The effect of e-commerce livestreaming services on customer loyalty: a test of the chain mediation model

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Abstract

The outbreak of COVID-19 has made the offline real economy suffer an unprecedented test, and the online e-commerce livestreaming model, as a new marketing model, has been rapidly developed. Based on the SOR model, this paper clarifies the interaction between e-commerce livestreaming and consumer decision-making, taking the e-commerce livestream as an independent variable, customer engagement and value co-creation as intermediary variables, and customer loyalty as the dependent variable. This paper explores the evolution from e-commerce livestreaming to customer loyalty. The target sample consists of 475 Chinese e-commerce livestream viewers. Structural equation modelling (SEM) is used for empirical analysis, and MPLUS8.0 is used for data analysis. Aesthetic appeal, functional layout and verbal communication have a direct impact on customer engagement, while financial security, Nonverbal communication and service skills have no significant impact. In value co-creation, customer engagement has a direct impact on functional, hedonic and social values, which all have a direct impact on customer loyalty. Customer engagement does not singularly mediate between e-commerce livestreaming and customer loyalty, while value co-creation does have a mediating effect. Customer engagement and value co-creation have an enchained mediating effect between e-commerce livestreaming and customer loyalty. The research results reveal the effects of e-commerce livestreaming, provide a new entry point for considering stimuli in the application of SOR theory to e-commerce, and demonstrate how e-commerce livestreaming provides customers with visual beauty and personalized experiences while enhancing the communication skills of the operations and service staff. This research extends the scene theory of e-commerce livestreaming services and provides significant insights into e-commerce livestreaming platforms and enterprise management.

Keywords: E-commerce live service scene, SOR model, Customer engagement, Value co-creation, Customer loyalty

Introduction

E-commerce livestreaming is the sales of products or services through a live stream, reflecting a change in the traditional shopping patterns of consumers and a kind of conversion of the consumption scene that is moving gradually towards a new engine

of economic development (Zhang et al., 2022a, 2022b). E-commerce sites and social commerce software have launched livestreaming features, such as Facebook Live, You-Tube Live, Periscope, Twitch.tv, Amazon Live and other livestreaming platforms, which have entered mainstream culture. Similarly, in China, with the launch of Mushroom Street, Taobao and JD.com in 2016, that year was dubbed "the first year of live ecommerce" by the industry, followed by the launch of TikTok Live by ByteDance in 2018. According to CNNIC, between May and April 2022, TikTok 2021 had more than 9 m livestreams per month and sold more than 10 bn items. The development of the "direct broadcast + energy industry" linkage has become the focus of the major e-commerce sales platforms. Three forms of direct broadcast drive the rapid growth of product sales: "e-commerce platform + direct broadcast", "direct broadcast platform + e-commerce" and "platform livestreaming". E-commerce livestreaming has become the main driver of economic promotions, changing the traditional e-commerce model, improving consumer shopping and quality of life. Consequently, e-commerce livestreaming is worth an in-depth discussion (Fig. 1).

This study used the SOR (stimulus–organism–response) model, which is a commonly used theory to analyse frameworks for online consumer behaviour (Poggesi et al., 2022). Floh and Madlberger (2013) explored impulsive online buying behaviour and spending in reaction to virtual environment cues (content, design, and navigation) using the SOR model. Liu et al. (2018) argue that creating an infectious consumer atmosphere (stimulus) in an online trading environment will produce impulsive buying behaviour (response).Wang (2022) verifies online consumers' purchase intentions when stimulated with e-commerce livestreaming scenes through the SOR model. Hussain et al. (2023) show that sponsored Instagram ad-related entertainment, informativeness, credibility, incentives, and celebrity endorsement are conducive to raising the effectiveness of ad stimuli, which in turn enhances consumers' cognitive and affective ad involvement and flow, influencing their purchase behaviours. Elisa et al. (2022) show that social media use moderates the relationship between scarcity messages and impulsive buying in Indonesia
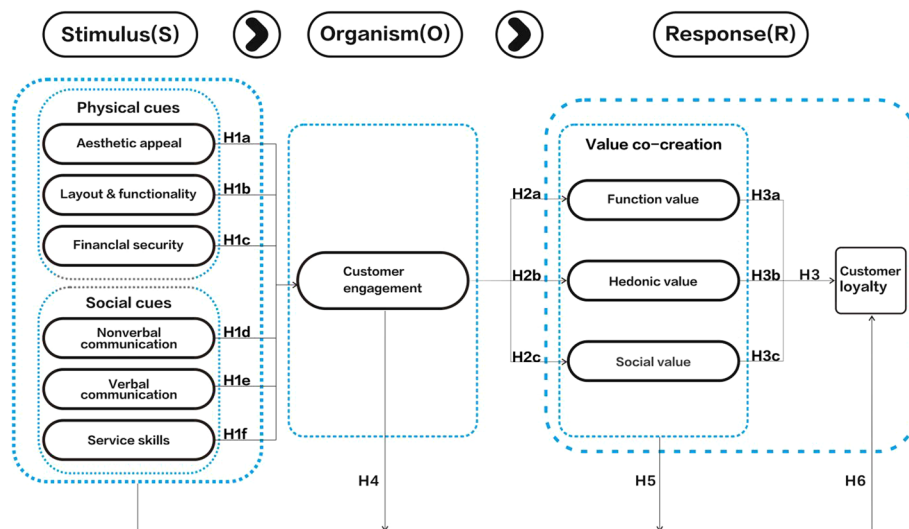

Fig. 1 Conceptual model

and that perceived value mediates the relationship between scarcity and impulsive buying. Alanadoly and Salem (2022) indicate that fashion involvement is significantly associated with sociopsychological stimuli, with product variety being an objective stimulus for Malaysian fashion e-consumers. Perceived quality is significantly represented as an organism through the framework, and buying behaviour is the latent response. These studies are less likely to integrate live studio scenes with service providers.

E-commerce livestreaming effectively connects e-commerce and livestreaming platforms, presenting them to users through rich content and diverse formats (Wei et al., 2021). Song et al. (2021) pointed out that livestreaming is a kind of transmission method based on network streaming media technology. Through the computer web page and the client, live information is displayed in the form of text, voice, image, video, and bullet screen, etc., and users can interact in real time. Hollebeek (2011) indicates that customer interaction produces a motivational, brand-related, context-driven state of mind. Customer engagement entails the cognitive and emotional processing of the customer as they interact with the brand or company (Bowden, 2009; Brodie et al., 2011). Malthouse et al. (2016) argue that customer engagement involves a degree of customer involvement in the production or provision of a service, in that the customer is in an interactive environment, where the company and the customer share a common interest in creating value. This interaction can generate a higher level of enthusiasm and may even promote customer behaviours (Hollebeek et al., 2016). Customer behaviour takes many forms, including purchases, recommendations, customer influence and so on (Kumar & Pansari, 2016). Therefore, it is necessary to verify the influence of physical and social cues on customer engagement and the interaction among the three factors of customer engagement, value co-creation and customer loyalty.

In this study, the SOR theory was used as the framework to achieve the following research objectives: (1) to explore the relationship between physical cues (aesthetic appeal, functional layout and financial security) and social cues (nonverbal communication, verbal communication and service skills) in an e-commerce livestreaming service; (2) to evaluate the relationship between functional, hedonic and social values in customer engagement and value co-creation; (3) to explore the relationship between functional, hedonic and social values and customer loyalty; and (4) to explore the relationship between functional, hedonic and social values. This paper discusses the mediating effects of customer engagement and value co-creation between e-commerce livestreaming services and customer loyalty. Based on the SOR model, the relationship among e-commerce livestreaming services, customer engagement, value co-creation and customer loyalty is tested to verify the effect of e-commerce livestreaming services on customer loyalty. The following sections include the theoretical background and hypothesis development, methodology, discussion and conclusion.

Background theoretical and hypothesis development

SOR model

Mehrabian and Russell (1974) first hypothesized the stimulus–organism–response framework, defining environmental stimuli (S) as factors that affect an individual's cognitive or emotional activities and organisms (O) as mental or cognitive states that an individual develops in response to stimuli, including positive and

negative emotions, such as delight, excitement, immersion, disgust and arousal, while response (R) is a behavioural response of approach or avoidance that is expressed through emotional and cognitive processes, including participation, buying, feedback, reviews, and nonuse. Donovan and Rossiter (1982) introduced the SOR model into the retail industry to analyse consumer buying behaviour. Eroglu et al., (20012003) argued that online retail stores also fit the model, with physical cues in the online environment as "stimuli", shoppers' emotional responses as "organisms", and proximity/avoidance behaviours as "responses". Sautter et al. (2008) used the SOR model to test the effects of the online store environment and the physical environment on consumers' internal reactions, mainly improving store image and consumer expectations of goods (Oh et al., 2007). The SOR framework extracts cognition and emotion from customers and finds that the online shopping or e-service interaction follow-up responses are more inclusive of approach behaviours (Poggesi et al., 2022; Tran & Strutton, 2019).

The application of the SOR model to the study of livestreaming audience behaviour is as follows: (1) from the perspective of the research object, anchors, bullet screen messages, gifts, coupons, scene clues and so on are analysed. For example, the presence of an anchor society tends to trigger impulse buying in consumers (Li et al., 2022). Zhou et al. (2019) reveals that audience interaction can influence arousal levels to promote increased levels of paid gifts; coupons facilitate consumer purchase behaviours directly during livestreaming, and e-commerce livestreaming scenarios (stimuli) influence customer engagement (organism), which in turn promotes customer loyalty (response) (Tankovic & Benazic, 2018; Yadav & Mahara, 2020). (2) Using the SOR model structure, Harris and Goode (2010) analyse online consumer behaviour from the three dimensions of aesthetic appeal, functional layout and financial security. In their study, aesthetic appeal is embodied by the uniqueness and entertainment of the website, while function and appearance are assessed by website usability, information relevance, customization, and engagement; financial security can be measured by payment convenience and perceived security (Tran et al., 2012). Tankovic and Benazic (2018) regard aesthetic appeal, layout function and financial security as stimuli in e-service scenarios, e-shopping value as the organism, and loyalty as the response in the SOR model. (3) In the specific application of SOR, online shopping interactivity and vividness (Cheng, 2020), streaming media attraction (Tu et al., 2018) and atmosphere cues (Ma et al., 2022) were identified as stimuli; emotional attachment, flow experience (Li & Peng, 2021), emotional commitment (Hu & Chaudhry, 2020) and customer engagement (Tu et al., 2018) were identified as organisms, and electronic loyalty intention (Fang et al., 2018) and impulsive buying behaviour were identified as responses.

In this study, the SOR model was used to select physical and social cues as stimuli, customer engagement as a reflection of consumers' internal states as the organism, and value co-creation and customer loyalty as consumers' response. By constructing the causal relationship among stimulus, organism and response, this paper provides a systematic framework to track the impact of e-commerce livestreaming services on customer loyalty.

E-commerce livestreaming services and customer engagement

According to Bitner (1992), the "servicescape" includes ambient conditions, space and function, and signs, symbols and artefacts. In ambient conditions, temperature, air, music, and light, etc. all play a role. The space layout and function include facility equipment, such as furniture, and their quantity and scale and so on. Signs, symbols and handicrafts include guidance, personal handicrafts, and decorative style. Harris and Goode (2010) proposed that the aesthetic appeal of physical cues, functional layout, and financial security in web services have a positive impact on consumer trust and willingness to buy. Eroglu et al. (2001) apply scene theory to the online store environment and argue that the image of online retail stores influences the purchasing behaviour of customers. Wang (2022) defines the physical cues of e-commerce livestreaming sites as aesthetic appeal, functional layout and financial security. Zhang (2019) explored the impact of social cues on consumers' online behavioural intentions during e-commerce livestreaming services. In this paper, the definition of e-commerce livestreaming includes physical and social cues. Physical cues include aesthetic appeal, functional layout and financial security. Social cues include nonverbal communication, verbal communication, and service skills.

Sashi (2012) argues that customer engagement is an interactive consumer experience facilitated by communication technologies such as social media and that consumer engagement is an emotional commitment. Brodie et al. (2011) reveal that customer engagement plays a role in the overall service relationship, with other relationships existing as specific antecedents and consequences. The antecedents of customer engagement include corporate reputation, service quality, organizational support, employee engagement, relationship marketing orientation, virtual brand community support, e-service quality, community relationship management, social media data, brand trust, and e-commerce livestreams (Cao et al., 2022; Eslami et al., 2021; Fan & Wu, 2019; Kumar & Pansari, 2016; Liu et al., 2022; Van Doorn et al., 2010; Vivek et al., 2014; Wang et al., 2014; Wongsansukcharoen, 2022). Hollebeek et al. (2016) indicated that customer engagement results included brand community participation, value, trust, emotion, commitment, word-of-mouth recommendations, and loyalty. This paper argues that the physical cues in the scene encouraging customer engagement result in other behaviours, such as emotion, trust, participation, value, and word-of-mouth recommendations, etc.

The aesthetic appeal of physical cues, the functional layout and the financial security in live e-commerce services have a positive impact on customer engagement (Lee, 2018; Lee & Chen, 2021; Saputra, 2021; Tankovic & Benazic, 2018). Tu et al. (2018) demonstrated that aesthetic appeal and functional layout in web services can effectively enhance customer cognition, emotion and behaviour towards websites. Usefulness and entertainment in live e-commerce services affect consumer engagement (Cao et al., 2022). In live e-commerce, users influence other customers' participation through real-time commenting on scrolling bullet screens, the number of fans in the livestreaming room, likes, gift-giving, retweeting, purchasing behaviour, and other information derived from functional layouts (Li et al., 2021). Zhang (2019) explored the impact of social cues (nonverbal communication, verbal communication, service skills) on consumers' online behavioural intentions. This study concludes that physical cues have a significant impact on customer engagement and proposes six hypotheses:

H1   The physical cues in e-commerce livestreaming services have a positive effect on customer engagement.

H1a   Aesthetic appeal has a positive impact on customer engagement.

H1b   Functional layout has a positive effect on customer engagement.

H1c   Financial security has a positive impact on customer engagement.

H1d   Nonverbal communication has a positive effect on customer engagement.

H1e   Verbal communication has a positive impact on customer engagement.

H1f   Service skills have a positive impact on customer engagement.

Customer engagement and value creation

Customer engagement is an inherent quality of communication that reflects the customer's perception and emotional processing of the experience of interacting with a brand or company (Bowden & Mirzaei, 2004; Bowden, 2009). Brodie et al. (2011) hold that customer engagement is primarily intrinsically psychological, encompassing both individual and group dimensions. Customer involvement includes participation, satisfaction, and cognitive, emotional and behavioural reactions as part of the customer role. Customer readiness is supported by organizational support, socialization directed by the organization, and the interactions and connections of a brand or company in social networks promoting their services or products. Other factors that promote engagement include user-generated content, involvement, interactivity, service quality and brand experience, the service ecosystem, customer trust, customer identity, virtual service landscape quality, online product reviews, video content and emotions (Agrawal & Mittal, 2022; Brodie et al., 2011; Hollebeek, 2011; Hollebeek & Chen, 2014; Hollebeek et al., 2016; Kumar & Pansari, 2016; Malthouse et al., 2016; Merdiaty & Aldrin, 2022; Torkzadeh et al., 2022; Verleye et al., 2014; Vivek, 2009; Vivek et al., 2014; Zhang et al., 2022a, 2022b; Zhou et al., 2022). Customer psychological factors at the group level include the following: enthusiastic, conscious engagement; social interaction; emotional, cognitive, and behavioural engagement; emotional, behavioural and social factors; shopping site service scenarios; social media; customer experience (seeking information, entertainment, social interaction), and so on (Chen et al., 2021; Dessart et al., 2015; Hollebeek et al., 2016; Linghu, 2019; Sashi et al., 2019; Tu et al., 2018; Vivek, 2009). Individual and group psychological factors have an important role in customer engagement. Many scholars emphasize the positive effects of customer engagement, but others are concerned about the negative effects, such as the potential for complaints (Naumann et al., 2017).

Normann and Ramirez (1993) argue that value creation is essential for firms to achieve sustainable competitiveness. Traditional industrial economies separate products from services and view products as even more important than services. * However, value is created by firms. * The creation of a value perspective shifts the focus from value creation by the firms alone to value co-creation (Prahalad & Ramaswamy, 2000, 2004; Vargo

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& Lusch, 2004, 2008). Vargo and Lusch (20042008) note that traditional commodity-oriented logic is replaced by a service-oriented logic in which enterprises and consumers create value together, and consumers facilitate value co-creation in the context of the service experience (Vargo & Lusch, 2008, 2016). This paper also argues that value co-creation should be defined in part by the value that customers obtain by interacting with enterprises on social business platforms.

Hollebeek et al. (2021) reveal that the end result of customer engagement is value co-creation. The impact of the concept of value co-creation on customer engagement is mainly expressed by interactive experiences (Brodie et al., 2011), the psychological ownership of customers (Zhou et al., 2022), and functional, hedonic, and social values (Hu, 2019; Wang et al., 2014; Zhang et al., 2014, 2017). Hu (2019) tested the positive impact of customer engagement on functional, hedonic, and social values in the context of social media. This study concludes that customer engagement has a significant impact on value co-creation and proposes three hypotheses:

H2   Customer engagement has a positive effect on value co-creation

H2a   Customer engagement has a positive impact on functional value.

H2b   Customer engagement has a positive impact on hedonic value.

H2c   Customer engagement has a positive impact on social values.

Customer engagement, value co-creation and customer loyalty

Customer loyalty is a promise that customers will buy or patronize their favourite products and services again in the future (Oliver, 1999). Ha and Park (2013) emphasize consumers' psychological attachment and commitment to a brand or company based on their own preferences, including cognitive, emotional, intentional and behavioural loyalties. Srinivasan et al. (2002)pointed out that customer loyalty is the extent to which consumers pay attention to and prefer a particular platform, thus leading to repeated consumer behaviour. Van Doorn et al. (2010) argue that motivational drivers such as word-of-mouth recommendations, interaction, and activity lead to customer engagement behaviours that go beyond transactional behaviours. This paper holds that customer loyalty is expressed when customers engage in any of the following behaviours: purchases, repeat purchases, linking to other sites, comments, retweets, recommendations, word-of-mouth recommendations, and positive evaluation of their experience based on their satisfaction and trust in the products or services of enterprises. At this point, customer loyalty includes transactional behaviour and nontransactional behaviour.

Value co-creation refers to the process by which consumers create value by fully utilizing their own resources and the resources provided by enterprises to solve problems (Xu, 2019). Value is what the customer gains from the use of the internet to view, exchange or use information in a particular situation; the customer builds a personalized experience through continuous dialogue and interaction that results in functional, hedonic, and social values (Ask et al., 2019; Zhang et al., 2017).

Functional value is the customer's assessment of the ability of the product or service to address customer-specific needs (Carlson et al., 2019); hedonic value is a key factor in customer engagement with social media (Ceyhan, 2019), and high hedonic value ensures that customers visit brand pages more frequently (De Vries & Carlson, 2014). Social value is generated by the emotion that comes out of the interaction that keeps the human connection going (Tsimonis & Dimitriadis, 2014). Verleye (2015) explores how hedonic and social values, use, and experience contribute to customer satisfaction and positive and pleasurable experience ratings, thereby enhancing customer loyalty. This study concludes that functional, hedonic and social values have significant effects on customer loyalty in value co-creation and proposes three hypotheses:

H3   Value co-creation has a positive effect on customer loyalty.

H3a   Functional value has a positive effect on customer loyalty.

H3b   Hedonic value has a positive effect on customer loyalty.

H3c   Social values have a positive impact on customer loyalty.

Livestreaming platforms such as Facebook, Instagram, WeChat, Quick Hand, Douyin, Taobao and JD.com are examples of the use of streaming to cocreate value, providing customers with better interactive experiences through the physical cues of live e-commerce service scenes, satisfying customer value co-creation and other needs promoting customer loyalty attitudes and behaviours (Ceyhan, 2019; Wang et al., 2022). Carlson et al. (2019) reveal that usability and hedonic search engine site placement have a positive effect on emotional commitment, establishing a long-term stable relationship with a customer, and that this pleasurable mood does not lead to a stronger willingness to buy. Zhang (2019) explored the impact of social cues (nonverbal communication, verbal communication, service skills) on consumers' online behavioural intentions. Brodie et al. (2011) believe that customer engagement results in customer satisfaction, self-brand connection, brand attachment, and brand loyalty. Hollebeek et al. (2019) note that value co-creation mediates the effect of customer engagement on customer loyalty. Hu (2019) examined the positive impact of value co-creation on customer engagement and customer loyalty in social media. This study proposes the following hypotheses:

H4   The effect of physical cues on customer loyalty in livestreaming service scenes is mediated by customer engagement.

H5   Value co-creation mediates the effect of physical cues in e-commerce livestreaming service scenes on customer loyalty.

H6   Customer engagement and value co-creation are enchained mediating variables between the livestreaming service scenario and customer loyalty.

Methodology

Research method

This study selected Guangdong, Zhejiang, Shanghai, Jiangsu, Fujian, Hubei, Beijing, Jiangxi, Guangxi and other areas. These are places, where China has both developed e-commerce and nondeveloped areas and have certain representativeness. Chinese e-commerce livestream users in these regions are the target audience, and respondents needed to use Taobao, JD.com, Douyin, Kuaishou, Mushroom Street, small red books or other platforms to watch e-commerce livestreams more than three times. These are China's relatively typical e-commerce livestreaming platforms, currently. The platforms gather a large number of fans, with a wide range of attention and influence, so the research object has a strong representative research value. On the other hand, the respondents are very familiar with this kind of e-commerce livestreaming platform and easily form a good sense of self-efficacy and degree of fit, thus realizing value co-creation. It is helpful for this research to understand the scene and process of value co-creation on e-commerce livestreaming sites.

Data collection

Using a simple random sampling method, the researchers collected participants to evaluate the questionnaire through its design and revision after a pretest to form an improved formal questionnaire. The survey was distributed through three types of channels: (1) WeChat groups, WeChat Friend Circle, WeChat friends, QQ Group, QQ friends, etc., for distribution; (2) e-commerce livestreaming platform users who were selected according to the relationships of questionnaire respondents; (3) the use of Questionnaire Star and Taobao customer function. The questionnaire could be completed and submitted through the following channels: (1) mobile phone scan QR code and (2) a web link. The questionnaire items are set through Questionnaire Star. Questionnaire Star in China is a professional online survey company with online questionnaire design, data collection and other functions that is widely used by the academic community. Respondents must answer all questions before submission of a questionnaire to avoid missing items.

In general, the ratio of respondents to the number of questions should be 5:1 or higher (Gorsuch, 1983). Since there are 53 items in this study, more than 265 questionnaires should be obtained; 475 valid questionnaires were received, which meets the basic requirements of empirical research with effective questionnaires.

Measures and assessment of the goodness of measures

A questionnaire was designed using a 7-point Likert scale, from strong dissatisfaction to strong satisfaction. We first discuss independent variables and then describe dependent and mediation variables. All α values showed acceptable values; $\alpha > 0.882$.

Physical cues in e-commerce livestreaming scenarios were measured using 17 criteria from Harris and Goode (2010) and Wang (2022) by exploratory factor analysis when making predictive questionnaires. One dimension had cross-loading and conflicted with other factors, and 4 items were deleted, including aesthetic demand, functional layout and financial security. Social cues were identified with scales from Sundaram (2000) and Zhang (2019) for e-commerce livestreaming scenes, including nonverbal

communication, verbal communication and service skills, which mainly emphasize the service personnel in the scenes.

Customer loyalty is assessed with Linghu's (2019) five items, and customer loyalty is assessed by customer purchases, likes, recommendations and nonbehavioural responses.

For the mediation variable, assessment of customer engagement follows Vivek et al. (2014) and Li and Zhang (2021). Value co-creation uses Linghu's (2019) customer value perspective measurement scale. The scale considered functional, hedonic and social values.

Goodness of measures

In this study, the hypothesis was tested by combining structural equation modelling with the statistical software MPLUS8.0. First, the reliability and validity of the measurement model were tested using confirmatory factor analysis, following the recommended practice of Anderson and Gerbing (1988). Second, the main structural model was evaluated with potential variable path analysis to test hypotheses H1a, H1b, H1c, H1d, H1e, H1f, H2a, H1b, H2c, H3a, H3b, and H3c. The mediating effects H4, H5 and H6 were tested according to Baron and Kenny (1986), and the stability of the construct estimates and the significance of the model coefficients were tested by bootstrapping (Hayes, 2009).

Measurement model

Demographic characteristics

Table 1 shows that women slightly outnumber men at 51.2 per cent and 48.8 per cent, respectively. The majority of respondents were aged 18–30, with all other age groups accounting for less than 20 per cent. The education level was mainly concentrated in junior college and undergraduate, accounting for 41.5 per cent and 50.5 per cent, respectively. The majority of the respondents were students (53.1 per cent) and employees of enterprises (29.3 per cent). The remainder of the respondents composed less than 10 per cent of the total and earned less than 3,000 yuan. Based on their participation in e-commerce livestreams, the respondents preferred Taobao, Douyin and JD.com, accounting for 32.3 per cent, 26 per cent and 16.7 per cent, respectively. Out of the total, 23.2 per cent had less than 1 year of experience, 28.8 per cent had 1–2 years and 3–5 years, 19.2 per cent had more than 5 years; as for frequency, 42.1 per cent visited 2–4 times per week, and 34.7 per cent visited less than 2 times per week, The average visit time was not long, mainly less than 1 h, accounting for 65.5 per cent of total respondents.

Validity and reliability

In this study, a confirmatory study design was used to estimate construct reliability using a composite reliability coefficient. Hair et al. (2014)state that the structural threshold should be greater than 0.07 to indicate sufficient reliability. The composite reliability (CR) value must exceed 0.07 (Bagozzi & Yi, 1988; Bearden et al., 1993), and as shown in Table 2, the CR value is greater than 0.874, indicating that the CR of all factors is good. Then, we use mean variance extraction (AVE) to evaluate the convergence effectiveness of the constructs. Fornell and Larcker (1981) state that the factor load for each construct should be above 0.7, and the AVE value must be greater than

Table 1 Demographic characteristics (*N* = 475)

Characteristics	Category	N	%	Characteristics	Category	N	%
Gender	Man	232	48.8	Favourite Platform for Live e-commerce	Taobao	394	32.3
	Female	243	51.2		JD.com	204	16.7
Age	Under 18	43	9.1		TikTok	317	26
	18–25 years	214	45.1		Speedy	127	10.4
	26–30 years	127	26.7		Little Red Book	68	5.6
	31–40 years	63	13.3		Mushroom Street	50	4.1
	41–50 years	17	3.6		Other	61	5
	51–60 years	8	1.7	E-commerce live room shopping time	Less than 1 year	110	23.2
	Over 60	3	0.6		1–2 years	137	28.8
Education	High School and below	15	3.2		3–5 years	137	28.8
	Specialist	197	41.5		More than 5 years	91	19.2
	Undergraduate	240	50.5	Average number of visits per week	Less than 2 times	165	34.7
	Master's degree or above	23	4.8		2–4 times	200	42.1
Occupation	Employees of enterprises	139	29.3		5–7 times	64	13.5
	Workers in government organs and institutions	32	6.7		More than 7 times	46	9.7
	Freelance	7	1.5	Length of visit per day	Less than 1 h	311	65.5
	Self-employed	30	6.3		1–2 h	100	21.1
	Students	252	53.1		2–3 h	40	8.4
	Other	15	3.2		3–4 h	12	2.5
Income	Less than $429.9	244	51.4		More than 4 h	12	2.5
	$430.0–$716.5	64	13.5				
	$716.6–$1146.3	72	15.2				

Table 2 Convergent validity and reliability (*N* = 475)

Constructs	No. of items	Mean	SD	CR	AVE	FLR
AA	5	4.811	1.279	0.893	0.626	0.706–0.845
FL	5	4.889	1.156	0.874	0.583	0.627–0.822
FS	3	4.929	1.318	0.896	0.743	0.808–0.900
NC	4	4.875	1.267	0.908	0.712	0.827–0.861
VC	4	4.970	1.238	0.894	0.680	0.792–0.860
SS	4	4.999	1.186	0.903	0.699	0.821–0.854
CE	6	4.522	1.356	0.934	0.702	0.815–0.878
FV	3	4.608	1.312	0.892	0.735	0.825–0.888
HV	3	4.686	1.261	0.882	0.714	0.826–0.867
SV	3	4.592	1.348	0.911	0.773	0.870–0.896
CL	5	4.796	1.228	0.926	0.715	0.792–0.869

AA aesthetic appeal, *FL* layout and functionality, *FS* financial security, *NC* Nonverbal communication, *VC* verbal communication, *SS* service skills, *CE* customer engagement, *FV* functional value, *HV* hedonic value, *SV* social value, *CL* customer loyalty, *CR* composite reliability, *AVE* average variance extracted, *FLR* factor loading range

0.50. The results show that the factor load is more than 0.7, and all the constructs have a large AVE, which proves their convergence effectiveness (Hayes, 2009).

The discriminant validity test devised by Hair et al. (1998) includes the recommendation that the open-root value of the AVE of potential variables should be greater

than the correlation coefficient of other different variables. As shown in Table 3, the values of the open root of AVE for each variable range from 0.764 to 0.879, which are greater than the correlation coefficients between the two factors (Fornell & Larcker, 1981). The discriminant validity of all variables in the proposed research model can be ensured.

Considering the use of cross-sectional data, multilayer tests are applied to test for potential common methodological biases. (1) Harman's one-way test for common method bias was run (Podsakoff & Organ, 1986; Podsakoff et al., 2003). Factor analysis was performed on all items, and 10 factors with characteristic roots greater than 1 were extracted from the unrotated exploratory factor analysis results. The AVE of the first factor was 39.211 per cent, less than the recommended value of 50 per cent (Podsakoff et al., 2003). (2) Results of the unmeasured potential method factor (ULMC) test (Podsakoff et al., 2003) showed that Factor Model I (CFI = 0.951, TLI = 0.947, RMSEA = 0.042, SRMR = 0.036) with 11 factors and Method Factor Model II (CFI = 0.961, TLI = 0.956, RMSEA = 0.038, SRMR = 0.03), when compared (δcfi = 0.01, δtli = 0.009, δsrmr = 0.006, δrmsea = 0.004), did not reach a significant level in the improvement of the fitting index (CFI and TLI did not increase by more than 0.1, RMSEA and SRMR decreased by more than 0.05), indicating that there was no serious common method bias (Tang & Wen, 2020).

Finally, the model fitness was tested to see if the assumed model was consistent with the observed data. The results of CFA showed that $X^2/df = 1.86 < 3$, $P = 0.000$; CFI = 0.955 > 0.90; TLI = 0.950.0.90; RMSEA = 0.042 < 0.08, SRMR = 0.035 < 0.06, indicating that the fitness index of the model in this study met the recommended criteria of scholars (Hu & Bentler, 1999) and had good adaptability. Therefore, this scale has good measurement quality.

Structural model analysis and hypothesis testing

MPLUS8.0 was used to analyse the data, and path analysis was used to explore the relationship among the research concepts to verify the research hypothesis. The structural model matched the appropriate values ($x^2/df = 2.04$; CFI = 0.945; TLI = 0.939; RMSEA = 0.047, SRMR = 0.045), referring to Hu and Bentler's (1999) suggested values,

Table 3 Correlation among constructs and the AVE square root ($N = 475$)

	AA	FL	FS	NC	VC	SS	CE	FV	HV	SV	CL
AA	**0.791**										
FL	0.678	**0.764**									
FS	0.533	0.628	**0.862**								
NC	0.591	0.670	0.612	**0.844**							
VC	0.640	0.663	0.642	0.688	**0.825**						
SS	0.518	0.611	0.555	0.711	0.731	**0.836**					
CE	0.402	0.418	0.307	0.360	0.261	0.312	**0.838**				
FV	0.466	0.479	0.427	0.512	0.518	0.435	0.507	**0.857**			
HV	0.430	0.491	0.401	0.458	0.510	0.454	0.525	0.653	**0.845**		
SV	0.321	0.464	0.352	0.339	0.371	0.343	0.602	0.682	0.668	**0.879**	
CL	0.538	0.600	0.490	0.575	0.564	0.563	0.560	0.692	0.684	0.695	**0.846**

The bold letters on the diagonal are the square root of Ave

Table 4 Path coefficients ($N = 475$)

Hypotheses direct effect	Path	Beta	t	p	R^2	Decision
H1a	AA → CE	0.259	3.593	***		Supported
H1b	FL → CE	0.232	2.81	**		Supported
H1c	FS → CE	0.062	0.897	NS	0.231	Not Supported
H1d	NC → CE	0.117	1.445	NS		Not Supported
H1e	VC → CE	-0.276	-2.988	**		Supported
H1f	SS → CE	0.124	1.495	NS		Not Supported
H2a	CE → FV	0.406	9.138	***	0.481	Supported
H2b	CE → HV	0.438	9.834	***	0.482	Supported
H2c	CE → SV	0.574	13.914	***	0.498	Supported
H3a	FV → CI	0.199	3.891	***		Supported
H3b	HV → CI	0.190	3.727	***	0.678	Supported
H3c	SV → CI	0.307	5.852	***		Supported

$*p < 0.05$; $**p < 0.01$; $***p < 0.001$; *NS* nonsignificant

illustrating that both were within the acceptable range. Table 4 shows that there are significant positive correlations between aesthetic appeal, functional layout and customer engagement ($\beta = 0.259$, $p < 0.001$), ($\beta = 0.232$, $p < 0.01$). There was a significant negative correlation between verbal communication and customer engagement ($\beta = -0.276$, p < 0.01). There was no significant correlation between financial safety, behaviour, posture, service skills and customer engagement ($\beta = 0.062$, $p > 0.01$), ($\beta = 0.117$, $p > 0.01$), ($\beta = 0.124$, $p > 0.01$). There were significant positive correlations between customer engagement and functional value, hedonic value, and social value in value co-creation ($\beta = 0.406$, $p < 0.001$, $\beta = 0.438$, $p < 0.001$, and $\beta = 0.574$, $p < 0.001$, respectively). In value co-creation, functional value, hedonic value and social value were positively correlated with customer loyalty ($\beta = 0.199$, $p < 0.001$, $\beta = 0.190$, $p < 0.001$ and $\beta = 0.307$, $p < 0.001$, respectively).

Confidence interval analysis (bootstrap distribution of effects) was used to validate the mediation effect. The indirect effect was examined by bootstrapping 5000 times (Hayes, 2009). The results showed that the mediating effect of customer engagement on customer loyalty was ($\beta = 0.003$, $P > 0.05$). The 95 per cent confidence interval was (-0.087, 0.088), including 0, so hypothesis H4 was not supported. The mediating effect of value co-creation on customer loyalty through the physical cues in e-commerce livestreaming scenes was ($\beta = 0.445$, $p < 0.001$). The 95 per cent confidence interval is (0.256, 0.693) and does not contain 0, so hypothesis H5 is supported. The chain mediating effect of customer engagement and value co-creation on customer loyalty through the physical cues of e-commerce livestreaming scenes was ($\beta = 0.177$, $p < 0.001$), and the 95 per cent confidence interval was (0.098, 0.274). The results showing that H6 is supported are shown in Table 5.

Discussion

This study mainly explores the mediating effect of customer engagement and value co-creation between the e-commerce livestream and customer loyalty. The combination of "people, goods and field" on the sets of e-commerce livestreaming sites

Table 5 Mediating effect test ($N = 475$)

Effect	Point estimate	Product of coefficient			Bootstrap 5000 TIMES 95% CI	
					Percentile	
		S.E	*Z* value	*P* value	Lower	Upper
SC → CE → CL	0.003	0.044	0.065	0.948	− 0.087	0.088
SC → VC → CL	0.445	0.113	3.953	***	0.256	0.693
SC → CE → VC → CL	0.177	0.044	3.983	***	0.098	0.274
Total	0.992	0.095	10.417	***	0.814	1.192

Cs service scenario, *CE* customer engagement, *VC* value co-creation, *CL* customer loyalty, ***Indicates $P < 0.001$

is effective, which accords with Bake's (1994) opinion that the scene of e-commerce livestreams includes three dimensions: atmosphere, design and society. The results show that there is a significant positive correlation between aesthetic appeal and functional layout in the physical cues in the e-commerce livestreaming scenes and customer engagement, and H1a and H1b are supported by a significant positive correlation (2018). Mainly because of China's implementation of the 7-day no-exchange policy, consumers do not have to worry about payment problems, so financial security is less of a concern. Among the social cues in e-commerce livestreaming, the effect of Nonverbal communication and service skills on customer engagement was not significant (H1d and H1e were not supported), and the effect of verbal communication between service staff and customer engagement was significantly negative (H1e was supported), which indicated that the customers paid relatively more attention to the language of the host and service staff in the livestreaming site, and the online language and humour were relatively popular with consumers. Zhang (2019) also confirmed the effect of verbal communication on scene attachment. Therefore, the atmosphere, aesthetic appeal and language of the service staff have a significant impact on customer engagement with the e-commerce livestream.

Value co-creation is a process of continuous interaction in the experience between enterprises and customers (Prahalad & Ramaswamy, 2000, 2004). From a customer experience perspective, value co-creation encompasses functional, hedonic, and social values (Linghu, 2019; Zhang et al., 2017). The research shows that there is a significant positive correlation among functional, hedonic and social values, and there is a significant positive correlation among H2a, H2b and H2c. This result is consistent with previous literature (Hollebeek et al., 2021; Kumar & Pansari, 2016; Linghu, 2019; Kumar, 2019). Customer engagement allows the audience to meet their needs, have a pleasant mood, and have social connections, thus stimulating customers to be more willing to participate in livestreaming activities.

Chen et al. (2021) believe that customer engagement in active information seeking, entertainment and social activities will affect customer experience, and customer experience will significantly affect customer use, participation, and other behaviours. The results show that value co-creation (functional, hedonic, and social values) has a significant positive correlation with customer loyalty, and the hypotheses of H3a, H3b, and H3c are verified. When customers feel that they are cocreating value, there

will be some kind of responsive behaviour, such as purchasing, recommending, liking, linking, retweeting, or commenting.

Customer engagement is a motivational, brand-related and context-dependent psychological state generated by customers' interactions with a brand and is characterised by specific input levels of cognition, emotion and behaviours (Dessart et al., 2015; Hollebeek, 2011). In e-commerce live streaming scenarios, the impact of customer engagement on value cocreation further promotes customer loyalty. The marketing research led by service logic indicates that customer engagement promotes the systematic process of value cocreation (Jaakkola & Alexander, 2014) by attracting more extensive resource integration. Therefore, customer engagement is seen as the basis for achieving value cocreation (Kumar & Pansari, 2016). From the perspective of customers, more information, help, pleasure and social experience obtained by customers embody value cocreation. This study focuses on the experiential value of customers in e-commerce live streaming as value cocreation, which meets the functional, hedonic and social communication needs of customers.

In e-commerce live streaming scenarios, customers watch the anchor introduce products or provide services with fun and humour. A warm layout of the live streaming room and high customer participation enthusiasm improve the degree of participation among customers. If customers receive more help, more information, more pleasure and more social experiences and the information obtained is found to be beneficial, interesting and useful, they will actively share their own experiences, participate in topic discussions and interaction with friends and help each other, resulting in higher customer loyalty. If customers participate in an e-commerce live streaming scenario and do not feel that they have gained something, they will not be loyal and may even leave the live streaming platform.

To analyse the intermediary role of customer engagement in e-commerce live streaming scenarios, value co-creation and customer loyalty, it is necessary to determine whether customer engagement has an intermediary effect on e-commerce live streaming scenarios and customer loyalty. Therefore, this research first analyses the relationship between customer engagement in e-commerce live streaming scenarios and customer loyalty. From the analysis results, customer engagement has no intermediary effect on e-commerce live streaming scenarios or customer loyalty, which means that H4 is not supported. That is, the higher the customer participation in e-commerce live streaming scenarios, the higher the customer loyalty. However, when customers participate in e-commerce live streaming scenarios to achieve value cocreation and feel functional value, hedonic value or social value, customer loyalty is higher, which means that H6 is supported. This finding is consistent with that of Linghu (2019) in the context of social media, which also lays the foundation for the subsequent analysis of customer engagement, value cocreation and customer loyalty. The reason is that in e-commerce live streaming scenarios, customers are loyal when they feel a strong connection with the products, and when customers do not feel the products, information or services have value for them, they are not loyal. Therefore, the customers are very realistic and honest.

Compared with traditional good-dominant logic, Vargo and Lusch (20042008) proposed service–dominant logic (S–D logic for short), which holds that value is created by enterprises and customers, and the focus of attention is shifted from exchange

value to use value. "The service-oriented logic of marketing" points out that "customers are always co-producers" means that "customers are always co-creators of value" (Vargo & Lusch, 2004, 2008). Value cocreation is an attempt to consciously create value using products and services in ecosystems (Cheung et al., 2020; Ro et al., 2018). Value cocreation involves the amount of knowledge, capabilities, and information that a customer uses to create value. These influential schools have conducted pioneering research on the empirical value, dominant logic, internal mechanism, role and behaviour of participants in value cocreation, making value cocreation an important theoretical system in marketing management. At present, the research on value cocreation is abundant and emphasises the dual relationship between enterprises and customers in the value cocreation of the network relationship among enterprises, customers and other stakeholders.

Value is obtained from viewing, exchanging or using information in a specific scenario or is produced during experience (Ranjan & Read, 2016). Participants share their own resources (knowledge, skills, etc.) in the process of experience and determine the value of users participating in the experience through cocreation experience (Linghu, 2019). Sheth et al. (1991) divided value into five categories: "functional value, social value, emotional value, cognitive value and situational value"; Zhang (2019) divided value cocreation into functional value, hedonic value, and social value from a customer perspective; and Linghu (2019) divided value cocreation into functional value, hedonic value and social value from the perspective of customers. From the analysis results, value cocreation mediates the relationship between e-commerce live streaming scenario and customer loyalty, and customer engagement and value cocreation mediate the relationship between e-commerce live streaming scenarios and customer loyalty, supporting H5 and H6. This research is consistent with the study of Linghu (2019) in a social media scenario, as a special form of social media, e-commerce live streaming provides a social interaction environment in which consumers have the opportunity to communicate with brands, exchange ideas with other users, produce content and influence the public. When customers feel value cocreation, they further promote their enthusiasm for participation, which improves customer loyalty.

Although the SOR model is applied to the web services scenario, similar to most previous studies (Linghu, 2019; Tu et al., 2018), some conclusions of this work can be applied to explore the e-commerce livestreaming scenario. This research promotes the development of service scenarios and SOR theoretical paradigms. At the same time, this paper effectively links e-commerce livestreaming (S), customer engagement and value co-creation (O) with customer loyalty (R) through SOR theory. The results show that in e-commerce livestreams, customer engagement has no intermediary effect between the scene of the livestream and customer loyalty, and value creation alone or in conjunction with customers has a chain mediating effect on e-commerce livestreams and customer loyalty; that is, hypothesis H4 does not hold, and hypotheses H5 and H6 hold. Thus, it is best to let customers feel the value in the livestreaming room. It was meaningful to stay in the livestreaming room to obtain more valuable information, enjoy the hedonic aspects of a shared consumer experience, participate in social activities, and so on; in short, the effect of customer value co-creation on customer loyalty cannot be ignored.

Conclusions

Structural equation modelling is used to validate the research framework for e-commerce livestreaming services. This proves that SOR theory is also applicable to the impact of e-commerce livestreams on customer loyalty. Through empirical analysis, we find that both physical cues and social cues from e-commerce livestreaming sites have an impact on customer loyalty, which makes up for the gap in scene theory and SOR model theory. Customer engagement has a higher path coefficient to functional value, hedonic value and social value in value co-creation. The results show that aesthetic appeal and functional layout have a positive correlation with customer engagement, while verbal communication has a negative correlation with customer engagement. The scene design, visual effect and verbal communication of service personnel play an important role in livestreaming rooms. Customer engagement is positively related to value co-creation (functional value, hedonic value, social value) and promotes customer loyalty. Customer engagement and value co-creation have a chain mediation effect between e-commerce livestreaming services and customer loyalty. Companies should provide more opportunities for value co-creation through the livestreaming site, which comes from the livestreaming consumer's pursuit of individuality, strong desire for self-expression, hope to participate in the scene, and good experience overall.

The design of this research is a case-crossover study that cannot directly assess causality, which limits our assertion and testing of the exact causal relationship between structures. For a more accurate understanding of causal observations, long-term methods of investigation should be used for future studies. The subjects were mainly college students aged 18 to 25 to facilitate sampling, but this reduces the external validity of the study. Although this age group is considered the most active e-commerce audience, given the age-specific habits of online video viewing, future studies should include more diverse samples to validate the results of this research. The model proposed in this research highlights the positive role of real-time e-commerce service scenarios, which is the first step in influencing customer loyalty. However, real-time e-commerce service scenarios may have negative effects, such as negative comments in product functional layouts, which may affect the impact of using real-time e-commerce service scenarios on customer loyalty. Future research can extend the results of this research by investigating the dark side of real-time e-commerce service scenarios.

Declarations

Competing interests
The authors declare that they have no competing interests.

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