in 2023, gaining mounting popularity among users across the mobile Internet landscape [5,6], as shown in Figure 1. Underlying this exponential adoption involves the rich content creation, interactive experience and mobile accessibility driving user stickiness [7]. As an emergent economic heavyweight digitally, webcasting promises cultural and commercial prospects that warrant continued investigation. Renowned for interactivity and sociability, entertainment live streaming has garnered tremendous user enthusiasm [8]. Playing an integral role, hosts utilize personal appeal and expertise to craft immersive performances, interviews and commentary for engaged participation [7,9]. However, as market rivalry intensifies, the expanding host count contrasts with declining attractiveness [10].

Additionally, indistinguishable content and interfaces across platforms frustrate user retention and platform differentiation [8,11,12]. These challenges underscore the timely need for novel technological augmentation to uphold user stickiness. Advancements enhancing participatory experiences stand to reignite platform uniqueness while recapturing audience attention.

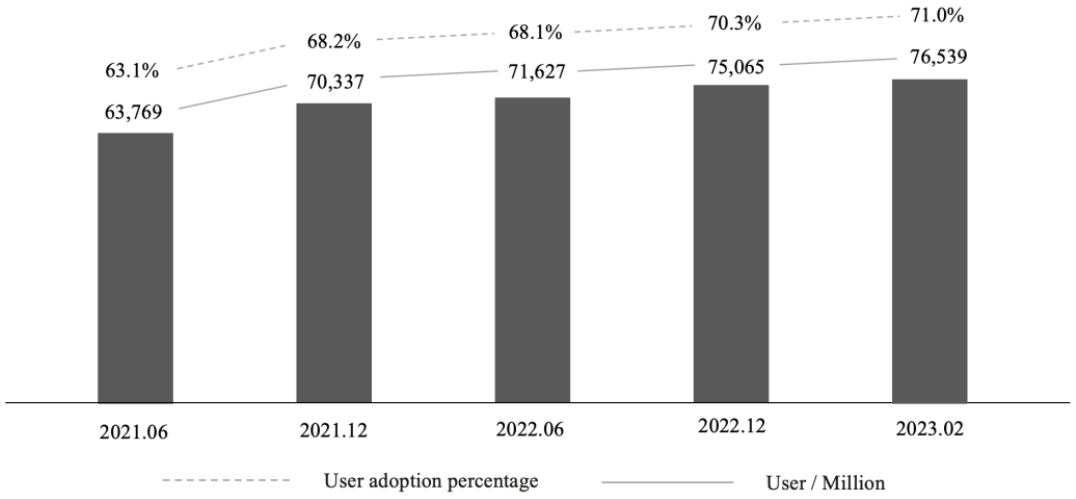

Figure 1. The magnitude and adoption rate of online streaming platform users in China (2021–2023).

In recent years, augmented reality (AR) technology has developed rapidly and been applied extensively in various industries, profoundly affecting consumer behaviors and business models [13,14]. Research has shown that the perception and memory features in visual scenes are constrained by visual attention and guidance methods, and the impact of brand recognition on consumers is significant [15]. As individual live streamers function as independent intellectual properties (IPs), emphasizing the communicative effect, they are similar to brand effects. Therefore, the brand effect of personal entertainment live streaming cannot be overlooked in its influence on consumers. Vital for user captivation and content creation, anchor persona charm offers decisive influence [16]. Anchors may electrify audiences by integrating AR-enabled embellishments on live platforms [17]. With research substantiating entertainment and interactivity as enhancers of online shopping satisfaction [18], technical interaction stands critical for relaying entertainment value [19]. As an emergent technology, AR qualifies as a novel interaction conduit between anchors and audiences [20,21], with studies documenting boosted immersion and payment willingness [22,23]. However, AR's impacts on user experience and the behavior of intention to pay in entertainment live streaming warrant further investigation, including the mechanisms by which AR augmentation on platforms shapes user perceptions and decisions behind engagement and spending.

Although there is rapid development in entertainment live streaming, the existing research on this emerging phenomenon remains limited, particularly regarding the fundamental mechanisms of user experience and motivation. Previous studies have indicated that augmented reality (AR) not only presents opportunities for enriching interactive experiences and differentiated services, but also has the potential to influence spatial presence and consumer behavior through media features [24,25]. AR technology offers immersive simulated environments and interactive experiences for consumers, thus shaping their perceptions, satisfaction and decision-making in new retail settings [26,27]. Understanding the mechanism of AR's influence on consumers from the perspective of motivational psychology has important theoretical and practical significance. However, existing research has not offered an integrative theoretical framework to explore this issue [28,29]. For instance, augmented reality has been found to enhance museum experiences and purchase intentions [30]. Clearly, further exploration is needed on strategically selecting or combining

augmented reality and virtual reality to enhance online experiential retail, as AR is a new technology that businesses are exploring for commercial use [31,32]. The existing research lacks a clear theoretical narrative on the impact of augmented reality (AR) on cognitive and willingness-to-pay behavior [33,34]. Additionally, in the context of commercial applications, as the scale of the online live streaming industry continues to expand, businesses need to understand the positive impact of AR technology transformation [35], particularly the urgent need to design a good user experience to promote sustainable willingness to pay among consumers, thereby facilitating industry upgrading under technological transformation. Therefore, to address the lack of understanding of the impact of AR on user experience, motivation and behavioral outcomes in the live streaming environment, especially from a theoretical perspective analyzing the factors influencing potential consumers' consumption behavior intentions, the hedonic motivation system adoption model (HMSAM) posits that in the entertainment domain, positive emotions are more influential in driving technology acceptance than utilitarian factors [36]. This study employed an expanded hedonic motivation framework to empirically examine the impact of augmented reality (AR) on immersion and intention to pay in a live streaming environment. Due to the high relevance of the theory to the current study, the incorporation of research content from the HMSAM model represents a rational research perspective. Therefore, it is imperative to verify a robust motivation model in the context of AR shopping, which can offer nuanced insights into consumers' adoption intentions and behaviors regarding AR technology [37,38].

Furthermore, from another perspective, the existing HMSAM theory overlooks the role of the aesthetic experience. The impact of augmented reality (AR) on aesthetic experiences has become an increasingly intriguing topic [39–41]. AR applications have been introduced in various environments such as tourist destinations, retail, museums and education, with the potential to enhance user experiences. For instance, AR has been found to improve and enhance user experiences in entertainment, medical and retail domains [42]. Additionally, the use of AR filters on social media has been found to have a positive impact on user experiences, particularly in terms of curiosity and playfulness [43]. However, the theoretical perspective on the influence of AR on social interaction is still uncertain [44]. Therefore, by introducing aesthetic appeal as an independent variable alongside perceived usefulness, ease of use and intrinsic motivation, this study extends HMSAM to develop a more comprehensive understanding. Aesthetics constitute a component of overall emotional experience and fulfill emotional needs beyond utility. However, in acceptance theory, its interaction with functionality and emotion has not been fully explored. Through the virtual interaction of augmented reality features, hosts can immerse users in participatory entertainment, stimulating curiosity and enjoyment. As these enhanced positive states promote continued usage and willingness to pay, uncovering the psychological impact of AR is crucial. Addressing the limitations of the current HMSAM, this study contributes unique theoretical insights by elucidating the synergistic impact of aesthetics with cognitive and emotional factors.

This study validates and broadens the Hedonic-Motivation System Adoption Model (HMSAM) within the context of Augmented Reality (AR), which holds significant importance for several reasons. Initially, HMSAM is grounded in motivation theory and is designed to elucidate the adoption of hedonic systems, aligning well with the experiential characteristics of AR technology. Secondly, although AR presents novel marketing opportunities, there is a dearth of behavioral research in this area, whereas HMSAM, known for its predictive capabilities, requires empirical validation in emerging domains such as AR. Lastly, the extension of HMSAM's application to AR enhances the model's adaptability in interpreting motivations related to experiential technologies. Therefore, this research adopts the Hedonic Motivation System Acceptance Model (HMSAM) as the theoretical framework. Complementarily, the lens of aesthetics is incorporated given its empirical bonds with AR adoption [45,46]. Central to HMSAM, emotional motivations precipitate technology use more profoundly than extrinsic calculus in hedonic contexts as such [47]. Through AR-empowered virtual interactions, anchors may immerse users in participative

entertainment, stirring intrinsic drives like enjoyment and curiosity. These heightened positive states boost continued usage and intention to pay in turn. This theoretical framework addresses the limitations of the pleasure motive model in analyzing the effects of multiple factors, providing a more comprehensive and systematic perspective for understanding the psychological mechanisms behind augmented reality interactions. Consequently, demystifying AR's impacts on user psychology is essential for expanding a theoretical and practical understanding of this emerging phenomenon.

1.2. Research Purpose and Significance

The primary objectives of this research encompass two main points. Firstly, it seeks to validate the viability of the HMSAM (Hedonic-Motivation System Adoption Model) in interpreting and forecasting consumers' inclinations and actions towards adopting AR (Augmented Reality) technology. Through an AR virtual encounter, this study investigates the model's capacity to elucidate the impact of aesthetic design on consumers' perceptions and attitudes. Secondly, the research endeavors to broaden the HMSAM's application domain from conventional online shopping scenarios to emerging experiential technologies like AR and VR (Virtual Reality). By testing the model within the novel realm of AR, this investigation enhances the theoretical relevance of the HMSAM in scrutinizing the motivational factors that drive the adoption of experiential information technologies. Accomplishing these dual objectives will establish a sturdy theoretical groundwork and offer valuable practical insights for consumer behavior studies related to AR marketing.

2. Relevant Research

2.1. Online Entertainment Live Broadcasting

The online entertainment live streaming industry has been rapidly expanding with the widespread adoption of 5G networks and AI technologies. According to data from Analyst company, the global online live streaming user base reached 2 billion in 2020 [5,6]. Various innovative forms such as live classroom sessions and e-commerce live streaming have been continuously emerging [48,49]. Entertainment live streaming is a form of entertainment that utilizes the internet, mobile devices or computers to deliver real-time entertainment and interaction with the audience without recording or playback functionality [50]. With the growth of the mobile internet, live streaming has become a noteworthy cultural and commercial phenomenon digitally. Existing research on live streaming communication has centered on news broadcasting [51] and video commerce [52]. However, academic inquiry into this emerging form of entertainment live streaming remains limited, especially regarding the underpinning mechanisms of user experience and sustainable business models [53]. Prior studies suggest entertainment live streaming is more social, interactive and engaging relative to other formats, providing immersive experiences [54]. The persona appeal of the host also influences user attachment and attention [55]. However, how to consistently engage users and unlock business values warrants further investigation. As such, the application effects of emerging technologies like augmented reality and best practices warrant further investigation [56]. From a platform perspective, benefiting from the development of digital technology, Chinese companies such as Tencent have leveraged the largest user base in China to introduce live streaming features on the popular social communication platform WeChat, focusing on mainstream content. Another company, ByteDance company, is actively building an ecosystem and establishing a diversified channel layout. These companies not only provide new employment opportunities for entertainment hosts but also meet consumers' demands for diversified social interactions [57,58]. Analyzing from a user perspective, digital native users seek convenient interactions, possess strong curiosity and exploratory psychology and platform stickiness is a core task [59]. Looking at the business model, e-commerce elements are increasingly important, with hosts becoming the dual drivers of content and revenue, and personalized entertainment services unlocking niche market potential [60]. The social psychology of user participation and sharing in a digital environment is particularly important. For example, satisfying curiosity and a

sense of achievement through virtual experiences such as collaborating with others to solve problems. This provides inspiration for companies to design personalized products and services. In conclusion, the online entertainment live streaming industry is rapidly growing, and future research will focus on deepening user needs and enhancing product interactivity through new technologies.

2.2. Hedonic Motivation System Acceptance Model (HMSAM)

The HMSAM model categorizes user experience into two classifications based on theory: utilitarian motivation and hedonic motivation. It suggests that these two motivations collectively influence the intention to use a system [61]. This model originates from consumer behavior research and analyzes individuals' experience and acceptance mechanisms of products/services from both psychological and behavioral perspectives [62]. Utilitarian motivation is reflected in evaluations of usability and usefulness, while hedonic motivation is reflected in evaluations of curiosity, exploration and perceived control. Users' technology acceptance is driven more by internal emotional experiences rather than external utility [47]. In recent years, this model has been widely utilized in the study of acceptance mechanisms for digital products such as apps and e-commerce platforms [63–65]. Positive emotions such as enjoyment and joy play a significant role in motivating users' engagement, especially in entertainment environments [66]. Numerous studies demonstrate the enjoyment factor's strong influence on users' technology usage, such as web games and social networks [67,68]. Applying HMSAM in emerging live streaming contexts can elucidate motivational mechanisms underlying user behaviors [69]. However, further empirical evidence is required to substantiate the operational mechanisms of the HMSAM model within the realm of entertainment live streaming. Therefore, this research sets forth to examine how AR technology elicits users' intrinsic enjoyment motivations and shapes their experiences and behaviors in the context of entertainment live streaming. Here is the model proposed in detail as shown in Figure 2.

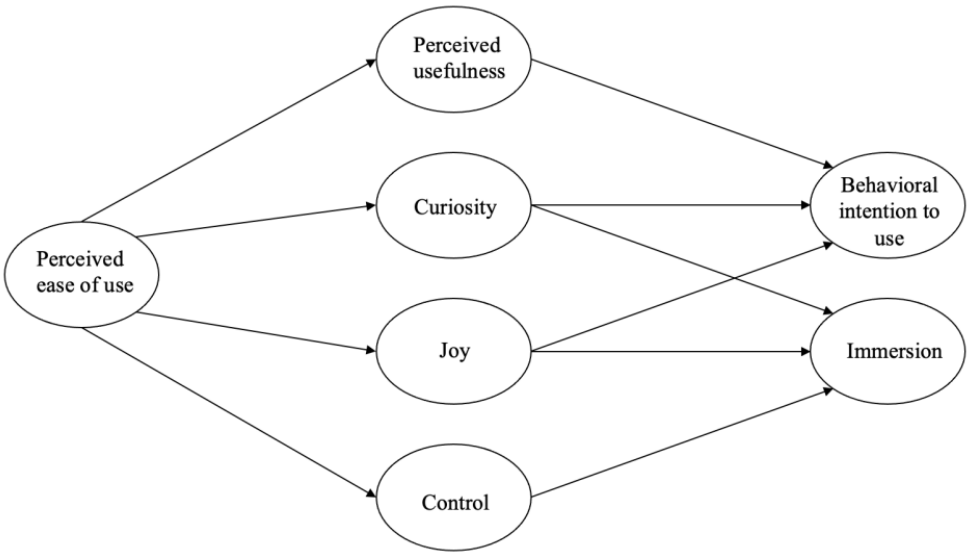

Figure 2. The model of HMSAM.

2.3. Immersion

The concept of immersion in digital media refers to the extent to which a user becomes engrossed and absorbed in a digital environment, often leading to a sense of presence and heightened engagement. Immersion can be characterized by various factors such as display resolution, tracking capabilities and sensory, challenge-based and imaginative components [70]. It has been shown to enhance education by enabling multiple perspectives, situated learning and transfer [71] (Holopainen, 2020). Immersion is considered a

driving force behind children's learning in digital educational games [72,73]. Immersion entails being deeply engaged and absorbed in an experience, especially in virtual environments [74,75]. In particular, immersion connects closely to the notion of presence—the subjective sensation of physically being in a virtual space. Research has shown that heightened levels of immersion can improve presence, participation and overall positive experience in virtual realities [76–78]. In the context of digital media usage, immersion refers to the user's involvement and focus on a single activity [79]. Additionally, immersion and media content play a role in the sense of presence, indicating the impact of immersion on the user's perception of being present in a digital space [80]. Immersion in digital fiction can be categorized as narrative or ludic immersion, highlighting the diverse forms it can take [81]. Moreover, immersive media, including virtual reality and artificial intelligence, have become essential in digital media art creation [82]. The concept of immersion is also significant in the study of storytelling in conjunction with virtual and augmented reality, indicating its relevance in various digital media applications [83,84]. In summary, by profoundly shaping user psychology across domains, the notion of immersion warrants extensive inquiry.

2.4. Intention to Pay

The intention to pay reflects users' assessment of the likelihood to purchase a technical application or service [85]. Multiple factors shape this intention to pay: content quality and interactive experience can heighten users' intention to pay in online entertainment [86]; trust, perceived benefits, risks and value are also vital antecedents [87,88]. Numerous studies have demonstrated that the willingness to use digital tools for payments is influenced by various factors. Trust, perceived ease of use, perceived usefulness, attitude towards digital payments and security have been identified as crucial determinants of the intention to use digital payment methods [89,90]. Additionally, it has been found that factors such as religious beliefs, subjective norms and perceived behavioral control can positively influence the intention to use digital tools for payments in specific environments [91,92]. The role of user experience in evoking emotional connections and predicting the continued use intention of digital payment applications has also been emphasized [93]. Furthermore, the COVID-19 pandemic has prompted governments to promote digital payment methods to boost economic activities and enhance financial inclusion [94]. For instance, individuals are more willing to embrace new technologies such as AR integrated into online social interactions, bringing potential economic value. Given the behavior of intention to pay indication of actual usage behavior [95], predicting and driving users' intention to pay is imperative for platforms to achieve monetization and sustainability.

2.5. Aesthetics

The aesthetics in Augmented Reality (AR) play a crucial role in influencing user satisfaction and experience. Several studies have emphasized the significance of aesthetics in AR applications [96,97]. The perceptual advantages and visual appeal of AR significantly impact user satisfaction with AR [98]. Despite existing technological limitations, high scores in usability and aesthetics attest to this fact [99]. The role of aesthetics in AR extends beyond user satisfaction and encompasses various domains. For instance, AR applications enhance tourists' aesthetic experiences at heritage sites [100], and AR triggers aesthetic, social and relational issues [101]. While mobile apps have achieved major improvements in functionality, usability and security [102], enhancing user experience holds the key to competitive advantage [103,104]. Specifically, interface aesthetics and interactive process appeal heighten app attractiveness and drive user acquisition and retention [105–107]. Moreover, aesthetics also critically impact human–computer interaction quality [108]. Given that the aesthetic experience significantly shapes users' app selection and usage satisfaction [103], assessing and optimizing the perception of apps' aesthetic qualities represents an effective approach to boost competitiveness and commercial values.

2.6. Perceived Ease of Use

Perceived ease of use (PEOU) represents how effortless users consider a technology to interact with [109]. Rooted in the technology acceptance model (TAM), PEOU alongside perceived usefulness (PU), shapes users' attitudes and adoption intention. It refers to the extent to which individuals perceive the use of a specific system or technology to be free and easy to use [110,111]. It is a key factor in the Technology Acceptance Model (TAM) and has been widely researched in the areas of human–computer interaction and usability. Perceived usability is closely related to self-efficacy, which is defined as an individual's judgment of their ability to perform the actions required in a given situation. It has been found to significantly impact users' acceptance of information technology [109,112]. Perceived usability has been shown to influence the intention to use digital technologies such as e-wallets and social media, as well as the acceptance of digital libraries and electronic payment systems [113]. Perceived usability is associated with various outcomes, such as its impact on the sustainable development of Micro, Small and Medium Enterprises (MSMEs) through social media marketing, and its effect on the digital marketing performance of companies [114]. When users deem a technology more accessible and user-friendly, they tend to develop more willingness to learn and utilize it [115]. Particularly in hedonic contexts like webcasting, PEOU substantially influences user acceptance [116]. By easing usage barriers, enhancing PEOU helps technologies appeal to targeted users.

2.7. Perceived Usefulness

Perceived usefulness (PU) depicts the subjective benefits users perceive regarding a technology's capability to enhance their performance [109]. Together with perceived ease of use, PU constitutes a pivotal predictor of users' adoption attitude and intention in the technology acceptance model (TAM). Extensively examined in information systems, education and user research [117,118], PU significantly shapes actual technology usage intention and behavior. Specifically for hedonic systems, PU meets users' expectations for enjoyment, fosters perceived value and promotes usage willingness, fosters perceived value and enhances willingness to use [39]. The PU in the digital media and augmented reality (AR) context refers to the extent to which users perceive these technologies as beneficial and enhancing their experiences. Several studies have explored the concept of PU related to AR and digital media [119], where AR applications enhance users' perceptions of the real world, influencing PU and perceived ease of use [120]. Research has confirmed that PU significantly influences the intention to use AR technology in retail stores [121], including novelty, interactivity and vividness of AR, and has identified their impact on the technological acceptance attributes of perceived ease of use and usefulness [38]. In conclusion, the PU of digital media and AR is a key factor in influencing user attitudes and intentions. It is believed that these technologies can enhance experiences, provide convenience and offer innovative and beneficial functionalities. These findings underscore the importance of PU in influencing user acceptance and the adoption of AR and digital media technologies.

2.8. Perceived Behavior Control

Perceived behavioral control (PBC) represents individuals' perceived ease or difficulty in performing a behavior [122], grounded in the theory of planned behavior (TPB). TPB posits that behavior intention is shaped by attitudes, subjective norms and importantly, PBC [123]. Encompassing facilitators and barriers that make behavior achievement easy or hard [124], PBC reflects one's confidence in executing behaviors [122]. In digital entertainment contexts, high PBC strengthens users' willingness to experiment with novel applications before adoption [125]. Perceived behavioral control (PBC) in digital media refers to an individual's belief in their ability to effectively use digital media and their confidence in overcoming any barriers or challenges that may arise in this process, as it influences attitudes and intentions toward using digital technology services (e.g., ICT, digital media, smart devices and social media) [126]. The literature shows that digital

media technologies play crucial roles in presenting information, sharing knowledge or skills, alleviating cognitive loads and facilitating knowledge understanding [127]. This underscores the importance of PBC in promoting effective knowledge communication and acquisition through digital media. In addition, studies on problematic online behaviors among youths during the COVID-19 pandemic indicate influences of pandemic-related digital media use time and emotional regulation on problematic internet use, emphasizing the relevance of PBC in managing youth digital media usage in challenging environments [128]. In summary, PBC in digital media encompasses an individual's belief in their ability to effectively use digital media as well as their confidence in overcoming challenges associated with its use. This concept influences attitudes and intentions toward using digital technology services, knowledge sharing, digital health utilization and impacts of digital media exposure on various aspects of life. Assessing PBC thus informs strategies to cultivate positive user attitudes and technology acceptance.

2.9. Curiosity

Inherently, curiosity propels humans to explore and discover novelties [129]. When channeled towards technology, curiosity compels users to proactively interact with new systems [130]. This innate motivation is particularly instrumental for hedonic platforms like entertainment apps, where curiosity-evoked enjoyment substantially uplifts user experience [131]. In the context of Augmented Reality (AR), curiosity plays a significant role in influencing user engagement, motivation and learning experiences. Various studies have underscored the impact of curiosity in AR applications across different domains. Perceptual curiosity, as an intrinsic desire involving interest and attention towards novel perceptual stimuli, suggests that AR can offer original interactive experiences, thereby stimulating curiosity and enhancing user experiences [132,133] (Tiwari et al., 2023; Gómez-Rios et al., 2022). AR has been demonstrated to spark curiosity in various scenarios such as museum visits and scientific learning [134], with its use as a learning medium shown to increase children's curiosity [135]. The use of AR technology has been found to stimulate learning curiosity among healthcare professionals, indicating its potential to enhance professional development and knowledge acquisition [136]. In summary, the literature indicates that AR has the potential to stimulate curiosity across different domains including education, museums and professional development. The ability of AR to evoke curiosity highlights its value in creating engaging immersive experiences that can capture user interest and drive exploration and learning. Therefore, activating curiosity promises enhanced technology-user bonding across applications designed for daily enhancement or temporary escape.

2.10. Joy

Joy epitomizes the delight and fulfillment stemming from positive affective states. As emotions profoundly direct human technology interactions, joy plays a pivotal role in driving user acceptance and system usage [137]. Within hedonic technologies purposed for enjoyment, joy elicited from the systems propagates perceived well-being and reinforces active participation [138]. Given its motivational prominence, engineers leverage joy as a guiding design principle for captivating and habit-forming products across industries. Joy has been studied in various contexts in augmented reality (AR), particularly its impact on emotional and learning experiences [139]. The majority of the public expressed positive emotions, including anticipation, trust and joy, when referring to AR and virtual reality [140]. Joy has been identified as an essential element in accepting new AR technologies [141]. AR's emotional impacts extend beyond educational realms, as it also relates to privacy concerns and continued intention to use AR-based systems, where joy positively correlates with privacy concerns and continued intention to use [142]. Additionally, positive influences of using AR have been observed in various environments, such as relieving stress and anxiety as seen in commercial off-the-shelf video games, finding it helps alleviate stress and anxiety [143]. In summary, the literature demonstrates AR's potential to evoke positive emotions, especially joy, in various environments (including

entertainment scenarios). These findings underscore the importance of considering AR's emotional impacts when designing and implementing AR-based systems and applications.

3. Research Methods and Hypothesis

3.1. Hypothesis and Model Construction

3.1.1. The Influence of Aesthetics on Perceived Ease of Use, Perceived Usefulness, Curiosity, Perceived Behavioral Control and Joy

This study focuses on the impact of aesthetics in the context of AR technology on the design elements of interactive features in the online personal entertainment live streaming industry, which enhances consumers' positive aesthetic experiences. For instance, consumers can purchase virtual sunglasses to enhance interaction by paying for them and wearing them on the live streamer's face. In this context, the aesthetic effects of rich and dynamic design elements potentially influence consumers' usability and curiosity in their usage experience.

The influence of aesthetics on perceived usability has been a topic of interest in various fields such as computer science, business and psychology [144–148]. Several studies have emphasized the significant role of aesthetics in influencing perceived usability [87–89]. For example, aesthetics are important in supporting content and functionality, appealing to target audiences' tastes, creating necessary imagery and meeting the requirements of website types [149]. The aesthetic appeal of a system influences users' perceptions of aesthetics and usability post-usage [150]. Nia and Shokouhyar (2020) further support this point, indicating that website aesthetics directly and positively impact perceived usefulness, usability and privacy, thereby influencing trust [151]. Interface design has a significant positive impact on perceived usability, demonstrating the critical role of aesthetics in enhancing usability [152]. The synthesis of these references collectively demonstrate the positive impact of aesthetics on perceived usability. In conclusion, aesthetics play a crucial role in influencing users' perceptions of usability. Therefore, the research hypothesis H1 is proposed: Aesthetics positively influence perceived ease of use.

The impact of aesthetics on the usefulness of perception is a multifaceted phenomenon that has been extensively studied in the context of human–technology interaction [106,153,154]. The aesthetic design of systems and the emotional experiences during system usage significantly influence the perceived quality of use, indicating a strong relationship between aesthetics and perceived usefulness [155–158]. This is evidenced by the strong correlation between perceived usability and perceptual aesthetics before and after actual usage, highlighting the enduring impact of aesthetics on perceived usefulness. Further research has found that aesthetics are more stable than perceived usability, as it is primarily influenced by hedonic attributes, regardless of the user experience [100]. The aforementioned studies collectively emphasize the positive influence of aesthetics on the perceived usefulness in human–technology interaction and underscore the need to consider aesthetics as an indispensable factor in perceived usefulness. In this study, users purchase dynamic aesthetic interactive design features based on AR technology for decorative purposes, seeking to achieve both entertainment and functional effects. Therefore, the research hypothesis H2 is proposed: Aesthetics positively influence perceived usefulness.

The relationship between aesthetics and curiosity is indeed complex and multifaceted. Research indicates that aesthetic appeal can influence curiosity through various mechanisms. For instance, Sevilla and Meyer (2020) proposed that when consumers can only view a portion of an aesthetic product, their assessment of its appeal will be influenced by their curiosity about the complete appearance of the product and their inferences about it [159]. This suggests that aesthetic appeal can stimulate curiosity by creating a sense of anticipation and a desire for further exploration. Additionally, Reppa and McDougall (2022) found that aesthetic appeal can impact a visual search performance, indicating that visually appealing stimuli can attract attention and arouse curiosity [160]. People have found that the emotional valence and vividness of images can predict aesthetic appeal in various domains such as poetry and music [161–163]. These emotional and image-related

factors can enhance the overall appeal of stimuli, potentially stimulating further exploration of aesthetic content and interest. It is worth noting that the influence of aesthetic appeal on curiosity may be moderated by factors such as availability, credibility and gender [164]. In conclusion, the relationship between aesthetics and curiosity is influenced by various factors, such as anticipation, attention capture, emotional valence and vividness of imagery. These findings collectively indicate that aesthetic appeal can indeed influence curiosity, leading individuals to engage more deeply with aesthetically appealing stimuli. In this study, aesthetically designed interactive elements themselves have dynamic aesthetic effects, and dynamic interactive elements together with presenters will produce new aesthetic visual effects. Therefore, the hypothesis H3 is proposed: Aesthetics positively influence curiosity.

The impact of aesthetic appeal on perceptual behavior control has been a topic of interest across various fields [165]. It has been found that aesthetic attractiveness influences emotions, behaviors and perceptions. Studies have examined the influence of aesthetic appeal on behavior within the context of website design. Research has explored the impact of customers' perceptions of the visual landscape of online shopping electronic services on the perceived value of electronic shopping and customer loyalty, emphasizing the potential influence of aesthetic appeal on consumer behavior [166,167]. Aesthetic appeal has been found to have a small but significant impact on participants' intention to revisit or recommend a website, indicating its potential influence on behavioral control [168]. The relationship between aesthetic appeal and perceived value has also been investigated. Wang and Hsu (2019) proposed that interface aesthetics and product form aesthetics must mediate sustainable perceived value in order to positively influence consumers' purchase intentions, suggesting a potential connection between aesthetics and perceived value that in turn affects behavioral control [169]. In summary, the literature indicates that aesthetic appeal can influence user satisfaction, consumer behavior and perceived value, all of which contribute to perceptual behavior control factors. In this study, different online live streaming platforms utilize dynamic visual icon effects designed using AR technology, with varying types and levels of aesthetic visual effects for names and icons; thus, potentially influencing consumers' decision to engage in consumption behavior. Therefore, the research hypothesis H4 is proposed: Aesthetics positively influence perceived behavioral control.

Schindler et al. (2017) have highlighted the significance of happiness as a crucial component of aesthetic experience [170]. The rating of vividness by individuals has been found to predict the aesthetic appeal of poetry, indicating a potential connection between vivid imagery and positive emotions such as happiness [161]. Stimuli that are appealing may inherently act as rewards, and temporary emotional constraints may impact any rewards generated by aesthetic appeal, suggesting the potential of aesthetic appeal to evoke happiness [171]. Positive aesthetic emotional experiences, such as joy or vitality, can be highly rewarding and exciting [172]. In the context of consumer behavior, perceived joy positively influences consumers' willingness to purchase in a live streaming environment, indicating the potential impact of aesthetic emotional interest on consumer pleasure in a psychological context [116]. Joy indirectly influences mobile shopping intentions, particularly for Chinese consumers, underscoring the relevance of joy in the context of aesthetic appeal on consumer behavior [173]. In summary, the literature supports the connection between aesthetic appeal and happiness, with happiness being considered a component of aesthetic experience, emphasizing the potential impact of aesthetic appeal on evoking positive emotions such as joy. In this study, the interaction of different dynamic aesthetic decorations provides consumers with an engaging consumption experience, leading to positive online experiences for consumers and hosts. Therefore, the research hypothesis H5 is proposed: Aesthetics positively influence joy.

3.1.2. The Influence of Perceived Usefulness on Curiosity, Perceived Behavioral Control and Joy

In this study, perceived usefulness refers to consumers' assessment of the price of dynamic decorations, as well as the intended meaning conveyed by dynamic decorations. Research indicates that increasing perceived usefulness can stimulate curiosity [174,175]. The integration of the planned behavior theory and the hedonic motivation system model suggests that perceived usefulness has a direct impact on behavioral intention, indicating its influence on curiosity [176]. Furthermore, in the context of technological adoption, immersive experiences can trigger curiosity and impulsive purchase intentions, further supporting the impact of perceived usefulness on curiosity [177,178]. Personalized learning experiences also influence user curiosity [179]. This further illustrates, from a practical perspective, that the positive usability experience brought by new technologies has an impact on stimulating user curiosity and purchase behavior. Therefore, the evidence from these studies supports the viewpoint that the attractiveness of perceived usefulness does indeed affect curiosity. These findings suggest that when individuals perceive a technology or system as useful, it not only influences their intention to use it but also stimulates their curiosity. This relationship between perceived usefulness and curiosity is crucial for understanding user behavior and the adoption of various technologies. Factors to be considered in the usability of AR technology during live experiences include the need for dynamic decorative effects to accurately reflect consumer intent and provide rich, innovative social experiences for the host. Different dynamic effects can bring two distinct experiences, namely content experience and visual experience, which further arouse users' curiosity to explore diverse interactions with the host. In this process, AR technology not only brings rich visual experiences to entertainment live broadcasts but also offers the potential for personalized expression. Therefore, the research hypothesis H6 is proposed: Perceived usefulness positively influences curiosity.

In addition, the perceived usefulness has a positive impact on perceived behavioral control [109,180,181]. For instance, research has demonstrated that perceived usefulness significantly influences the intention to adopt mobile healthcare services [182]. The Theory of Planned Behavior (TPB) emphasizes the importance of perceived behavioral control in explaining the intention of health-related behavior categories [183]. This is consistent with the findings of Otchengco and Akiate (2021), which demonstrated perceived behavioral control and personal attitude influence entrepreneurial intention, moderated by perceived structural support [126]. Furthermore, the integration of TPB and the Technology Acceptance Model (TAM) and other models provides further insights into the impact of perceived usefulness on perceived behavioral control. For example, a seminal work extends the original TAM by incorporating perceived usefulness and perceived ease of use as determinants of behavioral intention and actual system use. The study provides insights into how perceived usefulness influences users' perceived behavioral control in adopting new technologies [184]. This further supports the link between perceived usefulness and perceived behavioral control [185]. In summary, the comprehensive evidence from these references demonstrates a consistent and robust relationship between perceived usefulness and perceived behavioral control. Evidence from various studies supports the viewpoint that perceived usefulness significantly influences perceived behavioral control, particularly within the integrated framework of TPB and other relevant models. Therefore, the research hypothesis H7 is proposed: Perceived usefulness positively influences perceived behavioral control.

Finally, the research has found that perceived usability significantly influences perceived usefulness, joy and other factors [175,176]. Simultaneously, perceived usefulness and perceived joy have a positive impact on consumers' purchase intention in a live streaming environment [116]. Additionally, Seng and Hee (2021) proposed that perceived usability has a positive impact on joy, further demonstrating the potential influence of perceived usefulness on joy [62]. These findings collectively indicate that perceived usefulness indeed

can influence joy, affecting consumers' purchase intention, perceived usability and overall user experience. H8: Perceived usefulness positively influences joy.

3.1.3. The Influence of Perceived Ease of Use on Perceived Usefulness, Joy, Perceived Behavioral Control and Curiosity

The Hedonic-Motivation System Adoption Model (HMSAM), proposed by Lowry et al. in 2013, has demonstrated the significant impact of perceived ease of use on perceived usefulness, joy, perceived behavioral control and curiosity. It has been found that perceived ease of use has a substantial influence on various aspects of user behavior and attitudes [47], such as in terms of user perception and satisfaction [186]. Integrating joy into the technology acceptance model shows the relevance of the joy value in the context of ease of use [176]. In this study, AR is adopted as a technology used in the live streaming industry, allowing users to personalize their preferred AR interactive decorations and consume them with ease on the designed interface, requiring only the purchase of sufficient points. This convenient consumption experience brings about perceived usefulness and also provides a satisfying interactive experience [111,187]. Therefore, the research hypotheses are proposed as follows: H9: Perceived ease of use positively influences perceived usefulness, and H10: Perceived ease of use positively influences joy.

Previous research has demonstrated that perceived ease of use significantly amplifies the impact of perceived behavioral control on the intention to engage in transactions using social networking platforms. When individuals perceive a system as easy to use, they actively moderate the influence of perceived behavioral control on their intention to use the system [188]. Additionally, Chittao and Dhotah (2016) found that perceived ease of use and perceived usefulness both significantly influence behavioral intention [189]. This suggests that when individuals perceive a system as easy to use, it facilitates their behavioral intention, indicating a potential connection between perceived ease of use and perceived behavioral control. Therefore, the adoption of AR technology in live streaming platforms potentially influences users' perceived control through the dynamic decoration's ease of use. This refers to consumers' subjective perceptions of their ability to control and operate these new entities. Consequently, the research hypothesis H11 is proposed: Perceived ease of use positively influences perceived behavioral control.

Numerous studies have ultimately found that the perceived ease of use significantly influences curiosity, indicating a positive correlation between these two factors [103,175,190,191]. For instance, the perceived ease of use is influenced by the perceived playfulness, including attention, curiosity and enjoyment, further emphasizing the potential impact of ease of use on curiosity [192,193]. It also suggests that individuals with high situational cognitive curiosity tend to prioritize the ease of use and enjoyment of social technical systems when seeking new knowledge, indicating a potential relationship between these factors [193]. In summary, the synthesis of these references indicates a close relationship between the perceived ease of use and curiosity. The perceived ease of use has a positive impact on curiosity, emphasizing the importance of considering ease of use as a factor in understanding and promoting curiosity. In this study, the interactive experience brought about by AR technology is a direct factor in triggering consumer curiosity. Therefore, the research proposes Hypothesis 12: Perceived ease of use positively influences curiosity.

3.1.4. The Influence of Curiosity on Immersion and Intention to Pay

The curiosity and immersive feeling of concentration directly influence the intention to continue using, and these factors impact user behavior [194,195]. There is a positive correlation between high enjoyment and curiosity and usability, indicating that curiosity provides intrinsic motivation [196]. Curiosity mediates the relationship between immersive experiences and attitude learning, playing a role in shaping the user experience. Curiosity's impact on willingness to pay is supported [197], indicating that curiosity influences perceived usability, which is a factor affecting willingness to pay. For example, the concept of AI-driven technology increases consumer curiosity, potentially leading to an increase in

willingness to pay [198]. In summary, these references collectively indicate that curiosity has a positive impact on immersion and willingness to pay. In this study, consumers' use of AR technology for dynamic decoration as virtual props to reward entertainment hosts serves as a new way to express support. Therefore, the research hypothesis H13 is proposed: Curiosity positively influences immersion, and research hypothesis H14: Curiosity positively influences intention to pay.

3.1.5. The Influence of Perceived Behavioral Control on Immersion

The sense of immersion in VR refers to the degree to which all modalities of sensory input are controlled by the synthetic environment interface, thereby creating a sense of "presence" [199]. It has been found that perceived behavioral control (PBC) significantly influences individual behavior in various environments, including the adoption of virtual reality (VR) technology [200]. In the context of VR technology, PBC has been demonstrated to impact individuals' continued intention and adoption of VR applications, particularly when individuals perceive fewer barriers and have more resources and opportunities [201]. This suggests that individuals' beliefs about their control over the use of VR technology will influence their participation and continued use of VR applications. In summary, the literature indicates that perceived behavioral control affects individuals' engagement with VR technology, and the sense of immersion in VR environments plays a crucial role in determining the effectiveness of VR applications in various domains. Therefore, the research hypothesis H15 is proposed: Perceived behavioral control positively influences immersion.

3.1.6. The Influence of Joy on Immersion and Intention to Pay

The impact of joy on immersion and willingness to pay in virtual reality (VR) environments has been an intriguing topic of recent research. Studies have found that joy, as an emotional state, can significantly influence individuals' immersion in VR experiences [202–204]. This suggests that joy not only contributes to immersion but also intertwines with the rich emotional experience of VR. Furthermore, research has identified the relationship between joy in VR environments and willingness to pay in the context of consumer behavior and purchase intent [116]. Additionally, the emotional state of joy is associated with high engagement and excitement, thereby enhancing user stickiness and participation in VR content [205] In summary, the literature indicates that the feeling of joy significantly influences immersion in VR experiences and plays a key role in shaping individuals' willingness to purchase VR content. Therefore, this study proposes the hypothesis H16: Joy positively influences immersion, as well as the hypothesis H17: Joy positively influences intention to pay.

Based on the literature review, this research proposes a research model (Figure 3) to examine factors driving users' immersion and intention to pay in AR-enabled entertainment live streaming. It is argued that perceived usefulness, perceived ease of use, perceived behavior control, aesthetics, curiosity and joy are key antecedents. Accordingly, the following hypotheses are formulated:

H1. *Aesthetics positively influence perceived ease of use.*

H2. *Aesthetics positively influence perceived usefulness.*

H3. *Aesthetics positively influence curiosity.*

H4. *Aesthetics positively influence perceived behavioral control.*

H5. *Aesthetics positively influence joy.*

H6. *Perceived usefulness positively influences curiosity.*

H7. *Perceived usefulness positively influences perceived behavioral control.*

H8. *Perceived usefulness positively influences joy.*

H9. *Perceived ease of use positively influences perceived usefulness.*

H10. *Perceived ease of use positively influences joy.*

H11. *Perceived ease of use positively influences perceived behavioral control.*

H12. *Perceived ease of use positively influences curiosity.*

H13. *Curiosity positively influences immersion.*

H14. *Curiosity positively influences intention to pay.*

H15. *Perceived behavioral control positively influences immersion.*

H16. *Joy positively influences immersion.*

H17. *Joy positively influences intention to pay.*

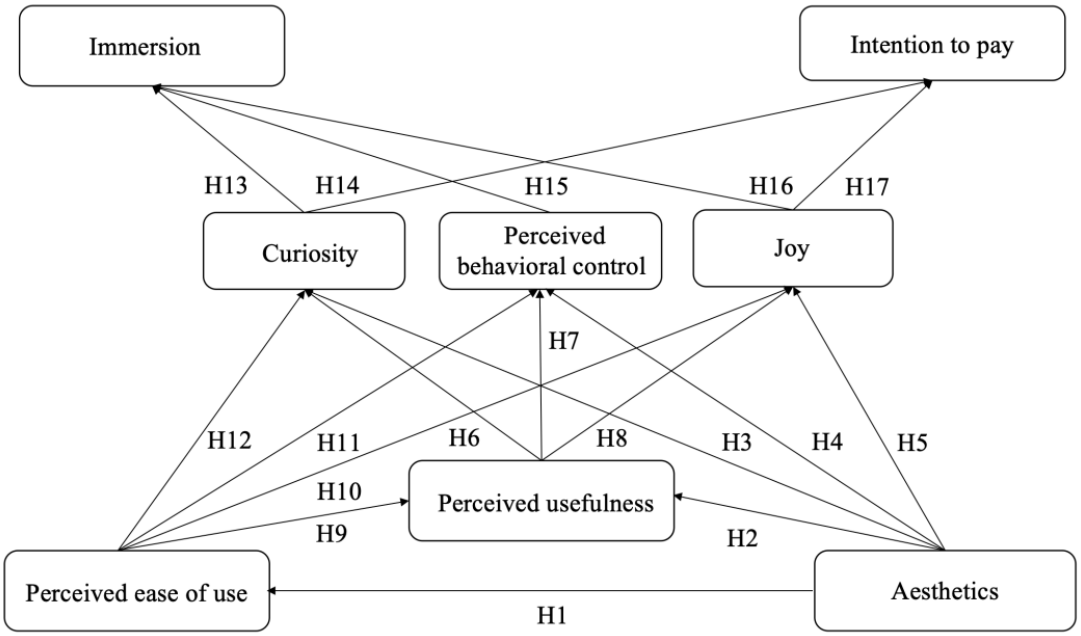

Figure 3. Hypothetical model.

3.2. Design of Questionnaire

In this study, questionnaire items are designed in accordance with the research topic and reference the relevant literature. Reference sources for variable codes, questions and scales are provided in Table 1.

Table 1. The construct and measurement items.

Construct	Code	Items	Reference
Perceived Usefulness	PU1	1. The anchor utilizes VR technology to create an engaging and interactive virtual experience.	[206]
	PU2	2. The anchor's VR content enhances my online entertainment experience.	
	PU3	3. The interactive nature of the anchor's VR content adds to the overall entertainment experience.	
	PU4	4. The anchor's use of VR effects meets my desire for innovative entertainment.	
Perceived Ease of Use	PEOU1	1. Navigating the anchor's content using VR is user-friendly.	[206]
	PEOU2	2. Using VR to explore the anchor's content does not require advanced technical skills.	
	PEOU3	3. Browsing the anchor's content with VR is straightforward.	
	PEOU4	4. The VR interface for the anchor's content is intuitive and easy to use.	
Perceived Behavioral Control	PBC1	1. I have access to various VR devices to explore the anchor's dynamic content.	[207–209]
	PBC2	2. I have the freedom to choose how I want to engage with the anchor's VR content.	
	PBC3	3. Browsing the anchor's VR content is effortless for me.	
	PBC4	4. I possess the knowledge and resources to utilize the anchor's VR content.	
Behavioral Intention to Pay	BI1	1. If the platform's AR features meet my needs, I am willing to pay for the experience.	[209,210]
	BI2	2. I am open to subscribing to the AR content of my favorite anchor.	
	BI3	3. I am more inclined to support high-quality and professional AR content through paid subscriptions.	
	BI4	4. If the live broadcast platform incorporates innovative AR technology, I would prioritize paying for it.	
Immersion	IM1	1. I am fully immersed in the anchor's VR content.	[210–212]
	IM2	2. The anchor's VR content provides a shield from external distractions.	
	IM3	3. Engaging with the anchor's VR content fully captivates my attention.	
	IM4	4. The anchor's VR content completely captures my interest.	
Aesthetics	AE1	1. The anchor's VR content has piqued my curiosity.	[213,214]
	AE2	2. I am eager to explore the virtual world presented in the anchor's VR content.	
	AE3	3. The anchor's VR content has sparked my imagination.	
Curiosity	CUR1	1. The anchor's VR content has piqued my curiosity.	[47,209]
	CUR2	2. I am eager to explore the virtual world presented in the anchor's VR content.	
	CUR3	3. The anchor's VR content has sparked my imagination.	
Joy	JOY1	1. Interacting with the anchor using VR is enjoyable.	[47,209]
	JOY2	2. The anchor's VR content provides an immersive and enjoyable experience.	
	JOY3	3. I find the dynamic content of the anchor's VR to be consistently engaging.	
	JOY4	4. Engaging with the anchor's VR content brings me great joy.	

3.3. Data Collection

In recent years, driven by the pandemic-induced live streaming e-commerce and the advent of the 5G era, live streaming has rapidly grown in the Chinese market, with the entertainment live streaming market entering a mature phase. According to statistical agency data, by 2023, the user base of online streaming platforms in China had reached 1.2 billion, becoming increasingly popular among the mobile internet user base [5,6]. With

the promotion of online live streaming on popular content platforms such as short videos, it has become a fundamental form of content, nurturing a large number of potential users. Different types of entertainment live streaming platforms are exploring their respective profit models. For instance, Huajiao Live focuses on discovering various high-quality hosts and attracting users through rich content to maintain high user engagement. WeChat Live leverages its platform WeChat, which has the largest user base in China, to expand entertainment live streaming, allowing every ordinary user to become a host with extremely low barriers to entry. Kugou Live provides a platform for the display and interaction of talents, both celebrities and amateurs, in a "live streaming + music" format, consolidating its leading position in the industry. "Live streaming +" has become an industry standard, no longer limited to traditional content, but incorporating emerging content such as gaming events and travel check-ins to offer users fresh experiences. Additionally, live streaming content fully utilizes its media attributes to integrate more socially valuable content and expand its influence through public welfare activities. With the rise of the concept of the "metaverse," some platforms are beginning to explore the integration of "online and offline", using AR technology to customize virtual images for online interaction or hosting offline events to enhance the sense of presence. Different platforms continuously enrich the industry development model through technological and content innovations, striving to enhance user engagement and commercial value. Therefore, given that WeChat live streaming is a key feature of WeChat, although it is still in a growth stage amidst the wave of internet live streaming, WeChat stands out as the most stable, highly trusted and widely used social platform in China. Hence, this study selects WeChat live streaming as the potential subject for user surveys.

This study utilized an online survey method to gather data, with the survey constructed on the Questionnaire Star survey platform. Subsequently, the survey link was distributed to eligible participants who met the criteria for this research study to complete. The online survey was conducted in November 2023 among users familiar with augmented reality (AR) interactions in entertainment live streaming. To encourage thoughtful responses and ensure data quality, participants completing the questionnaire will receive a monetary reward. Specifically, potential respondents should have prior experience with anchors using AR elements on platforms like WeChat streaming (host images are shown in Figure 4 with privacy protection). The process of user purchasing comprises three essential stages as outlined below.

Figure 4. The three steps of experiencing AR on live streaming.

The initial step involves selecting a preferred entertainment host on the platform. Subsequently, in Step 2, the process entails purchasing virtual currency to acquire an AR accessory and then gifting it to the host. The third step involves experiencing aesthetically pleasing visual effects when the host activates the AR accessory. All measurement items, apart from basic information, are rated on a 7-point Likert scale ranging from "strongly disagree" to "strongly agree". The survey introduction and guidelines are presented

through embedded URL links. Participation is entirely voluntary, and respondents can opt out at any time.

Ultimately, this study collected 454 samples, with participants excluding invalid samples (logical errors or excessive identical responses), resulting in a remaining sample size of 450. The questionnaire comprised 30 items, with 450 valid samples, aligning with Jackson's proposal. In maximum likelihood estimation, the ratio of estimated parameters to sample size (p/n) should exceed 1:10 [215] and was thus utilized in subsequent data analysis. Statistical analysis was conducted based on the data collected from valid questionnaires, examining the distribution of various demographic variables as presented in Table 2.

Table 2. Demographic characteristics of the respondents.

Sample	Category	Number	Percentage (%)
Gender	Male	228	50.67
	Female	222	49.33
Age	≤20	65	14.44
	21–40	249	55.33
	41–65	115	25.56
	≥65	21	4.67
Education	High school diploma or below	81	18.00
	Associate degree	137	30.44
	Bachelor's degree	191	42.44
	Master's degree	25	5.56
	Doctoral degree	16	3.56
Marriage Status	Married	309	68.67
	Unmarried	141	31.33
Time to use live streaming	≤1 y	101	22.44
	2 y	144	32.00
	3 y	161	35.78
	≥4 y	44	9.78
Platform	WeChat	45	10.00
	TikTok	115	25.56
	Douyu	91	20.22
	Kuaishou	87	19.33
	Huya	101	22.44
	The others	11	2.44

4. Research Data Analysis and Results

4.1. Reliability Analysis

In this questionnaire, Cronbach's alpha and corrected item-total correlation (CITC) were used to assess reliability. As shown in Table 3, all CITC values were above 0.4. Removing any items did not significantly improve alpha, with all constructs exhibiting Cronbach's alpha greater than 0.6 [216]. This indicates high internal consistency between measurement items and constructs in this study [217,218], supporting further analysis.

Table 3. Results of reliability analysis.

Item	Mean	Std. Deviation	CITC	Cronbach's α If Item Deleted	Cronbach's α
PU1	4.358	1.632	0.740	0.855	0.885
PU2	4.316	1.669	0.757	0.849	
PU3	4.380	1.661	0.738	0.856	
PU4	4.356	1.669	0.759	0.848	
PEOU1	4.384	1.672	0.710	0.845	0.873
PEOU2	4.389	1.642	0.729	0.837	
PEOU3	4.409	1.676	0.739	0.833	
PEOU4	4.478	1.599	0.735	0.835	

Table 3. *Cont.*

Item	Mean	Std. Deviation	CITC	Cronbach's α If Item Deleted	Cronbach's α
AE1	4.362	1.638	0.692	0.749	0.826
AE2	4.438	1.551	0.666	0.776	
AE3	4.413	1.626	0.689	0.752	
CUR1	4.513	1.598	0.674	0.739	0.815
CUR2	4.431	1.585	0.656	0.757	
CUR3	4.513	1.639	0.670	0.743	
JOY1	4.260	1.689	0.722	0.850	0.878
JOY2	4.304	1.575	0.748	0.840	
JOY3	4.291	1.693	0.724	0.849	
JOY4	4.384	1.654	0.755	0.836	
PBC1	4.369	1.669	0.734	0.830	0.870
PBC2	4.256	1.666	0.732	0.831	
PBC3	4.424	1.635	0.710	0.839	
PBC4	4.369	1.631	0.717	0.837	
BI1	4.427	1.613	0.733	0.855	0.883
BI2	4.509	1.682	0.740	0.852	
BI3	4.491	1.628	0.771	0.840	
BI4	4.433	1.630	0.739	0.852	
IM1	4.513	1.588	0.715	0.830	0.866
IM2	4.509	1.545	0.693	0.838	
IM3	4.424	1.652	0.718	0.829	
IM4	4.376	1.634	0.739	0.820	

4.2. Exploratory Factor Analysis

In this study, SPSS 26.0 was utilized to conduct exploratory factor analysis assessing unidimensionality of all constructs. Principal component analysis was adopted whereby new factors with eigenvalues exceeding 1 were extracted for each dimension. The resulting KMO values were all above 0.70, and Bartlett tests significant at $p < 0.05$, indicating the suitability of the data for factor analysis [219,220]. For every construct only one new factor, explaining over 70% of total variance, could be extracted with an eigenvalue greater than 1 [221], demonstrating satisfactory validity [222].

Furthermore, the correlation matrix suggested partial correlations between the items, rejecting the null hypothesis of the identity matrix. Hence, exploratory factor analysis was applicable [223]. Notably, all item communalities exceeded 0.5 with factor loadings over 0.6. This, aligned with the emergence of a single factor for every construct, showed inter-relationships between items measuring that same dimension which met the recommended criteria [222]. Overall, the results provide adequate evidence for the unidimensionality of all measurement constructs.

Due to the fact that the data for this study was self-reported by participants, there is a potential for common method bias. During the data collection process with the research sample, the experimenter emphasized the anonymity and confidentiality of the questionnaires, stating that the data would be used solely for scientific research purposes in order to minimize the sources of common method bias. To examine common method bias, this study employed exploratory factor analysis (EFA), also known as the Harman single-factor test method. This involved conducting an EFA on all items of the scales, where if only one factor emerged or if the first factor explained a significant amount of variance (typically above 50%), it would indicate the presence of common method bias; conversely, the absence of such bias would be indicated [224]. The results revealed that without rotation, eight eigenvalues greater than 1 were obtained, with the first factor explaining 33.17% of the variance (<40%). Therefore, it can be inferred that common method bias did not significantly impact the findings of this study.

4.3. Confirmatory Factor Analysis

Convergent and discriminant validity were assessed using confirmatory factor analysis (CFA).

Firstly, convergent validity was examined. As shown in Table 4, all model fit indices met the recommended criteria. All measurement items exhibited standardized factor loadings exceeding 0.5, with statistically significant critical ratios ($p < 0.05$), satisfying convergent validity metrics. Moreover, the construct reliability (CR) values for all structures were above 0.6 [225] while the average variance extracted (AVE) estimates exceeded 0.36 [226]. As displayed in Table 5, fit statistics confirm the adequacy of the first-order CFA model to describe the data [226]. Taken together, these results in Table 5 provide evidence supporting the convergent validity of all measurement constructs.

Table 4. Adaptation indices of the CFA model.

Common Indices	x^2	df	x^2/df	GFI	AGFI	CFI	NFI	RMSEA	SRMR
Judgement criteria	-	-	<3	>0.9	>0.9	>0.9	>0.9	<0.08	<0.08
CFA value	417.111	377	1.106	0.943	0.93	0.943	0.946	0.015	0.028

Table 5. CFA validity of convergence.

Item	Coef.	Std. Error	Z (CR)	Sig.	Factor Loading	AVE	CR
PU1	1	-	-	-	0.801	0.658	0.885
PU2	1.049	0.057	18.51	0.001	0.821		
PU3	1.014	0.057	17.923	0.001	0.798		
PU4	1.052	0.057	18.578	0.001	0.824		
PEOU1	1.000	-	-	-	0.772	0.633	0.873
PEOU2	1.011	0.060	16.776	0.001	0.794		
PEOU3	1.055	0.062	17.145	0.001	0.812		
PEOU4	0.997	0.059	16.989	0.001	0.804		
AE1	1	-	-	-	0.799	0.613	0.826
AE2	0.897	0.061	14.671	0	0.756		
AE3	0.986	0.066	14.919	0	0.793		
CUR1	1	-	-	-	0.783	0.596	0.815
CUR2	0.956	0.068	14.008	0.001	0.755		
CUR3	1.018	0.072	14.122	0.001	0.777		
JOY1	1	-	-	-	0.783	0.644	0.879
JOY2	0.97	0.055	17.698	0.001	0.815		
JOY3	1.007	0.059	17.042	0.001	0.787		
JOY4	1.031	0.058	17.909	0.001	0.825		
PBC1	1	-	-	-	0.805	0.627	0.87
PBC2	0.994	0.056	17.607	0.001	0.802		
PBC3	0.944	0.056	16.986	0.001	0.776		
PBC4	0.952	0.055	17.187	0.001	0.784		
BI1	1	-	-	-	0.79	0.655	0.883
BI2	1.058	0.06	17.697	0.001	0.801		
BI3	1.076	0.058	18.647	0.001	0.841		
BI4	1.029	0.058	17.77	0.001	0.804		
IM1	1	-	-	-	0.783	0.619	0.867
IM2	0.943	0.059	16.049	0.001	0.758		
IM3	1.05	0.063	16.746	0.001	0.79		
IM4	1.071	0.062	17.233	0.001	0.814		

Next, discriminant validity was appraised using the heterotrait–monotrait ratio (HTMT). As suggested by Henseler et al. (2015) and Hair et al. (2019), HTMT compares inter-construct correlations against intra-construct correlations, serving as a suitable statistic for evaluating discriminant validity in SEM models with many constructs. HTMT values below 1 indicate validity, with estimates under 0.85 or 0.90 considered satisfactory evidence [227,228]. As shown in Table 6, all HTMT estimates in this study were below the thresholds, demonstrating adequate discriminant validity across the constructs.

Table 6. Discriminant validity (HTMT method).

	PU	PEOU	AE	CUR	JOY	PBC	BI	IM
PU	-							
PEOU	0.42	-						
AE	0.431	0.493	-					
CUR	0.427	0.445	0.413	-				
JOY	0.409	0.441	0.403	0.381	-			
PBC	0.445	0.424	0.421	0.395	0.451	-		
BI	0.479	0.459	0.472	0.395	0.393	0.498	-	
IM	0.448	0.443	0.422	0.431	0.4	0.429	0.399	-

4.4. Results of the Structural Equation Model

To validate the hypothesized model, a structural equation model was established in AMOS. Path analysis of latent variables was conducted using Amos 24 to assess their impact. The maximum likelihood method was employed with 2000 bootstrap samples at a 95% confidence interval. Key model fit indices were: $x^2/df = 1.392$, RMSEA = 0.030, GFI = 0.927, NFI = 0.929, CFI = 0.979, AGFI = 0.913, SRMR = 0.071, all meeting recommended thresholds (Hair et al., 2016). As shown in Table 7 and Figure 5, path coefficients between 0.1–0.3, 0.3–0.5 and 0.5–1.0 signify weak, moderate and strong influences, respectively, based on past research [229]. The illustrated structural model has the effect sizes labelled, evidencing positive inter-construct correlations.

Table 7. Adaptability of SEM.

Common Indices	x^2	df	x^2/df	GFI	AGFI	CFI	NFI	RMSEA	SRMR
Judgement criteria	-	-	<3	>0.9	>0.9	>0.9	>0.9	<0.08	<0.08
Value	552.546	389	1.392	0.927	0.913	0.979	0.929	0.030	0.071

In summary, all 17 proposed hypotheses were supported, providing a strong validation of the research model, as shown in Table 8. Specifically, aesthetics had significant positive effects on perceived ease of use (H1: $\beta = 0.495$, $p < 0.001$), perceived usefulness (H2: $\beta = 0.293$, $p < 0.001$), curiosity (H3: $\beta = 0.213$, $p < 0.001$), perceived behavior control (H4: $\beta = 0.213$, $p < 0.001$), perceived pleasure (H5: $\beta = 0.188$, $p < 0.001$) and immersion (H7: $\beta = 0.224$, $p < 0.001$). Furthermore, significant relationships were found between perceived ease of use and perceived behavior control (H7: $\beta = 0.224$, $p < 0.001$), perceived usefulness and pleasure (H8: $\beta = 0.239$, $p < 0.001$), perceived ease of use and perceived usefulness (H9: $\beta = 0.274$, $p < 0.001$), perceived ease of use and pleasure (H10: $\beta = 0.269$, $p < 0.001$), perceived usefulness and perceived behavior control (H11: $\beta = 0.273$, $p < 0.001$), as well as perceived ease of use and curiosity (H12: $\beta = 0.270$, $p < 0.001$). Moreover, curiosity positively affected both immersion (H13: $\beta = 0.303$, $p < 0.001$) and intention to pay (H14: $\beta = 0.339$, $p < 0.001$). Perceived behavior control also impacted immersion (H15: $\beta = 0.242$, $p < 0.001$). Likewise, pleasure influenced immersion (H16: $\beta = 0.203$, $p < 0.001$) and intention

to pay (H17: β = 0.2973, $p < 0.001$). Based on the beta values, the hypotheses are ranked as follows: H1 > H14 > H13 > H9 > H11 > H12 > H10 > H8 > H7 > H2 > H3 > H4 > H15 > H6 > H5 > H17 > H16. It can be seen from the hypothesis ranking that H1 has the largest effect while H16 has the smallest effect among the 17 hypotheses tested.

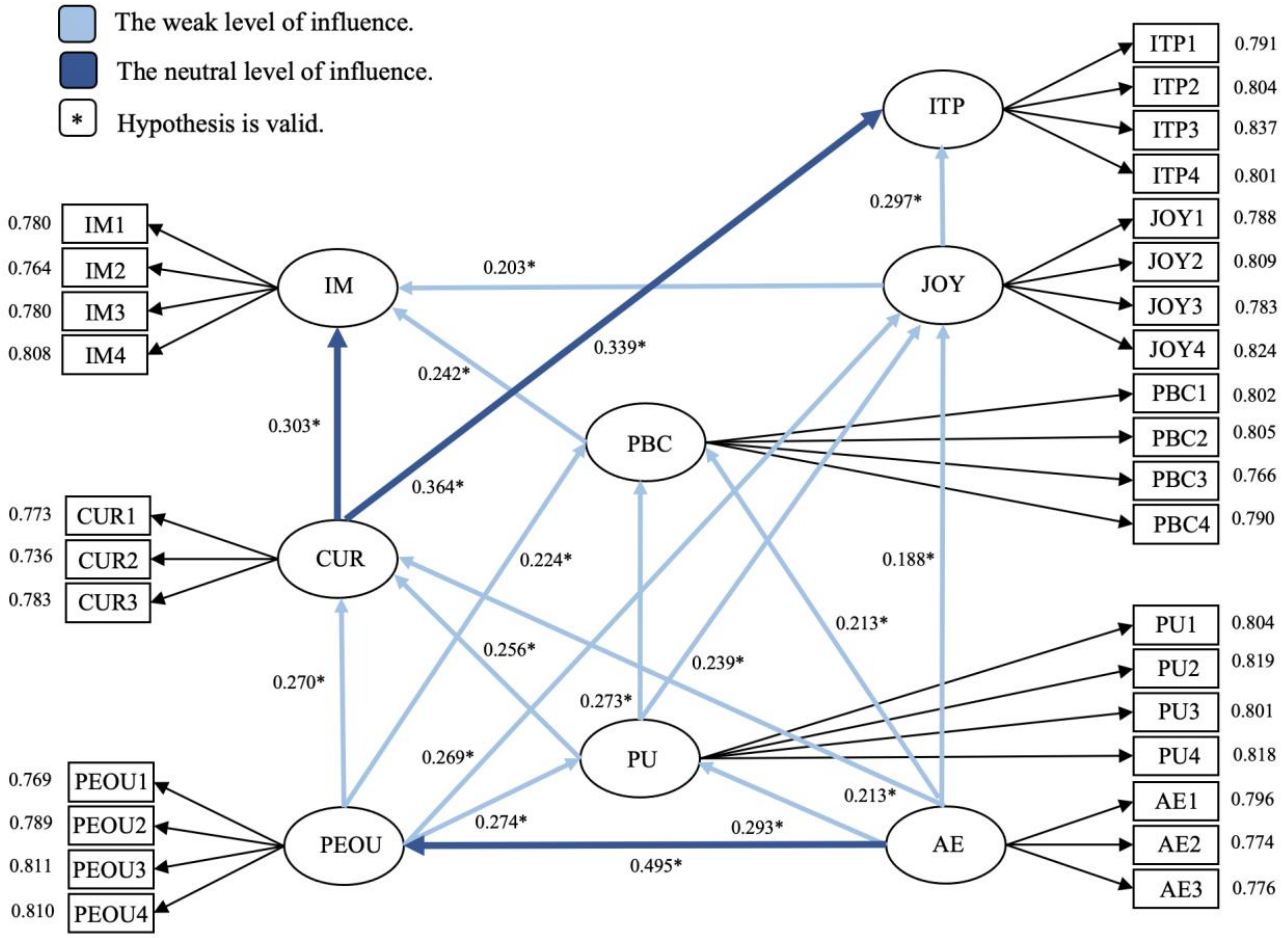

Figure 5. Results of the structural equation model.

Table 8. Regression coefficients.

Relationship	Estimate	S.E.	C.R.	*p*	Hypotheses	Support
AE ⇒ OY	0.192	0.063	3.059	0.002	H5	Yes
AE″ ⇒ CUR	0.21	0.063	3.36	0.001	H3	Yes
AE″ ⇒ PBC	0.219	0.063	3.451	0.001	H4	Yes
AE″ ⇒ PEOU	0.488	0.057	8.624	0.001	H1	Yes
AE″ ⇒ PU	0.295	0.062	4.741	0.001	H2	Yes
CUR ⇒ IM	0.31	0.059	5.291	0.001	H13	Yes
CUR ⇒ ITP	0.336	0.056	6.024	0.001	H14	Yes
JOY ⇒ IM	0.2	0.053	3.815	0.001	H16	Yes
JOY ⇒ ITP	0.284	0.051	5.53	0.001	H17	Yes
PBC ⇒ IM	0.237	0.053	4.474	0.001	H15	Yes
PEOU ⇒ CUR	0.27	0.062	4.368	0.001	H12	Yes
PEOU ⇒ JOY	0.278	0.062	4.466	0.001	H10	Yes
PEOU ⇒ PBC	0.233	0.062	3.756	0.001	H7	Yes
PEOU ⇒ PU	0.28	0.061	4.559	0.001	H9	Yes
PU ⇒ CUR	0.25	0.057	4.401	0.001	H6	Yes
PU ⇒ JOY	0.242	0.057	4.236	0.001	H8	Yes
PU ⇒ PBC	0.279	0.058	4.818	0.001	H11	Yes

5. Discussions

5.1. The Value Enhancement Role of AR Technology in Network Entertainment Live Streaming

This study utilized quantitative methods to systematically evaluate the impact mechanisms of Augmented Reality (AR) in live streaming. The research confirmed that AR technology significantly enhances users' perceived usefulness of online entertainment live streaming services. This finding aligns with the results of Mekni et al. AR's rich mixed reality content and interactions improve judgments of functionality and practicality, thereby increasing technology adoption rates [230]. This is primarily attributed to AR's rich, novel and realistic visual effects, which attract and focus users' attention, deepening their understanding of the value of AR.

The results from H1 to H17 indicate that the use of AR technology with a strong aesthetic design foundation for dynamic decorations can effectively enhance user immersion and willingness to pay. This aligns with our proposed theoretical model. Specifically, research hypothesis H1 confirms that adopting virtual dynamic aesthetic decorations created with AR technology positively impacts users' perceived ease of use, consistent with previous studies [151,152,231,232]. This reveals that in the live streaming industry, aside from attracting users through traditional advertising and promoting more excellent live broadcasts to meet entertainment needs [233,234], incorporating AR technology to design interactive dynamic decorations with aesthetic significance can lower user barriers and enhance usability for consumers or potential users. Similarly, research hypothesis H2 confirms that virtual dynamic aesthetic decorations created with AR technology significantly influence users' perceived usefulness, consistent with previous research [153–157]. This finding is intriguing because traditional views often separate aesthetics and functionality for independent evaluation [235]. However, in the context of AR technology in live streaming scenarios, the connection between aesthetics and functionality becomes relevant. As shown in Figure 3 of this study, when consumers want to express a feeling of chicness towards the host, decorations with aesthetic appeal need to be designed to convey this functional concept of chicness. At this point, the successful transformation of aesthetics into functionality occurs, where aesthetics become a direct factor for consumers to decide on making a purchase. Therefore, this finding reveals that the relationship between aesthetics and perceived usefulness is relative and depends on the usage scenario. The research hypothesis H3 confirms the significant impact of aesthetics on curiosity. The relationship between aesthetics and curiosity has been widely validated [101–106]. In this study, the diverse dynamic decorations that arouse users' curiosity meet consumers' needs for interaction with hosts across different categories, spending levels, functions and emotional aspects, providing consumers with choices based on their individual needs. Hypothesis H4 confirms the influence of aesthetics on perceived behavioral control. The complexity of aesthetic effects in AR technology design on live streaming platforms varies, with high-quality aesthetic effects typically characterized by longer duration and richer content. Therefore, the sophistication or complexity of decorations in different categories on the interface directly indicates the level of difficulty in consumption, where components with higher consumption amounts are usually more refined and complex. This finding is consistent with the actual user experience in this study case. It reveals a principle that highly aesthetic decorations potentially guide the size of consumption for designers. Hypothesis H5 confirms the significant impact of aesthetics on joy, consistent with previous research indicating that aesthetics can evoke joy [159–164]. In the entertainment live streaming context, elaborately designed dynamic effects carry various meanings such as blessings and humor. Clearly, AR technology further integrates dynamic effects with the host's image, enhancing users' joy experience. In conclusion, it is evident that in the entertainment live streaming context using AR technology, aesthetics have a multidimensional impact on user experience.

In the context of entertainment live streaming, research hypothesis H6 confirms the positive impact of perceived usefulness on user curiosity, a finding also supported by previous studies [174–179]. In this study, perceived usefulness refers to consumers' perceptions

of the pricing of dynamic decorations and the intended meanings behind them. When consumers realize that AR technology-designed interactive decorations can accurately convey different emotions (such as joy and humor) and functions (spending limits), the diverse choices further stimulate consumer curiosity. Similarly, research hypotheses H7 and H8 confirm the impact of perceived usefulness on perceived behavioral control and joy. Due to the functional differences in various dynamic decorative effects, consumers' operational behaviors in selecting different styles can lead to different visual outcomes, posing a challenge as consumers need to pay for their choices based on the pre-assessment of whether the dynamic decorative effects meet their expectations. Furthermore, the decorative aspects fulfilling users' functional expectations evidently satisfy emotional needs for interaction between consumers and hosts in the entertainment setting, achieving the purpose of creating an atmosphere for this new form of social interaction.

The hypotheses H9–H12 of this study confirm that perceived ease of use significantly influences users' perceived usefulness, joy, perceived behavioral control and curiosity. These research findings are consistent with previous studies [47,50–56,66–69], and the results of the hypotheses in the Hedonic Motivation System Acceptance Model (HMSAM) have been revealed in this study. Furthermore, when consumers can quickly understand the meaning of the dynamic effects of icons with dynamic decorations (as shown in Figure 4), they are more likely to use them in line with their expectations, thereby achieving the purpose of perceived usefulness and experiencing more joy. Similarly, perceived behavioral control refers to the ease or difficulty of estimating the corresponding consumption amount and effects of dynamic decorations. When consumers perceive the operational process as quick and convenient, they are more likely to engage in payment behavior. This finding clearly indicates that, in addition to the aesthetics of the interface, clearly conveying the effects of payment and consumption amount to users is necessary. This will enhance user experience and satisfaction, reduce the risk of improper operation and help reduce the loss of users due to misleading consumption caused by poor design of apps [236,237]. H12 demonstrates that a user-friendly interactive interface can reduce consumers' confusion and frustration during use, and stimulate their curiosity. This highlights the importance of interface design in guiding consumer emotions.

H13 and H14 have demonstrated the significant impact of curiosity on user immersion and intention to pay. Curiosity represents an intrinsic drive for seeking new knowledge, which is beneficial for long-term user engagement and learning. It can enhance user attention and participation in content, leading to a deeper immersive experience. This provides insights for management, suggesting that live streaming platforms should prioritize how to continuously stimulate and satisfy users' curiosity for new knowledge through AR technology. For instance, hosts should incorporate a variety of interactive projects based on trending topics to attract users; regularly introduce innovative features and diverse themes to engage potential users; utilize personalized recommendation technology to enhance content coverage and explore users' latent interests. Additionally, research hypothesis H15 posits that perceived behavioral control influences user immersion. Prior studies support this research finding [199–201]. To enhance users' sense of behavioral control, platforms should focus on the following aspects: optimizing the usability of AR content and interface operations to reduce learning costs; providing diverse interactive methods to meet personalized experiential needs; guiding users to participate in creative interactive projects to enhance subjective involvement and a sense of control.

The research findings of H16 and H17 ultimately demonstrate the significant impact of curiosity on user immersion and intention to pay. This implies that positive emotional states such as happiness play a crucial role in the quality of user experience and engagement. Theoretically, happiness, by satisfying users' psychological needs, is beneficial in enhancing users' subjective evaluations of content. As a positive emotion, it can profoundly influence users' cognition and behavioral decisions [238,239]. Particularly, the impact of happiness on payment intention ranks second only to curiosity among indirect influencing factors, highlighting the important role of happiness in guiding user purchasing behavior.

From a managerial perspective, platforms and content creators should focus on how to cultivate a positive mood through personalized content. For example, content creators can combine personal characteristics and interactive methods to foster a sense of affinity between themselves and the audience. Additionally, platforms can utilize big data analysis of user preferences to accurately recommend content that brings entertainment value. Furthermore, it is recommended that platforms incorporate occasional relaxed group activities to enhance users' emotional well-being and alleviate stress during engagement.

5.2. The Influencing Factors of Immersion and Intention to Pay

The research findings demonstrate that well-designed AR technology interactive works with good aesthetics can significantly enhance the user immersion experience and intention to pay by improving the perceived usefulness, perceived ease of use, perceived behavioral control, curiosity and joy. This study hypothesizes that H1–H5 demonstrate the positive influence of aesthetics introduced in this study on perceived ease of use, perceived usefulness, curiosity and perceived behavioral control. Evidently, aesthetics are an indispensable key factor in facilitating the design of interactive live broadcasting using AR technology. This finding is consistent with existing research conclusions, which indicate that aesthetics are an important factor in attracting user attention, enhancing perceived usefulness and ease of use and positively influencing consumer purchasing decisions [120,151,159]. The innovation of this study, in contrast to previous research, lies in the theoretical expansion of the Hedonic Motivation System Adoption Model by introducing aesthetics as a crucial factor in the adoption of AR technology in the entertainment live broadcasting industry, and validating the impact pathway of this aesthetic factor. However, it is important to note that this does not imply that aesthetics will have a positive impact on consumer willingness to purchase in all areas, as it is also influenced by other factors such as national considerations. Arifah and Juniarti (2021) pointed out that perceived value and perceived ease of use are key factors driving consumer purchase intention, and for Indonesian consumers, the aesthetic appeal of a watch interface does not directly affect purchasing behavior [240]. Therefore, the type of product and national factors may be influencing factors for the impact of aesthetics on consumer intention. Another study suggests that the aesthetic appeal of website interfaces does not have a direct impact on usability [145]. However, this does not negate the impact of aesthetics on usefulness, or rather, the influence of aesthetics on consumer decision-making is conditional. The main difference between the aforementioned studies and this study lies in the fact that under the influence of AR technology, the possibilities for interaction are more diverse; thus, enhancing the importance of aesthetics, especially the impact of aesthetics on the visual effects of the host. Additionally, the paths analysis in Figure 4 indicates that hypothesis H13 found curiosity to be the most influential factor impacting user immersion and intention to pay, which is supported by previous studies identifying curiosity as an essential motivation for individuals seeking new information and experiences [241,242]. Moreover, curiosity's role in decision-making and risk taking is especially related to intention to pay, since curious users about a product or service may be more inclined to invest in satisfying their curiosity [243,244]. Hypotheses H16 and H17 confirmed that pleasure is the least impactful factor influencing user immersion and intention to pay. This implies that triggering user curiosity is critical to enhancing user experience. Immersion represents a good user experience, which forms the foundation of user's intention to pay [245].

In this study, the factors directly affecting immersion and intention to pay are curiosity, perceived behavioral control and pleasure. According to the influence of H13, H15 and H16, the importance order of the three variables influencing immersion is curiosity, perceived behavioral control and joy. Judging from the influence of H14 and H17, the importance order of the two variables influencing intention to pay is curiosity and pleasure. This reveals the relative weights of factors impacting immersion and intention to pay. Regarding the direct determinants of intention to pay, this study also highlights the guiding role of curiosity [245]. Users are more inclined to pay for AR as they are attracted to novel content.

Additionally, the study conducted in H17 provides evidence that positive user experiences contribute to the decision-making process regarding payments [246]. Therefore, stimulating intrinsic motivations is critical to converting spending intention, as brand managers can create meaningful experiences and strong emotional bonds to improve loyalty and premium intention [247]. In terms of indirect factors, those influencing immersion and intention to pay are ease of use, perceived usefulness and aesthetic appeal. Per factor weights, those impacting curiosity are ease of use, usefulness and appeal (H12, H6, H3). Factors affecting behavioral control are usefulness, ease of use and appeal (H12, H6, H3). Factors of pleasure are ease of use, usefulness and appeal (H12, H6, H3). The order of factors impacting usefulness is appeal and ease of use (H2, H9). Prioritizing indirect factors reveals an alternative approach to augmenting immersion and intention to pay propensity. Specifically, targeted promotion based on key factor weights is advisable, such as focusing on appeal and usability to enhance curiosity.

The aforementioned findings establish the relative importance of complex mechanisms and variables influencing users' cognitive processes, emotions and behaviors. It provides a strategic framework for online live broadcasting platforms employing augmented reality technology, emphasizing the optimization of positive psychological experiences through interaction, novelty and aesthetics alongside diverse functionalities. In resource constraints, prioritizing impact factors acts as a critical reference for platform enterprises formulating effective business strategies [248]. Consequently, enterprises can leverage these research insights foundationally in decision-making to accomplish favorable marketing goals.

5.3. The Value of Aesthetics in the Application of AR Technology

This study asserts that H1–H5 support the notion that aesthetics play a critical role in AR user adoption, aligning with findings from Schweiger et al. (2021) [46]. This suggests that well-designed visual effects and simulations enhance perceived usefulness of AR systems and willingness to engage. Furthermore, H3 and H5 demonstrate aesthetic experiences elicit emotions like curiosity and enjoyment, facilitating positive human–computer interaction. This underscores the significance of visuals and smooth interaction for AR's influence on user psychology and behaviors [249]. Particularly, innovative and dynamic AR content visuals stimulate intrinsic motivation to actively control content while facilitating a reduced cognitive load through user-friendly interfaces. Traditional online broadcasts face challenges creating such immersive and controllable atmospheres due to technical constraints [12,250]. In contrast, AR provides users with a more open and engaging immersive environment meeting emotional needs through superior experiences. Consequently, the art and interactivity of AR content achieve synergy of functionality, emotion and experience collectively cultivating engaging journeys [251]. These insights offer value for platforms leveraging AR to enrich content and enhance interactions. Therefore, alongside expanding functionality, sufficient attention to aesthetic design is prudent. In comparing the impact of H1-H5 pathways, it is evident that the hierarchy of aesthetic influence is as follows: H1 > H2 > H3 = H4 > H5. This observation indicates that aesthetics have the greatest impact on perceived ease of use, while the impact on pleasure is minimal. This finding theoretically elucidates the pattern of aesthetic influence. For apps developed using AR technology, this insight can help enhance the emphasis on aesthetics among management and designers from a theoretical perspective, and can be utilized to effectively allocate design resources, particularly when addressing issues related to perceived usability.

In contrast to other studies that primarily focus on the traditional aesthetics in website or app interfaces [154,164,252], there is relatively less research that articulates the application of AR technology in aesthetics from an expanded theoretical perspective, particularly in the context of user entertainment live streaming, which is an emerging industry with economic growth potential. Given that the factors influencing consumer immersion and willingness to consume are multidimensional [253,254], this study aims to provide a more precise and diverse understanding of the relationship between aesthetics and AR from the perspective of the expanded theory of the Hedonic Motivation System Adoption Model,

thereby addressing the shortcomings of the previous research. The research findings, as supported by hypotheses H1–H5, broadly align with previous studies on the positive significance of aesthetic elements in consumer adoption of AR technology [255,256]. By incorporating aesthetics into the model, this study reveals the direct impact of aesthetic design on user cognition and emotions, shedding new light on the importance of aesthetics in AR scenarios. Theoretically, aesthetic design can enhance perceived content value and usability through visual and sensory appeal, fostering positive emotions. Empirical results demonstrate that in AR dynamic decoration examples, excellent visual design significantly enhances the judgment of the host's image and content value by providing a rich interactive experience, thereby stimulating user curiosity and driving engagement. Furthermore, with the advancement of AR technology and biometric recognition capabilities, it will be possible in the future to achieve personalized aesthetic design dynamically integrated with scenes and user states, thereby providing a deeper immersive experience. This study's findings propose practical insights for product design and content marketing at both user engagement and business model levels: firstly, emphasizing interface interaction and optimizing visual details to stimulate user curiosity; secondly, combining efficient recommendations from content providers to enhance user engagement. Theoretically, this offers new insights into the impact mechanisms of AR technology in cultural and retail fields, while practically guiding product and marketing innovations driven by user needs.

5.4. Aesthetic Variables Expand the Theory of HMSAM

This study expanded the original HMSAM theoretical model by incorporating aesthetic variables. In contrast to previous HMSAM models that primarily focused on functional and external components, this research emphasizes that the aesthetic experience is an essential part of an overall emotional experience, satisfying users' non-functional needs within the hedonic system. In this study, hypotheses H1–H5 were introduced to incorporate aesthetics as an independent variable to examine its impact on users' cognition, emotions and behaviors (perceived usefulness, perceived ease of use, perceived behavioral control, curiosity and joy). The findings of this study indicate that aesthetics significantly influence various aspects of the user experience. This contributes to the extension of the Hedonic Motivation System Adoption Model (HMSAM), suggesting that aesthetic experience should be considered when elucidating the impact of technology on emotional driving factors. The primary distinction from previous work lies in broadening the research scope of the hedonic motivation theory rather than merely applying it to different domains [102,257]. This study reveals that aesthetics are not merely a utilitarian judgment but also contribute to the overall emotional experience, generating non-utilitarian and emotional incentive effects for users. Specifically, refined AR content and environments not only enhance perceived utility but also fulfill emotional needs such as enjoyment and exploration, thereby fostering deeper engagement. This enriches the intrinsic mechanisms of technology acceptance within the hedonic motivation theory. Therefore, future research should pay more attention to the synergistic interaction between aesthetics and functionality and emotions.

The study emphasizes the significant role of aesthetic variables in understanding user experience and behavioral mechanisms, supported by a large body of literature. Findings indicate that aesthetic design, through visual appeal, can influence users' perception of content value and usability, as well as evoke intrinsic motivations such as curiosity and pleasure. This reveals the underlying mechanisms of aesthetic variables in influencing the emotion-driven mechanisms in HMSAM. Path analysis results clearly demonstrate that, compared to other variables H2~H5, aesthetics have the greatest direct impact on perceived usability and usefulness (H1). This theoretical and empirical evidence validates the successful introduction of aesthetic variables as a new independent variable in the HMSAM framework. It not only meets users' external needs but also enriches the model's understanding of users' internal motivations. In conclusion, this study explores how expanding the HMSAM theory through aesthetic variables lays the foundation for personalized research on user experience and preferences. Future research can further

validate the model across disciplines and provide practical insights, which will facilitate the in-depth development of HMSAM in emerging technological contexts.

6. Conclusions and Suggestions

6.1. Theoretical Implications

This research study verified and extended the application of the Hedonic Motivation System Adoption Model (HMSAM) in the context of augmented reality by confirming 17 proposed hypotheses. This study demonstrated that aesthetic design can significantly impact users' perceived usefulness, perceived ease of use, curiosity and joy when considered as independent variables. The refinement of the model addressed its previous limitation of focusing solely on external determinants. Moreover, the model offered nuanced insights into how interactions in augmented reality shape user experiences and behaviors. By examining the direct and indirect effects of different elements on immersion and payment intention, the model provided valuable insights for future research endeavors. This study also scrutinized the logic behind construct selection in the model and presented a coherent description of the relationships between these variables, thereby enhancing the internal consistency of the model. Importantly, the findings of this study aligned closely with the existing literature, highlighting the continued relevance of the HMSAM model in the realm of hedonic motivation. In summary, this study contributed theoretical extensions and offered practical insights for industry applications. However, future studies may need to refine construct selection based on sample attributes to further build on this research foundation.

6.2. Practical Implications

The research insights assist practitioners in augmenting AR capabilities for superior alignment with user motivations. Accordingly, key implications include:

(1) Based on a comparison of the levels of support for various hypotheses, research indicates that aesthetic design has the greatest impact on curiosity. Therefore, it is recommended that platforms prioritize enhancing the user experience in this aspect. Consequently, live streaming platforms may consider focusing on improving aesthetic interactive experiences as a primary task for technological upgrades, drawing from the research findings. Specifically, this could involve optimizing the rendering effects of AR content on the platform, enhancing visual enjoyment through smooth and continuous redrawing techniques and designing personalized AR components tailored to different user attributes.

(2) Incorporating aesthetic factors enriches enjoyment motivation theory and provides a supplementary psychological framework, informing targeted interface design and content innovations that leverage key drivers like curiosity and perceived control. In order to enhance the application of augmented reality technology in real-time internet broadcasting, a reference framework for user behavior mechanisms has been provided. This framework can guide platforms on how to optimize technological design to effectively address issues related to poor user experience and user attrition. This discovery will aid businesses in identifying key strategies to enhance user engagement and provide new design perspectives for improving user experience. For instance, based on research findings, platforms can focus on enhancing factors such as interactivity of high-quality content and visual design. Same as in the process of interface interaction design, the use of game design guidance can be employed to stimulate user curiosity.

(3) According to the analysis of the dominant variables, this study identified that user curiosity is a key factor directly influencing immersion and payment intention. The research provides specific methods for live streaming platforms to promptly propose, such as developing diverse augmented reality interactive projects to stimulate users' exploration willingness and curiosity, effectively enhancing immersion and payment intention. For instance, the development of AI-assisted AR creation tools tailored to different age groups and audience participation in AR creative interactive programs hosted by broadcasters.

(4) The research findings serve as a reference for the formulation of regulatory standards, facilitating the industry's transition towards providing excellent user experiences. Additionally, they can also guide policy-making to support technological advancements and optimize user experiences.

6.3. Limitations and Future Research

The following limitations of this study may indicate future research directions:

(1) The sample specifically targeted AR users, meaning the conclusions may not directly generalize to virtual reality or other technologies. Future comparative studies assessing alternatives like VR are needed, with the current model serving as a baseline. Secondly, focusing solely on the entertainment live streaming scenario also constrains generalization of findings to other domains such as e-commerce. Further validation across different areas is necessary to improve external applicability.

(2) The singular quantitative methodology and self-reported data remain susceptible to biases. Future qualitative studies could provide beneficial complements—mixed-methods balancing surveys and interviews may yield additional insights.

(3) Incorporating individual differences and cross-cultural variables may uncover currently undiscussed variances. Subsequent studies could introduce moderating factors to expand the model.

(4) Expanding the sample size to improve representativeness across wider age groups and geographical locations would strengthen result robustness and practical relevance. This is also crucial for tackling user adoption barriers.

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