

How does gamification enhance consumer purchase intention in AI live streaming commerce? An fsQCA approach

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Abstract. With the rapid development of AI technology, AI live streaming commerce has gradually become an important way for enterprises to interact with consumers. However, how to enhance consumers' purchase willingness through effective design is still a key problem in theory and practice. This study focuses on the influence of gamification drivers on consumers' purchase intention. Based on Octalysis Gamification Framework, a configuration model including eight condition variables and one outcome variable is constructed, and multiple reconfiguration paths are revealed by fuzzy set qualitative comparison analysis (fsQCA). The results show that the seven intermediate solution paths show the promotion effect of different gamification types on consumers' purchase intention, which respectively reflect various mechanisms. Further analysis shows that epic meaning is the core conjunctural conditions affecting all paths, while scarcity, unknown and loss avoidance form alternative conditions. This study enriches the application of Octalysis Gamification Framework in AI live streaming commerce scenarios from the theoretical level, expands the perspective of the configuration of gamification mechanism's impact on consumer behavior, and provides a new way to understand the multi-factor interaction in complex business scenarios. From the practical level, it provides specific guidance for live streaming platforms and brands to design gamification strategies, and suggests that consumers' participation and purchase intention can be further enhanced by strengthening the sense of mission, designing limited-time interactive activities and optimizing human-computer interaction scenarios.

Keywords: AI live streaming, gamification, Octalysis Gamification Framework, purchase intention, fsQCA, configurational paths

1. Introduction

Against the backdrop of the booming digital economy, the application of AI live streaming technology in the e-commerce sector is becoming increasingly widespread. Compared to traditional live streaming by real people, AI streamers have the ability to stream continuously for long periods and can effectively respond to consumer needs through natural language processing and information extraction technologies. The high stability and operability of this technology allow it to save labor costs while ensuring round-the-clock live streaming operations. Currently, consumer purchase intention has become the core focus of AI live streaming research, as whether AI streamers can stimulate and maintain consumer purchase intention directly relates to the practical application effectiveness of this technology. For example, Baidu Smart Cloud's Xiling platform has initially demonstrated the potential of AI live streaming in enhancing consumer purchase intention by offering personalized AI live streaming services. However, AI streamers have not yet been able to achieve the live streaming effect of real human streamers. AI streamers have limited emotional expression capabilities, making it difficult to replicate the nuanced emotions and deep interactions of real human streamers, which may lead to insufficient personalized communication [1]. Moreover, the preset interaction modes of AI streamers are prone to content homogenization, lacking the innovation and adaptability of real human streamers, thereby reducing consumers' sense of experience and purchase intention [2]. In contrast, consumers' willingness to purchase in AI live commerce is relatively low.

In light of this, gamification, as an innovative strategy, is gradually being applied to AI live streaming in order to effectively stimulate consumers' purchase intentions. "Gamification" refers to the incorporation of game design elements into non-game environments. Specifically, gamification is considered an effective means to enhance consumers' purchase intentions because it can increase user interaction interest and engagement by incorporating game-like system designs or game-like experiences into non-game environments [3,4]. For example, the hotel industry has launched membership reward programs, and the airline industry has adopted frequent flyer programs, both of which incorporate certain game design techniques. These programs utilize concepts such as points, rewards, and upgrades in customer management to enhance customer loyalty. However, if gamification merely

adopts superficial elements such as points, badges, or leaderboards without deeply integrating with users' intrinsic motivations and behavior triggers, it has certain limitations [5]. Surface-level gamification design often relies on external rewards to stimulate user behavior, making it difficult to evoke emotional engagement or create an immersive experience. Therefore, the focus of gamified marketing should be to use gamification drivers to provide users with a game-like experience, creating psychological and behavioral incentives for the target users.

The key to achieving this motivational effect is to identify and apply different gamification drivers to meet the multi-layered needs of users. However, current studies mostly focus on single or isolated gamification drivers, and lack systematic configuration analysis, resulting in insufficient understanding of how gamification drivers work together and affect consumers' purchase intention. It is necessary to further explore their combined effects in AI live broadcasting. The Octalysis framework provides a comprehensive analysis path, based on eight core drivers, that helps uncover the synergies of gamification elements and the mechanisms by which they affect purchase intention.

Therefore, this study, based on the Octalysis Gamification Framework and from the perspective of gamification drivers, systematically explores the mechanisms by which these factors influence consumers' purchase intentions. The Octalysis Gamification Framework constructs an analytical path for consumer behavior through eight core drivers, providing a theoretical basis for the combination of gamified elements in AI live streaming [6]. The contributions of this study are reflected in the following aspects: First, it expands the research perspective on e-commerce live streaming by extending the research focus from human streamers to AI streamers, enriching the theoretical achievements in this field. Second, it fills the gap in the application of gamification configuration effects in AI live streaming, providing practical guidance for platforms when designing gamification strategies. Finally, the innovation of this study lies in the empirical analysis of the combinatory effects of gamification factors to reveal their deeper impact mechanisms on purchase intention. Overall, this study not only advances the theoretical development of gamification strategies in the context of AI live streaming but also provides managerial insights for e-commerce platforms to enhance consumer purchase intentions.

2. Literature review

2.1. AI live streaming commerce

In recent years, internet users have shown great enthusiasm for sharing joyful moments of their lives through social media. The way users share their experiences has undergone a fundamental transformation, transitioning from text and images to short videos and then to live streaming. In this process, live streaming, as a form of social media that combines real-time dissemination and interaction, has experienced explosive growth. Live streaming has achieved an unprecedented combination of immediacy and participatory culture [7].

Live streaming commerce is a form of e-commerce that emerged with the rise and popularity of video live streaming in the mobile internet era [8-10], representing an upgrade to user-centered product marketing models [11, 12]. Its most prominent feature is real-time interaction through video and text-based chat functions, allowing streamers to instantly promote products and interact with consumers [13-15]. In this model, the streamers (usually associated with the merchant or acting as the merchant's agent) is the organizer of the live streaming, the presenter of the content, and the facilitator of the transactions [16]. They use the live streaming platform as an interactive interface, providing real-time demonstrations of products and sharing usage experiences to offer viewers an intuitive display and transmission of product information [17, 18]. Therefore, live streaming commerce provides a more vivid and authentic online shopping environment, allowing consumers to better understand the products and helping them decide whether to make a purchase [19-22].

AI streamers are virtual digital streamers created by applying artificial intelligence technology to the e-commerce live streaming field [16]. They integrate advanced perceptual intelligence and cognitive intelligence technologies, encompassing multimodal fusion algorithms such as vision, speech, and natural language processing, enabling them to display realistic expressions and movements [23]. In addition to showcasing products and explaining discount mechanisms, AI streamers can also interact with consumers in real-time, including greetings, guiding purchases, and answering questions [24]. In addition, AI streamers can continuously live stream while maintaining a perfect brand image, offering advantages such as low operational costs, round-the-clock availability, high adaptability, and stable performance. They play an important role in attracting consumer attention and increasing engagement [25-26]. In view of this, the number of businesses attempting to use AI streamers for live streaming is continuously increasing, such as in the entertainment industry, advertising and marketing, customer service, and healthcare sectors, but there is little research focusing on AI streamers in e-commerce. At this stage, research on AI streamers mainly analyzes their role generation, content production, and visual presentation from a technical perspective, or systematically reviews the current development status, functional characteristics, and application prospects of AI streamers [13, 27, 28]. The impact of AI live streaming in e-commerce still has significant exploration potential [29, 30].

2.2. Gamification

Gamification refers to the process of applying game design elements and game dynamics to non-game environments, aiming to enhance user engagement, stimulate motivation, and achieve specific goals. Essentially, it is a form of incentive that attracts

customers to voluntarily participate by using various game design elements, allowing them to perceive more rights and gain multiple experiences [5, 31, 32].

Gamification has been widely adopted by e-commerce platforms to enhance consumer engagement and interest in live streaming [4]. Studies have shown that gamification has an impact on consumer buying behavior. Helmeffalk and Marcusson [33] analyzed the relationship between gamification and the service industry, pointing out that gamification can affect consumers' cognitive and emotional responses, and thus affect their purchase intention. Varshney et al. [34] found that gamification has a positive impact on consumers' online purchasing behavior through empirical study of structural equation model. Vilkaite-Vaitone et al. [35] found significant potential for gamification in promoting customer loyalty, with badges, MEDALS, quests, avatars, and contests being the most promising gamification tools for small e-commerce retailers in promoting customer loyalty. These studies show that gamified marketing methods play an important role in the purchase intention of consumers in the traditional e-commerce context.

Gamification can be seen as a concept involving multiple processes involving motivational availability, psychological outcomes, and behavioural outcomes [36, 37]. However, no scholars have studied the effect of gamification on purchase intention in the scenario of AI live commerce. Although gamification has been practiced in traditional live streaming commerce, the practice of introducing game mechanics such as point systems, leaderboards, badges, and virtual rewards creates engaging interactive experiences that encourage audience participation and continuous attention [38]. For example, a business model has developed around the purchase and giving of virtual gifts, which activates the intrinsic and extrinsic motivation of users' gifting behaviour through effective gamification strategies, thereby supporting consumers' transactional behaviour [39]. However, considering that AI live commerce is an emerging form of live streaming in the development process of artificial intelligence, the application and effect of gamification in AI live commerce still need to be further studied and explored. Therefore, this study focuses on the purchase intention of consumers under AI live commerce, and focuses on the influence mechanism of gamification on AI live commerce.

2.3. Octalysis gamification framework

Yu-Kai Chou describes gamification as "gamification is the craft of deriving all the fun and engaging elements found in games and applying them to real-world or productive activities." Based on this, Chou developed the Octalysis Gamification Framework for gamification after integrating game design, motivational psychology, and behavioural economics. This framework comprehensively summarizes and reveals the eight key factors that drive consumer engagement through gamification, as shown in Table 1. This framework has become a systematic and comprehensive design method within the field of gamification, aiming to enhance user engagement and motivation in non-game contexts such as education, marketing, and management through game design principles. This framework goes beyond the early "what" and "why" of gamification, shifting towards exploring the complex questions of "how" and "when," becoming a key tool in the field of gamification research. Mohanty and Christopher B [40] revealed the significant attention and driving force of the Octalysis Gamification Framework in the academic field through bibliometric analysis and scientific mapping.

Table 1. Definition of core drives

Core Drives	Definitions	Examples
Epic Meaning (EPI)	Epic Meaning is the Core Drive where a player believes that he is doing something greater than himself or he was "chosen" to do something.	Alipay's ant forest is not a tree, but a little green of the earth. Editing Wikipedia isn't just about preserving entries, it's about transferring human knowledge. Then there's Apple's constant emphasis on "Think Different."
Accomplishment (ACC)	Development is the internal drive of making progress, developing skills, and eventually overcoming challenges.	Zhihu divides the medal into multiple levels, so that users feel that they have been making progress. In Ant Forest, users can earn certificates by planting trees.
Empowerment (EMP)	Empowerment is when users are engaged in a creative process where they have to repeatedly figure things out and try different combinations.	Such as Go, chess, poker and mahjong, as well as LEGO physical activities are the embodiment of this drive. NetEase Cloud Music allows users to participate in content creation by allowing them to create their own playlists. Coca-Cola put people's names on Coke bottles, making the user's name part of the product.
Ownership (OWN)	This is the drive where users are motivated because they feel like they own something. When a player feels ownership, she innately wants to make what she owns better and own even more.	In order to gather the Water Margin characters small card, many people will buy plain noodles even if they do not want to eat. When people invest time and effort in customizing and updating content on social media, users develop a strong sense of psychological ownership and loyalty, even when there is no physical or legal ownership.

Table 1. (continued)

Social Influence (SOC)	This drive incorporates all the social elements that drive people, including mentorship, acceptance, social responses, companionship, as well as competition and envy. When you see a friend that is amazing at some skill or owns something extraordinary, you become driven to reach the same level.	When you see someone in your social circle who excels at a certain skill or has an extraordinary item, you're motivated to reach the same level. When you see a product that reminds you of your childhood, nostalgia may significantly increase the likelihood that you will buy that product.
Scarcity (SCA)	This is the drive of wanting something because you can't have it.	The "hunger marketing" strategy is the best embodiment of this driving force. Facebook was initially open only to Harvard students, then gradually expanded to other prestigious schools, and when it was finally open to all users, many were eager to join because they were previously inaccessible.
Unpredictability (UNP)	This is a harmless drive of wanting to find out what will happen next. If you don't know what's going to happen, your brain is engaged and you think about it often.	This drive is the reason why people focus on the lottery and lottery, but avoid revealing the action of the story. The popularity of blind boxes is a direct manifestation of this drive. When consumers buy a blind box, they do not know which product is inside, and this design meets people's need for surprise and exploration of the unknown, driving the purchase behavior.
Avoidance (AVO)	This Core Drive is based upon the avoidance of something negative happening.	When investors lose money due to falling stock prices in the stock market, due to sunk cost effect, they are still reluctant to sell stocks, hoping that the stock price can recover, so as to avoid realizing losses. By giving shopping coupons to e-commerce platforms, even if customers do not have a purchase plan, they will not be willing to waste psychological consumption.

The Octalysis Gamification Framework is widely applied in research across various fields such as education, e-commerce, retail, and fintech. In the field of education, Reyes et al. [41] implemented a teaching assistant robot platform, which, through gamification and Octalysis Gamification Framework analysis, supports high school mathematics teaching. It was confirmed that the robot platform, as a teaching aid, can enhance classroom vitality and student collaboration behavior. In the field of fintech, Yang et al. [42] combined the UTAUT2 model and the Octalysis Gamification Framework to study the impact of gamified mobile wallet systems on consumer behavioural intentions. In addition, Karać and Stabauer [4] used the Octalysis Gamification Framework to investigate the use of gamification elements in e-commerce, finding that gamification can significantly enhance consumer engagement and shopping experience.

Gamification, as a marketing strategy, has been extensively explored by scholars across various fields. However, in the context of AI live commerce, there has been no research addressing the gamification elements and their configurational effects that influence consumers' purchase intentions. Given the significant role of gamification in AI live streaming commerce, this study, based on the Octalysis Gamification Framework, analyses the key gamification drivers affecting consumers' purchase intentions in AI live streaming commerce scenarios. It explores the complex mechanisms of these drivers' joint and interactive

2.4. Research model

The purchase intention of consumers in live streaming commerce is combined by the eight core driving factors in the Octalysis Gamification Framework: epic meaning, accomplishment, empowerment, ownership, social influence, scarcity, unpredictability, and avoidance. This paper uses the perspective of configuration to study the driving path of gamification on consumers' purchase intention in AI live commerce, as shown in Figure 1.

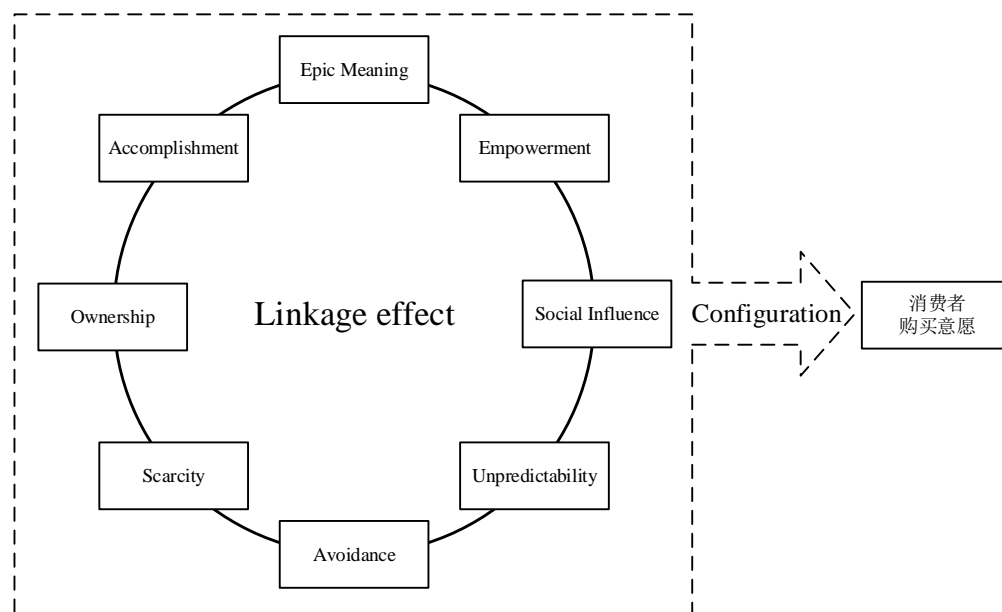


Figure 1. Research framework

(Note: “消费者购买意愿” means “Consumer purchase intention”)

3. Methodology

QCA achieves full comparison and analysis of cases through Boolean logic and algebra, so as to explore the "joint effect" of the interaction process between various factors on a specific phenomenon. This method can effectively answer the complex configuration problem of "How does gamification in AI live delivery improve consumers' purchase intention". In terms of specific analysis techniques, fsQCA is selected in this paper mainly for the following three reasons: First, fsQCA realizes sufficient comparison and analysis of cases through Boolean logic and set theory, and can explore the combined effects of various conditions. Traditional statistical methods, such as regression analysis, are usually only used to analyze the "net effect" of a single variable and cannot adequately explain complex phenomena under the combined action of multiple factors. fsQCA is especially suitable for analyzing the combination pattern of these factors and revealing which combination of factors can effectively improve consumers' purchase intention. Second, fsQCA is able to identify complex causal relationships and the interdependencies between conditions, and identify the configuration relationships between these factors, rather than the linear causal relationships in traditional analysis. Third, fsQCA can recognize configuration equivalence. Consumers' purchase intention may be influenced by a combination of different factors, and this configuration equivalence means that multiple combinations of different gamification drivers may increase purchase intention. Compared with traditional factor analysis or cluster analysis, fsQCA is more suitable to deal with this complex multi-cause and one-effect problem and reveal different paths to enhance purchase intention.

3.1. Data collection

In this study, a total of 280 participants with live shopping experience were recruited based on the Credamo platform, and data were collected by using the virtual context experiment method.

3.1.1. Stimulus materials

In view of the limitations of the research conditions, this paper plans to use video footage to present the scenario of consumers watching AI live shopping. In the video material, the life situation of AI live shopping is presented from the perspective of first-person users, the real experience of consumers in the process of watching AI live shopping is simulated, and their perception of gamification drivers and purchase intention are measured.

This study first built an AI digital human streamer based on Tencent Zhiying platform. Previous studies have shown that gender has no significant impact on purchase intention under different streamer types [16,43]. Therefore, this study sets the gender of digital streamer as female, and presets sound elements such as tone, intonation, speech speed and timbre that are close to the communication voice line in live streaming commerce. Secondly, since the viewing interface presented to consumers by e-commerce live streaming mainly consists of three parts: product, anchor and text [16], it is also considered that consumer interaction, brand name and number of online viewers in live streaming will affect subjects' attention and behavioural decisions. Therefore, the interface of AI live streaming in this study mainly includes an AI streamer who is introducing product information, product display area and text display area, and tries to exclude the influence of the name of the direct streaming room, the live

streaming barrage and the number of viewers. Thirdly, this study chooses the thermos cup products familiar to the subjects and consumers as the target products in the experiment, in order to avoid the influence of professional knowledge on the experimental results, and in line with the representative product purchase scenario in the current AI live streaming commerce. Finally, by adding language materials that stimulate gamification motivation into the streamer's introduction to product features and use experience, such as "Match hand speed, the first ten friends who place orders, we will add a water cup", the research finally obtained an 80-second AI live video material for formal experiment.

3.1.2. Variable Measurement and Questionnaire Design

In this study, the variable measurement is based on the AI live streaming context experiment, combined with questionnaire survey data to measure eight gamification drivers and consumer purchase intention. These variables were measured using a 7-point Likert scale, with 1 being "strongly disagree" and 7 being "strongly agree." This study refers to the domestic and foreign mature gamification drivers and consumer behaviour related scales to build measurement tools. As the core dependent variable of this study, purchase intention is used to measure whether consumers have actual purchase intention after watching live streaming. Based on the scale of purchase intention measured by Lu et al. [44], the paper adapted it in combination with AI live streaming commerce scenarios. Starting from the motivation of human behaviour, gamification drivers measure eight motivational dimensions of consumers in AI live streaming and measure eight variables. In this study, Yu-kai Chou defined each gamification driver and interpreted the framework in existing literatures at home and abroad, and combined with AI live streaming commerce scenarios to form an initial entry. In order to ensure the applicability, reliability and validity of the scale, three experts in consumer behaviour were invited to review and modify the questionnaire content. In order to improve the understanding and operability of the questionnaire, this paper conducted a small-range pre-survey, invited 10 consumers who had participated in live streaming to fill in the questionnaire, and further revised the expression and structure of the questionnaire according to their feedback.

The questionnaire of the formal experiment consisted of four parts. The first part asked the subjects to watch AI live experimental stimulus video materials. Before watching the video, the participants were told to imagine themselves as consumers watching live shopping and integrate themselves into the situation of live shopping as much as possible to experience the whole shopping process. After watching the video, the attention of the subjects was tested to ensure that the subjects watched the video material carefully. The second part measures the study variables of this paper. Participants were asked to review their experience during the live stream and respond to their perceptions of eight core gamification drivers (i.e., epic meaning, accomplishment, empowerment, ownership, social influence, scarcity, unpredictability, and avoidance) and their willingness to buy. The third part collects the basic information of the subjects, including gender, age, educational background and monthly income.

3.1.3. Experimental procedure

Formal experimental research was carried out through the Credamo platform. In order to ensure data quality, the following measures were taken in this paper: First, before the questionnaire was released, we communicated with the staff of Credamo platform for many times to ensure that the structure and semantics of the questionnaire were clear. Secondly, screening questions were set in the questionnaire to ensure that only respondents who had truly participated in the live shopping experience filled in the questionnaire. Thirdly, the short filling time (less than 2 minutes) and invalid questionnaires that were not completed were excluded. Finally, a total of 280 questionnaires were collected, and 259 valid samples were obtained after eliminating invalid questionnaires. The descriptive statistical results of the experimental samples show that the samples are mainly middle-aged and young people with higher education and middle income, which accords with the basic situation of live shopping groups. Detailed sample descriptive statistics are shown in Table 2.

Table 2. Analysis of demographic data structure

Items	Category	Sample number	%
Gender	Male	85	32.82
	Female	174	67.18
Ages	<20	13	5.02
	21-30	126	48.65
	31-40	88	33.98
	41-50	23	8.88
	51-60	8	3.09
	>60	1	0.39
	JHS	5	1.93
	SE (Voc/Tech)	8	3.09
Education	AD	22	8.49
	BD	184	71.04
	MS/MA	34	13.13
	PhD	6	2.32

Table 2. (continued)

Monthly income (RMB)	<2000	30	11.58
	2001-5000	51	19.69
	5000-10000	86	33.20
	10001-20000	77	29.73
	>20000	15	5.79

Note. JHS: Junior High School; SE (Voc/Tech): Secondary Education (Vocational/Technical); AD: Associate Degree; BD: Bachelor's Degree; MS/MA: Master's Degree; PhD: Doctoral Degree.

3.2. Reliability and validity analysis

In order to ensure the reliability and validity of the measurement tool, SPSS 26.0 and AMOS 26.0 were used for reliability and validity analysis. The results are shown in Table 3 and Table 4. In terms of reliability analysis, SPSS 26.0 was used to test the internal consistency reliability of each scale, and Cronbach's α coefficient was used to measure the reliability of each variable. The results showed that the Cronbach's α coefficient range of each variable was higher than the accepted critical value of 0.7, indicating that each scale had high internal consistency (that is, high reliability). AMOS 26.0 was used for confirmatory factor analysis (CFA) to test the convergence validity of the scale. The analysis results show that the factor load value of each measurement item ranges from 0.704 to 0.966, which is higher than the critical value 0.5, indicating that the measurement items can effectively reflect each latent variable. Further calculation of combined reliability (CR) shows that CR values of all variables are greater than 0.7, indicating that latent variables have good reliability. At the same time, the average extraction variance (AVE) values are all greater than 0.5, which proves that each variable has high convergence validity. In order to evaluate the discriminative validity of the variables, the AVE square root method is used in this paper. As shown in Table 4, the AVE square root of each variable is greater than the correlation coefficient between variables, indicating that different variables can be effectively distinguished, thus supporting the discrimination validity of the model. To sum up, the reliability and validity analysis of this paper shows that each scale has good reliability, convergence validity and discrimination validity.

Table 3. Reliability and validity of measurements

Constructs	Items	Loading	Cronbach's α	AVE	CR
EPI	Q2_1	0.704	0.810	0.712	0.829
	Q2_2	0.966			
ACC	Q3_1	0.842	0.853	0.749	0.857
	Q3_2	0.857			
EMP	Q4_1	0.756	0.731	0.578	0.733
	Q4_2	0.764			
OWN	Q5_1	0.828	0.809	0.682	0.811
	Q5_2	0.822			
SOC	Q6_1	0.842	0.841	0.725	0.841
	Q6_2	0.861			
SCA	Q7_1	0.867	0.830	0.716	0.835
	Q7_2	0.825			
UNP	Q8_1	0.852	0.850	0.739	0.850
	Q8_2	0.868			
AVO	Q9_1	0.833	0.828	0.709	0.830
	Q9_2	0.851			
PUR	Q1_1	0.784	0.885	0.664	0.888
	Q1_2	0.846			
	Q1_3	0.850			
	Q1_4	0.778			

Table 4. Correlation analysis and discriminative validity

Constructs	1	2	3	4	5	6	7	8	9
EPI	0.844								
ACC	0.617	0.865							
EMP	0.534	0.680	0.760						
OWN	0.521	0.739	0.752	0.826					
SOC	0.577	0.715	0.689	0.750	0.851				

Table 4. (continued)

SCA	0.590	0.602	0.626	0.718	0.734	0.846			
UNP	0.649	0.718	0.684	0.713	0.766	0.795	0.860		
AVO	0.544	0.553	0.587	0.641	0.613	0.683	0.687	0.842	
PUR	0.670	0.787	0.626	0.683	0.734	0.672	0.757	0.586	0.815

3.3. Common method bias testing

In order to avoid the common method deviation in this study, this paper adopts the strategy of combining pre-control and post-test. Pre-control is mainly reflected in the process of questionnaire design and data collection. In the questionnaire design stage, this paper adopted an anonymous method to ensure that participants can freely express their true feelings, so as to reduce social expectation bias. In the post hoc test, the Harman single factor test was used to evaluate the existence of common method bias. After unrotated exploratory factor analysis for all measurement items, the results show that 8 factors with feature roots greater than 1 are extracted, and the variance contribution rate of the first factor is 22.842%, which is lower than the critical value of 40%. This suggests that while there is some correlation between gamification factors, the variance in their common interpretation is not sufficient to generate serious common methodological bias problems. Therefore, it can be considered that the data quality of this study is high, and the research conclusions are not significantly affected by common methodology bias.

3.4. Calibration

In order to ensure the scientificity, objectivity and repeatability of the calibration process, the direct calibration method is used to deal with eight gamification factors and variables of consumer purchase intention. In terms of calibration principles, this paper follows the existing calibration standards to avoid the influence of subjective judgment on the results. Specifically, for each conditional variable (i.e., eight core drivers of gamification) and outcome variable (i.e., consumers' purchase intentions), its measurements are converted into membership scores of a fuzzy set. This process uses three quantiles, 95%, 50%, and 5%, as the thresholds for "full membership", "crossing point", and "no membership at all" respectively. Table 5 shows the specific data of the antecedent conditions and outcome variables after calibration.

Table 5. Variable calibration

Constructs	Calibration		
	Full-in Membership	Crossover Point	Full-out Membership
PUR	6.5	5.5	2
EPI	6.5	5.5	2.5
ACC	6.5	4.5	2.5
EMP	6.5	5.5	2.5
OWN	6.5	5.5	2
SOC	6.5	5.5	2
SCA	6.5	5.5	2
UNP	6.5	5	2
AVO	6.5	5.5	2

4. Results

4.1. Analysis of necessary conditions

This paper follows the existing research standards and conducts necessity tests on each condition variable in order to analyse whether a single factor is the necessary condition for the result variable. According to fsQCA3.0 software, the consistency of all conditional variables is less than 0.9, so the change of consumers' purchase intention in the model is the result of multiple factors, and the model setting conforms to the hypothesis. See Table 6 for details.

Table 6. The results of necessary conditions analysis

Conditions	High Level of Purchase Intention		Low Level of Purchase Intention	
	Consistency	Coverage	Consistency	Coverage
EPI1	0.757	0.814	0.545	0.514
~EPI1	0.548	0.579	0.803	0.744

Table 6. (continued)

ACC1	0.789	0.846	0.532	0.500
~ACC1	0.533	0.565	0.836	0.777
EMP1	0.787	0.798	0.563	0.501
~EMP1	0.507	0.570	0.773	0.761
OWN1	0.777	0.808	0.571	0.521
~OWN1	0.539	0.589	0.790	0.757
SOC1	0.754	0.850	0.514	0.509
~SOC1	0.564	0.570	0.848	0.752
SCA1	0.773	0.815	0.540	0.500
~SCA1	0.525	0.566	0.800	0.756
UNP1	0.747	0.848	0.513	0.510
~UNP1	0.569	0.571	0.848	0.746
AVO1	0.791	0.793	0.570	0.501
~AVO1	0.502	0.571	0.764	0.763

4.2. Analysis of sufficient conditions

After analysing the necessary conditions, fsQCA3.0 adopts the truth table algorithm to get the different configurations of the antecedent conditions. The truth table lists all possible antecedent condition configurations, or the number of 24 potential configurations. Each sample will be assigned to one of these 256 configurations, so some configurations may have no samples, while others may include multiple samples. Then the number of rows in the truth table is reduced by setting frequency threshold and consistency level. Considering the minimum number of cases required for the solution and the sample size of this paper, the frequency threshold is set to 1; Considering that the retention configuration needs to meet the adequacy requirements, the RAW Consistency is set to 0.80, and the threshold for PRI Consistency is set to 0.70.

Algorithmic logic based on Boolean algebra reduces the truth table to a simple combination. By combining simple and easy counterfactual analysis, fsQCA will arrive at a Parsimonious Solution, using only the simple counterfactual analysis as the Intermediate Solution. Specifically, conditions that occur only in the results of intermediate solutions are auxiliary conditions, while conditions that occur in both the results of intermediate solutions and reduced solutions are core conditions [45]. According to the reduced solution and intermediate solution calculated by fsQCA3.0 software, the condition configuration leading to high purchase intention is shown in Table 7. Among them, there are 7 antecedent configurations that can make consumers have high purchase intention, which proves the important feature of the configuration perspective of "all paths to the same destination".

Table 7. Results of configuration analysis

High Level of Purchase Intention							
Configurations	C1	C2	C3	C4	C5	C6	C7
EPI	●	●	●	●	●	●	●
ACC	•	•	•	•		⊗	•
EMP	•	•	•			•	⊗
OWN	•	•	•	•	•	•	⊗
SOC	●	●	●	●	●	●	●
SCA	•	•		•	•	•	⊗
UNP	•		•	•	•	⊗	•
AVO		•	•	•	•	⊗	•
Consistency	0.972	0.975	0.976	0.971	0.968	0.963	0.976
Raw Coverage	0.455	0.443	0.444	0.452	0.433	0.216	0.208
Unique Coverage	0.026	0.014	0.014	0.013	0.008	0.004	0.011

Table 7. (continued)

Solution Consistency	0.957
Solution Coverage	0.559

In qualitative comparative analysis, consistency and coverage are important indicators to judge the relationship between different antecedent configurations and results. The results of this study show that the consistency of the seven configurations leading to high purchase intention is greater than 0.9, indicating that all cases in the seven antecedent condition configurations in this paper meet the consistency condition, that is, all the seven antecedent condition configurations are sufficient conditions leading to high purchase intention. The overall coverage of the configuration leading to the high purchase intention was 0.559, that is, the result of fsQCA processing explained about 55.9% of the reasons for the formation of high purchase intention. According to the original coverage and unique coverage, configuration 1 has a strong explanation for the result of high purchase intention.

5. Discussions

5.1. Seven configuration paths

EPI1 * SOC1 is a reduced solution path. This path means that when consumers are in an environment with a strong sense of purpose and social influence, they tend to be more willing to buy. In this path, only the interaction of these two conditions can drive the formation of purchase intention. This solution path represents a collective and meaning-driven purchasing behaviour model. Consumers are not only psychologically driven by a sense of purpose and mission, but also influenced by their social circle or social group, and these consumers' purchase intentions are driven by both internal sense of meaning and external social pressure.

C1 is EPI1 * ACC1 * EMP1 * OWN1 * SOC1 * SCA1 * UNP1. It is an immersive gamification mode that is full of challenges and achievements. This path shows that in an environment full of challenges, creativity, scarcity and uncertainty, it is possible to maximize consumer motivation to buy. In a challenging and rewarding game environment, players need to constantly break through, explore and achieve themselves in multiple dimensions. Mechanistically, this path reflects a complex gamified experience where consumers are not only driven by a sense of purpose and accomplishment, but also satisfied through creative expression and social interaction. At the same time, the existence of scarcity and curiosity increases the urgency and exploration of behaviour, and consumers will be more inclined to buy to meet their psychological needs.

C2 is "EPI1 * ACC1 * EMP1 * OWN1 * SOC1 * SCA1 * AVO1". This is a goal-oriented competitive gamification model with scarce incentives. This path shows that when consumers feel there is an opportunity for advancement, are able to creatively express and receive feedback, and are more willing to buy in situations of scarcity and possible loss. Analogous to gamification design with reward incentives and competitive elements, players not only need to reach goals, but also need to make quick decisions under the pressure of scarce resources and potential losses. In theory, consumers, while feeling progress and achievement, are also driven by scarcity and loss aversion, prompting them to act early to avoid missing opportunities.

C3 is "EPI1 * ACC1 * EMP1 * OWN1 * SOC1 * UNP1 * AVO1". This is an immersive adventure gamification mode that combines exploration and achievement. Consumers need constant feedback and achievement in the process of exploring the unknown, while facing possible losses. This path represents those time-sensitive, opportunity cost-sensitive consumer groups, especially for "limited-time sales" or "exclusive release" types of consumers. From the mechanism, consumers are driven by the sense of mission and achievement, and are motivated by scarcity and unknown, and the psychology of avoiding mistakes drives consumers' purchasing decisions.

C4 is "EPI1 * ACC1 * OWN1 * SOC1 * SCA1 * UNP1 * AVO1". This is a socially driven gamification of resource management. When there is a strong sense of purpose, accomplishment, ownership, and social impact, and when consumers feel threatened by scarcity, unknowability, and loss, they show a strong willingness to buy. At this point, consumers need to make decisions with limited resources, both to manage resource scarcity and to avoid loss. Theoretically speaking, consumers increase their emotional investment in products through creative expression and sense of ownership, while scarcity and unknowingness prompt them to have a stronger desire to buy. At the same time, loss aversion enables consumers to make quick purchasing decisions when faced with opportunities that may be missed.

C5 is "EPI1 * EMP1 * OWN1 * SOC1 * SCA1 * UNP1 * AVO1". It's a game of creative empowerment and challenge driven instant feedback. In an instant feedback scenario, consumers get constant feedback on rapid decisions. Theoretically speaking, although consumers do not have a strong sense of accomplishment and curiosity, they still generate purchase intentions through social identification, a sense of ownership, and sensitivity to scarcity. In addition, loss avoidance and uncertainty reduction allow consumers to make decisions in an environment with social impact and resource perception.

C6 is EPI1 * ~ACC1 * EMP1 * OWN1 * SOC1 * SCA1 * ~UNP1 * ~AVO1. This approach is a meaning-driven and resource-optimized gamification model. In the absence of progressive achievement, curiosity, and loss avoidance, purchase intentions can still be stimulated only when epic significance, creative empowerment, ownership, social impact, and scarcity are all high. Consumers' willingness to buy is not only dependent on self-actualization motivation, but also on external resources such as creative empowerment, social acceptance, and scarcity. In terms of mechanism, consumers are mainly driven by "progress and

sense of achievement" and "social influence", lacking factors such as creative licensing, ownership and scarcity, but still have the influence of exploration motivation and loss avoidance.

C7 is $EPI1 * ACC1 * \sim EMP1 * \sim OWN1 * SOC1 * \sim SCA1 * UNP1 * AVO1$. This path is achievement-driven and competitive social gamification model, where consumers may still have purchase intention when creative authorization and ownership are not strong and scarcity is low. In scenarios that require social interaction and competition, consumers derive satisfaction by achieving goals and competing with others. Mechanically, this path does not emphasize creative expression and a sense of ownership, and it lacks the curiosity drive of scarcity and exploration. It relies more on consumers' sense of purpose and accomplishment, as well as external motivation through social influence.

5.2. Further discussion

This study further subdivides several major conjunctural conditions and alternative conditions. These conditions have conjunctural or alternative effects in the path respectively, thus affecting consumers' purchase intention under different psychological driving mechanisms.

5.2.1. *Conjunctural conditions*

(1) Epic meaning and accomplishment. In the AI live streaming scenario, when consumers feel that participating in live events not only has a progressive effect on themselves, but also has a broader sense of mission, the purchase motivation will be greatly enhanced. Consumers may engage in interactions or activities that have social value or public significance, such as supporting a cause project or helping a brand solve a significant challenge. Participating in these activities not only provides a sense of progress, but also allows the audience to feel that what they are doing has greater value or meaning. The combination of a sense of purpose and progress leads to more active consumer engagement and buying behaviour.

(2) Social influence and ownership. The combined effect of social influence and ownership can greatly improve the purchase intention of users. AI live streaming often stimulates interaction through social functions, such as interaction between viewers, interaction with streamers, or the purchase behaviour of users is seen by other viewers, and this social sense of identity will promote users to have a stronger desire to own a product or service. At the same time, if users can obtain some unique items through purchase, such as virtual goods and limited goods, the synergy of these two conditions will make the purchase intention stronger.

(3) Empowerment and scarcity. AI live streaming is highly interactive, and viewers often participate in content creation through messages, voting, interactive games, and other ways. This creative licensing allows users to feel part of the live content. When certain interactions or items are scarce (such as limited-time events, limited releases, etc.), viewers are motivated to buy because of their desire for scarce resources.

5.2.2. *Alternative conditions*

(1) Accomplishment and empowerment. If an AI live streaming scene emphasizes a sense of progress and challenge, the audience may pay more attention to completing tasks and achieving achievements, and not necessarily need to show their value through creative performance. On the other hand, if the live content emphasizes creative expression (such as creation, interaction), users may be satisfied by the feedback of creative expression, without the need to focus on the sense of progress. If an AI livestream platform focuses on the audience's skill display, creative expression and interactive feedback (such as design, artistic creation livestream), then the audience's purchase motivation comes more from creative authorization, rather than the traditional sense of progress or ability improvement. In this context, creative empowerment and a sense of progress can substitute for each other, as they each provide different types of achievement and satisfaction.

(2) Scarcity and unpredictability. When there are scarce limited products or limited time discounts in the live streaming, consumers are often strongly driven by scarcity, thus stimulating the desire to buy. However, when there is no scarcity factor, curiosity (especially novelty content and surprise elements in AI live streaming) can replace the role of scarcity by stimulating consumers' interest in exploration. In an AI live streaming scenario, viewers may be attracted by "what novel content will be next" and make a purchase decision, a process that does not depend on scarcity.

(3) Epic meaning and unpredictability. When the content or activity of AI live streaming has a strong sense of mission or social meaning, consumers are less concerned with exploring unknown content and concentrate on task completion or goal achievement. If the content is more entertaining, innovative, or exploratory, curiosity may replace mission as the primary driver of purchase. Conversely, if live content is more about addressing the audience's curiosity, or providing a fresh entertainment experience, then the role of curiosity will outweigh the sense of mission.

6. Conclusions

6.1. Research conclusion

Contrast the configuration path of contracted and intermediate solutions, in the AI live streaming scene, the formation of consumer purchase intention is not dependent on a single condition but the result of the multiple game drivers weaving effect. In particular, "epic meaning" played a central role in all paths, combining with other variables in each path to drive purchase intentions. The results also show that there are seven configuration paths driving the increase of consumers' purchase intention, in which some conditions such as "accomplishment" and "empowerment" appear in multiple paths, which can not only directly affect the purchase intention but also indirectly enhance the purchase motivation through other variables such as ownership and social influence. The negative conditions in the path also show that even if some drivers are not fully present, consumers' willingness to buy can still be strengthened through alternative paths. Further, there are cooperative conditions and alternative conditions in the condition configuration of gamification drivers affecting consumers' purchase intention, indicating that consumers' motivation in AI live streaming scenarios is affected by multiple drivers.

6.2. Theoretical contribution

Through the configuration analysis of eight conditional variables, this study enriches the practical applicability of gamification theory, deepens the mechanism of consumer purchase intention theory, and expands the application boundary of octagonal analysis framework.

Firstly, it expands the research scenario of gamification. Gamification has been widely used in the field of user experience and consumer behaviour [4,33-35], but the research on AI live streaming commerce scenarios is still limited. In this study, the synergistic and substitution effects of multi-variable configuration are included in the analysis, and the dynamic combination characteristics of gamification drivers in AI live streaming are revealed, including how to jointly enhance purchase intention through multi-dimensional drivers, which provides a richer practical basis for gamification theory. The findings not only focus on the increase in consumer purchase intentions, but also reveal how the interactivity and situational sense of AI live streaming shapes consumer motivation and behavior. For example, the "Empowerment and scarcity" path shows that combining scarce-driven and interactive licensing in gamification design can lead to more engaging experience mechanics.

Secondly, further analysis and supplementation of the Octalysis Gamification Framework. The Octalysis Gamification Framework is an important theoretical model in the field of gamification, defining eight core elements that drive human behaviour. The configuration paths obtained in this study clearly verify the effectiveness of the Octalysis Gamification framework in AI live streaming scenarios. At the same time, this study proposes that synergistic or substitution among drivers is an important supplement to achieve the target effect, adding a combinatorial effect perspective to the gamification framework and expanding the scope of application of its theory.

Thirdly, starting from gamification and AI live streaming scene, this study injected the perspective of psychological drivers and contextualization mechanisms into the study of purchase intention. AI live streaming scene is different from live streaming scene, making it difficult for traditional purchase intention model to fully explain consumer behaviour [46]. This study reveals the role of multi-dimensional drivers in live streaming scene, especially how psychological variables (epic meaning, scarcity, etc.) are amplified through the interactivity in live streaming scene, thereby increasing purchase intention. Therefore, the combination of variables of multiple gamification drivers can affect purchase intention in a non-linear manner.

Fourth, the research scope of e-commerce streamers is expanded from human streamers to AI streamers, further enriching the relevant research of e-commerce live streaming. Previous studies on streamers in e-commerce live streaming generally focus on a certain type of human streamers, such as celebrity streamers dominated by Internet celebrities and opinion leaders [47], while AI streamers in e-commerce live streaming are rarely involved. This paper provides a new research direction for the study of live streaming commerce, focusing on consumer behaviour in AI live streaming scenarios and optimizing live streaming effects from gamified interactive design.

6.3. Management suggestion

First, design mission-driven interactions that combine a sense of progress and social impact to increase consumer engagement. This includes creating mission-driven themed events, increasing challenge and achievement, and highlighting social feedback mechanisms. Platforms and brands should design public welfare themes, social responsibility activities, or scenarios that give higher meaning to purchases (such as environmental live streaming, helping the rural economy, etc.) to make consumers feel that their purchases are connected to a sense of mission. For example, live streaming with an environmental theme, where users can participate in a carbon-neutral project by purchasing "sustainable goods," can give consumers a deeper meaning to their purchases. Incorporate a sense of progress into these activities, such as setting up phased tasks (donate a certain amount to unlock achievements) or reward points, so that the user can feel the accomplishment of "gradually achieving the goal" through hard work. Moreover, the social value and influence of consumers' purchase behaviour are highlighted through bullet screens, lists and other

forms, such as thanking users for their contributions in real time or displaying lists and rankings in live streaming to form a strong sense of social identity.

Secondly, scarcity and unpredictability are used to stimulate immediate purchase behaviour, and the effect of limited-time promotion on purchase intention is strengthened, which includes optimizing limited-time and limited-time promotion strategies, introducing unknown reward mechanisms, and integrating psychological drives to avoid losses. In the AI live scene through the combination of scarcity and unpredictability to design promotional activities, such as "surprise limited-time gift pack" or "limited exclusive offer" function, prompt "limited goods only in the broadcast room," forcing consumers to make quick decisions to avoid potential losses. "Buy and you may draw a mysterious gift" or "Place an order and you will get an unknown exclusive goodie", using consumers' curiosity about unknown rewards to make a quick purchase. In this way, the combination of the two measures emphasizes the scarcity of the promotional goods and the possible loss caused by consumers missing the offer, creating a sense of urgency to buy.

Third, encourage consumers to deeply participate in live content creation, enhance the sense of ownership and interactive experience, which includes providing deep creative participation opportunities, strengthening the emotional connection of ownership, and combining scarcity to enhance users' sense of investment. Live streaming platforms should develop creative tools or features that allow consumers to participate in the generation of live content. For example, AI technology could allow viewers to design virtual goods, customize studio skins, or submit interactive ideas, ultimately turning consumer ideas into visible results. In addition, turn consumer interactions into exclusive honours or rewards, such as a "Content Creator Honor Roll" in a live stream, and reinforce consumer identification with their actions through points, virtual items, or identifiers such as a "creative Contributor badge." Through creative participation activities can increase the scarcity attribute and further stimulate consumers' purchase willingness.

6.4. Limitations and future research directions

This study adopts the data collection method of experimental design. Although the configuration path of the model is effectively verified, there may be some differences between the experimental data and the dynamic data in real AI live streaming commerce scenarios. Future studies can verify the external validity of research conclusions based on real platform user behavior data so as to improve the practicability and generalization of research. In addition, this study mainly focuses on the gamification effect of eight conditional variables but does not deeply discuss the common "game-like experience" (real-time competition, task reward, immersive scene interaction, etc.) in AI live streaming scenes. This can lead to a lack of overall understanding of gamification mechanics. Future studies can further explore the differentiated impact on purchase intention by combining specific gamification experience forms in live streaming scenes. Finally, in this study, gamification features are reflected through text materials in the experimental design. Although it can effectively highlight the role of psychological variables, this presentation method may not be able to fully simulate the multi-modal interactive experience in real AI live streaming scenes. In particular, considering the interactive advantages of AI technology in voice, image, virtual streamers, and other aspects, future research can be closer to the actual characteristics of AI live streaming scenes through multi-modal experimental design (such as combining video, virtual streamers, and text materials) to improve the ecological validity of the research.

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