EXPLORING ONLINE CUSTOMER ENJOYMENT AND ENGAGEMENT: THE ROLES OF STORE ATMOSPHERE, INTERACTIVE TECHNOLOGY, AND TECHNOLOGICAL READINESS IN SAUDI ARABIA

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Abstract

The present study explores how digitally mediated retail environments shape consumer affect and engagement as online platforms increasingly operate as immersive experiential spaces. It examines how online store atmosphere and interactive screens foster engagement through customer enjoyment and evaluates how technology readiness conditions these effects. Utilizing a quantitative cross-sectional design, the research obtained survey data from 470 Saudi online shoppers and used structural equation modelling with validated multi-item scales to assess atmospherics, interactivity, enjoyment, engagement, and readiness. Results evidence that both atmospheric and interactive cues significantly heighten enjoyment, which in turn strongly predicts engagement, with partial mediation by enjoyment of both pathways. Technology readiness amplifies all relationships, demonstrating that individual technological predispositions critically shape affective and behavioral responses. These findings validate an integrated S–O–R/TRI framework and offer theoretically grounded and practically relevant insights for designing emotionally resonant, user-aligned online retail environments.

Keywords: Online Store Atmosphere; Interactivity; Customer Enjoyment; Customer Engagement.

1. INTRODUCTION

The rapid pace of digital transformation in world retail economies—most recently due to the COVID-19 pandemic—has revolutionized the way people interact with brands profoundly. Consumer buying has evolved from a transactional to an experiential and emotional behavior where feelings, senses, and technology mix and interact and come together to shape consumer behavior (Xi et al., 2024; Gao et al., 2023). Consumers now more and more desire online sites not only to be easy to use and practical but to generate immersion, delight, and personalized interaction that reflect or even beat in-store experiences (Shi et al., 2025; Mariani et al., 2022). As such, virtual store space has evolved as an experiential strategic space where design beauty, data visualization, and interactive affordances jointly influence consumer attitudes, satisfaction, and behavior intentions (Dash et al., 2023; Calvete et al., 2022). It is an issue here in the virtual world where it becomes an essential issue for researchers as well as practitioners to grasp how the emotional and psychological aspects of virtual store design influence engagement.

In spite of this acknowledgment, predominance of utilitarian and functionalist ideals in much of the existing body of research on consumer online behavior continues, only considering efficiency, security, and usability (Albarq, 2021; Hollebeek et al., 2019). Being narrow-minded has put a limit on theoretical comprehension of affective and experiential processes for customer engagement in online contexts (Mariani et al., 2022). Stimulus–

Organism–Response (S–O–R) model (Mehrabian & Russell, 1974) offers a strong theory to bridge this gap. It suggests that external stimuli (S)—e.g., design elements, interactivity, or sensory inputs—elicits internal emotional and cognitive responses (O), which in turn affect behavioral responses (R). In virtual servicescapes, online shopping environment and interactivity are the immediate stimuli that can evoke affective responses like pleasure, which eventually influence consumers' interest, happiness, and loyalty (Eroglu et al., 2003; Novak et al., 2000; Xi et al., 2024). But the mediating influence of enjoyment as an organismic state of coordinating digital inputs into behavioral involvement has not been adequately researched in literature, especially in emerging digital markets where consumer experience is changing at a rapid rate. A second theoretical limitation concerns the effect of between-subjects differences in technology readiness, i.e., one's psychological inclination to use and engage in new technologies (Parasuraman & Colby, 2015). The Technology Readiness Index (TRI 2.0) has already proven to frame innovativeness and optimism as drivers and discomfort and insecurity as inhibitors of technology engagement (Blut et al., 2020). Although earlier studies have already assessed the impact of technology readiness on adoption or satisfaction, its moderating role in emotionally based engagement models is yet to be studied. High technology readiness consumers tend to feel in control, interested, and pleasurable when interacting technologically, but low readiness consumers will tend to feel apprehension, doubt, or mental overload to discouragement from participation (Parasuraman & Colby, 2015). Such dynamics are particularly pertinent in Saudi Arabia, where e-commerce has grown exponentially via the Vision 2030 digital economy initiative but continues to be defined in terms of different technology adoption and divergent emotional reactions across demographic and psychographic segments (Binsaeed et al., 2023). Such a dimensional differentiation in terms of how environmental design, affective states, and technology predispositions interactively drive participation here is therefore theoretically and managerially critical. In order to address these voids, this study formulates and empirically tests a moderated mediation model that incorporates both environmental and psychological attitude in explaining digital involvement. According to the S–O–R paradigm, the model suggests online shopping mall atmosphere and interactive screens as stimuli inducing customer enjoyment as an organismic mediator, which in turn affects customer engagement as the behavior response. Based on Technology Readiness Theory, the model furthermore theorizes that technology readiness is a moderator of these relationships, such that interactivity and online design have stronger positive effects on enjoyment and involvement among more technologically ready consumers. Consequently, there are three objectives of the research: one, to test direct impacts of online shopping environment and interactive screens on customer participation and enjoyment; two, to test enjoyment by customers as a mediator in these associations; and three, to measure the moderating influence of technology readiness in promoting or hindering these impacts.

Through this integrative approach, the research contributes to digital consumer behavior theory development in some ways. Theoretically, it applied the S–O–R model to modern online shopping contexts by focusing on affective and experiential routes that link

environmental stimuli to engagement consequences (Csikszentmihalyi, 1990; Mariani et al., 2022). At the same time, it supplemented the model with Technology Readiness Theory (TRI 2.0), adding a person-difference factor that is the source of differences in consumer reactions to digital experiences (Blut et al., 2020; Parasuraman & Colby, 2015). This cross-theoretical synthesis brings environmental psychology and technology adoption theory together in a more comprehensive explanation of how design, affect, and personality interact in the determination of involvement. Empirically, the research provides context-relevant information from Saudi Arabia, an emerging digital economy in which consumer technology uses are culturally situated and dynamically changing. In practice, the outcomes will guide digital strategists and e-retailers how to create more engaging and participative e-retailing spaces that add fun, trust, and interaction among different consumer groups. In general, this study provides conceptual and managerial contributions to constructing digital engagement in technology-enabled retail spaces.

2. LITERATURE REVIEW

2.1 Overview of the Research Domain

E-business has evolved from a transaction site to an entirely engaging, experience-driven setting where sensory, affective, and interactive components collectively affect value creation between consumers. Within the last ten years, researchers have rephrased online purchasing as an experiential activity as opposed to a utilitarian one, with the argument that consumers gain psychological, hedonic, and symbolic pleasure from online purchasing beyond the purchase of products (Huang & Benyoucef, 2013; Krasonikolakis et al., 2022). In this paradigm, online shop atmospherics, from visual look to beauty of interface, color balance, navigation order, and clarity of information, are key precursors of affective responses like pleasure and flow (Laroche et al., 2022; Nadroo et al., 2024). These atmospherics create what Bitner (1992) described as a servicescape but which has been reconstituted in a digitalscape that generates similar emotions to those generated by off-line store settings but through web-mediated signs.

Along with these visual enhancements, interactivity has also emerged as the hallmark of the new online store. It is users' perceived control, system responsiveness, and two-way communication between consumer and interface (Liu & Shrum, 2002; Arghashi & Yuksel, 2022). Studies increasingly indicate that interactive functionalities like augmented-reality visualization of products, 3-D product configurators, and live chat functions increase immersion and telepresence—psychological conditions at the center of digital experiences (Shi et al., 2025; Li et al., 2025). Such functionalities have redirected marketing strategy from providing static content to dynamic co-creation of experience by companies and consumers, emphasizing engagement as a pre-condition and outcome of successful digital experiences. Theoretical development of customer interaction has therefore followed the development trajectory of e-commerce technology. Interaction is now considered an abstract higher order multidimensional state that includes cognitive absorption, emotional bonding, and behavioral involvement, a more profound level of relationship than satisfaction or loyalty (Kumar et al., 2023; Hollebeek et al., 2014).

Recent systematic reviews demonstrate that engagement serves to mediate digital stimuli (e.g., interactivity, attractiveness) and relational outcomes such as trust, advocacy, and repurchase intent (Roy et al., 2018). Engagement's antecedents and processes, though, are still context-dependent, and design-based and psychological factor-simultaneous models are required to explain its development. In the meantime, consumer heterogeneity in technological readiness has become a major moderator in digital behavioral studies. Technology readyness—measured in terms of optimism, innovativeness, discomfort, and insecurity about new technology—is accountable for the degree to which customers criticize, judge, and react to internet experiences (Parasuraman & Colby, 2015; Zhao et al., 2025). Empirical findings show that more customers who are ready-to-use enjoy more and feel more presence in interactive or AI-based stores (Blut et al., 2020; Parasuraman & Colby, 2015). Though its moderating role in models connecting atmospherics, interactivity, and engagement has not been researched to a great extent, especially in emerging markets such as Saudi Arabia where digital literacy is not homogeneous.

2.2 Theoretical Perspectives

This study is grounded in two connected theories—the Stimulus–Organism–Response (S–O–R) model and Technology Readiness Theory (TRI 2.0)—that together provide a comprehensive explanation of environmental sign interactions, internal psychological processes, and technological individual orientations due to which consumer participation with online spaces is established. The synthesis of such models enables rich comprehension of consumer behavior that goes beyond the single functionalist framework, highlighting affective and dispositional processes through which technology-based consumption is made available.

The S–O–R model, initially established in the field of environmental psychology (Mehrabian & Russell, 1974), suggests that environmental stimuli (S) evoke internal organismic states (O), which in turn yield observable behavioural responses (R). This tripartite construction provides a malleable framework for understanding how people react to their physical or virtual worlds. For the case of electronic retailing, the model has been widely used to detail how design features—visual look and feel, navigability, information content density, and interactivity—impact affective and cognitive states which themselves determine behavior outcomes like satisfaction, involvement, and purchase intention (Eroglu et al., 2003; Novak et al., 2000; Xi et al., 2024). In this model, interactivity and online store atmosphere are assumed to be crucial environmental signals that guide consumers' internal states, such as experienced enjoyment, flow, and telepresence, which finally express themselves as engagement behavior. Recent empirical research has shown the continued applicability of the S–O–R model to virtual and hybrid consumption contexts, including augmented reality shopping (Arghashi & Yuksel, 2022), live streaming e-commerce (Cai et al., 2023), and virtual brand communities (Dash et al., 2023). The research quotes that affective and experiential responses act as the mediator between digital stimuli and behavioral consequences. Yet, the S–O–R model alone offers a context-free theory with minimal explanation of why or how people will vary in their reaction to identical stimuli from their environment. That shortfall demands an integrative

theoretical extension that incorporates individual-level psychological predispositions, specifically in technologically demanding environments. To the extent of closing this theoretical gap, the present study incorporates Technology Readiness Theory (TRI 2.0) (Parasuraman & Colby, 2015), which defines technology readiness as a complex individual factor that defines how individuals perceive and apply new technology. TRI 2.0 suggests four large dimensions—optimism and innovativeness, which stimulate technology adoption, and discomfort and insecurity, which hinder it. These factors in tandem capture the ambivalence people bear toward technology, balancing optimism and fear (Blut et al., 2020). Empirical evidence shows technology readiness impacts consumer control perceptions, enjoyment, and trust in virtual environments considerably (Uren & Edwards, 2023; Parasuraman & Colby, 2015). People who are optimistic and innovative will engage technological interfaces with hope and interest, thus more enjoyment and engagement. On the other hand, those defined by insecurity or distress can be anxious, high in cognitive efforts, and lower in willingness to interact.

By combining TRI 2.0 with the S–O–R model, this study brings in a moderating mechanism that accounts for variation in consumers' affect and behavior reactions to digital stimuli. While the S–O–R model explains how environmental stimuli result in organismic and behavioral responses, TRI 2.0 puts this process into perspective by explaining when and for whom these responses will be intensified or minimized. Interestingly, technologically ready consumers who are most ready are likely to react more favorably to provocative and interactive virtual environments, with higher enjoyment and activity levels. By contrast, low-readiness consumers might exhibit more limited affective responses and lower engagement even when presented with the same stimuli. This integration among theories offers a more detailed explanation of consumer involvement including environmental as well as dispositional factors—a thread best nurtured in recent studies of consumer behavior (Gao et al., 2023; Mariani et al., 2022). The theoretical integration of S–O–R and TRI 2.0 therefore provides a two-levelled framework of explanation for this study. On the one level, the S–O–R model lays down the cause–effect chain between online shop ambience and interactivity (stimuli) and consumer enjoyment (organismic state) and engagement (response). On another level, TRI 2.0 brings in technology readiness as a moderator that qualifies these relationships by taking into account variations in orientation towards technology. This integration captures dynamic interaction among environmental design, affective response, and consumer disposition in digital consumption. Thus, the theoretical model for the study not only broadens the ecological validity of the S–O–R paradigm to modern digital retailing contexts but also enriches insights into consumer preparedness to technology on emotion and behavior outcomes in technology-mediated consumption experiences.

2.3 Key Constructs and Definitions

The conceptual development of this study centers on five leading constructs—customer enjoyment (CE), customer engagement (CENG), interactive screens (IS), online store atmosphere (OSA), and technology readiness (TR). While they are distinct, related dimensions of the total theoretical digital consumer behavior model, the conceptual

boundary and definitions derive from recent theoretical advances and empirically grounded research in psychology, marketing, and information systems.

Online Store (Interface) Atmosphere: Online store or interface setting covers the design, sensory, and symbolic information in an online setting that influences consumers' feelings, emotions, and attitude. Contrary to physical store-based atmospherics, digital atmospherics combine visual attractiveness, navigability, color arrangement, symmetry of layout, and information arrangement, all together specifying the quality of online aesthetics and usability (Krasonikolakis et al., 2022). There is growing support that this construct represents a subcategory of the overall digital servicescape, where the integration of sensory and information signals guides affective and cognitive appraisals. Recent research reports that atmospheric qualities such as navigability, vivid imagery, and information clarity enhance users' pleasure and interest, thereby influencing behavioral intent (Laroche et al., 2022; Guo et al., 2023). Therefore, web atmospherics are increasingly regarded by everyone worldwide as strategic communication tools and psychological stimuli to stimulate emotional responses required for engagement and loyalty formation.

Perceived Interactivity: Perceived interactivity is the degree to which a web system permits users to control content, share information, and sense two-way communication (Liu & Shrum, 2002). Today's research operationalizes it as a technology characteristic (encoding the system's responsiveness and functionality) and a psychological feeling (encoding users' perception of mutuality and control). The construct is key to explaining digital immersion, especially as interactive technologies—e.g., customized suggestions, real-time conversation, and AR interfaces—spread across e-commerce (Arghashi & Yuksel, 2022). Findings in AR and live shopping environments reveal that perceived interactivity increases flow experiences and telepresence among consumers, and leads to emotional engagement and sustained use intentions (Li et al., 2025). Interactivity is thereby a central experiential driver, connecting technological affordances and consumers' emotional states.

Customer Enjoyment: Customer enjoyment is the internal pleasure and emotional satisfaction gained from online interaction regardless of functional or utilitarian outcomes (Nguyen et al., 2023). It is an organismic component of the S–O–R model reflecting the effect of ambient and interactive stimuli on involvement and buying behavior (Deng et al., 2022). Enjoyment is also a central construct in flow theory (Csikszentmihalyi, 1990), which refers to sustained engagement and positive affect leading to extended participation. For e-shopping, enjoyment heightens perceived value and hedonic motivation, which drive customers' impulse buy and repeat purchase intentions. Recent research illustrates that enjoyment acts as a mediator between quality of interface and behaviour outcome in online shopping through live-streaming business (Shi et al., 2025; Nguyen et al., 2023).

Customer Engagement: Customer engagement is referred to as a psychological state and behaviour outcome that describes consumers' cognitive, affective, and behavioural attachment with a platform or brand. It involves cognitive involvement, emotional

involvement, and behavioral involvement (Brodie et al., 2019; Kumar et al., 2023). It is achieved when customers expend personal resources—time, effort, and emotion—into interactions that go beyond transactional exchange and produce co-created value. Existing systematic reviews identify engagement as an intervening construct that connects experiential cues with advocacy and loyalty behavior, in addition to the need for standardized conceptualization and measurement across digital media (Kumar et al., 2023). Accordingly, engagement is both a process and an outcome that refers to consumers' long-term psychological commitment in digital brand relationships.

Technology Readiness (TRI 2.0): Technology readiness is the extent to which an individual is ready to embrace and use new technology based on the positive (optimism, innovativeness) and negative (discomfort, insecurity) factors (Parasuraman & Colby, 2015). The updated TRI 2.0 scale has higher predictive validity and reliability in settings ranging from online banking to online shopping (Blut et al., 2020; Parasuraman & Colby, 2015). Empirical evidence shows that customers of high technology readiness are more self-assured, believing, and pleasant in using sophisticated digital systems, but the low readiness customers can find technological complexity as a source of anxiety (Zhao et al., 2025). In the model built in this study, technology readiness is a moderator that influences consumers' feelings and thoughts regarding digital atmospherics and interactivity—hence it is a boundary variable of great importance to describe online participation behavior.

2.4 Empirical Studies and Findings

Empirical research in the last twenty years has extensively studied how online environments influence consumer behavioral and affective reactions. Trailing the Stimulus–Organism–Response (S–O–R) framework, this line of research consistently shows that environmental stimuli inherent in online environments affect users' internal emotional states, which in turn generate engagement, satisfaction, and loyalty (Eroglu et al., 2003; Gao et al., 2023). In this regard, online store ambiance and interactivity are prominent environmental cues that influence consumers' online experience experiences. An increasing number of studies show that aesthetic design, visual attractiveness, and navigational simplicity foster users' immersion and emotional arousal, provoking positive attitudes and repeat patronage intentions (Dash et al., 2023; Calvete et al., 2022). Similarly, bidirectionality and responsiveness of interactive features have been shown to increase feelings of control and connectedness that, in turn, lead to engagement and brand attachment (Xi et al., 2024; Pizzi et al., 2019).

More recent empirical research emphasizes the mediating function of affective states— enjoyment, flow, and telepresence, in particular—in environmental design cue translation into behavioral outcomes. Shi et al. (2025) discovered that digital museum perceived interaction quality facilitates telepresence and enjoyment, which result in continuance intention. In the same way, Arghashi and Yuksel (2022) discovered that interactivity and vividness in augmented reality retail applications create flow experiences that are conducive to engagement and purchase intentions. Live streaming commerce studies validate that visual richness and real-time interactivity evoke affective reactions that

heighten viewers' engagement and conversion rates (Cai et al., 2023). These observations support the S–O–R argument that stimuli achieve their behavioral impact mainly through internal affective processes, with enjoyment being a salient organismic reaction that mediates the relationship between environmental design and engagement outcomes. Parallel research on online atmospherics still demonstrates their multidimensionality within visual, navigational, and informational design cues. When these attributes consistently complement each other, they elicit positive feelings of pleasure and arousal, activating hedonic and utilitarian value perceptions at the same time (Krasonikolakis et al., 2022; Mariani et al., 2022). Calvete et al. (2022) showed that the combination of color harmony, layout symmetry, and navigation ease increases perceived usability and enjoyment, which generate engagement and repurchase intentions. In mobile and omnichannel retailing, immersive design and gamified interface elements have been found to increase enjoyment and flow experience, which translate into increased behavioral engagement and loyalty (Xi et al., 2024). Cumulatively, these findings cement online interactivity and atmosphere as the key stimuli for affective states that mediate consumer engagement in virtual worlds.

In spite of the robustness of these findings, studies still recognize the impact of individual differences as moderators of these processes. The incorporation of Technology Readiness (TRI 2.0) has added richness to the understanding of how individual attitudes toward technology impact affective and behavioral reactions. Optimistic and innovative customers have more entertainment, trust, and satisfaction with digital interfaces, whereas customers who feel discomforted or insecure are more inclined to show reluctance and less engagement (Blut et al., 2020; Parasuraman & Colby, 2015). Uren & Edwards (2023) validated that technology readiness empowers the interactivity-perceived enjoyment relationship in digital service environments. Such findings point to the value of including readiness as a moderating concept that affects how stimuli are processed within the S–O–R paradigm. In technologically mature or digitally emerging markets, readiness differences can dictate the degree of emotional and behavioral response elicited by identical design stimuli.

Although theoretical development has been extensive, empirical study is fragmented and contextually limited. Most of the extant evidence comes from Western or East Asian markets with convenience samples or student samples that restrict external validity (Mariani et al., 2022; Gao et al., 2023). In addition, most studies use cross-sectional or single-level designs that preclude investigation of dynamic affective processes or conditional effects. None have incorporated fun as a mediating process and technology readiness as a moderator in one integrative framework that can account for both emotional and dispositional determinants of engagement. This omission leaves open questions about how environmental cues, affective states, and personality traits together shape digital engagement, especially in new digital economies where technological access and cultural orientations towards technology are still highly diverse. The current research thus builds on previous empirical research in examining a moderated mediation model featuring environmental, affective, and individual-level determinants of engagement. In particular, it argues that online store ambiance and interactive screens

are stimuli that activate customer enjoyment, which mediates their effect on customer engagement, with technology readiness moderating the effect. By placing this study in the fast-evolving e-commerce market of Saudi Arabia, the study unfolds empirically grounded understanding of how experiential design and personal readiness combine to influence interaction in an emerging digital economy. In the process, the study responds to persistent appeals in consumer behavior research for cross-contextual validation of S–O–R processes and for the establishment of psychological heterogeneity as a boundary condition for digital experience models.

2.5 Methodological Limitations in Existing Research

While the Stimulus–Organism–Response (S–O–R) model and Technology Readiness Theory (TRI 2.0) have been extensively used to describe online consumer behavior, the empirical research still demonstrates a set of methodological flaws compromising theoretical contribution and empirical soundness. These range from contextual limitations of current research, designs used, conceptual and operational consistency of measures, and analytical rigor used to examine complex relationships. Recognizing these shortcomings is essential to position the present study within the broader scholarly discourse and to justify the use of a moderated mediation framework grounded in these two theoretical perspectives.

A principal limitation concerns the contextual narrowness and cultural homogeneity of prior research. Most research into online atmospherics and electronic involvement is done in technologically advanced Western or East Asian markets like the United States, China, and South Korea (Dash et al., 2023; Arghashi & Yuksel, 2022). These settings provide sophisticated digital infrastructure and advanced consumer familiarity with online technologies, which may not be representative of emerging economies with different rates of technological diffusion, cultural orientations, and consumer trust dynamics. The external validity and cross-cultural generalizability of these findings thus remain partial. In addition, research has concentrated on individual digital interfaces like social media, mobile apps, or augmented reality apps, yet not holistic e-commerce spaces that incorporate atmospheric, interactive, and informational cues (Gao et al., 2023; Mariani et al., 2022). The limited scope restricts our knowledge of the ways in which multi-dimensional online store atmospheres as a whole affectively and behaviorally engage across technological and cultural contexts. Another limitation is the common use of cross-sectional and self-report survey designs, which, although convenient, are susceptible to common method bias and temporal indeterminacy (Podsakoff et al., 2012). Single-source data, gathered at one time point, have been used in many studies, thus restricting the potential for making causal inferences among variables implicated in the S–O–R process. In addition, whereas structural equation modeling (SEM) has been the default data analysis technique for consumer behavior research, its use in the previous research has generally been restricted to examining direct or straightforward mediation effects, sans controlling for conditional and indirect mechanisms that more accurately indicate psychological process complexity in digital engagement (Kline, 2023). The dynamic affective routes—telepresence, flow, and enjoyment—through which digital stimuli are

translated into engagement behaviors are more theorized than tested empirically using rigorous modeling techniques. Third, there are still significant inconsistencies in construct conceptualization and measurement in the literature. For example, customer engagement has been operationalized differently as a psychological state, as a collection of behavioral consequences, or as a multidimensional concept that includes cognitive, affective, and behavioral dimensions (Hollebeek et al., 2019). These conceptual differences have created measurement fragmentation, compromising construct validity and study-to-study comparability. Online store atmosphere has also been measured variably sometimes focusing on visual design and color schemes, sometimes encompassing navigational and informational features (Eroglu et al., 2003; Dash et al., 2023). Interactivity has similarly been plagued by definitional uncertainty, operationalized variably as system responsiveness, perceived control, or two-way communication, thereby producing inconsistency in operational measures and scale performance (Arghashi & Yuksel, 2022). The lack of commensurate measurement frameworks across these constructs inhibits knowledge accumulation and makes theory testing less possible. A second methodological limitation involves the scarce inclusion of individual difference variables, specifically those that capture users' psychological orientations to technology. In spite of the proven utility of Technology Readiness Theory (TRI 2.0) in the technology adoption and usage behavior explanation (Parasuraman & Colby, 2015; Blut et al., 2020), its application to the context of S–O–R-based digital engagement models is still uncharted land. Research has commonly controlled for demographic or attitudinal factors but not considered technology readiness as a moderator of affective and behavioral reactions to environmental stimuli. This oversight ignores the psychological diversity that is a hallmark of today's digital consumers. The lack of such moderating research constrains theoretical understanding of when and for whom online interactivity and design are most likely to be effective at eliciting engagement (Parasuraman & Colby, 2015). Last, the analytical complexity of much prior research has not been adequate to reflect the multilevel, interactive character of digital engagement processes. It is relatively uncommon for research to have used sophisticated statistical methods—like latent interaction modeling, bootstrapped mediation tests, or moderated mediation models—to empirically test the theoretical assumptions embedded in the S–O–R and TRI 2.0 models. Consequently, empirical investigations are descriptive or at best correlational instead of being explanatory, with minimal insight into the causal processes and boundary conditions underlying consumer interaction in technology-mediated contexts.

Collectively, these methodological shortcomings reflect a pressing need for research that (a) replicates the S–O–R and TRI 2.0 models to culturally diverse and technologically advancing settings like Saudi Arabia, (b) uses a statistically stringent analytic design to model mediating and moderating processes in tandem, and (c) utilizes standardized, theory-based measures to provide construct validity and comparability. By overcoming these limitations, the current research adds to digital consumer research by methodological practice in the sense that it brings forward a deeper understanding of how environmental stimuli, affective reactions, and personal technological readiness combine to influence involvement in today's e-commerce settings.

2.6 Conceptual Framework and Hypothesis Development

The conceptual model of this study is anchored in the Stimulus–Organism–Response (S–O–R) paradigm (Mehrabian & Russell, 1974) and the Technology Readiness Index (TRI 2.0) framework (Parasuraman & Colby, 2015). The two theories collectively offer an explanatory basis of how digital environmental stimuli influence consumer emotions and engagement behaviors and technology readiness individual differences moderate such influences. As shown in Figure 1, online store atmosphere (OSA) and interactive screens (IS) are environmental stimuli that cause customer enjoyment (CE) as an organismic state, and the latter produces customer engagement (CENG) as the response behavior. In addition, technology readiness (TR) is argued to moderate both the stimulus–organism and organism–response relationships.

The S–O–R paradigm describes that responses of individuals to environmental stimuli are mediated by internal affective or cognitive states (Donovan et al., 1994). In e-retail environments, visual design, sensory stimulation, and interactive features are stimuli that generate internal psychological states such as pleasure, arousal, or enjoyment, which in turn lead to behavioral responses such as engagement, purchase, or advocacy (Kamboj et al., 2018; Shi et al., 2025). The S–O–R model therefore offers a general framework to examine how technological and affective processes operate together to influence digital behavior. Online store atmosphere (OSA) in this regard is the general aesthetic, structural, and informational nature of a digital servicescape. It includes facets of color schemes, navigation simplicity, clarity of layout, and richness of information that build the perceptual experience of the customer (Krasonikolakis et al., 2022). Studies show that online interface atmospherics affect emotional arousal, trust, and hedonic appreciation (Laroche et al., 2022). An effectively designed online atmosphere communicates professionalism, reliability, and warmth, and thus increases the user's enjoyment and satisfaction (Guo et al., 2023). Therefore, the model argues that OSA is a positive stimulus that generates pleasant emotional states that encourage engagement.

Combined, interactive screens (IS) reflect the felt interactivity and responsiveness of the online environment. Interactivity, or the degree of control users have, participate in two-way communication, and get immediate feedback, stimulates the feeling of autonomy and immersion (Liu & Shrum, 2002). Interactivity in digital media—facilitated by personalized recommendations, live chat, and adaptive interfaces—is conducive to feelings of involvement and flow, and an intrinsic enjoyment is enhanced (Arghashi & Yuksel, 2022; Li et al., 2025). Empirical research validates that interactive features propel engagement through facilitating consumers' perceived participation and social presence, strengthening the psychological connection to the digital atmosphere (Nguyen et al., 2023). Therefore, IS will have a positive influence on customer enjoyment, which will result in higher engagement.

Customer enjoyment (CE) is the organismic mediator through which OSA and IS's impact is directed towards engagement outcomes. Enjoyment demonstrates inherent joy experienced in utilizing digital interfaces, regardless of instrumental objectives (Deng et al., 2022). Enjoyment was also revealed to be the mediator of the influence of online

design cues on behavioral intentions, demonstrating its fundamental function in maintaining engagement and satisfaction (Nguyen et al., 2023; Shi et al., 2025). In this framework, pleasure interprets design stimuli into affective motivation, connecting the perceptual experience of digital atmospheres and the behavioral expression of engagement.

Customer engagement (CENG) is framed as a multidimensional behavioral response with cognitive, emotional, and participatory dimensions (Brodie et al., 2019; Kumar et al., 2023). Engagement is performed when consumers spend time, attention, and emotional energy interacting with brands beyond transactional behaviors. When customers enjoy pleasure in online engagement, they are most likely to demonstrate loyalty, advocacy, and co-creation activities (Hollebeek et al., 2019). As such, CE is the affective bridge between stimuli and loyal, long-term engagement.

Lastly, technology readiness (TR) moderates the strength of these relationships. As the individual's inclination to accept or resist new technologies, TR entails optimism, innovativeness, discomfort, and insecurity (Parasuraman & Colby, 2015). People with greater TR are more receptive to new technology and have more online enjoyment and self-efficacy (Blut et al., 2020). In contrast, low-TR people can feel anxious or uneasy that incapacitates affective and behavioral reactions. Empirical studies validate that TR plays a moderating role in interactivity, usefulness, and enjoyment perceptions of users in digital environments (Parasuraman & Colby, 2015; Zhao et al., 2025). Therefore, TR is predicted to enhance the positive influences of OSA and IS on enjoyment and to consolidate the transfer of enjoyment into engagement.
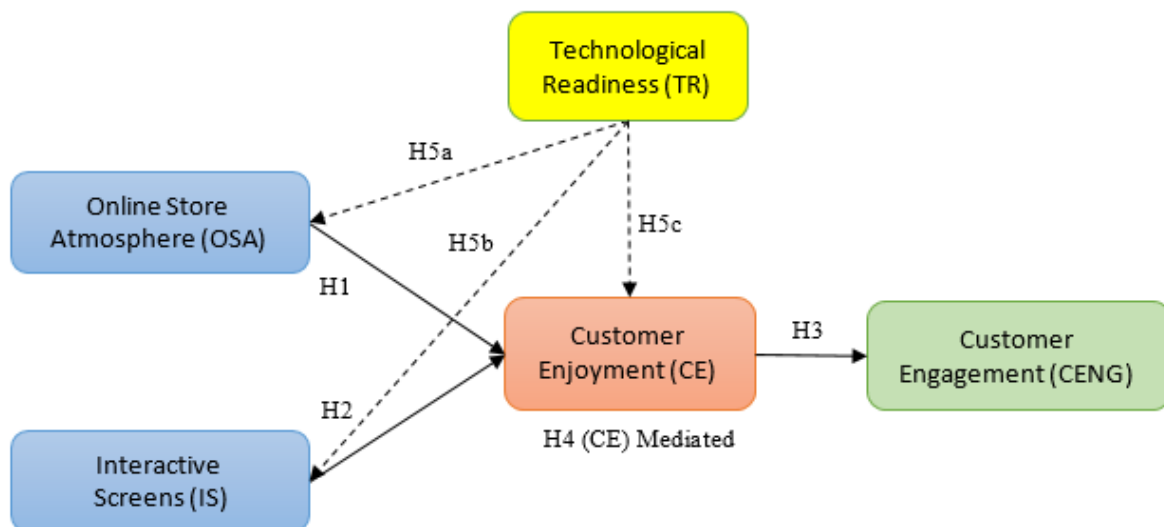
Figure 1: Conceptual model

Source: prepared by the author

2.6.1 Online Store Atmosphere → Customer Enjoyment

The ambiance of an online retailer—the virtual equivalent of a servicescape—has evolved to be a strategic influencer of consumers' affective and behavioral responses in online shopping environments. Online ambiance encompasses visual composition, aesthetic unity, organizational navigation, and informational structure, all of which form a multisensory virtual experience that evokes affective states of pleasure, arousal, and enjoyment (Chou & Chen, 2022). From the Stimulus–Organism–Response (S–O–R) model (Mehrabian & Russell, 1974), atmospheric signals are stimuli, which produce internal emotional responses (organisms), which respectively affect subsequent behavior (responses). Online, the hedonic aspects of the site—color scheme, imagery, animation, and symmetry of layout—have been found to create intrinsic delight by creating more perceived control and presence (Hsu et al., 2012).

Empirical evidence confirms that visually coherent and functionally responsive web environments boost pleasure by involving consumers' sense of involvement, comfort, and cognitive activation (Muhammad et al., 2014). For example, Serravalle et al. (2023) illustrated that visual design richness had a positive impact on online consumers' pleasure through perceived flow and emotional arousal. In the same vein, Chang et al. (2014) proved that atmospheric stimuli greatly enhance hedonic experience that, in its turn, boosts users' emotional satisfaction and continuity while browsing. This evidence stands in accordance with flow theory (Csikszentmihalyi, 1990), whereby optimally constructed environments maximize challenge and control, therefore boosting enjoyment in engagement. Psychologically, virtual atmospherics are affective stimuli that elicit pleasure responses and intrinsic motivation (Li & Lee, 2024). Strategically designed atmospheres induce comfort, familiarity, and engagement feelings that enhance customers' enjoyment from e-shopping. Thus, as theorized by the S–O–R model and supported through online retail studies, this research argues that a more potent online store atmosphere enhances customers' enjoyment.

- *H1: Customer enjoyment is strongly and positively influenced by the mood of the online store.*

2.6.2 Interactive Screens → Customer Enjoyment

Interactivity is a distinguishing feature of digital consumption experiences, including the extent to which consumers feel in control, responsive, and two-way communication in their online interactions (Lemon & Verhoef, 2016). Building on the S–O–R model, interactive elements are stimuli that trigger internal affective states—chiefly, enjoyment—which in turn influence user engagement and loyalty. Previous research on human–computer interaction and internet marketing supports that interactivity promotes psychological engagement, autonomy, and enjoyment through the provision of feelings of dialogue and agency between the consumer and the system (Van et al., 2012).

In e-commerce settings, interactive screens like responsive product visualizations, virtual try-ons, or adaptive chatbots increase users' perceived control and immersion, which enhance intrinsic enjoyment (Yoo et al., 2010). Interactivity fosters a participatory

experience that allows consumers to co-create their encounters, aligning with self-determination theory, which identifies autonomy as a core antecedent of enjoyment (Ryan & Deci, 2000). For example, Milanesi et al. (2022) found that interactive feedback mechanisms in mobile apps significantly enhanced users' hedonic value through perceived playfulness and flow. Moreover, Zhou et al. (2023) indicated that responsiveness in real-time systems and user control contributed together to enhance perceived enjoyment during digital retailing, mediating subsequent interactive behaviors. In addition, interactivity is a significant precursor for flow experiences such that consumers are in deep engagement and disconnection from time (Novak et al., 2000). High interactivity provides an illusion of continuous interaction, creating a delightful state that reinforces extensive attention as well as emotional enjoyment. Therefore, interactivity not only increases usability but is also an affective stimulus that turns utilitarian engagement into enjoyable experiences. Based on this theory and evidence, the current study further asserts that interactive screens have a significant and positive impact on customers' enjoyment in digital retail spaces.

- *H2: Interactive screens have a significant and positive impact on customers' enjoyment.*

2.6.3 Customer Enjoyment → Customer Engagement

In the S–O–R theory, customers' enjoyment is an affective organismic state mediator environmental stimuli and behavior responses (Mehrabian & Russell, 1974). Enjoyment is a naturally pleasing emotional state induced by interactive and visual experiences in virtual environments (Alkhiyami et al., 2025). Flow theory (Csikszentmihalyi, 1990) also dictates optimal enjoyment experiences induce cognitive absorption, time distortion, and involved attention, all of which precipitate behavior participation. In online shopping environments, engagement is multi-faceted, involving cognitive interest, emotional attachment, and participative interaction with web content or products (Harrigan et al., 2018).

Empirical studies invariably validate pleasure as the most common precursor to mobile and virtual platform engagement. For instance, Buckley et al. (2023) illustrated that intrinsic enjoyment during mobile usage greatly amplified customer engagement through positive affect and co-created perceived value. Likewise, Jo and Park (2023) discovered that hedonic delight of browsing virtual stores was a predictor of enduring attention and brand recommendation. Delight leads to stronger mental involvement and affective engagement, triggering feelings of personal stake which amplifies relational commitment with brands (Skare et al., 2023). Within the context of online marketing, enjoyment is a reciprocal fostering psychological motivator. Positive affect experienced during digital interaction gets consumers to come back, transmit, and engage in brand-related activities (Goldenberg et al., 2020). Enjoyment also strengthens perceived authenticity and trust, two potent motivators of long-term interaction (Xi et al., 2024). Consequently, by creating intrinsic satisfaction, enjoyment converts passive shoppers into active, emotionally committed stakeholders. In line with these theoretical and empirical knowledge, this

research argues that customer enjoyment has a strong and positive impact on customer engagement in online shopping situations.

- *H3: Customer enjoyment has a strong and positive impact on customer engagement.*

2.6.4 Mediating Role of Customer Enjoyment

The S–O–R model speculates affective states—enjoyment, in our case—as mediators that transform environmental stimuli (cues) into behavioral responses (Donovan & Rossiter, 1982). In online contexts, online store atmosphere and interactivity are both stimuli that influence consumers' affective experiences. When these stimuli are found to be aesthetically appealing and participatory, they cause enjoyment, which leads to greater engagement (Chou & Chen, 2022). Enjoyment, therefore, serves as a psychological link connecting environmental design to consumer engagement.

This mediating process has been corroborated by empirical evidence. For example, Riskos et al. (2021) validated enjoyment as mediating the connection between website design quality and online engagement. Yan et al. (2023) also illustrated that interactivity supported engagement through hedonic pleasure in live-stream commerce. This mediational process is in accordance with flow theory, which argues hedonic absorption leads to a self-reinforcing cycle of pleasure and engagement (Csikszentmihalyi, 1990). Moreover, enjoyment enables cognitive engagement, which increases the consumer's inclination to interact, seek, and co-create value with companies (Zhao et al., 2025). The mediating theoretical function of enjoyment highlights the affective process by which sensory and interactive stimuli achieve their effect. Rather than serving as utilitarian inputs alone, digital atmospherics and interactivity trigger a hedonic engagement pathway (Pappas et al., 2023). Enjoyment enhances customer experience through making browsing a rewarding experience, which enhances affective and behavioral involvement (Lin & Wu, 2023). Hence, the moment users notice an environment with high interactivity and aesthetic appeal, they are likely to feel enjoyment, which, in turn, enhances engagement. Based on these theoretical reasoning and empirical confirmations, this research formulates the hypothesis that enjoyment mediates the impact of online store atmosphere and interactive screens on customer engagement.

- *H4: Customer enjoyment mediates the impact of online store atmosphere and interactive screens on customer engagement.*

2.6.5 Moderating Effect of Technological Readiness

Technology Readiness (TRI 2.0) is the cognitive dispositions of individuals toward adopting or resisting new technologies (Parasuraman & Colby, 2015). It has four dimensions: optimism, innovativeness, discomfort, and insecurity. Consumers with high-technological readiness are more confident, inquisitive, and open when interacting with digital systems, whereas low-TR users are resistant or apprehensive (Blut et al., 2020).

From Technology Readiness Theory, high-TR consumers can get more hedonic value from evolved, beautiful interfaces since they experience technology as liberating and not alarming. These customers are more involved and enjoy experiencing online

atmospherics more (Vize et al., 2013). Low-TR customers will most likely react negatively, being swamped or confused. TR therefore emphasizes the positive impact of online atmosphere on enjoyment.

Active engagement is required for interactivity. High-TR consumers enjoy such interactivity as entertaining and enjoyable, in accordance with self-determination theory, which equates perceived autonomy with intrinsic motivation (Ryan & Deci, 2000). Empirical research indicates that high optimism and innovativeness consumers appreciate interactive attributes more (Rauschnabel et al., 2023). TR, therefore, enhances the interactivity–enjoyment association.

Lastly, TR tempers the enjoyment–engagement boundary. TR-high customers lead to converting hedonic enjoyment into constructive engagement due to enhanced digital confidence and self-efficacy (Roy et al., 2018). Low-TR customers may enjoy but maybe not maximize engagement. Thus, TR strengthens the linkage between enjoyment and engagement.

- *H5a: Technological readiness has a tremendous effect on the role of online shop atmosphere in influencing enjoyment of customers.*

- *H5b: Technological readiness exerts a positive moderating influence on the interactive screens–enjoyment relationship.*

- *H5c: Technological readiness has a positive moderating influence on the enjoyment–engagement relationship.*

3. STUDY METHODOLOGY

This study has adopted a quantitative cross-sectional research design to empirically investigate the structural relationships among OSA, IS, CE, and CENG, and simultaneously determine the moderating role of TR. A quantitative approach was suitable to the objective of the study, which is to test theoretically grounded hypotheses and validate multi-item latent constructs through SEM-a methodology well suited for estimating complex behavioral models with multiple reflective indicators (Hair et al., 2021). The cross-sectional design allowed for efficient data collection of perceptual measures from a large number of respondents at one point in time, consistent with methodological practices in digital consumer behavior research (Podsakoff et al., 2012; Kline, 2023).

The target population consisted of adult Saudi consumers who had made at least one online purchase within the last six months, thereby ensuring the respondents had recent and relevant e-commerce experience. A total of 470 valid responses were obtained, which exceeds the recommended sample size for SEM studies, ranging between 200 and 400 cases with several latent constructs (Wolf et al., 2013). Non-probability convenience sampling was utilized, a generally accepted method in behavioral and technology-adoption studies where the emphasis is on theoretical explanation rather than population representativeness (Etikan & Bala, 2017). Participants were recruited from social media

platforms, university communications channels, and online consumer groups to ensure demographic diversity.

The data were collected using a bilingual Arabic–English self-administered online questionnaire. The instrument has undergone a rigorous translation and back-translation process based on Wood (1988) to ensure it reaches conceptual and linguistic equivalence. A pilot test with 40 respondents confirmed clarity, internal consistency, and suitability of the instrument. All constructs were operationalized reflectively using validated scales drawn from prior scholarship: OSA items from Güleç and Ünüsan (2024), Shi et al. (2025), and Eroglu et al. (2003); IS items from Alghamdi et al. (2023), Utami et al. (2022), and Liu and Shrum (2002); CE items from Deng et al. (2022), O'Brien and Toms (2010), and Güleç and Ünüsan (2024); and CENG from Hollebeek et al. (2014), Vinerean (2021), and Islam et al. (2019). TR was measured using the TRI 2.0 framework (Parasuraman & Colby, 2015; Blut et al., 2020). Measurement items for all the variables used a seven-point Likert scale, ranging from 1 = strongly disagree to 7 = strongly agree, and where necessary, items were reverse-coded.

In order to minimize common method bias, anonymity assurances, randomised item sequencing and conceptual separation of constructs were used. Data analysis followed the two-step SEM procedure by Anderson and Gerbing, using AMOS. Confirmatory factor analysis (CFA) was used to evaluate the measurement model. Reliability was confirmed based on Cronbach's alpha and composite reliability of ≥ 0.70, while convergent validity was assessed using average variance extracted of ≥ 0.50.

The Fornell-Larcker criterion and HTMT ratio of < 0.85 supported discriminant validity. Standard fit indices were used to evaluate structural relationships, namely: $\chi^2/df \leq 3$, CFI/TLI ≥ 0.90 and RMSEA/SRMR ≤ 0.08. Bias-corrected bootstrapping with 5,000 resamples was used to test mediation, while latent interaction modeling was performed using the product-indicator approach to analyze moderation effects. Ethical procedures were in accordance with the Declaration of Helsinki, ensuring informed consent and voluntary participation as approved by the appropriate institutional review board before data collection.

4. DATA ANALYSIS AND RESULTS

4.1 Descriptive Statistical Analysis

Descriptive statistical analysis was performed to establish a basic understanding of the sample characteristics and to develop preliminary insights into respondents' perceptions of the core study constructs. This is an important stage of the analysis in behavioral and consumer research, given that demographic and descriptive trends often contextualize the structural patterns identified at later stages of the analysis.

The findings below summarize the demographic attributes of the participants and present the descriptive means and standard deviations for the main study variables, hence providing a complete background of the dataset used for subsequent model estimation.

4.1.1 Demographic information

The demographic distribution across participants appears in Table 1 below. It indicates a diverse but analytically coherent sample. Specifically, the gender distribution is biased towards males, as they represent 67.7%, while female respondents amount to 28.7%, and 3.6% of the sample prefer not to disclose their gender. This gender imbalance is not particularly unusual in regional online survey studies, especially those investigating digital consumption and e-commerce environments, which tend to have higher male participation. Age distribution shows that the majority of the respondents fall into the categories of 26-35 years (43.6%) and 36-45 years (43.2%), indicating that the sample focuses on middle-aged consumers who are usually tech-savvy and have stable purchasing power. The lower percentage of both younger participants (18-25 years, 7.7%) and older participants (46+, 5.5%) further indicates that this sample is concentrated among those more engaged in economic activities and with more likelihood to interact regularly with online shopping platforms. Educational attainment is relatively high across the sample; 64.3% have a Bachelor's degree, while another 18.1% have postgraduate qualifications (Master's or Doctorate). Only 17.7% have a high school diploma. This educational profile enhances the reliability of perceptual data, since greater levels of education are related to better item understanding and more stable evaluative tendencies in the context of digital commerce. Income distribution indicates that a majority of the respondents are in middle and high-income groups. As such, 38.3% receive 10,001–15,000 SAR, while 40.2% earn more than 15,000 SAR, which indicates a somewhat financially capable consumer base. These income levels denote good purchasing potential and familiarity with frequent interaction in digital markets. Regarding online shopping habits, 69.1% of the respondents shop rarely, 26% occasionally, and 4.9% shop on a monthly or weekly basis. This reflects generally low transaction frequencies in spite of high digital literacy and purchasing power. The observed pattern could point toward cultural aspects, market maturity, platform trust, or particular preferences for specific products in the region, which will be further explored using structural analysis.

Table 1: Demographic Information of Respondents

Demographic Variable	Category	Frequency	Percentage (%)
Gender	Male	318	67.7
	Female	135	28.7
	Prefer not to say	17	3.6
Age	18–25	36	7.7
	26–35	205	43.6
	36–45	203	43.2
	46+	26	5.5
Education Level	High school	83	17.7
	Bachelor's	302	64.3
	Master's	53	11.3
	Doctorate	32	6.8
Monthly Income (SAR)	≥ 5,000	41	8.7
	5,001–10,000	60	12.8
	10,001–15,000	180	38.3
	≤ 15,000	189	40.2

Online Shopping Frequency	Rarely	325	69.1
	Occasionally	122	26.0
	Monthly	17	3.6
	Weekly	6	1.3

Source: Researcher's compilation from field study results.

4.1.2 Descriptive Statistics for the Study Dimensions

Table 2 presents the descriptive statistics for study variables: Online Store Atmosphere, Interactive Screens, Customer Enjoyment, Customer Engagement, and Technological Readiness. Means range from 4.01 to 4.59, while standard deviations range from 0.736 to 0.923, showing relatively high agreement among respondents and favorable perceptions of all constructs. The dimension Online Store Atmosphere has high mean scores, indicating that the responding subjects perceive the virtual shopping environment as well-designed, aesthetically appealing, and user-friendly. These findings point out the importance of visual and structural cues in shaping the immediate emotional responses of consumers. Interactive Screens scored particularly high, reflecting the strong appreciation by the respondents of interactive elements like navigation tools, dynamic menus, and real-time interface responsiveness. This corroborates the literature emphasizing the importance of interactivity in creating immersive digital experiences. Customer enjoyment and customer engagement-the organismic and behavioral response variables, respectively, of the S–O–R framework-were rated very highly, illustrating that consumers derive positive affective states from online shopping and engage actively with digital storefronts. Finally, Technological Readiness received high ratings, meaning that the sample is technologically confident, open to digital innovation, and generally at ease with online shopping technologies.

Table 2: Descriptive Results for Study Dimensions

Dimension	Mean Range	Std. Dev. Range	Interpretation
Online Store Atmosphere (OSA)	4.01 – 4.31	0.804 – 0.923	High
Interactive Screens (IS)	4.15 – 4.59	0.736 – 0.856	Very High
Customer Enjoyment (CE)	4.13 – 4.51	0.757 – 0.867	Very High
Customer Engagement (CENG)	4.15 – 4.52	0.738 – 0.796	Very High
Technological Readiness (TR)	4.13 – 4.20	0.781 – 0.857	High

Source: Researcher's compilation from field study results.

4.2 Structural Equation Modeling (SEM) Analysis

4.2.1 Measurement Model Assessment

An extensive examination of the measurement model was conducted in order to gain confidence that the latent constructs had been measured in a reliable and valid way before testing the structural relationships among these constructs. This assessment followed established SEM guidelines, incorporating tests of indicator reliability, internal consistency reliability, convergent validity, discriminant validity, and an evaluation of overall model fit. Collectively, these analyses provide the necessary empirical foundation

for confirming that the constructs represent the underlying theoretical concepts appropriately.

Reliability and Convergent Validity

Confirmatory Factor Analysis (CFA) was employed to test the reliability and convergent validity of constructs. The results are presented in Table 3, indicating factor loadings (λ), Composite Reliability (CR), Average Variance Extracted (AVE), and Cronbach's alpha coefficients for every latent construct.

Table 3: Construct Reliability and Validity Assessment (CFA) Results

Construct	Factor Loadings (λ)	AVE	CR
Online Store Atmosphere (OSA)	0.78 – 0.59	0.68	0.86
Interactive Screens (IS)	0.75 – 0.69	0.62	0.79
Customer Enjoyment (CE)	0.72 – 0.63	0.60	0.76
Customer Engagement (CENG)	0.77 – 0.60	0.70	0.88
Technological Readiness (TR)	0.69 – 0.59	0.61	0.75

Source: Prepared by the researcher

All factor loadings were above the minimum acceptable level of 0.60, reflecting satisfactory indicator reliability. The loadings, in this range, reveal that each of the items contributes significantly to explaining its respective latent construct. Further, all CR values fell between 0.75 and 0.88, exceeding the threshold recommended of 0.70, thus confirming strong internal consistency (Hair et al., 2021). The AVE for all the constructs ranged from 0.60 to 0.70, well above the threshold of 0.50, which suggests that each construct explains more than half of the variance in its observed indicators, therefore establishing strong convergent validity. Finally, Cronbach's alpha coefficients (0.75–0.88) support the reliability of the constructs, showing that items consistently measure intended theoretical dimensions. Taken together, these findings confirm that the measurement model demonstrates high reliability and convergent validity. Therefore, the empirical foundation for proceeding with discriminant validity testing and structural model testing is sound.

Model Fit Assessment

The overall measurement model fit was examined by applying various measures of goodness-of-fit, as suggested by the methodological literature on SEM. Results, as shown in Table 4 and visually depicted in Figure 2, reflect an exceptionally good model fit.
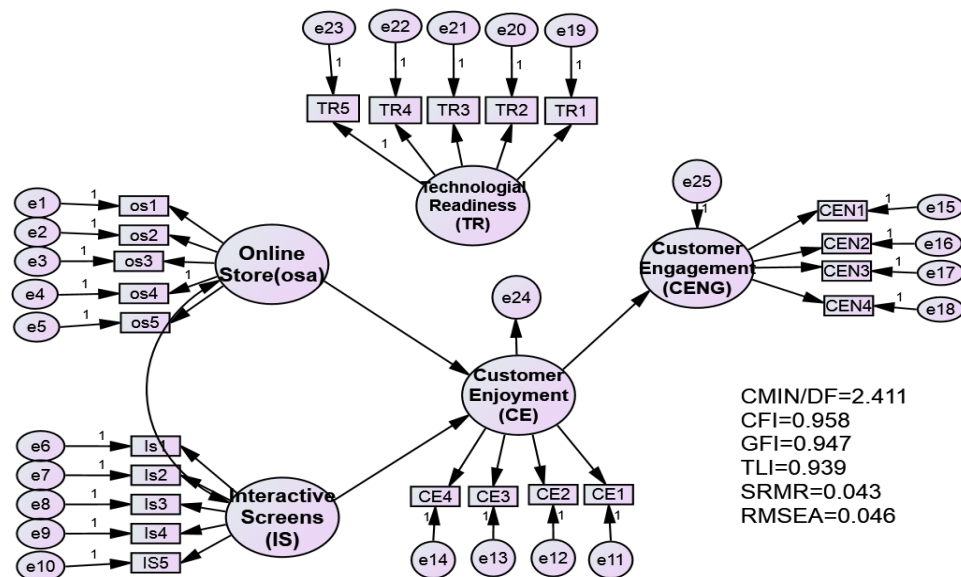
Table 4: Model Fit Indices for the Measurement Model

Fit Index	Obtained Value	Recommended Threshold
χ^2/df	2.411	≤ 3.00
CFI	0.958	≥ 0.90
TLI	0.939	≥ 0.90
RMSEA	0.041	≤ 0.08
SRMR	0.046	≤ 0.08

Source: Prepared by the researcher

The chi-square to degrees of freedom ratio (χ^2/df = 2.411) falls well below the conservative threshold of 3.00, indicating that the model has a balanced and acceptable level of complexity relative to data variance. Both CFI (0.958) and TLI (0.939) are above the recommended minimum cut-off value of 0.90, indicating good comparative and incremental fit.

These findings, collectively, establish that the measurement model provides a significantly better fit to the observed data than an independence model. The values of RMSEA of 0.041 and SRMR of 0.046, both below the threshold of 0.08, further confirm that the model effectively captures the underlying covariance structure with minimal residual error.

Figure 2: Fit Indices for the Measurement Model

Source: Prepared by the researcher

By combining these indices, there is strong evidence that the measurement model is empirically sound and theoretically coherent, and that it is statistically well-specified. The model is therefore suitable for proceeding to structural path analysis, mediation and moderation testing, and evaluation of effect size and predictive relevance.

4.3 Hypotheses Testing

After establishing a well-specified and empirically robust measurement model, the next step in this process was to estimate the structural model in order to test the hypothesized causal pathways. Following the best practices in SEM, the model evaluation proceeded through three successive analytical stages: direct effects testing, mediation analysis, and moderation analysis. These analyses, taken together, assess the validities of the

theoretical propositions embedded within the Stimulus–Organism–Response (S–O–R) framework and its extension through technological readiness as a boundary condition.

4.3.1 Direct Effects Analysis

The direct effects test the immediate causal associations between (OSA) and IS with (CE), and also then link the latter, in turn, to (CENG). These associations conceptually represent the sequential experiential processing chain-stimulus → affective state → behavioral outcomes-which is at the heart of the proposed conceptual model.

Figure 3 summarizes the structural paths considered at this point, using a diagram to show the directionality of the links and the standardized coefficients. Corresponding numerical estimates are shown in Table 5, which supplies an empirical summary for path coefficients β, critical ratios (CR) and levels of significance.
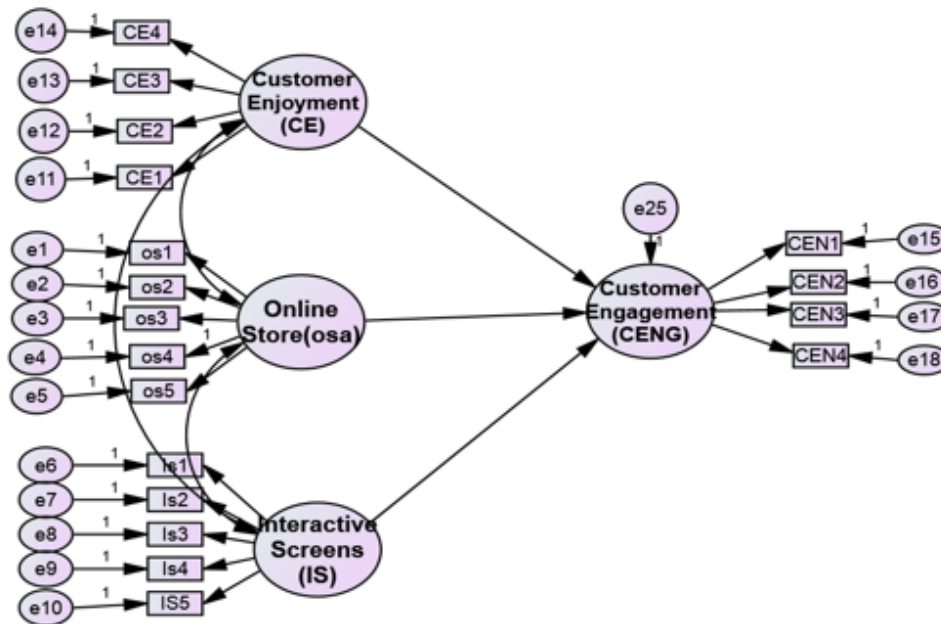

Figure 3: Direct Effects Analysis

Source: Prepared by the researcher

**Table 5: Direct Path Coefficients (Main Effects)**

Hypothesis	Path Relationship	β	CR	p-value	Decision
H1	Online Store Atmosphere → Customer Enjoyment	0.412	8.721	0.0001	Supported
H2	Interactive Screens → Customer Enjoyment	0.358	7.904	0.0001	Supported
H3	Customer Enjoyment → Customer Engagement	0.553	12.31	0.0000	Supported

Source: Prepared by the researcher

As presented in Table 5, all direct hypotheses (H1–H3) are strongly supported. The influence of OSA on CE (β = 0.412, $p < 0.001$) suggests that increased atmospheric features—visual appeal, navigational clarity, and sensory richness—significantly enhance users' emotional enjoyment. The finding further strongly supports the S-O-R literature by indicating that environmental cues will evoke positive affective responses in digital environments. Similarly, IS and (CE) are significantly related with β = 0.358, $p < 0.001$, showing that the integration of dynamic, responsive, and interactive interface elements significantly contributes to users' hedonic gratification. Taken together, these findings indicate that environmental and technological stimuli jointly form the emotional landscape of online consumers. We find the strongest effect among the main paths between CE and CENG: β = 0.553, $p < 0.001$, thus confirming H3. This implies that customers who perceive feelings of pleasure and/or immersion in digital environments are significantly more likely to act in an engaged way, exploring the content and maintaining continued interaction with online platforms.

4.3.2 Mediation Analysis

The second step in analysis was to see whether customer enjoyment serves as a mediating mechanism through which OSA and IS influence customer engagement. The mediation was tested via bootstrapped indirect effects with 5,000 resamples, a high enough number that guarantees high accuracy of inference and robustness against non-normal sampling distributions. Figure 4 shows the mediation framework, and Table 6 presents standardized estimates for indirect effects, along with their statistical significance and classification of mediation type.
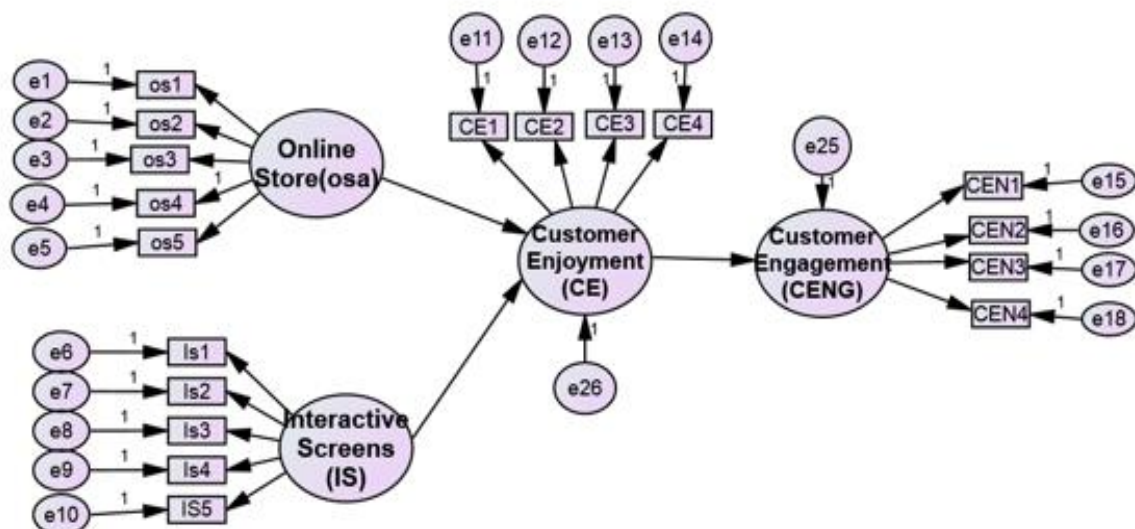
Figure 4: Mediating Effects Analysis

Source: Prepared by the researcher

Table 6: Mediation effects of customer enjoyment

Hypothesis	Mediation Path	Indirect Effect	CR	p-value	Decision	Mediation Type
H4a	OSA → CE → CENG	0.228	7.113	0.001	Supported	Partial
H4b	IS → CE → CENG	0.198	6.742	0.001	Supported	Partial

Source: Prepared by the researcher

The results in Table 6 offer strong support for partial mediation in both routes. For H4a, the indirect effect of OSA on CENG via CE (β = 0.228, p = 0.001) reveals that atmospheric cues foster engagement in part by increasing emotional enjoyment. However, the mediation is partial, suggesting that OSA still directly affects engagement separately from enjoyment. Similarly, H4b shows that IS positively influences CENG through the effect of CE (β = 0.198, p = 0.001). A significant bootstrapped indirect effect confirms that interactive features elevate hedonic experiences, and such hedonic experiences subsequently raise customer engagement. Partial mediation suggests that interactive screens have an affective route, via enjoyment, along with a direct behavioral influence.

Together, these findings indicate that emotional enjoyment is a key psychological pathway through which digital stimuli are connected with behavioral engagement, and also reinforces the theoretical underpinning of the S–O–R model.

4.3.3 Moderation Analysis

The final stage examined whether TR reinforces the relationships between the study variables. The moderating effects were analyzed using interaction terms generated as a result of the product-indicator approach and tested for significance at the level of 5,000-resample bootstrapping within a PLS-SEM framework. Results are summarized in Table 7, which reports interaction coefficients, CR values, and p-values.

Table 7: Moderation Effects of Technological Readiness

Hypothesis	Moderating Relationship	Interaction Term	CR	p-value	Decision
H5a	TR × OSA → CE	0.163	3.842	0.001	Supported
H5b	TR × IS → CE	0.147	3.521	0.001	Supported
H5c	TR × CE → CENG	0.119	2.984	0.003	Supported

Source: Prepared by the researcher

The hypotheses of moderation (H5a-H5c) are all supported, indicating that TR significantly enhances the relationships tested. The interaction effect for H5a (β = 0.163, p = 0.001) indicates that high-TR individuals derive more emotional enjoyment from enriched online store atmospheres. This implies that technologically savvy users are in better position to perceive, process, and appreciate sophisticated environmental design cues. In a similar vein, for H5b, TR reinforces the influence of IS on CE (β = 0.147, p = 0.001), which implies that technologically confident users derive more enjoyment from interactive digital features such as navigable panels and responsive interfaces. Finally, H5c confirms that TR positively moderates the effect of CE on CENG (β = 0.119, p = 0.003). This means that enjoyment is better translated into continued engagement for

those users who exhibit higher technological readiness, highlighting, again, the interaction between individual characteristics and affective responses.

Taken together, these findings mark TR as a critical boundary condition that amplifies the experiential and behavioral consequences of digital stimuli.

5. DISCUSSION

5.1 Summary of Findings

The study aimed to explain the affective and behavioral mechanisms through which online store atmosphere and interactive screens shape customer engagement within digital retail contexts. The findings provide compelling empirical support for the theorized S–O–R structure. Both environmental stimuli-atmospheric cues and interactivity-exerted significant positive effects on customer enjoyment, thereby corroborating the proposition that technologically mediated environments have the potential to create emotionally charged organismic states (Mehrabian & Russell, 1974; Eroglu et al., 2003). The magnitude of these effects reflects the growing experiential sophistication of modern-day digital interfaces and concomitantly finds support in the emergent research on immersive e-retailing contexts (Shi et al., 2025; Gao et al., 2023). Customer enjoyment subsequently proved to be a robust driver of customer engagement, highlighting enjoyment's role as a key psychological gating condition for sustained platform engagement (Nguyen et al., 2023). Further, the partial mediation that was evidenced along both paths suggests that, although hedonic affect represents an important mechanism, there are direct environmental stimuli effects on engagement independent of any affective processing involved. Last but not least, technology readiness significantly moderated all focal paths, which thus once again reaffirmed its foundational role as an individual-difference variable shaping the degree to which consumers are receptive to digital stimuli (Parasuraman & Colby, 2015; Blut et al., 2020). The foregoing discussion thus combines to validate the integrated S–O–R/TRI 2.0 framework advanced for the present study.

5.2 Theoretical Implications

The findings of this research materially advance the theoretical understanding of digital customer engagement on a number of counts. First, it reinforces the empirical validity of the S-O-R paradigm within contemporary digital servicescapes. The positive impacts of online atmospherics and interactivity on enjoyment confirm that immersive and aesthetically structured interfaces continue to operate as potent experiential stimuli-even in the context of increasingly automated and algorithmically managed digital channels (Laroche et al., 2022; Calvete et al., 2022). This, therefore, underlines the continued importance of concepts derived from environmental psychology in digitally mediated behaviors. Second, the integration of technology readiness significantly extends existing theoretical models. Whereas previous research typically conceptualized readiness as an antecedent to technology adoption (Parasuraman & Colby, 2015; Blut et al., 2020), this research shows its moderating role regarding both affective formation and the affect–engagement link.

This means that digital experiences are co-constructed through environmental design and dispositional receptivity and, thus, provide a more balanced theoretical perspective on consumer–technology interaction (Zhao et al., 2025). For example, such an integrated model directly addresses recent calls for more psychologically grounded digital engagement research. Third, the finding of partial mediation contradicts simpler models that assume hedonic affect fully mediates the impact of digital stimuli.

Instead, the findings support a dual-process account in which both atmospheric and interactive qualities convey functional, symbolic, or epistemic cues that separately drive engagement (Guo et al., 2023; Hollebeek et al., 2019). This brings an important expansion toward the theoretical conceptualization of experiential processing in digital settings. By situating the study within the Saudi Arabian digital ecosystem, which is in a state of rapid technological growth and concurrent cultural transformation, this research extends the cross-cultural relevance of the S–O–R and TRI frameworks. This helps mitigate the strong Western and East Asian biases prevalent in the literature and contributes to the development of more globally representative theories of digital consumer behavior.

5.3 Comparison with Previous Studies

The findings show broad consonance with prior empirical studies on digital atmospherics and interactivity. The powerful impact of online store atmosphere on enjoyment is in line with research showing that visually appealing, navigable, and aesthetically coherent platforms create positive affective states (Krasonikolakis et al., 2022; Laroche et al., 2022). So too, the strong effect of interactivity resonates with earlier findings that system responsiveness and user control are associated with hedonic experiences and psychological immersion (Liu & Shrum, 2002; Arghashi & Yuksel, 2022).

However, this research extends earlier literature in that it examines both atmospheric and interactive cues jointly within a singular structural model, and finds that they serve as conceptually and empirically distinct antecedents of enjoyment. This contrasts with other research which implicitly treats interactivity and atmospherics as interchangeable or overlapping constructs. The strong effect of enjoyment on engagement is also consistent with recent work which stresses hedonic gratification as a driver of sustained digital participation, for example, Buckley et al. (2023) and Xi et al. (2024). Indeed, the size of this effect is comparatively greater, suggesting that those markets experiencing accelerated digital transformation, of which Saudi Arabia is one, may exhibit greater affective responsiveness.

Further, while prior studies often reported full mediation, the partial mediation uncovered in this study points to recent findings that modern digital platforms convey instrumental and symbolic cues beyond hedonic value (Shi et al., 2025; Guo et al., 2023). Finally, although consistent with theoretical expectations, the moderating role of technology readiness has rarely been empirically validated in S–O–R contexts. The results thus extend and nuance earlier propositions related to psychological heterogeneity among digital consumers (Blut et al., 2020; Zhao et al., 2025).

5.4 Practical and Managerial Implications

The study carries several actionable implications for digital retailers, UX strategists, and platform designers. First, the strong influence of online store atmosphere suggests there is a high need for great care in crafting visual, structural, and information design. Highquality digital aesthetics, like color harmony, layout symmetry, graphical coherence, and information clarity, are basic determinants of positive affective states (Laroche et al. 2022; Guo et al. 2023). Accordingly, managers should not consider atmospheric design to be an ancillary visual attribute, but rather one strategic lever of experiential value. Second, the large size of the effect of interactivity uncovers the strategic value of two-way responsiveness and user control in digital platforms. Adding advanced navigation, real-time support, intelligent product visualizations, and conversational interfaces will significantly enhance hedonic and cognitive engagement levels (Arghashi & Yuksel, 2022; Li et al., 2025). Interactivity has to be embraced by retailers as an experiential key asset rather than a technological enhancement. Third, technology readiness has a moderating effect, which suggests that there should be heterogeneous user competencies in platform design. Consumers with high readiness benefit from complex, feature-rich, and immersive interfaces; low-readiness consumers do better with low-friction, guided, and simplified pathways (Parasuraman & Colby, 2015; Zhao et al., 2025). Designing adaptive or personalized interface modes would improve engagement across readiness levels. Finally, the partial mediation underlines that engagement does not relate only to hedonic pleasure. Therefore, managers should focus on both affective qualities-for example, enjoyment and immersion-and instrumental qualities-for example, reliability, usability, and clarity-to create ongoing engagement.

5.5 Limitations

Several limitations should be considered. First, the cross-sectional design limits the ability to infer temporal causality. Although consistent with common practice in S–O–R research, longitudinal or experimental designs would yield more definitive causal claims (Podsakoff et al., 2012; Kline, 2023). Second, the reliance on self-reported data may be subject to perceptual biases or common method variance, despite procedural remedies implemented. Third, the sample—drawn from digitally active Saudi consumers—limits generalizability to markets with different technological infrastructures or cultural orientations (Binsaeed et al., 2023). Fourth, the model's parsimony necessarily excluded variables such as trust, cognitive load, and perceived risk, which may interact with enjoyment and engagement in meaningful ways. Finally, technology readiness was modeled at the aggregate level; future research may benefit from examining readiness's subdimensions (optimism, innovativeness, discomfort, insecurity) to derive more granular psychological insights (Blut et al., 2020).

5.6 Future Research Directions

Future research should pursue several extensions. Longitudinal or experimental approaches would allow for stronger claims regarding the unfolding of causality and affective and behavioral responses over time. Other mediators such as flow,

telepresence, cognitive absorption, or perceived control should be integrated to further deepen the understanding of organismic processing (Shi et al., 2025; Nguyen et al., 2023). Cross-cultural comparative research would further establish whether the S–O–R and TRI mechanisms identified here generalize across disparate digital ecosystems and broader cultural landscapes. Furthermore, a disaggregated view of the dimensions of TRI 2.0 may unravel differentiated moderating effects and yield an increasingly nuanced psychological typology of digital consumers (Blut et al., 2020). Finally, future work may examine adaptive interface architectures that can adjust in real-time both atmospheric and interactive complexity based on assessments of users' states of readiness, emotional states, or behavioral cues as part of the development of intelligent experiential design systems.

6. CONCLUSION

This research aimed to extend the theoretical and empirical knowledge on how digital environmental cues shape consumer affect and engagement in online retail contexts. Anchored in the Stimulus–Organism–Response framework and extended through Technology Readiness Theory, the findings illustrate that online store atmosphere and interactive screens operate as salient experiential stimuli that significantly heighten customer enjoyment, which in turn serves as a pivotal antecedent of customer engagement. These findings confirm that affective processes remain at the heart of digital consumption, even as online environments become increasingly sophisticated and technologically mediated. This study further shows that enjoyment only partially transmits the influence of the atmospherics and interactivity to engagement, suggesting that the value of contemporary digital interfaces is emotionally and instrumentally communicated. This dual-path explanatory mechanism enriches existing theoretical perspectives by placing into focus that digital environments shape behavior through more than hedonic pleasure alone. Of equal importance, the moderating role of technology readiness confirms that individual differences meaningfully shape how people perceive, process, and react to digital stimuli. The users with higher readiness are more emotionally responsive to atmospheric and interactive cues and more capable of converting enjoyment into sustained engagement. From a broader conceptual point of view, these findings highlight the continued relevance of environmental psychology within digital commerce but also contribute to a more fine-grained and psychologically valid interpretation of consumer–technology interaction. The study provides contextually relevant empirical support in a swiftly changing digital market, such as Saudi Arabia, which adds to the geographic and cultural diversification of research on digital behaviors.

Combined, these findings provide a theoretically integrated and empirically substantiated explanation of the mechanisms that connect digital design, affective experience, and behavioral engagement. In showing precisely how environmental features and individual dispositions interact to influence digital consumer behavior, this research carries important implications for scholars working toward the development of more nuanced experiential theories and for practitioners working to design more effective and psychologically sensitive digital retail environments. Further research might extend these

findings by taking longitudinal, experimental, and cross-cultural perspectives to further explicate the dynamic and context-contingent nature of digital engagement.

Author Contributions

The entire study was conceptualized, designed, and implemented by the author alone, including the formulation of the theoretical framework, collection of data, statistical processing, interpretation, and drafting the manuscript. The author is solely accountable for the entire process of this research study and the validity of its results.

Conflicts of Interest

The author declares no conflicts of interest related to the research, authorship, or publication of this article.

Data Availability Statement

The data that underpin the findings of this study are available upon reasonable request from the author and were collected in full compliance with ethical and institutional research standards.

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Appendix

Appendix (1): Questionnaire

Constructs, Scales, and Sources for Survey Questions			
Construct	**Definition**	**Survey Items**	**Source**
Online Store Atmosphere (OSA)	Sensory, design, and informational features of Web stores affecting consumers' perception and affective reactions.	1. Online shopping websites are visually stimulating. 2. The design and structure of online websites make it easy to find products. 3. The overall online shopping environment gets one into a good browsing mood. 4. Colors, graphics, and fonts used in online shops are visually appealing. 5. The visual presentation of online websites appears professional and trustworthy.	Güleç & Ünüsan (2024); Shi et al. (2025); Eroglu et al. (2003)
Interactive Screens (IS)	The degree to which Web pages offer interactive, responsive, and personalized experiences expanding user control and interaction.	1. Online shopping websites react fast to users' behavior. 2. I have a sense of control when using interactive tools on shopping websites. 3. Online websites tend to personalize to users' tastes or browsing records. 4. Interactive features enhance online shopping entertainment. 5. I am able to easily manipulate product details (e.g., zoom in/out, rotate, customize).	Alghamdi et al. (2023); Utami et al. (2022); Liu & Shrum (2002)
	Positive affect marked by pleasure,	1. I generally like to spend time on online shopping websites.	Deng et al. (2022);

Constructs, Scales, and Sources for Survey Questions			
Construct	**Definition**	**Survey Items**	**Source**
Customer Enjoyment (CE)	enjoyment, and happiness derived from online shopping experiences.	2. Online shopping is enjoyable and entertaining to me.	O'Brien & Toms (2010); Güleç & Ünüsan (2024)
		3. I am delighted and feel at ease when online shopping.	
		4. Online shopping websites are enjoyable to use.	
Customer Engagement (CENG)	Multidimensional mental state representing customers' mental engagement, emotional involvement, and behavioral investment in online shopping behavior.	1. I pay attention to the content and products presented on online platforms.	Hollebeek et al. (2014); Vinerean (2021); Islam et al. (2019)
		2. I am attached emotionally to my online shopping experiences.	
		3. I enjoy interacting with online platforms (e.g., reviews, likes, shares).	
		4. I intend to continue using online shopping in the future.	
Technological Readiness (TR)	The individual's overall disposition towards embracing and using new technologies, including optimism, innovativeness, and reduced discomfort/insecurity.	1. New technologies tend to improve my daily life.	Parasuraman & Colby (2015); Blut et al. (2020)
		2. I like being among the first to try out new technology.	
		3. (R). Technology systems sometimes intimidate me. (reverse)	
		4. (R). I worry about not being able to handle sophisticated online features. (reverse)	
		5. I'm confident in using new digital gadgets.	