How live-streaming commerce influences consumers' impulse buying of near expiry-date food: implications for reducing food waste

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Consumers often hesitate to purchase and consume food near expiry-date (FNED), contributing to significant food waste. The emerging practice of selling FNED through live streaming commerce (LSC) holds promise for promoting FNED sales and reducing food waste, as LSC can stimulate impulsive purchasing behavior among consumers. This study integrates the para-social theory, consumer value theory, and face negotiation theory to develop a research framework that examines how online interactions and face consciousness in Chinese culture influence consumers' impulse buying of FNED through LSC. Using structural equation modeling and data from 352 valid online survey responses, the study reveals that streamer-viewer interaction (SVI) all contribute to impulse buying (IB). And perceived ease of use (PEOU), streamer-viewer interaction (SVI), and co-viewer interaction (CVI) strongly influence IB and is sequentially mediated by perceived risk (PR), highlighting the importance of PR. Only SVI directly impacts perceived value and further drives impulse buying. Additionally, the study demonstrates that face consciousness mitigates the impact of streamer-viewer interaction on impulse buying through consumers' recognition of and reimbursements for streamers' efforts. This study provides theoretical and managerial implications for online retailers and LSC platform practitioners for FNED sales.

KEYWORDS

live streaming commerce, near expiry-date food, food waste reduction, face negotiation theory, online interactions, expectance theory

1 Introduction

Statistical data indicates that a substantial portion of global food is wasted, ranging from approximately 30% (FAO, 2017) to 50% (EPRS, 2014). In China, the annual food wasted amounts to 17 to 18 million tons (von Massow et al., 2019). Besides food losses in the field and during processing, food waste at the consumption stage accounts for 35% of total food waste. In the consumption stage, consumers frequently reject suboptimal food, either due to aesthetic standards not being met or to the limited period for optimal flavor (Aschemann-Witzel, 2018; Aschemann-Witzel et al., 2021; Mullick et al., 2021; See Meng et al., 2023; Xiao et al., 2024). Prior research has shown that consumers are generally averse to consuming suboptimal food and food near its expiry date (FNED; Aschemann-Witzel, 2018). FNED refers to food that is approaching its best-before date (Rohm et al., 2017). The waste of FNED entails squandering inputs utilized during manufacturing, including raw materials, labor, and machinery (Aschemann-Witzel, 2018; Mullick et al., 2021; Puteri et al., 2022). Therefore, encouraging

consumers to accept, purchase, and consume FNED can significantly reduce food waste and protect the environment.

Currently, FNED is sold through various offline sales channels (e.g., Supermarkets, specialized FNED stores and online retailers). With the popularity of LSC, some vendors have started utilizing LSC to enhance FNED sales (Figure 1) and the detailed information are shown in Appendix 1. LSC is an audio and video-based platform that allows streamers to promote and sell products or services in real-time (Zhao et al., 2021; Zhao et al., 2023). This platform is recognized for fostering impulse buying due to its ability to provide stable and convenient sales services, rich visual and verbal cues of products, and real-time interactions between streamers and viewers. These attributes expand customers' reach and trigger impulse buying tendencies and behaviors (Fu and Hsu, 2023). LSC's features and functionalities align well with FNED sales requirements, such as offering multiple varieties in small quantities, facilitating quick sales, delivery, and consumption, addressing high uncertainty, and providing specific product information, especially considering FNED's limited expiry date.

Statistical evidence indicates that impulse buying constitutes 40% of online consumer spending and that 84% of consumers admit they have made impulse purchases. In China, approximately 44% of consumers engage in impulse buying through LSC. Consequently, to expedite the sale, delivery, and consumption of FNED, streamers must gain a deeper understanding of the psychological mechanisms underpinning impulse buying of FNED via LSC. Furthermore, face consciousness has been identified as a significant barrier to the adoption of suboptimal food, yet there is a scarcity of studies exploring this phenomenon within the context of LSC for the sale of

FIGURE 1
FNED sale through living streaming commerce.

FNED. Therefore, this study aims to address the following research gaps.

First, previous research has emphasized the impacts of stakeholder interactions and technologies utilized on social commerce platforms on the para-social theory (Xue et al., 2020; Zhou et al., 2021). Typically, online interactions are categorized into four types: platform-related interactions, which include perceived ease of use and perceived usefulness, and interpersonal-related interactions, encompassing streamer-viewer and co-viewer interactions (Ma et al., 2022). However, prior studies have typically focused either solely on platform-related factors (Xue et al., 2020; Zhou et al., 2021; Qu et al., 2023) or personal-related factors (Fu and Hsu, 2023; Hsieh et al., 2023) in the context of LSC, adopting a fragmented approach. On the one hand, increased accessibility and convenience are listed as prominent reasons for consumers' adoption of LSC (Qu et al., 2023). On the other hand, personal interaction is a pivotal and distinctive characteristic of information transfer and communication within LSC (Fu and Hsu, 2023; Gao et al., 2023). Furthermore, the platform provides the technological infrastructure and framework for social interaction, fostering a more authentic and interactive shopping experience (Ming et al., 2021). Therefore, this study intends to explore consumers' perceptions of both platform-based and personal-based interactions when they watch and purchase FNED sales through LSC.

Second, a substantial body of literature has employed the prospect theory to examine the influence of consumers' perceptions on their purchase intentions (Nguyen, 2016; Meng and Weng, 2018). Most studies have focused on value perception (Fu and Hsu, 2023) or risk perception (Zhang et al., 2023; Zhang and Zhang, 2024) in isolation. Research exploring value and risk perceptions within the context of LSC is limited. Only a few studies, such as Mao and Lyu (2017) and Yang et al. (2022), have investigated the effects of both value and risk perception on consumers' adoption intentions in the contexts of Airbnb reuse and surplus food sales through live streaming. However, it is anticipated that perceived value and risk are particularly relevant in the LSC context. On the one hand, the price-quality schema has been identified as a significant factor driving consumers to use LSC, as it enhances their value perception (Chang et al., 2024). On the other hand, perceived risks, including health risks, financial risks, quality risks, overdue risks, psychological risks, and social risks, are considered key inhibitors in the food industry, especially for suboptimal foods, such as FNED (Bartels and Onwezen, 2014). Hence, in the context of FNED in LSC, consumers would confront with both value perception (e.g., lower price, higher accessibility and varieties) and risk perceptions (e.g., health, financial, delivery, overdue risks). Therefore, this study employs the prospect theory and intends to explore perceived value and risk effects on FNED sales through LSC.

Third, previous research underscores the significance of cultural elements in food consumption with Mianzi culture being a prominent embodiment of these elements (Zhang et al., 2018). Studies have shown that face consciousness, a crucial aspect of Mianzi, greatly influences food waste generation (Bai et al., 2022). Individuals with high levels of face consciousness are more concerned with their social image and prestige and are inclined to engage in prosocial behaviors. In the FNED realm of food consumption, such consumers tend to order excess food when hosting dinners and avoid purchasing suboptimal foods, such as FNED, to maintain their face (Aschemann-Witzel et al., 2021; Bai et al., 2022). Prior studies indicate that individuals with high face consciousness prefer to purchase products
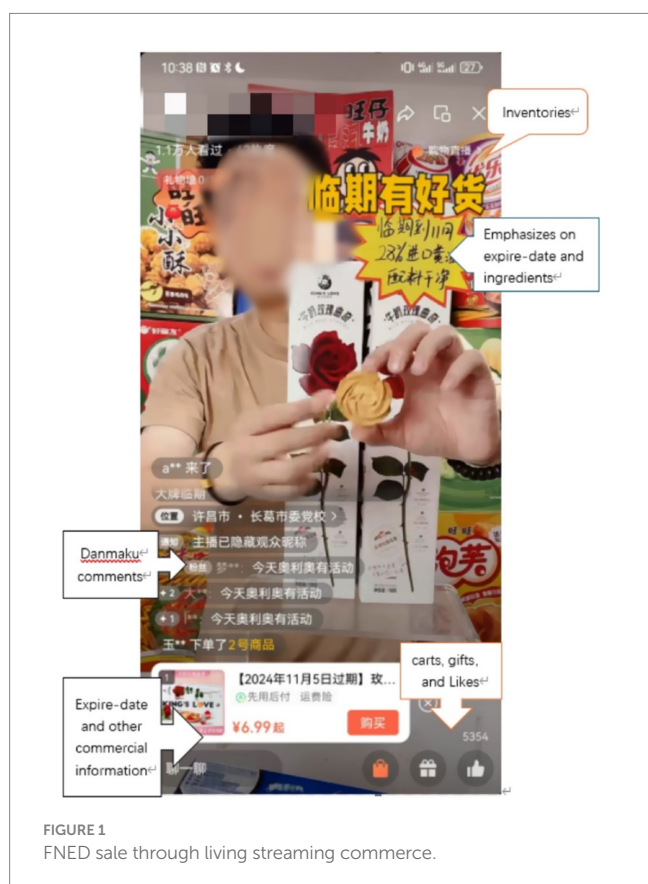
from famous brands (Tse, 1996) and conspicuous products (Du and Xu, 2014). Furthermore, face consciousness has negatively impacted the relationship between virtual social capital and sustainable clothing consumption patterns (Zhang and Dong, 2021). In offline marketing, consumers' identities are openly displayed to their peers and community members. However, in the emerging context of LSC, viewers often use nicknames, and their identities remain hidden. Therefore, this study adopts the face negotiation theory and explores whether face consciousness influences consumers' purchase intentions in the context of LSC for FNED sales.

This study aims to investigate the relationship between online interaction and impulse purchase intention for FNED in the context of LSC, with perceived value and risk serving as mediating factors. While there is an extensive body of literature on related concepts and the structure of online interaction (Zhang and Dong, 2021; Li et al., 2024), scholars have also explored the direct and moderating effects of Mianzi/face consciousness on purchase intention (Du and Xu, 2014; Zhang and Dong, 2021). However, there is a scarcity of research examining these relationships within the context of LSC. The current research on this topic holds exploratory significance. Furthermore, this study aims to expand our understanding of the relationship between online interaction and consumers' impulsive purchasing of FNED by integrating the influencing factor of face consciousness, a cultural characteristic unique to China, within the context of FNED. Consequently, a research framework has been developed to be tailored to Chinese consumers and the FNED context. Given the vast population of China and the increasing amount of food waste, exploring FNED sales through LSC has the potential to satisfy consumers' food consumption needs, promote sustainable FNED consumption, and reduce food waste.

The remainder of this paper is organized as follows: Part 2 presents the literature review and theoretical hypotheses. Part 3 outlines the research methods employed in this study. Part 4 discusses the results obtained. Part 5 provides a discussion of the findings and their implications. Finally, Part 6 addresses this study's limitations and suggests future research directions.

2 Literature review and hypotheses development

2.1 LSC of FNED sale

In recent years, LSC has emerged as a promising avenue in online commerce. By presenting rich visual and verbal cues, LSC facilitates a convenient and promotional sales environment and stimulates consumers' impulse purchasing behavior toward the featured items (Xue et al., 2020; Zhang and Zhang, 2024).

Given its effectiveness, LSC is now being utilized to sell FNED for several compelling reasons. Firstly, FNED necessitates swift sale and consumption due to its limited shelf life. LSC addresses this challenge by showcasing a diverse range of products to a vast online audience, enhancing the likelihood of sales. Secondly, FNED is often perceived as less tasty. Furthermore, some FNED is perceived as less nutritious which has less value. And some FNED containing peanuts ingredients may even pose health risks or even life-threatening dangers to consumers due to excessive levels of potential aflatoxin. Hence, consumers may evaluate more health risks over the potential financial
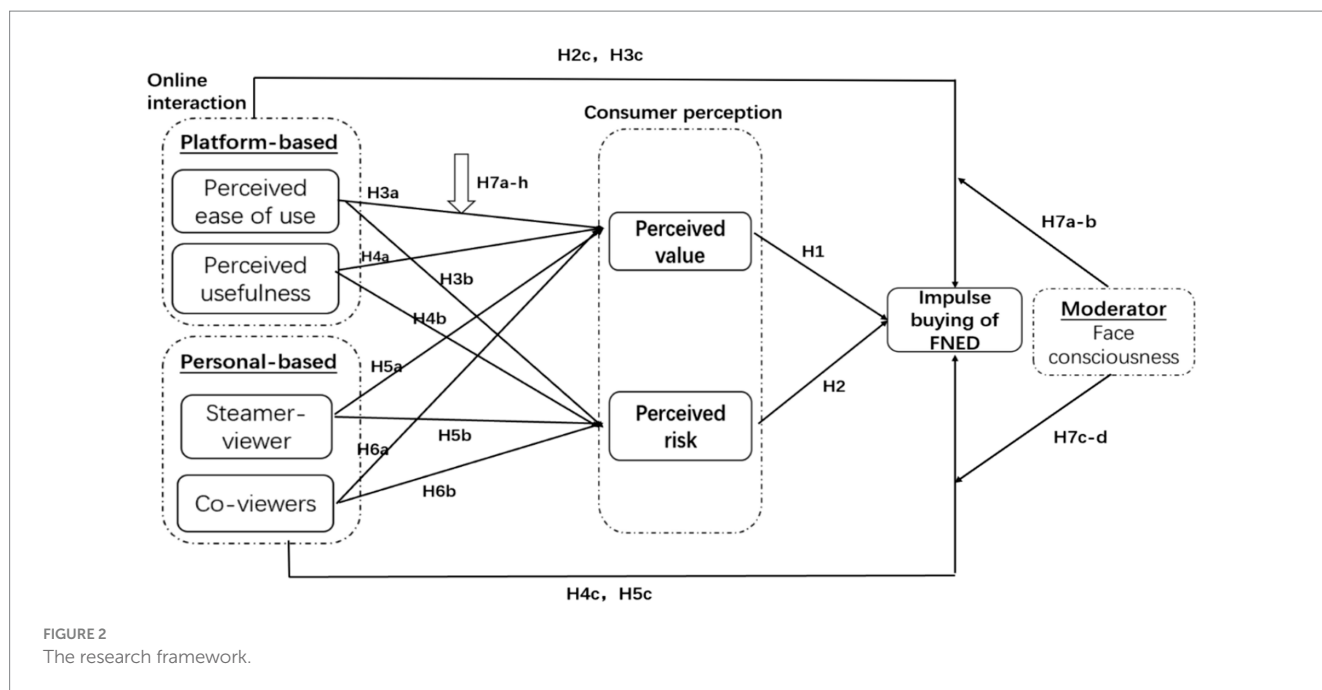
benefits originated from price reduction. This conforms to the distinguished features in the Prospect theory in that consumers may demonstrate more risk aversion in the domain of gains. Furthermore, the purchased FNED will be delivered to consumers in 3–6 days, which will shorten the remained shelf-life. Hence, consumers will pay more attention to and seek the information of remaining shelf-life and delivery time needed to evaluate the potential risk, regardless that streamers already emphasize key details such as the best-before date, ingredients, volume, and brand, providing consumers with comprehensive product information. And this conforms to the features of prospect theory in that consumers may conduct risk seeking behavior in the domain of potential health and financial losses. And these two features justify the application of prospect theory. Thirdly, LSC fosters online interactions among the platform, streamers, and viewers. During the live streams, viewers can post danmaku or barrage comments on the screen, and streamers respond to their questions through verbal or typed communication (Xiong et al., 2024). Simultaneously, viewers in the chat room share information about their purchase experiences, consumption experiences, and other pertinent questions and requirements. These interactive techniques and commercial designs collectively contribute to the successful sale of FNED and justifies the employment of para-social theory. Lastly, consumers with higher face consciousness are prone to be reluctant or even reject to consume suboptimal food like FNED, and we employed face negotiation theory to explore whether this effect exists in the context of FNED sale in LSC context. Therefore, we developed the research framework in Figure 2.

2.2 Consumers' perception and impulse buying

Developed and refined in the late 20th century, Prospect Theory (PT) stands as one of the foremost theories elucidating the decision-making mechanisms of individuals under conditions of risk or uncertainty (Kahneman, 1979). According to PT, consumers engage in a comparative assessment of perceived gains, losses, and risks before making decisions (Meng and Weng, 2018). Extant literature underscores that consumers derive a composite of perceived value and risk from their shopping experiences, and PT is both applicable and suitable for predicting consumer behavior (Nguyen, 2016).

In the framework of PT, perceived value serves as a metric for consumers' immediate evaluations concerning the surplus of potential gains/benefits over potential losses/sacrifices (McDougall, 2000). Typically, consumers exhibit psychological loss aversion, valuing one unit of loss more than one unit of gain (Kahneman, 1979). This implies that the psychological impact of an equivalent number of losses outweighs gains on their behavioral decisions (Mao and Lyu, 2017). The perceived value construct encompasses utilitarian and hedonic values (Liao et al., 2022). Utilitarian value pertains to consumers' cognitive appraisal of the functionalities of a product, service, or platform (Mao and Lyu, 2017; Liao et al., 2022). In contrast, hedonic value pertains to consumers' positive sentiments and emotions (Fu and Hsu, 2023).

In the context of LSC for selling FNED, streamers and platforms provide utilitarian and hedonic value to viewers and consumers. On the one hand, streamers furnish product information, demonstrate usage, offer discounted prices, and arrange spontaneous promotional

FIGURE 2
The research framework.

activities, thereby enhancing utilitarian perception (Xu et al., 2024). As consumers observe the demonstrated product, visualize its application, and assess the price-quality relationship (Xiao and Nicholson, 2013), they perceive higher benefits relative to costs, generating an impulse to purchase (Chen et al., 2016). On the other hand, streamers utilize audio and video techniques to emulate offline shopping experiences, eliciting consumers' sense of presence and positive emotions (Zhao et al., 2024). Furthermore, spontaneous promotional activities render the sales process novel, enjoyable, and exhilarating. These features and activities augment consumers' hedonic perception, and a positive mindset may prompt them to reward themselves through impulse buying (Zheng et al., 2019). Prior research has demonstrated that both utilitarian and hedonic values positively influence impulse buying (Chen et al., 2016; Zheng et al., 2019; Fu and Hsu, 2023). Therefore, we propose the following hypothesis:

H1: Perceived value positively influences consumers' impulse buying of FNED.

Perceived risk represents a subjectively determined anticipation of potential loss associated with a contemplated action (McDougall, 2000). Given the prevalence of loss aversion among consumers, they tend to accentuate potential losses or risks (Kahneman, 1979). Numerous studies indicate that consumers hesitate to purchase products when they perceive high levels of potential risk (Deshbhag and Mohan, 2020). Since impulse buying is primarily driven by positive sentiments and effects (Zafar et al., 2021), consumers with high-risk perceptions are less inclined to engage in impulse buying (Vonkeman Vonkeman et al., 2017). A study by Kang (2020) revealed that consumers are less willing to engage in impulsive travel when they perceive increased risk in a VR travel context. Similarly, Zhang et al. (2023) and Zhang and Zhang (2024) corroborate the negative impact of risk perception on consumers' impulse buying intention in the general LSC context.

In the context of this study, FNED is often perceived as lower in quality, nutrition, and taste, with limited time for consumption, leading consumers to perceive higher risks in their purchasing and consumption decisions. FNED rich in fat and oil like aflatoxin in peanut products is more likely to be considered to pose potential food safety and health risks. All these risks may lead to potential loss in finance and health, triggering consumers' loss aversion perception and further inducing impulse buying intention. Therefore, we hypothesize:

H2: Risk perception negatively influences impulse buying of FNED.

2.3 Consumers' perception and impulse buying

Online interaction is defined as a modality for the exchange and transmission of information facilitated by computers and the internet (Qu et al., 2023). This form of interaction can mitigate the inconveniences associated with face-to-face negotiations and significantly broaden the scope and methods of communication.

Scholars have assessed online interaction from various perspectives. The most utilized approach involves a two-dimensional classification, namely machine/computer-mediated and interpersonal communication (Qu et al., 2023). In this study, we adopt this methodology and measure online interaction in terms of platform-based and interpersonal-based communication.

Platform-related interaction pertains to the interactions between users and social commerce platforms (Qu et al., 2023). This type of interaction is contingent mainly upon consumers' recognition and perception of the platform's convenience and effectiveness (Koehler et al., 2011). A high degree of interactivity between the website and its stakeholders contributes positively to consumer evaluations (Qu et al., 2023). Consistent with prior research, this study evaluates

platform-related interaction using perceived ease of use (PEOU) and perceived usefulness (PU).

Interpersonal interaction refers to interactions among the stakeholders involved (Hughes and Ahearne, 2010). In the LSC context, interpersonal interaction is measured through interactions between streamers, viewers, and co-viewers. The two-dimensional approach employed in this study is summarized in Table 1.

2.3.1 Platform-based interaction and consumers' perception

Platform-based interaction is defined as consumers' perception of the convenience and effectiveness of the functional design of LSC platforms (Qu et al., 2023). The level of website interactivity is positively correlated with consumer evaluations and affect.

The first dimension of platform-based interaction is perceived ease of use (PEOU). PEOU pertains to consumers' perception of the effectiveness and convenience during online shopping experiences (Chiu et al., 2014). It primarily focuses on the technical aspects of the online shopping platform (Lyu et al., 2024), including shopping guidance, meta-voicing, logistics design, and after-sale services (Sun et al., 2019). When a platform is designed with a customer-centric approach, consumers may encounter fewer difficulties and experience greater convenience in communication and operation, which can expedite the purchase process and enhance consumers' shopping value (Qu et al., 2023). Prior research has demonstrated that PEOU has significant and positive effects on consumers' utilitarian and hedonic shopping values in online shopping, mobile shopping, and social commerce (Fu and Hsu, 2023; Qu et al., 2023). Furthermore, a smooth purchase process and rapid delivery ensure sufficient time for FNED consumption, thereby reducing consumers' concerns about delivery risk, health risk, and financial risk perception in the context of FNED. Based on these insights, we propose the following hypotheses:

> H3a: PEOU positively impacts perceived value.
>
> H3b: PEOU negatively impacts perceived risk.
>
> H3c: PEOU positively impacts impulse buying of FNED.

Perceived usefulness (PU) refers to consumers' evaluation of whether the platform can enhance their transaction performance (Chiu et al., 2014). A concise and clear website design can facilitate users' access to various information and further increase consumers' utilitarian perception (Qu et al., 2023). For instance, in LSC for FNED sales, the remaining near-expiry time of presented products is posted and highlighted on the screen, prompting consumers to pay attention and make decisions, which can reduce consumers' health risk perception. Additionally, the online platform offers functions such as store favorites, user customization, and information-pushing services,

which significantly increase the accessibility and amount of information, and decrease search time. These information services can fulfill consumers' needs, enhance utilitarian and hedonic shopping value, and reduce health and delivery risk perception. Consequently, we propose the following hypotheses:

> H4a: PU positively impacts perceived value.
>
> H4b: PU negatively impacts perceived risk.
>
> H4c: PU positively impacts impulse buying of FNED.

2.3.2 Interpersonal-based interaction and consumers' perception

Para-social interaction (PSI) is defined as "an individual's illusion of a face-to-face relationship with a media personality," explaining why audiences sometimes believe and behave as though the media personality cares for them, despite never having met in the physical world (Wohn et al., 2018). Originating in the context of traditional media, the concept has been adapted to study online social commerce (Xiang et al., 2016). In LSC, two types of interpersonal interaction exist: streamer-viewer and co-viewer interactions.

In LSC, timely and comprehensive communication is crucial for streamers and viewers to foster mutual understanding. In social media, interpersonal relationships can be imagined or real (Ma et al., 2022). On the one hand, streamers provide detailed product information, usage demonstrations, highlighted features, bonuses, and price discounts to viewers, fostering a sense of being cared for and human warmth (Fu and Hsu, 2023; Xu et al., 2024). This enhances consumers' self-esteem and status values. Furthermore, the abundant and productive information generated through streamer-viewer interactions significantly shorten the psychological distance. It reduces uncertainty and risk perceptions towards the product and the deal (Gao et al., 2023), ultimately leading to impulse buying. With frequent interactions, viewers develop positive emotions and feelings towards the streamer, increasing their perception of the value of the information and product provided while decreasing their perception of uncertainty and risk (Li et al., 2024). Based on these insights, we propose the following hypotheses:

> H5a: Streamer-viewer interaction positively impacts perceived value.
>
> H5b: Streamer-viewer interaction negatively impacts perceived risk.
>
> H5c: Streamer-viewer interaction positively impacts impulse buying of FNED.

In addition to streamer-viewer interactions, viewers also interact with each other. LSC platforms have developed an entirely constructed social interaction environment, offering viewers a virtual community to share information, emotions, and experiences (Hsieh et al., 2023; Qu et al., 2023). They can respond to other viewers' questions, share experiences, and report booking results in the chat window, post danmaku to express their immediate feelings and emotions and give "likes" to show their favor for the streamer or product (Xiong et al., 2024). These interactions not only satisfy viewers' cognitive, and

TABLE 1 Dimensions of online interaction and measurements.

Scale of interaction	Measurements
Platform-based interaction	Perceived ease of use
	Perceived usefulness
Interpersonal-based interaction	Streamer-viewer interaction
	Co-viewer interaction

information needs but also fulfill their desire for participation, generating a sense of belonging and trust and even triggering flocking phenomena among co-viewers (Ma et al., 2022; Li et al., 2024; Li et al., 2024). Such a sense of virtual community and self-satisfaction helps increase value perception and decrease risk perception, leading to impulse buying. Therefore, we propose that:

> H6a: Co-viewer interaction positively impacts perceived value.

> H6b: Co-viewer interaction negatively impacts perceived risk.

> H6c: Co-viewer interaction positively impacts impulse buying of FNED.

2.4 Face awareness as a moderator

The face represents individuals' pride and dignity stemming from their social status and achievements (Bartels and Onwezen, 2014; Bai et al., 2022). It can be acquired when individuals' performance aligns with social expectations and lost when their behaviors deviate from these norms and expectations. According to face-negotiation theory, face (mianzi) influence Chinese people's personal relationships, roles and self recognition. Prior research suggests that people with high face consciousness are prone to purchase luxury and eye-catching items while avoiding discounted products (Hanson et al., 2021). Mianzi has also been found to play significant moderating role in influencing consumer behavior avior (Siu et al., 2016; Wei and Jung, 2017). Therefore, in the context of FNED sale via LSC, face consciousness may play an important moderating role in influencing FNED purchae behavior because public settings are conducive to Mianzi development (Peloza et al., 2013; Segev et al., 2013). Hence, face consciousness is taken as a moerator in this study. The design of LSC platforms mimics offline scenarios. The structure of purchase and communication procedures and diverse information dissemination methods enhance marketing and purchase convenience while rendering information more helpful. These platform designs immerse viewers, giving them a rich sense of presence (Fu and Hsu, 2023; Zhao et al., 2024). Consequently, viewers perceive live streaming rooms as offline stores, where face consciousness operates similarly. Specifically, a high level of facial consciousness mitigates the impact of Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) on impulse buying.

> H7a: Face consciousness negatively moderates the relationship between PEOU and impulse buying of FNED.

> H7b: Face consciousness negatively moderates the relationship between perceived usefulness and impulse buying of FNED.

Moreover, consumers with heightened face consciousness are inclined to purchase organic food and avoid suboptimal food, as consuming suboptimal food may evoke a sense of losing face. This aversion to suboptimal food contributes to increased food waste (Bartels and Onwezen, 2014). Notably, suboptimal food is often sold at significant discounts, with the magnitude of the discount increasing as the expiry date approaches (Arienzo et al., 2020). Therefore, consumers with high face consciousness are less likely to impulse buy when faced with substantial price deductions streamers offer.

Furthermore, streamers frequently employ promotional strategies in live streaming contexts such as limited-time and limited-quantity offers (Wu et al., 2021), fostering a competitive atmosphere among viewers. According to the Face-Negotiation Theory (Zhao et al., 2024), consumers in competitive environments may engage in conflict over interests and protect their self-mianzi (Hsieh et al., 2023), further triggering impulse buying behavior. Specifically, higher face consciousness amplifies the influence of streamer-viewer and co-viewer interactions on impulse buying.

> H7c: Face consciousness negatively moderates the relationship between streamer-viewer interaction and impulse buying of FNED.

> H7d: Face consciousness positively moderates the relationship between co-viewer interaction and impulse buying of FNED.

3 Method

3.1 Instruments

All measurement items utilized a five-point Likert scale, ranging from "totally disagree" to "totally agree," to capture participants' responses. These items were adapted from previously validated questionnaires and tailored to the context of LSC for the sale of FNED. For the constructs related to interpersonal-based interactions, three items were drawn from Qu et al. (2023) and Zhang et al. (2023), and three items were sourced from Xiang et al. (2016) and Li et al. (2024) to measure streamer-viewer interaction (SVI) and co-viewers interaction (CVI), respectively. For platform-based interactions, two items were adopted from Qu et al. (2023) to measure perceived ease of use (PEOU), and four items were used to measure perceived usefulness (PU).

Regarding the constructs in Purchase Intention Theory (PT), three items were adapted from Yang et al. (2022) to measure perceived value, while three items from Bai et al. (2022), Zhang et al. (2023), and Zhang and Zhang (2024) were used to measure perceived risk. Additionally, three items from Xiang et al. (2016) were employed to measure impulse buying. To measure the moderating variable of face consciousness, two items were drawn from Hsieh et al. (2023) and Zhang et al. (2023). The measurement items for all constructs are listed in Table 2.

The questionnaire was initially developed in English by two professors specializing in marketing and the English language. It was then translated into Chinese and back-translated into English to ensure linguistic accuracy. Furthermore, two additional professors with expertise in marketing and information systems reviewed and refined the measurement items to guarantee their validity. A pilot test involving 41 respondents was conducted, confirming the acceptable reliability and validity of the measurements. Therefore, the questionnaire is deemed suitable for further surveys.

3.2 Data collection

To gather data on the theoretically derived multivariate relationships, we utilized an online questionnaire survey, recognized

TABLE 2 Constructs and measurements.

Construct	Item	Description	Sources
Streamer-viewer interaction	SV1	The streamer enhances the viewer's viewing interest through various interactions.	Qu et al. (2023); Zhang et al. (2023)
	SV2	The streamer is able to respond to topics actively and promptly for consumers.	
	SV3	This streamer is able to effectively communicate with the viewer during the process of introducing products.	
Co-viewer interaction	CVI1	The viewers in the live-streaming room were interested in the products recommended by the streamer.	Li et al. (2024)
	CVI2	The viewers in the live-streaming room were enthusiastic and active in their communication.	
	CVI3	The viewers in the live-streaming room enthusiastically provided information about products.	
Perceived usefulness	PU1	The platform is accurately positioned.	Qu et al. (2023)
	PU2	The platform will provide the consumers with sufficient product information.	
	PU3	The platform provides convenient purchase process for consumers.	
	PU4	The after-sale service system in the platform is easy to use.	
Perceived ease of use	PEOU1	The functions set by the living streaming platform are simple and easy to learn and operate.	Qu et al. (2023)
	PEOU2	I know how to use the platform efficiently.	
Perceived risk	PR1	Buying food near expiry date is harmful to my health.	Zhang et al. (2023)
	PR2	When buying food near the expiry-date, I worried whether it is nutritious.	
	PR3	When buying food near the expiry-date, I worried about the taste.	
Perceived value	PV1	Buying food near expiry date will save my money.	Li et al. (2024)
	PV2	Food near expiry date sold in live-streaming platform is diversified than sold offline.	
	PV3	Buying food near expiry date will increase my prestige of personal responsibility.	
Face consciousness	FC1	Buying food near expiry-date recommended by the streamer can respect the streamer's effort.	Bai et al. (2022)
	FC2	When buying FNED, I am conscious of other people's opinion.	
Impulse buying of FNED	IB1	As I browsed the LSC, I had the urge to purchase FNED beyond my specific shopping goal.	Xiang et al. (2016); Zhang et al. (2023)
	IB2	As I browsed the LSC, I always buy too much FNED than I need or can eat.	
	IB3	"Buy now, think about it later" describes my food shopping behavior	

as a suitable method for such examinations (Mullinix et al., 2015). Studies have indicated that estimates of causal effects derived from convenience samples are comparable to those from population-based samples (Mullinix et al., 2015). Given our focus on exploring theoretical relationships rather than estimating population parameters, the validity of our approach was not significantly compromised. Online convenient sampling is a prevalent method in research on consumers' online behavior.

The questionnaire was developed on Wenjuanxing, a widely used platform for marketing and research surveys in China. We obtained a QR code and a URL link to disseminate the survey on popular social media platforms, including WeChat, QQ, and Weibo, as well as FNED forums, to reach potential respondents (Hsieh et al., 2023). Following the methodology of Hsieh et al. (2023), we incorporated two screening questions to ensure the suitability of participants. Specifically, we asked, "When was the last time you watched LSC?" and "Have you purchased FNED in LSC in the past 6 months?" Only respondents who had utilized LSC within the past 6 month and made purchases of FNED within the past half year were eligible to proceed with the survey.

The survey was conducted between June 15th and July 30th, 2023. They were conducted in accordance with local legislation and institutional requirements. We set a question at the beginning denoting the aim of the survey and asked the participants whether they understand the aim or not. If the participant resent to participate voluntarily, he/she should tick Yes to go on with the process.

Furthermore, participants were free to withdraw at any time. All these measures ensured that their participation was based on informed consent (Yang et al., 2022). To incentivize participation, we offered a lottery for gift certificates worth RMB 2500 (equivalent to USD 357) for valid responses. Ultimately, we received 375 responses, of which 23 were excluded due to incomplete questionnaires or identical answers for five consecutive items. This resulted in a total of 352 valid responses for further analysis.

As shown in Table 3, 51.23% of the respondents were female. The majority (55.99%) of respondents were aged between 30 and 45 years, with 42.86 and 34.81% earning RMB 4,000–6,000 and RMB 600–8,000 per month, respectively (equivalent to USD 561.84–842.76 and USD 84.28–112.37). To assess nonresponse bias, we conducted an analysis of variance (ANOVA) by comparing responses from early and late waves. The results indicated no significant differences, suggesting that nonresponse bias was not a concern in our study.

4 Results

4.1 Reliability and validity

Initially, we assessed the data's normality and determined that the variance inflation factor (VIF) values were below 2.61, which is within the acceptable threshold of 3, indicating the absence of multicollinearity.

Subsequently, we employed partial least squares-structural equation modeling (PLS-SEM) using SmartPls 4 and SPSS 20 for our analysis.

To examine the reliability and validity of our measures, we conducted a confirmatory factor analysis (CFA). As presented in Table 4, Cronbach's α values and composite reliabilities were all above 0.683, and the factor loadings ranged from 0.722 to 0.93, exceeding the recommended threshold of 0.7. To further assess discriminant validity, we adopted three approaches. Firstly, following the methodology of Hsieh et al. (2023), we conducted paired constructs tests and found that all $\Delta\chi^2$ values ranged from 7.21 to 114.68, surpassing the recommended threshold of 3.84. Secondly, as shown in Table 5, the square root of the average variance extracted (AVE) for each construct exceeded its correlations with other constructs, aligning with the guidelines provided by Sarstedt et al. (2023). Thirdly, we performed a PLS-SEM algorithm analysis, and the Heterotrait-Monotrait (HTMT) ratio results indicated that all values were below the recommended maximum threshold of 0.85 (Sarstedt et al., 2023). Collectively, these findings confirmed the discriminant validity of our measures.

Furthermore, we assessed common method bias (CMB) using two methods, as suggested by Hsieh et al. (2023). Firstly, all correlation coefficient values were below the recommended threshold of 0.9. Secondly, we conducted Harman's single-factor test and found that the first factor explained 31% of the variance within the acceptable range. These results demonstrate that CMB was not a significant concern in this study.

4.2 Hypotheses analyses

We utilized Partial Least Squares Structural Equation Modeling (PLS-SEM) and conducted a bootstrapping procedure with 10,000 subsamples to test the proposed hypotheses. The results indicated a satisfactory model fit, as evidenced by the values of the Standardized Root Mean Square Residual (SRMR) at 0.071, the Chi-square value at 866.666, and the Normed Fit Index (NFI) at 0.725, all of which were within the recommended thresholds. Furthermore, the constructs under investigation explained 33.8, 29.1, and 44.5% of the variance in perceived risk, perceived value, and FNED impulse buying, respectively.

Generally, both perceived value (β = 0.147, t = 2.896, $p < 0.005$) and perceived risk (β = −0.186, t = 2.922, $p < 0.005$) were related to impulse buying, supporting hypotheses H1 and H2.

The results of the path analyses are presented in Table 6. Concerning the impacts of platform-based interactions, both perceived ease of use and perceived usefulness were significantly correlated to impulse buying, supporting H1 and H2. However, perceived ease of use (β = −0.227, t = 4.847, $p < 0.001$) was only found to correlate to perceived risk, and perceived usefulness (β = 0.109, t = 2.178, $p < 0.05$) were only positively related to perceived value. These findings support H3b, H3c, H4a, and H4c.

Regarding the effects of interpersonal-based interactions, the streamer-viewer interaction was found to be negatively related to perceived risk (β = −0.393, t = 8.92, $p < 0.001$), positively associated with perceived value (β = 0.492, t = 10.235, $p < 0.001$), and impulse buying (β = 0.335, t = 5.813, $p < 0.001$). These results lend support to hypotheses H5a, H5b, and H5c. However, co-viewer interaction was only negatively associated with perceived risk (β = −0.351, t = 7.008, $p < 0.001$), supporting hypothesis H6b.

TABLE 3 Demographic characteristics of the respondents (*n* = 352).

		n	%
Gender	Male	172	48.77
	Female	180	51.23
Education	Junior high school	18	5.09
	Senior high school and below	31	8.70
	Under-graduated	239	67.82
	graduated and above	64	18.39
Age	Under 18	24	6.73
	18–30	51	14.61
	31–45	197	55.99
	above 45	80	22.66
Disposable income monthly	Under 4,000	48	13.30
	4,000–6,000	151	42.86
	6,000–8,000	123	34.81
	above 8,000	30	9.03

To examine the moderating role of face consciousness, we utilized the moderating effect function available in SmartPLS 4.0. The results revealed that face consciousness only negatively moderated the effects of streamer-viewer interaction on impulse buying (β = −0.129, t = 3.055, $p < 0.005$), supporting H7c. However, face consciousness had nonsignificant moderating effects on the relationship between perceived ease of use, perceived usefulness, and co-viewers interaction on impulse buying. Consequently, hypotheses H7a, H7b, and H7d were not supported.

5 Discussion

5.1 Summary of findings

Drawing upon prospect theory, para-social theory, and face-negotiation theory (Kahneman, 1979; Wohn et al., 2018; Zhao et al., 2024), this study developed a research model to explore consumers' impulse buying behavior toward FNED sold through LSC. The results and findings offer valuable insights for both researchers and practitioners in the field of LSC for FNED sales.

Firstly, the findings concerning platform-based interactions on the live streaming platform contribute to our understanding of LSC for FNED sales by confirming the impacts of novel technologies and platform design on reducing risk perception and increasing impulse buying. Technologies such as video, visual aids, and danmaku (floating comments) can provide greater convenience and information while also reducing product quality uncertainty (Xiong et al., 2024). This, in turn, diminishes risk perception and triggers impulse buying, aligning with the findings of Qu et al. (2023) and Zhang and Zhang (2024). However, contrary to prior study of Hsieh et al. (2023), perceived ease of use was found to have insignificant effect on perceived value. The possible reason for this may be that the technologies utilized in the LSC platform are relatively common in other Chinese online commerce contexts, leading consumers' low recognition of additional convenience or feasibility in the purchase process. Therefore, this study underscores the importance of considering more innovative

TABLE 4 Measurement statistics.

Constructs	Items	Factor loading	Cronbach's alpha	Composite reliability (rhea)	Composite reliability (rho_c)	Average variance extracted (AVE)
Co-viewer interaction (CVI)	CVI1	0.722	1	1	0.9	0.66
	CVI2	0.869				
	CVI3	0.84				
Face awareness (FA)	FA1	0.885	1	1	0.9	0.76
	FA2	0.857				
Perceived ease of use (PEOU)	PEOU1	0.93	1	1	0.9	0.86
	PEOU2	0.929				
Impulse buying (IB)	IB1	0.803	1	1	0.9	0.67
	IB2	0.843				
	IB3	0.798				
Perceived risk (PR)	PR1	0.844	1	1	0.9	0.68
	PR2	0.842				
	PR3	0.793				
Streamer-viewer interaction (SVI)	SVI1	0.885	1	1	0.9	0.7
	SVI2	0.863				
	SVI3	0.796				
	SVI4	0.8				
Perceived value (PV)	PV1	0.866	1	1	0.9	0.68
	PV2	0.726				
	PV3	0.879				
Perceived usefulness (PU)	PU1	0.843	1	1	0.9	0.68
	PU2	0.837				
	PU3	0.79				

Significance level for factor loading <0.01.

TABLE 5 Discriminant validity-Heterotrait-monotrait ratio (HTMT).

	CVI	IB	PEOU	PR	PU	PV	SVI
CVI	*0.813*						
IB	0.165	*0.815*					
PEOU	0.324	0.09	*0.93*				
PR	0.552	0.448	0.34	*0.826*			
PU	0.091	0.498	0.249	0.093	*0.823*		
PV	0.08	0.592	0.187	0.215	0.312	*0.827*	
SVI	0.076	0.699	0.202	0.392	0.344	0.637	*0.837*

The bold and italic numbers on the front diagonal are the squares of AVE shared between the constructs and their items. Elements in the off-diagonal are the correlations between constructs.

technologies and consumer-centric platform designs for reducing risk perception, particularly in the context of LSC for FNED sales. Given that FNEDs are often perceived to have higher quality risks, health risks, and financial risks, the integration of novel technologies and user-friendly platform designs becomes crucial in mitigating these risks and fostering impulse buying behavior among consumers.

Secondly, the findings related to interpersonal-based interactions enhance our understanding of LSC for FNED sales by confirming the impacts of streamer-viewer interaction on perceived value, perceived risk, and impulse buying. These results emphasize the role of streamers in providing productive and abundant information, which fosters a sense of human warmth among consumers, shortens psychological distance and uncertainty, and ultimately leads to impulse buying. Our findings align with previous studies that have identified streamer-viewer interaction as an influential factor in influencing viewers' value and risk perception (Konuk, 2019; Gao et al., 2023). Furthermore, our study confirms that streamer-viewer interactions drive impulse buying in the context of LSC for FNED sales (Li et al., 2024). Therefore, as the sale of FNED through LSC continues to grow, this study proposes that increasing streamer-viewer interaction is indispensable for influencing consumers' impulse buying behavior towards FNED sold through LSC.

Thirdly, the findings indicate that co-viewer interaction influences risk perception. However, co-viewer interaction has insignificant impacts on perceived value and impulse buying, which contradicts most prior research in this area (Ma et al., 2022; Fu and Hsu, 2023; Zhang et al., 2023; Li et al., 2024). A possible reason may be that the information, evaluations, and experiences of products presented and shared by co-viewers generate affective cognition among consumers. This effective cognition directly induces consumers to follow the behaviors of other co-viewers and triggers a flocking phenomenon (Ma et al., 2022). And in online platfrom, customers prefer to share negative information to positive ones, which triggered risk perception. Consequently, co-viewer interactions do not necessarily lead to value

TABLE 6 The results of path analyses.

Path	β	T Values	p values	Hypotheses	Supported?
PV -> PI	0.147	2.896	0.004	H1	Yes
PR -> PI	−0.186	2.922	0.003	H2	Yes
PEOU -> PV	−0.057	1.055	0.292	H3a	No
PEOU -> PR	−0.227	4.847	0	H3b	Yes
PEOU -> PI	0.107	2.457	0.014	H3c	Yes
PU -> PV	0.109	2.178	0.029	H4a	Yes
PU -> PR	0.094	1.874	0.061	H4b	No
PU -> PI	0.25	5.91	0	H4c	Yes
SVI -> PV	0.492	10.235	0	H5a	Yes
SVI -> PR	−0.393	8.92	0	H5b	Yes
SVI -> PI	0.335	5.813	0	H5c	Yes
CVI -> PV	0.011	0.221	0.825	H6a	No
CVI -> PR	−0.351	7.008	0	H6b	Yes
CVI -> PI	0.026	0.555	0.579	H6c	No
FA x PEOU -> PI	0.059	1.486	0.137	H7a	No
FA x PU -> PI	−0.098	1.95	0.051	H7b	No
FA x SVI -> PI	−0.129	3.055	0.002	H7c	Yes
FA x CVI -> PI	0.009	0.221	0.825	H7d	No

perception and impulse buying intention. Therefore, to accelerate the sale of FNED, streamers should encourage viewers to post positive product information and share favorable consumption experiences in the danmaku, thereby triggering consumers' impulse purchases (Xiong et al., 2024).

Lastly, face consciousness within Confucian culture is a pivotal factor in impression management and has been linked to study of suboptimal food consumption (Bai et al., 2022). The findings of this study extend the impact of face consciousness on purchase decision to the realm of LSC for personal FNED sales. Despite the virtual nature of the LSC environment, where streamers and viewers engage without face-to-face interaction, face-consciousness still significantly influence the impact of online interaction over impulse buying, suggesting that public interaction serves as a conduit for protecting or granting face. The results reveal that face consciousness amplifies the effect of streamer-viewer interaction over impulse buying, consistent with the results of Hsieh et al. (2023). In LSC for FNED sales, streamers often exert more efforts than in offline sales by providing detailed product information, showcasing FNED from various angles, demonstrating usage, and promptly responding to requirements and comments. These efforts may enhance consumers' evaluations of the streamer's output, increasing satisfaction and favor (Zhao et al., 2024). Consequently, viewers may increase their impulse buying behaviors as a form of reimbursement for the streamer's efforts. Viewers may appreciate the streamer's diligence and respond with increased purchases.

In summary, this study's findings contribute to our understanding that, despite the absence of face-to-face interaction between streamers (sellers) and viewers (buyers), face consciousness continues to moderate the relationship between interpersonal interaction and impulse buying in the context of LSC for FNED sales.

5.2 Theoretical implications

This study offers valuable insights into the purchase behavior of FNED sale within the emerging and relatively unexplored online market of LSC. We focus on examining the determinants of consumers' impulse buying behavior on LSC platforms related to FNED. This research makes three notable theoretical contributions to existing literature.

First, the research model presented in this study integrates the prospect theory (Kahneman, 1979), para-social theory (Wohn et al., 2018), and face-negotiation theory (Zhao et al., 2024) to explain FNED purchase behavior and the influence of face-consciousness. By extending these theories to the context of LSC for FNED sales, the model provides a novel and enhanced understanding of FNED purchase behavior through live streaming.

Second, from the perspective of FNED purchase behavior, this study identifies three key determinants: perceived ease of use, perceived usefulness, and streamer-viewer interaction. These factors reflect platform- and interpersonal-based interactions and have received limited attention in the literature on LSC and FNED marketing. To the best of our knowledge, prior studies have primarily focused on either the technical or interpersonal aspects of interactions, and this is the first study to incorporate all four types of interactions within a single research framework. Additionally, while prior studies have explored the impact of perceived value or risk, this study includes both to understand better the overall effects of consumers' perceptions on online interactions and impulse buying. Both value and risk perception are crucial psychological reactions in the context of FNED sales. In summary, the findings related to these four types of interactions and two kinds of consumer perceptions contribute significantly to research on LSC for FNED adoption.

Third, this study confirms the moderating effects of face consciousness within the research model by integrating face negotiation theory with parasocial theory. The study identifies the

existence and impact of face consciousness on unplanned and immediate purchase intentions, aligning with previous research by Hsieh et al. (2023). Consequently, this study contributes to the impulse buying literature by recognizing face consciousness as a novel contextual factor in FNED purchase and consumption environments.

In conclusion, this paper provides theoretical contributions to studies on FNED consumption decisions and social media by presenting a research model integrating three theories with four online interaction types and one face-consciousness moderating factor.

5.3 Managerial implications

This study provides several implications for practitioners in the field of LSC for FNED sales.

First, this study confirms that face consciousness influences FNED purchase behavior within the context of LSC, a finding that has not been widely explored in previous research. The results indicate that viewers with a higher level of face consciousness are highly concerned with their image and are likelier to engage in competitive purchasing behavior in LSC settings, even within the virtual community. Therefore, we recommend that LSC platform operators develop tools to identify and target viewers with higher face consciousness and provide this information to streamers to facilitate the design of promotional activities. In addition to established strategies such as limited quantity and time scarcity (Wu et al., 2021), streamers could emphasize the waste reduction attributes of FNED consumption, which may arouse viewers' moral sentiments and concerns for environmental issues, thereby enhancing their moral recognition and leading to impulse buying intentions. Furthermore, the results show that face consciousness positively moderates the relationship between streamer-viewer interaction and impulse buying, highlighting consumers' recognition of the streamers' productive efforts. This recognition may prompt viewers to engage in face-giving behavior (impulse buying) as reimbursement to the streamers. Therefore, we suggest that streamers understand the types of FNED-related information consumers are most concerned about and fulfill their information requirements through various means, such as verbal introductions, subtitle prompts, and identification prompts. Streamers should engage in activities such as food-tasting and product demonstrations from different angles and provide knowledge about the presented FNED products to demonstrate their responsible work and care for customers and the environment, thereby triggering consumers' sense of reimbursement and promoting impulse buying behavior.

Second, perceived value and risk play crucial roles in mediating the relationship between online interactions and impulse buying. Therefore, streamers should leverage real-time online interactions to increase consumers' perceived value and reduce perceived risk. On the one hand, since platform-related interactions help minimize risk perception, platform operators should design functions from the viewers' perspective, utilizing IT-mediated vicarious learning processes for product demonstrations (Fu and Hsu, 2023) to provide information more vividly and reduce risk accordingly. On the other hand, streamers should increase product variety, offer impromptu promotional activities, and enhance the price-quality schema to increase consumers' value perception. Furthermore, streamers should provide additional information, such as expiry dates, ingredients, packaging, and taste,

through text, oral communication, or signage to further increase consumers' value perception and reduce risk perception. Lastly, streamers are encouraged to induce consumers to share their purchase experiences and product evaluations using danmaku and comments and respond promptly to increase streamer-viewer and co-viewer interactions (Xiong et al., 2024), increasing perceived value and reducing risk, ultimately leading to impulse buying.

6 Limitations and future research

Four limitations in this study may restrict its interpretive power and applicability and necessitate further examination. Firstly, the scope of the products studied is limited to processed FNED, such as biscuits, drinks, and other snacks. Furthermore, this study does not account for differnences across LSC plaforms and FNED promotion stratteies which prohibit the generalization of the results. Future research could expand to more types of FNED (e.g., fresh, suboptimal food items, vegetables, and fruits) and compare the differnences across LSC platforms (e.g., TikTok vs. Tabao live vs. Vlog) to gain a more comprehensive understanding. Secondly, while we measured consumers' impulse buying intention, a potential discrepancy exists between intention and actual behavior. Furthermore, this study does not explore the effects of long-term para-social relationship (e.g., repeated viewership) and consumption rates on trust or/and repurchased behavior, which would affect the generation of the results. To bridge this gap, future studies should use experimental methods to measure longitudial and real behaviors and examine any differences between intentions and actual, cross-sectional and longitudial purchasing actions. Thirdly, our exploration of the moderating effects of face consciousness was conducted with limited dimension (face-consciouness) within the context of Chinese consumers. To enhance the generalizability of our findings, future research should include other cultural factors (e.g., collectivism, guanxi network), and extend to different countries and cultural contexts and compare the observed differences across cultures. Lastly, we only focused on demand-side factors and ignored supply-side barriers (e.g., logistics for perishable goods, retailer incentives for FNED sales, further studies will consider these factors and conditions). Addressing these limitations will contribute to a deeper understanding and broader applicability of the study's findings.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found in the article/Supplementary material.

Ethics statement

The requirement of ethical approval was waived by the Civil Aviation Flight Univertiy of China where the author is currently working has not yet established this committee. The studies were conducted in accordance with the local legislation and institutional

requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

Funding

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2025.1570483/full#supplementary-material

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Appendix 1

The description of process of FEND sale via LSC

FNED sold through LSC mainly includes non-perishable processed foods such as biscuits, snacks, milk, and other beverages, with prices typically ranging from 20 to 50% that of the normal commodity prices sold through regular channels. The closer the food is to its expiration date, the lower the price will be. FNED can be sold either in normal packaging or packaged with multiple products, usually with higher discounts for larger quantities. During each live-broadcasting, the streamer will introduce around 10 products and put them into the sales cart. The streamers sell each product one by one, introducing the name, manufacturer, ingredients, processing technology, taste, and other information of the food. They also specifically introduce the remaining shelf life and discounted prices of the food. Sometimes, the streamers even perform live tasting to increase liveliness and intuitiveness. Then the viewers buy the food, pay via platform, and receives the delivered food. In China, food producers are required to be responsible for handling expired food. Hence, the producers not only have to bear the production cost of expired food, but also the cost of handling expired food. Therefore, manufacturers usually sell FNED to live streamers at a price of 70–90% off, and some even give it away for free. Therefore, streamers usually earn a profit of 20–70% from selling FNED.