



## Why do consumers buy impulsively during live streaming? A deep learning-based dual-stage SEM-ANN analysis

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### ABSTRACT

The power of livestreaming commerce to rake in billions of revenues within hours has thrust this nascent commercial model into the global spotlight; that said, despite the prevalence of impulsive buying in live-streaming commerce, the existing knowledge regarding the phenomenon remains relatively scarce. This research seeks to unravel the critical determinants that influence consumers' impulsive buying in livestreaming. Grounded in the Stimulus-Organism-Response paradigm, a framework is proposed to elucidate the underlying mechanism on how parasocial interaction, social contagion, vicarious experience, scarcity persuasion, and price perception translate into impulsive buying urge and behaviour in livestreaming commerce via the cognitive-affective processing system. A self-administered online questionnaire survey was conducted with 295 respondents. The data collected was validated empirically through a multi-analytical hybrid structural equation modelling-artificial neural network (SEM-ANN) technique. The results reveal that parasocial interaction, vicarious experience, scarcity persuasion, and price perception can drive cognitive and affective reactions, which in turn, induce impulsive buying urge, subject to the boundary condition of impulsive buying tendency. In sum, the findings have drawn some insightful theoretical and practical implications that can facilitate the advancement of livestreaming commerce in the modern business arena.

### 1. Introduction

The global prevalence of livestreaming represents a major stride forward for the democratisation of live production beyond the dominance of old media institutions (i.e., television and radio); granting the general public the power to broadcast live video content over the Internet. Livestreaming commerce is a new shopping channel grounded in electronic social commerce that leverages the feature of livestreaming to foster an interactive, informative, and immersive online shopping experience. Livestreaming commerce revolutionizes the conventional electronic commerce business model by offering unprecedented real-

time interactions between sellers and consumers, thereby effectively reducing perceived distance, and resolving the problem of information opacity (Ang et al., 2018; Forrester, 2021). In particular, a two-way synchronous connection is realized where sellers can directly acknowledge and respond to consumers, and consumers can actively participate through written communication (Kang et al., 2021). Livestreaming commerce has grown from a niche alternative to becoming an indispensable mainstream marketing channel for firms worldwide due to the potential capability of livestreaming commerce in exploiting the consumers' impulsive "see-now-buy-now" mentality. Correspondingly, the stunning \$6 billion sales recorded in the Global 11.11 Shopping Festival

**Abbreviations:** IB, Impulsive Buying; IBU, Impulsive Buying Urge; IBB, Impulsive Buying Behaviour; IBT, Impulsive Buying Tendency; PSI, Parasocial Interaction; PSR, Parasocial Relationship; SC, Social Contagion; VE, Vicarious Experience; SP, Scarcity Persuasion; PP, Price Perception; CR, Cognitive Reaction; AR, Affective Reaction; SSI, Susceptibility to Social Influence.

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in 2020 has presented livestreaming commerce not only as a lucrative industry for firms to venture into but also as an interesting research context that is worth further investigation (Hallanan, 2020).

The concept of impulsive buying (IB) has been studied extensively over the past decades across both academic and practical fields (Block & Morwitz, 1999). The proliferation of e-payment, e-commerce, and social (s-) commerce in recent years have shifted the examination of impulsive buying behaviour from brick-and-mortar to online retail setting (Abdelsalam et al., 2020). Yet, the transferability of findings from these studies into the specific context of livestreaming commerce is questionable due to the distinctive nature of livestreaming commerce as a real-time and entertainment-based online shopping platform. The majority of the studies in livestreaming commerce focused on the issue of viewership or user engagement in livestreaming with very few that have investigated consumers' impulsive buying behaviour (Zuo & Xiao, 2021). Even though a few prior studies did attempt to explain the formation of impulsive buying urge (IBU) in livestreaming commerce via information quality, visual quality, media richness, and browsing duration, the aspect of real-time interaction, particularly between viewer and product in livestreaming commerce has been overlooked. To bridge the knowledge gap, this research investigates the impact of vicarious experience (VE) on IB in livestreaming commerce to reflect the vividness of viewer-product interaction, which is experienced through the encounters projected by the anchor; rather than by the viewers themselves. Furthermore, this research also contributes to the current literature by probing into the role of social contagion (SC), which reflects automatic, unintentional, uncontrollable, and generally unconscious influence by others that lead to the mimicry of the attitudes and behaviour (Hatfield et al., 1992). This research broadens the understanding of social influences in relation to IB, setting apart from past studies that adopted factors such as similarity, social presence, and social support, to better decipher the virality of social influences that transpire in the real-time viewer-viewer interaction in livestreaming commerce (Xue et al., 2020; Zhang et al., 2017).

Online vendors are facing intense competition as the market in e-commerce and s-commerce become more saturated; hence, the expansion into livestreaming commerce is imperative for online vendors to stand apart from the crowded online marketplace (Marshall et al., 2012). From the practical point of view, the insights from this research can help livestreaming commerce platforms, vendors, and anchors to identify factors in promoting IBU and impulsive buying behaviour (IBB), with the ultimate aim to accelerate sales conversions. Besides, given the time-sensitive nature of livestreaming commerce whereby anchors are subjected to limited "stream-time" of up to 8 hours, a quick impulsive purchase decision is critical for their operation. On that account, the investigation into the antecedents of IBB in livestreaming commerce is of utmost importance as the insights can enrich the knowledge of vendors and anchors on the attitudes and behaviours of shoppers to improve their business operation in livestreaming commerce. From the theoretical perspective, the findings offered a novel perspective that encompasses livestreaming content, vendors, and anchors in promoting consumers' impulsive buying, which remains an underexplored area in the current literature (Xue et al., 2020). The research further facilitates the formation of a detailed mechanism that outlines the inter-relationships between the above-mentioned factors by including cognitive and affective reactions as intermediary factors, and susceptibility to informational influence as a moderator.

## 2. Theoretical background

### 2.1. Concept of impulsive buying

Stern (1962) defined IB as unplanned purchases; however, the definition was later argued to be oversimplistic. According to Block and Morwitz (1999), IB represents a hedonically complex and rapid process that precludes the deliberations on alternative information and

selections as well as consequences of decision-making. IBB was found to be propelled by an instantaneous, persistent, and overpowering impulse to purchase, called IBU (Rook, 1987). Beatty and Ferrell (1998) have proposed that the concept of IB should be limited to spontaneous purchases with no pre-purchase intention; thus, habitual purchases was excluded from consideration because the rapid purchase process of habitual purchases occurs due to the low level of product involvement required, rather than the impetus of IBU. In line with prior studies, the S-O-R paradigm was implemented to study the effects of stimulus on organism and response because the theory has been proven to be applicable in understanding the IB formation process (Abdelsalam et al., 2020; Chopdar et al., 2022). The proclivity of individuals to experience IBU and subsequently, engage in IBB is guided by impulsive buying tendency (IBT) (Beatty & Ferrell, 1998). IBT can be sorted into two main themes: (1) as a general personality trait that indicates an individual's predisposition to act impulsively in a purchase situation; or (2) as a situational factor that influences decision-making based on specific purchase conditions (i.e., product class) (Jones et al., 2003; Verplanken & Herabadi, 2001).

### 2.2. Theories of emotions

The states of affectivity have long been established to have an interdependent relationship with the logical reasoning process. Based on the feelings-as-information paradigm, the current affective states serve as a prominent information source, which can influence the judgement of consumers (Högborg et al., 2019). In an extreme case, the cognitive abilities of individuals can even be impaired by intense emotions which may lead to limited computational ability, selective memory, and false perception (Kaufman, 1999). Loewenstein and Lerner (2003) determined that immediate emotions have a direct influence on the individuals' immediate decisions or behaviours and indirect influence on the individuals' expected consequences and perceived desirability of behavioural decisions. Intense immediate emotions can overwhelm cognitive processing and deliberative decision-making, thereby resulting in out-of-control or risk-seeking behaviours. Affective reactions must be evaluated along with cognitive reactions because both reactions serve as pivotal inputs in decision-making under a symbiotic relationship, albeit affective reactions play the more dominant role seeing that emotions can pervert perceptions and beliefs (Parboteeah et al., 2009). Weinberg and Gottwald (1982) found that individuals who engage in IBB are usually more emotionally driven than regular shoppers. In particular, the scholars argue that positive affective states have a greater influence on IBU than negative affective states, even though pre-existing negative affective states (i.e., jealousy, depression, and dissatisfaction) may positively contribute to IBU too, as individuals attempt to feel better by reducing the negative emotional tensions through retail therapy (Beatty & Ferrell, 1998; Lucas & Koff, 2017). All in all, affective states, guided by cognitive processes, play a critical role in the IB process. Affective and cognitive reactions are, thus, assessed concurrently in this research to reflect the symbiotic loop which exists in actual real-life decision-making (Mosteller et al., 2014; Kang et al., 2020).

## 3. Hypotheses

### 3.1. Impulsive buying urge

IBU refers to the intense, overpowering, and persistent desire to purchase a product or service (Rook, 1987). IBU can become intensely preoccupying and dominate the centre of information processing; thus, IBU may lead to out-of-control behaviours as individuals seeks immediate relief from the instant gratification of specific needs and wants (Loewenstein and Lerner, 2003). Although IBU may not always result in IBB as certain situational constraints (e.g., time, money, and will-power) may intervene the IB process, the predictability of IBU to IBB has been well-established in prior studies, whereby it has been advocated

that individuals can only engage in IBB after IBU is triggered by stimulus (Beatty & Ferrell, 1998; Rook, 1987). Hence, the following hypothesis is constructed.

*H1: Impulsive buying urge positively correlates with impulsive buying behaviour.*

### 3.2. Impulsive buying tendency

IBT refers to the personality trait of individuals in terms of the proclivity to act impulsively in purchase situations (Verplanken and Herabadi, 2001). General IBT has been established by previous research as a critical moderator in the relationships between organisms' reactions and IBU (Zafar et al., 2021), as well as between IBU and IBB. Individuals with general high IBT tend to carry other traits, such as weak cognitive planning, low conscientiousness, high action-orientation, and/or weak affective autonomy; thus, such individuals may have a higher tendency to develop stronger urges to act impulsively in purchase situations (Baumeister, 2002; Goel et al., 2022). Based on the theoretical arguments and empirical evidence, IBT is, therefore, included in the research framework as a moderator with the hypotheses formulated as follows.

*H2a: Impulsive buying tendency moderates the relationship between affective reactions and impulsive buying urge.*

*H2b: Impulsive buying tendency moderates the correlation between impulsive buying urge and impulsive buying behaviour.*

### 3.3. Affective reactions

Affective reactions (AR) can be defined by the pleasure, arousal, and dominance (PAD) dimensions of affective response towards the external environmental encounters; albeit, the PAD typology is argued by Eroglu et al. (2001) to be too narrow to cover the comprehensiveness of AR. Therefore, we argue that other moods, feelings, and emotions (i.e., affection and intimacy) should be examined as well (Beatty & Ferrell, 1998). Past literature revealed that AR has a significant influence on IBU (Parboteeah et al., 2009; Xiang et al., 2016), given that IB is inherently a hedonically complex process guided by emotions (Rook, 1987). Liu et al. (2013) posit that expected instant gratification from IBB can lead to IBU. The correlation between AR and IBU may be explained by the approach-avoidance theory as shoppers can be aroused into performing approach behaviours in a pleasurable shopping journey (Eroglu et al., 2001). Apart from the general gratifications derived from the overall shopping experience, product affection and subjective affection towards social actors in terms of personal closeness and intimacy also contribute to IBU (Chen et al., 2019; Xiang et al., 2016). This is because stronger AR towards the social actors increases the persuasive power of social actors, thereby evoking a greater IBU (Xiang et al., 2016). Hence, the hypothesis is formulated as follows.

*H3: Affective reactions positively correlate with impulsive buying urges.*

### 3.4. Cognitive reactions

Cognitive reactions (CR) refer to the mental processes in the mind of individuals triggered by the encounter with a stimulus (Parboteeah et al., 2009). Gartner (1994) posits that informational and perceptual constraints must be evaluated cognitively before social and internal constraints can be addressed. CR act as the basis for AR, whereby information must be deemed reliable before emotional attachment towards the individual, brand, or product can be established (Chen et al., 2019). Similarly, the usefulness of information must be examined cognitively before attitudes can be formed (Hsu et al., 2013). Parboteeah et al. (2009) and Xiang et al. (2016) proposed that CR in terms of observational learning and perceived usefulness is positively related to AR, which consequently leads to IBU. The research by Hsiao (2020) complements the prior studies, in which cognitive evaluation of values

was found to contribute positively to AR in terms of satisfaction and can, in turn, stimulate purchase intention. Hence, the hypothesis is formulated as follows.

*H4: Cognitive reactions positively correlate with affective reactions.*

### 3.5. Parasocial interaction

The concept of PSI was initially introduced by Horton and Wohl (1956) to explain the illusory relationship or the feeling of intimacy developed unilaterally by the viewers towards the social actors in mass media. As evidenced in recent studies, the application of PSI has been extended from the context of traditional mass media to social media (Labrecque, 2014; Aw and Chuah, 2021). PSI is defined as the digital interactions between viewers and social actors, conceptualized by the feeling of reciprocity that is comprised of mutual awareness, attention, and adjustment. Prior studies have established that PSI positively contributes to the creation of a one-way emotional attachment with the social actors (Aw and Labrecque, 2020; Chen et al., 2019). The media and communication literature has demonstrated that parasocial interaction reflects involved media use as it can affect the emotional response of users towards media persona and media (i.e., website) (Labrecque, 2014; Rubin et al., 1985). For instance, PSI was found to nurture affective trust (Chen et al., 2019). Gong and Li (2017) determined that PSI with the anchors can shape the attitudes of viewers towards the products and services (Sokolova and Kefi, 2020), and even, contribute to the perceived enjoyment in shopping experience (Xiang et al., 2016). Hence, the following hypothesis is constructed.

*H5: Parasocial interaction positively correlates with affective reactions.*

### 3.6. Vicarious experience

Rook (1987) proposed that IBU is triggered by visual confrontation. Beatty and Ferrell (1998) explained that the power of visual encouragement to purchase can be attributed to the pleasure in vicarious product experience (MacInnis and Price, 1987). VE is defined as the vivid imaginary encounter with the products and services envisioned by the viewers via the actual experience projected by the anchors (Chen et al., 2019). The anchors can facilitate VE in livestreaming commerce through extended demonstrations, complemented with detailed descriptions of personal experience with products and services. The indirect encounter via the narrative of VE can create a strong emotional impression on individuals (Sowińska and Sokół, 2019). The research by Chen et al. (2019) supported the proposition as it was found that VE facilitated by immersive narrative in product recommendation can positively influence product affection and perceived enjoyment (Vazquez et al., 2020). Besides, individuals can learn from VE via active listening and reflective thinking (Roberts, 2010). The vicarious learning concept stated that the viewers will internalize the information collected from the experience shared by the anchor, and relate the indirect encounter to personal experience in determining subsequent behaviour; as such, VE serves as a pivotal input that positively stimulates CR with the hypotheses formulated as follows.

*H6: Vicarious experience positively correlates with affective reactions.*

*H7: Vicarious experience positively correlates with cognitive reactions.*

### 3.7. Scarcity persuasion

Scarcity persuasion (SP) is defined as the use of limited volume and/or limited time promotions to stimulate the scarcity effects in livestreaming commerce (Eisend, 2008). According to Malhotra (2010), SP arouses individuals via the sense of competition with the desire to win. The competitive arousal model posits that head-to-head rivalry and time pressure can fuel an individual's emotional desire to partake in

competitive behaviours (Malhotra, 2010). Wu et al. (2020) further established the influence of time and volume scarcity on perceived arousal. In a nutshell, SP induces AR. Furthermore, Eisend (2008) demonstrated the power of SP in shaping perceived value—a manifestation of affection and cognition—whereby it has been shown that scarcity can influence the evaluation of product value. The research by Chung et al. (2017) supports the notion by evincing that the scarcity effects can positively contribute to both hedonic and utilitarian shopping values. Hence, the following hypotheses are constructed.

*H8: Scarcity persuasion positively correlates with affective reactions.*

*H9: Scarcity persuasion positively correlates with cognitive reactions.*

### 3.8. Price perception

Price perception (PP) is defined as the perceived monetary value of a product or service. Price has always been a significant driver of purchase intention as the monetary consideration in acquiring products and services can influence the overall perceived value (Sweeney and Soutar, 2001). The research by Zafar et al. (2020) found that common promotional tactics (e.g., bundle offers) that foster high PP can arouse individuals. In addition, PP can influence the evaluation of utilitarian value of livestreaming commerce because the perceived usefulness of livestreaming commerce is examined based on the ability to deliver functional and instrumental benefits, which include cost-reduction benefits (Gan and Wang, 2017). Moreover, PP attracts online shoppers with hedonic motives who initially partake in shopping for gratification without a pre-existing mission to buy a specific product or product category, which fits the condition of IB (Beatty & Ferrell, 1998; Park et al., 2012). Price plays an even more prominent role in livestreaming commerce as it is a common (some might even say “critical”) practice for anchors to use attractive monetary deals (i.e., exclusive discounts) to boost as many sales as possible within the limited “stream-time” available for a single live session (Zhong et al., 2022). In the past, Donthu and Gilliland (1996) have uncovered that infomercial shoppers are generally “more price-conscious” than regular shoppers; thus, this research seeks to uncover whether PP plays a significant role under the “new era” of infomercial—that is, livestreaming commerce with the hypothesis formulated as follows.

*H10: Price perception positively correlates with cognitive reactions.*

### 3.9. Social contagion

Social influences, in general, have been found to have a positive influence on IBU. The concept of social contagion (SC) was extended from prior studies in epidemic disease to explain human psychology in various social phenomena. According to Hatfield et al. (1992), individuals may naturally mimic the emotions and actions of others as part of their innate ability, called primitive emotional contagion. The notion explained the reasons individuals may feel happy when they are with excited people and irritated when they overheard a heated argument. The behavioural contagion concept is similar, yet the individuals usually possess a pre-existing self-imposed constraint against the action that suppressed the initial urge to act. The demonstration of such attitudes and behaviours by others lowers the internal restrictions, thereby resulting in executions (Wheeler, 1966). SC, on the other hand, refers to the automated, unintentional, uncontrollable, and mostly unconscious influence on or by others to mimic the attitudes and behaviours of each other, which encompasses more complex aspects of individuals’ thoughts and behaviours (Wheeler, 1966). SC has been adopted in the research of livestreaming commerce due to the relevance of the construct to the co-existence and co-creation nature of livestreaming that enable viewers to influence one another on multiple levels (Hu et al., 2017; Xue et al., 2020). Furthermore, Wang et al. (2018) have found that SC can influence the IB process via conformity and emotional

repair. Given that emotions can also be transmitted over a text-based computer-mediated environment (Hancock et al., 2008), SC is proposed to be present in livestreaming commerce and possess a significant impact on AR with the hypothesis formulated as follows.

*H11: Social contagion positive correlates with affective reactions.*

### 3.10. Susceptibility to social influence

Although social influences have been established as a driver of impulsive buying, we argue that the power of social influences can be moderated by the individuals’ susceptibility to social influences (SSI) (Thürmer et al., 2020). SSI refers to the general tendency of individuals to be influenced by others, which include the willingness to conform to the expectations of others in regard to a purchase decision, the inclination to learn about products and services by accepting the information given by others as evidence of reality, and the propensity to be swayed by the emotions of others to give afferent feedback, formed from mimicry (Bearden et al., 1989; Doherty, 1997). Individuals may exhibit a varying level of SSI. Individuals with a high level of SSI tend to exhibit low conscientiousness but high neuroticism and openness and thus, are more reliant on others to form opinions and more vulnerable to manipulation (Oyibo and Vassileva, 2019). In sum, SSI augments the relationship of SC and AR (Luo, 2005; Wang et al., 2018). Hence, the following hypothesis is constructed.

*H12: Susceptibility to social influence moderates the relationship between social contagion and affective reactions.*

### 3.11. Conceptual model

The conceptual model is shown as Fig. 1:

## 4. Methods

### 4.1. Data collection

Given that Malaysia is a highly conducive market for the rapid expansion of livestreaming commerce with immense business opportunities out for grab due to the high Internet, mobile, and e-commerce penetration, the population of general Malaysian livestreaming commerce users was targeted for this study (International Trade Administration, 2021). According to the survey conducted by Oppotus, a market research company, Malaysian consumers have started to embrace the burgeoning livestreaming commerce with an increasing number of consumers who make livestreaming purchase (Oppotus, 2021). To collect the primary data, a self-administered online questionnaire survey was conducted. The invitation link to the questionnaire was distributed across multiple social media and livestreaming commerce platforms, whereby only individuals with purchase experience in livestreaming commerce were targeted. A total of 295 valid and eligible responses were collected. The demographic of the sample was then assessed against the demographic of the Malaysian online population to ensure representativeness. Based on the Internet User Survey Report 2020, the current online demographic comprised of the majority of young adults in their 20s, followed by middle-aged adults in their 30s is congruent with the sample collected (MCMC, 2020). Besides, the monthly income of the sample matched the findings of the report, which stated that over 70% of the current Malaysian Internet users have a monthly income below RM3,000 (MCMC, 2020). Hence, sample representativeness is unlikely an issue in this study.

### 4.2. Profile of respondents

The sample consisted of 46.1% of males and 53.9% of females. In terms of age, the majority of the respondents (48.2%) aged between 15 and 29 years old with 35% aged between 30 and 39 years old. The



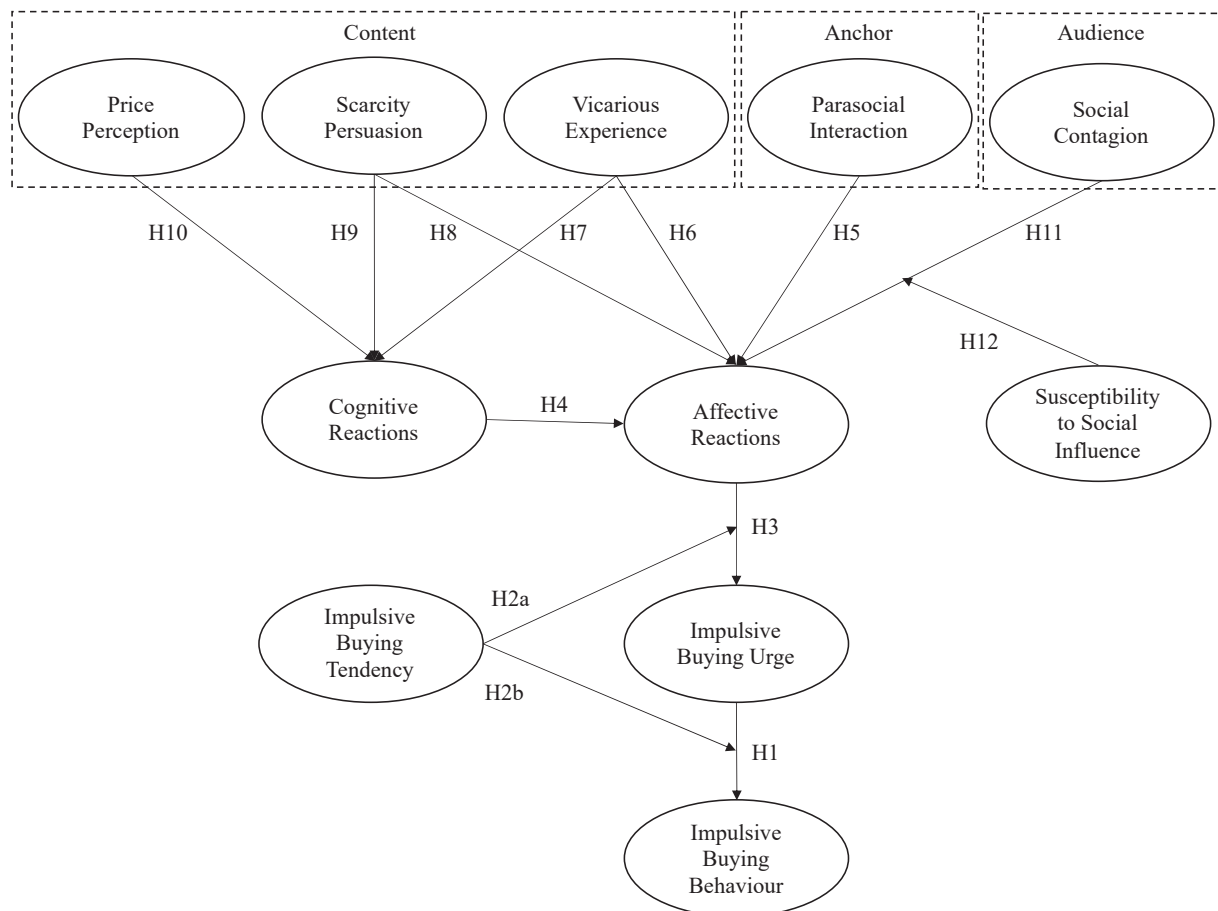


Fig. 1. Research model.

remaining 17% of the respondents were 40 years old and above. Over 55% of the respondents earn below RM4,001 per month, and the majority of the respondents have acquired tertiary education. Moreover, 60.8% of the sample generally watch less than one hour of livestreaming commerce, the majority only watched between 20 and 40 min of a live session at a time. 24.1% of the sample purchased products and services priced averagely within the range of RM100 to RM200 in livestreaming commerce, whereas 32.8% of the respondents buy products and services priced averagely between RM201 to RM400.

4.3. Research instrument

The questionnaire was divided into three sections: Section A consisted of background questions to collect demographical and behavioural usage information; Section B evaluated SSI and IBT, and Section C comprised situational questions to determine the perceptions of respondents toward the constructs. A pre-test was conducted to ensure the face and content validity of the measurement items, by which practitioners and academicians with knowledge and experience in livestreaming commerce were consulted. The measurement items were modified accordingly. The sources of the measurement items adapted from prior studies are displayed in Table 1.

4.4. Statistical analysis

The research adopted the Partial Least Squares Structural Equation Modelling approach (PLS-SEM) with SmartPLS software version 3.2.8 in the first stage of analysis to test the proposed conceptual model. PLS-SEM is suitable for two reasons. First, in comparison to covariance-based Structural Equation Modelling (CB-SEM), PLS-SEM is more

Table 1 Measurement items and sources.

Constructs	Number of Measurement Items	Sources
Susceptibility to Social Influences (SSI)	4	(Doherty, 1997; Bearden et al., 1989)
Individual Impulsive Buying Tendency (IBT)	4	(Verplanken and Herabadi, 2001)
Parasocial Interactions (PSI)	5	(Dibble et al., 2016; Rubin et al., 1985; Thorson & Rodgers, 2006)
Vicarious Expression (VE)	3	(Chen et al., 2019; Sims & Manz, 1981)
Scarcity Persuasion (SP)	3	(Eisend, 2008; Wu et al., 2020)
Price Perception (PP)	4	(Park et al., 2012; Sweeney & Soutar, 2001)
Social Contagion (SC)	5	(Doherty, 1997; Lim et al., 2012)
Cognitive Reactions (CR)	4	(Chen et al., 2019; Parboteeah et al., 2009)
Affective Reactions (AR)	4	(Beatty & Ferrell, 1998)
Impulsive Buying Urge (IBU)	3	(Beatty & Ferrell, 1998)
Impulsive Buying Behaviour (IBB)	4	(Beatty & Ferrell, 1998)

superior for the prediction of complex models and theory building (Ooi et al., 2021; Ooi & Tan, 2016), which characterize this study. Additionally, PLS-SEM places minimal restrictions on the sample size and the non-normal distributions (Lew et al., 2020; Leong et al., 2013). Given that the Mardia’s multivariate skewness ( $\beta = 17.12$ ) and kurtosis ( $\beta = 184.09$ ) have p-value less than 0.001 respectively, the study affirmed

**Table 2**  
Loadings, composite reliability and average variance extracted.

Constructs	Items	Loadings (p-levels)	Composite Reliability (CR)	Average Variance Extracted (AVE)
AR	AR1	0.815 (p < 0.001)	0.853	0.592
	AR2	0.726 (p < 0.001)		
	AR3	0.753 (p < 0.001)		
	AR4	0.782 (p < 0.001)		
CR	CR1	0.767 (p < 0.001)	0.833	0.556
	CR2	0.686 (p < 0.001)		
	CR3	0.734 (p < 0.001)		
	CR4	0.792 (p < 0.001)		
IBB	IBB1	0.839 (p < 0.001)	0.799	0.572
	IBB2	0.725 (p < 0.001)		
	IBB3	0.697 (p < 0.001)		
IBT	IBT1	0.805 (p < 0.001)	0.822	0.538
	IBT2	0.644 (p < 0.001)		
	IBT3	0.745 (p < 0.001)		
	IBT4	0.730 (p < 0.001)		
IBU	IBU1	0.775 (p < 0.001)	0.755	0.509
	IBU2	0.729 (p < 0.001)		
	IBU3	0.629 (p < 0.001)		
PP	PP1	0.755 (p < 0.001)	0.817	0.528
	PP2	0.758 (p < 0.001)		
	PP3	0.642 (p < 0.001)		
	PP4	0.745 (p < 0.001)		
PSI	PSI1	0.77 (p < 0.001)	0.847	0.527
	PSI2	0.662 (p < 0.001)		
	PSI3	0.754 (p < 0.001)		
	PSI4	0.681 (p < 0.001)		
	PSI5	0.755 (p < 0.001)		
SC	SC1	0.711 (p < 0.001)	0.862	0.555
	SC2	0.726 (p < 0.001)		
	SC3	0.785 (p < 0.001)		
	SC4	0.746 (p < 0.001)		
	SC5	0.756 (p < 0.001)		
SP	SP1	0.748 (p < 0.001)	0.804	0.578
	SP2	0.796 (p < 0.001)		
	SP3	0.736 (p < 0.001)		
SSI	SSI1	0.782 (p < 0.001)	0.806	0.510
	SSI2	0.687 (p < 0.001)		
	SSI3	0.695 (p < 0.001)		
	SSI4	0.687 (p < 0.001)		
VE	VE1	0.841 (p < 0.001)	0.833	0.625
	VE2	0.764 (p < 0.001)		
	VE3	0.765 (p < 0.001)		

that the data is not multivariate normal. Hence, PLS-SEM was deemed a better fit for this research over covariance-based structural equation modelling (CB-SEM). The sample size of 295 exhibited adequate statistical power, surpassing the minimum sample size of 131 computed using G<sup>2</sup>power, with a power level of 0.80, 13 predictors, an alpha value of 0.05, and an effect size of 0.15. Given that PLS-SEM can only capture linear relationships, the Artificial Neural Network (ANN) approach was taken in the second stage of analysis to identify the complex linear and non-linear relationship among the constructs, to determine the importance of the predictors (Al-Sharafi et al., 2021).

#### 4.5. Common method bias

Due to the cross-sectional design, there may be a threat of common method bias (CMB). Therefore, this research follows the approach taken by Tan and Ooi (2018) to apply both statistical and procedural remedies. Concerning the procedural measures, respondents were assured of confidentiality and anonymity of their responses. In addition, simple sentences were used, and unfamiliar terms were removed to avoid ambiguity in the questionnaire. In respect to statistical remedies, the latent method factor in the structural model was assessed using the PLS approach (Liang et al., 2007). Given that most of the Rb2 values are insignificant with only 9 significant paths and all the indicators' Ra values are substantially greater than Rb values, implying that CMB is unlikely a major concern in this dataset.

#### 4.6. Assessing the outer measurement model

Reliability was assessed using composite reliability (CR) measures. Given that all the values in Table 2 were above the minimum threshold of 0.70, no major issues were found (Wong et al., 2020; Lau et al., 2021). Convergent validity (CV) was tested using factor loading (FL) and average variance extracted (AVE). While FL should be higher than 0.708 to be considered as satisfactory, FL between 0.4 and 0.7 was acceptable given that AVE values were above 0.50 for the particular construct (Hair et al., 2016). Hence, CR2, IBB3, IBT2, IBU3, PP3, PSI2, PSI4, SSI2, SSI3 and SSI4 were retained. In addition, the values for all FL were significant at a p < 0.001 level. As displayed in Table 2, all items also exhibited AVE values ranging from 0.509 to 0.625, thus satisfying CV (Wong et al., 2014). Discriminant validity (DV) was examined using Fornell and Larcker's (1981) criterion. Table 3 demonstrated that all square roots of AVE for each construct were greater than the corresponding correlation coefficients and thus DV is ascertained (Wong et al., 2015).

#### 4.7. Inspecting the inner structural model

All the variance inflation factor (VIF) values were between 1.502 and 3.154, well below the threshold of 3, suggesting the absence of a serious multicollinearity issue (Wong et al., 2020). The results from the structural model in Table 4 and Fig. 2 indicated that all hypotheses were statistically significant except H2b, H7, H8 and H11. In order to check on the moderating effect of SSI and IBT, this research employed the

orthogonalizing approach for the interaction term. The results as displayed in Table 4 and Fig. 2 demonstrated that SSI significantly moderates the relationship between SC and AR. Moreover, IBT moderates the relationship between AR and IBU but not the relationship between IBU and IBB. Thus, H2a was supported but H2b was not.

4.8. The predictive relevance and effect size

According to Cohen (1992), effect size ( $f^2$ ) of 0.02, 0.15, and 0.35 suggests small, medium, and large impact, respectively. Values below 0.02 indicate no effect (Hew et al., 2017; Tan and Ooi, 2018). All the  $f^2$  values ranged from 0.000 to 0.396, which suggests that the study was deemed to have no effect to large effect. Furthermore, all the values of  $Q^2$  were higher than zero, implying predictive relevance for the endogenous constructs in the conceptual model. This research further employed PLSpredict to validate the predictive power of the study (Shmueli et al., 2019). The results show that the majority of RMSE values of the linear model (LM) are greater than PLS-SEM values for the key target construct of IBB. Therefore, PLSpredict indicates that the model has medium predictive power. The model also explained 61.2%, 49.7%, 53.4%, and 46.1% of the variance in AR, CR, IBB, and IBU, respectively.

4.9. Artificial neural network (ANN) analysis

According to Haykin (2001, p.2) ANN is regarded as a “massively parallel distributed processor made up of simple processing units, which have a neural propensity for storing experimental knowledge and making it available for use” and has been uncovered to surpass

traditional regression methods. Four ANN models were constructed for AR, CR, IBU and IBB. Table 5, on the other hand, showed the predictive accuracy of Models A, B, C and D. All the mean values for Root Mean Squared Error (RMSE) for training and testing stages ranged from 0.083 to 0.117 which are relatively small. Thus, it can be concluded that the ANN models show a great level of predictive accuracy (Leong et al., 2019; Lau et al., 2021). Next, a sensitivity analysis was performed to rank the exogenous constructs in terms of their normalised relative importance to the endogenous constructs. The results in Table 6 showed that in ANN Model A, CR is the most prominent predictor of AR (100% normalized relative importance), followed by VE (92.205%), PSI (89.290), and SSI (35.330%). Pertaining to ANN Model B, PP (100%) is of great importance to CR, whereas SP (63.077%) is the second most important predictor of CR. Next, as displayed in ANN model C, IBT (100%) has emerged as the most important predictor of IBU, followed by AR (92.864%). Finally, for ANN Model D, as there is only 1 single neuron model, hence the sensitivity analysis shows a 100% of normalized importance. The ranking for PLS-SEM and ANN was further compared in Table 7 based on path coefficient and normalized relative importance, respectively. Results for ANN Model A, B, and D were consistent for both PLS-SEM and ANN, except for ANN Model C.

5. Discussion

First, by extending prior studies that found social media content attributes as influence attempts in evoking consumer responses, the findings revealed the relevance of livestreaming commerce content (i.e., PP, SP, and VE) as influence attempts with significant impacts on consumers’ CR and AR (Dolan et al., 2019). More specifically, PP and SP

Table 3  
Fornell-Larcker Criterion.

	AR	CR	IBB	IBT	IBU	PP	PSI	SC	SP	SSI	VE
AR	<i>0.770</i>										
CR	0.663	<i>0.746</i>									
IBB	0.633	0.673	<i>0.756</i>								
IBT	0.588	0.559	0.591	<i>0.733</i>							
IBU	0.610	0.583	0.690	0.571	<i>0.713</i>						
PP	0.648	0.678	0.637	0.612	0.636	<i>0.726</i>					
PSI	0.698	0.684	0.655	0.636	0.613	0.718	<i>0.726</i>				
SC	0.591	0.675	0.671	0.544	0.532	0.669	0.704	<i>0.745</i>			
SP	0.562	0.596	0.537	0.517	0.562	0.689	0.587	0.581	<i>0.760</i>		
SSI	0.549	0.435	0.465	0.520	0.496	0.571	0.602	0.457	0.469	<i>0.714</i>	
VE	0.627	0.515	0.478	0.461	0.456	0.621	0.660	0.568	0.580	0.513	<i>0.791</i>

Note: Diagonal elements (in italic) are the square root of the average variance extracted.

Table 4  
Outcome of the structural model examination.

PLS Path	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics ([O/STDEV])	P Values	Bias Corrected Confidence Interval	Remarks
AR → IBU***	0.416	0.418	0.058	7.217	0.000	0.295 0.514	Significant
CR → AR***	0.294	0.287	0.074	3.970	0.000	0.142 0.434	Significant
IBU → IBB***	0.526	0.526	0.055	9.600	0.000	0.422 0.626	Significant
PP → CR***	0.467	0.471	0.072	6.474	0.000	0.300 0.610	Significant
PSI → AR**	0.218	0.221	0.076	2.863	0.004	0.064 0.354	Significant
SC → AR <sup>n.s.</sup>	-0.009	0.000	0.072	0.121	0.904	-0.163 0.108	Not significant
SP → AR <sup>n.s.</sup>	0.060	0.063	0.067	0.900	0.369	-0.063 0.182	Not significant
SP → CR**	0.217	0.214	0.067	3.252	0.001	0.079 0.338	Significant
VE → AR**	0.210	0.208	0.064	3.295	0.001	0.088 0.33	Significant
VE → CR <sup>n.s.</sup>	0.099	0.101	0.058	1.697	0.090	-0.024 0.222	Not significant
AR*IBT → IBU**	0.139	0.138	0.046	3.016	0.003	0.046 0.226	Significant
IBU*IBT → IBB <sup>n.s.</sup>	-0.025	-0.024	0.039	0.652	0.515	-0.113 0.050	Not significant
SC*SSI → AR*	0.097	0.092	0.041	2.380	0.018	0.023 0.192	Significant

Notes

- a. \* Significant at  $p < 0.05$  level.
- b. \*\* Significant at  $p < 0.01$  level.
- c. \*\*\* Significant at  $p < 0.001$  level.
- d. n.s. Not supported.

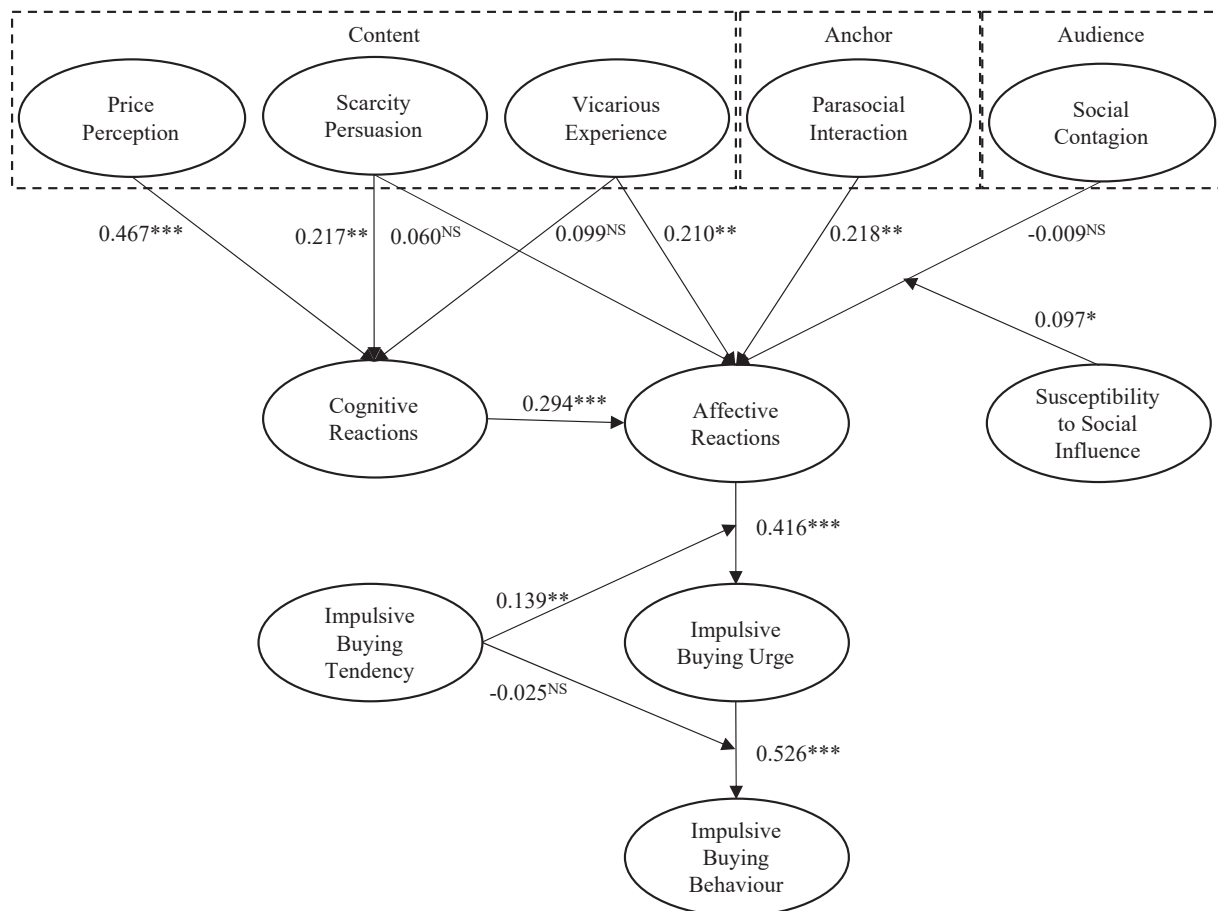


Fig. 2. Results of hypotheses testing.

Table 5  
RMSE values for AR, CR, IBU and IBB.

Neural network	Model A Input: CR, PSI, VE, SSI Output: AR		Model B Input: PP, SP Output: CR		Model C Input: AR, IBT Output: IBU		Model D Input: IBU Output: IBB	
	Training	Testing	Training	Testing	Training	Testing	Training	Testing
ANN1	0.089	0.099	0.102	0.099	0.098	0.086	0.087	0.085
ANN2	0.092	0.079	0.100	0.118	0.095	0.110	0.099	0.131
ANN3	0.092	0.108	0.103	0.128	0.101	0.094	0.089	0.066
ANN4	0.324	0.081	0.101	0.110	0.099	0.074	0.086	0.087
ANN5	0.096	0.080	0.105	0.140	0.097	0.095	0.090	0.068
ANN6	0.093	0.117	0.106	0.078	0.098	0.115	0.085	0.105
ANN7	0.095	0.077	0.103	0.085	0.099	0.084	0.088	0.064
ANN8	0.107	0.121	0.099	0.125	0.096	0.116	0.088	0.068
ANN9	0.090	0.104	0.106	0.076	0.096	0.107	0.089	0.099
ANN10	0.091	0.098	0.101	0.103	0.097	0.109	0.028	0.067
Mean	0.117	0.096	0.103	0.106	0.098	0.099	0.083	0.084
SD	0.073	0.017	0.002	0.022	0.002	0.014	0.020	0.022

have emerged as significant factors that positively influence CR. The mental accounting theory supports the findings as the theory postulates that consumers inherently involve mental accounting in decision-making to maximize utility, evidencing cognitive involvement in IB (Thaler, 2008). In livestreaming commerce, the merchants may provide occasional price negotiations on top of regular discounts, thereby triggering utility value evaluation by viewers (Hu and Chaudhry, 2020). The findings support the positive impact of PS on CR, signalling the power of scarcity appeal in livestreaming commerce as an attempt to

hint exclusivity and product value to viewers, especially with the co-presence of others in the livestreaming session.

Second, in line with prior studies (Chen et al., 2019; Parboteeah et al., 2009; Zheng et al., 2019), CR was established as a significant contributor to AR. The findings also demonstrated the positive impacts of VE and PSI on AR. In accordance with Chen et al. (2019), VE in social commerce can foster a vivid imagination of products and services, with anticipated usage experience to arouse positive emotions and attitudes towards the recommended products and services. The power of VE has



**Table 6**  
Sensitivity analysis.

Neural network	Model A (Output: AR)				Model B (Output: CR)		Model C (Output: IBU)		Model D (Output: IBB)
	CR	PSI	VE	SSI	PP	SP	AR	IBT	IBU
ANN1	0.310	0.290	0.285	0.115	0.641	0.359	0.507	0.493	1.000
ANN2	0.337	0.282	0.285	0.096	0.666	0.334	0.491	0.509	1.000
ANN3	0.277	0.319	0.278	0.126	0.591	0.409	0.390	0.610	1.000
ANN4	0.342	0.181	0.339	0.138	0.529	0.471	0.527	0.473	1.000
ANN5	0.319	0.400	0.247	0.034	0.635	0.365	0.522	0.478	1.000
ANN6	0.316	0.286	0.318	0.081	0.527	0.473	0.517	0.483	1.000
ANN7	0.295	0.302	0.277	0.126	0.638	0.362	0.473	0.527	1.000
ANN8	0.346	0.269	0.219	0.165	0.679	0.321	0.478	0.522	1.000
ANN9	0.306	0.232	0.345	0.116	0.556	0.444	0.480	0.520	1.000
ANN10	0.308	0.257	0.317	0.118	0.648	0.316	0.430	0.570	1.000
Average relative importance	0.316	0.282	0.291	0.112	0.611	0.385	0.482	0.519	1.000
Normalized relative importance (%)	100.000	89.290	92.205	35.330	100.000	63.077	92.864	100.000	100.000

**Table 7**  
Comparison between PLS-SEM and ANN results.

PLS Path	Original sample (O)/Path Coefficient	ANN results: Normalised relative importance (%)	Ranking (PLS-SEM) [based on Path Coefficient]	Ranking (ANN) [based on Normalised relative importance (%)]	Remark
Model A (Output: AR)					
CR → AR	0.294	100.00	1	1	Match
PSI → AR	0.218	89.290	3	3	Match
VE → AR	0.210	92.205	2	2	Match
SC*SSI → AR	0.097	35.330	4	4	Match
Model B (Output: CR)					
PP → CR	0.467	100.000	1	1	Match
SP → CR	0.217	63.077	2	2	Match
Model C (Output: IBU)					
AR → IBU	0.416	92.864	1	2	No match
AR*IBT → IBU	0.139	100.000	2	1	No match
Model D (Output: IBB)					
IBU → IBB	0.526	100.000	1	1	Match

become even more profound in livestreaming commerce, with higher telepresence and social presence facilitated by real-time narrative and rich media. Besides, PSI was found to positively impact AR in IB. The interactive nature of livestreaming commerce can facilitate two-way dialogues in which viewers are no longer passive actors, but co-producers in media consumption. It is even truer when the anchors acknowledge the presence of the viewers during the livestreaming session (Lim et al., 2020). In line with the meaning transfer model, the intimate and friend-like interactions fostered between anchor and viewers can be translated to other positive reactions in livestreaming commerce (McCracken, 1989). Besides, the findings deviate from prior studies of which SP and SC have demonstrated an insignificant impact on AR (Ang et al., 2018; Wang et al., 2018; Wu et al., 2020). A plausible explanation is that though SP can evoke excitement, it can simultaneously exert pressure, thus offset the effects of each other (Beatty & Ferrell, 1998). The insignificant influence of SC can be explained by the emotional transmission barrier between the viewers in livestreaming commerce. The media richness and interactivity though evident in the anchor-viewer interactions is less apparent in the viewer-viewer interactions as the viewers remain confined to text-based communication, hence limiting the influence of SC. Notably, SSI has demonstrated a significant moderating effect, which indicates that SC may display greater influence on AR if individuals have a higher susceptibility to

interpersonal influence. Given livestreaming commerce can facilitate the feeling of “being in the same room”, the contagion effects in such computer-mediated social situations require further investigation, whereby a simpler contagion process in terms of EC that does not involve complicated decision-making can be examined to decipher the effects of viral influences on collective individuals in the same virtual environment with limited interaction and connection with one another.

Third, AR was determined to significantly influence IBU, thus supporting the prior established notion that IB is an emotionally driven process (Beatty & Ferrell, 1998; Rook, 1987). Besides, the positive relationship between IBU and IBB was identified, corroborating the prior findings by Beatty and Ferrell (1998) and Wang et al. (2018). Notably, the findings shed light on the moderating effects of IBT in the relationship between AR and IBU. It is articulated that IBT as an individual trait can augment the effects of AR, prompting the development of IBU. However, the moderating effect of IBT in the relationship between IBU and IBB was found insignificant, contradicting previous studies by Beatty and Ferrell (1998) and Wu et al., (2020). The discrepancy in findings can be explained by the deficiency of IBT as a general trait, which may be insufficient to exert influence in specific purchase conditions (Jones et al., 2003). The insignificant moderating effect of IBT in the relationship between IBU and IBT may suggest that the dual approach should be adopted in future research, by which

general IBT can be used to predict the proclivity of individuals to feel IBU, and situational IBT can be employed for the likelihood to buy impulsively.

## 6. Implications

### 6.1. Theoretical implications

This research enriches the current knowledge of livestreaming commerce literature in several ways. First, unlike past research that primarily investigated the outcome of livestreaming commerce purchase intention or adoption, the present research examined consumers' impulsive buying in livestreaming commerce, which remain largely unexplored, yet it is a highly relevant behavioural outcome triggered in livestreaming commerce (Ming et al., 2021). Second, the cognitive-affective relationship established implies that CR still plays a pivotal role in the emotionally driven process—CR is the most important predictor of AR; hence, should not be overlooked in the IB literature, so as to ensure the realities of rapid decision-making are reflected. Moreover, the conditions for SP have been highlighted, whereby the desirability of the commodity should be controlled to achieve consistent findings. Third, prior studies demonstrated the power of consumers' internal state such as utilitarian or hedonic motivations (Cai et al., 2018) and perceived values (Wongkitrungrueng & Assarut, 2020) as the antecedents of livestreaming commerce purchase and participation but they failed to explicate how these internal states are driven. To address this gap, the research tapped into the uncharted area in livestreaming commerce literature by delineating the mechanism by which three primary aspects of livestreaming commerce, namely content (i.e., price perception, scarcity persuasion, and vicarious experience), anchor (i.e., parasocial interaction), and viewer (i.e., social contagion) can ultimately result in the formation of impulsive buying behavior. The research contributes to the body of knowledge by evidencing the simultaneous impacts of content, anchor, and viewer on cognitive and affective reactions, thereby complementing past research that focused on a single perspective (e.g., relational, or technical). Lastly, although the impact of SC on affective reactions is insignificant, the current research uncovers the moderating effect of susceptibility to informational influence, paving the way towards understanding the interaction between livestreaming environment and consumers' personal traits, and subsequent perceptual and behavioural outcomes.

### 6.2. Practical implications

The results generated from this research provide some insightful practical implications, which can benefit the merchants and anchors in livestreaming commerce to evoke IBU to drive sales conversion. First, the anchors must ensure that the viewing experience in livestreaming commerce is fun, pleasurable, and entertaining to induce IBU via emotional arousal. One way to attain this objective is by facilitating an engaging and immersive narrative to immerse the viewers into the storyline thus stimulating VE. The anchors can foster VE by offering extensive information, particularly on the sensory aspects of the products and services (i.e., taste, smell, and texture) to forge a vivid illustration of usage experience. In addition, the anchors must also keep in mind the entertainment nature of livestreaming commerce, so as to ensure that the authenticity and immediacy in the live interactions are achieved, which can be translated into product affection that stimulates IBU. Moreover, the anchors can try to foster personal dialogues with active participators in the livestreaming session to better facilitate PSI, which act as the ultimate driver of IBU.

Furthermore, the merchants and anchors should ensure that the desirability of the products and services is established via quality information before imposing SP, as ineffective SP made to drive sales via excitement and pressure can pose countereffects on IB, given that individuals evaluate SP via CR rather than AR. Next, PP can guide the

heuristic evaluation of products and services, thus the merchants can consider implementing price-off promotions on top of SP to drive sales conversions via IB. The merchants can continue the practice of regular discounts to position livestreaming commerce as a relatively economical online sales channel, yet promotional discount needs to be designed in a strategic manner to avoid the strategy from becoming counterproductive. Finally, albeit SC displayed an insignificant relationship with AR, the anchors must still ensure that the atmosphere of livestreaming commerce jolly ensures an overall pleasurable experience for all, particularly for consumers with a high level of susceptibility to informational influence. As the viewers co-create the consumption experience in livestreaming commerce, SC may still take a toll on the engagement of viewers (Beatty & Ferrell, 1998).

## 7. Limitations and future research

There are some important caveats to the research that deserve attention. First, this study draws results from a single country, which may limit the generalizability of the findings to other countries due to social-cultural differences (Al-Saedi et al., 2019). Future research can conduct a cross-countries comparison to identify the potential differences in the path model, for better generalizability. Next, the cross-sectional design employed in this research might prohibit the drawing of causal inferences. Future studies are suggested to undertake field or laboratory experimental designs to validate the findings. Third, though this study delineates the relevance of content, anchor, and audience in stimulating consumers' internal responses and subsequent IBB, future studies are suggested to incorporate other situational factors (e.g., shopping motivation, time pressure, and product class) to bolster the comprehensiveness of research in answering the questions: *Can the reactions towards SP change when the consumers are bargain hunting rather than variety-seeking? Can parasocial interactions be discounted when the number of viewers is high?* Furthermore, this research might be complemented and enhanced via the examination of optimal criteria for an effective anchor. Fourth, as previous research suggested, viewers display different behaviours in different social networking platforms, thus it may be fruitful for future studies to direct efforts into examining consumer attitudes and behaviours across different livestreaming platforms (Aw and Labrecque, 2020). Finally, a more uncharted perspective (e.g., informational exchange and value co-creation) facilitates the understanding of consumer attitudes and behaviours in livestreaming commerce awaits (Chen & Lin, 2018).

## 8. Conclusion

Given the surging popularity of livestreaming commerce, it is imperative for brands and retailers to recognize the trend shifting in the consumer shopping journey to seize this opportunity. This study put forth a comprehensive framework elucidating the mechanism to which content, anchor, and audience factors contribute to the consumers' cognitive and affective reactions, and ultimately translate into impulsive buying urge and behaviour. This study further highlights the boundary condition of two consumer traits, namely impulsive buying tendency and susceptibility to social influence. In sum, this research is believed to constitute an extra step towards understanding consumer attitudes and behaviours in livestreaming commerce, an emerging marketing channel in the era of new media, with a flow of information that is multidirectional, interconnected, and hard to predict (Hennig-Thurau et al., 2010). This research outlines implications for livestreaming commerce merchants and anchors in attuning effective strategies to leverage consumers' impulsive buying for better business performance.

### CRedit authorship contribution statement

**Pei-San Lo:** Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis,

Data curation. **Yogesh K. Dwivedi**: Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Conceptualization. **Garry Wei-Han Tan**: . **Keng-Boon Ooi**: Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Conceptualization. **Eugene Cheng-Xi Aw**: . **Bhimaraya Metri**: Writing – review & editing, Supervision, Conceptualization.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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