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Digitally Empowered Experiences: Investigating How AR Interactivity Shapes Online Customer Experience

Kiran Shehzadi *, Muhammad Amir Rashid, Syed Muhammad Irfan

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Kiran Shehzadi*, is affiliated with National Textile University Faisalabad, Pakistan.
Email: Kirannouman786@gmail.com

Muhammad Amir Rashid & Syed Muhammad Irfan are affiliated with COMSATS University Islamabad, Pakistan.
Email: Amirrashid@cuilahore.edu.pk
Email: syedirfan@cuilahore.edu.pk

***Corresponding Author**

Abstract

This article explores the relationship between Augmented Reality (AR) interaction and Online Customer Experience (OCE) with Customer Empowerment as the mediator and Digital Literacy as the moderator based on the Stimulus-Organism-Response (SOR) framework. A quantitative, positivist, and deductive methodology was used, gathering data from 300 online consumers with experience and knowledge of AR-enabled shopping and analysing it using Partial Least Squares Structural Equation Modelling (PLS-SEM). These findings established that AR interactivity was a significant contributor to customer empowerment, which in turn positively affected OCE, thereby demonstrating empowerment as the primary bridging mechanism. A smaller direct effect of interactivity on OCE was also identified, indicating both direct and indirect effects. Moreover, digital literacy had a modifying effect on the interaction between interactivity and experience in that techno-savvy users benefited more from the experience. Despite the negative moderating effect, digitally savvy users gained advantages, as their cognitive preparedness mitigated overload, enabling easier navigation and affording interactivity that translated into better control, enhanced engagement, and better experiences. The research contributed to the conceptualisation of the SOR model of online retail and offered practice-based guidance for creating adaptive, inclusive, and empowerment-oriented AR interfaces.

Keywords: Digitally Empowered, AR, Interactivity Shapes, Customer Experience

INTRODUCTION

In todays competitive online markets Online customer experience (OCE) has emerged as a strategic differentiator that leverages customer satisfaction, trust, and loyalty. (Lemon and Verhoef, 2016). Unlike traditional physical stores that rely on sensory richness and interpersonal interactions to influence customer evaluations, digital platfoms often struggles to replicate the same level of trust and engagement (Pangarkar et al., 2022). This has prompted retailers to develop immersive and interactive shopping expereinces to sustain competitive edge in digital markets. Augmented reality (AR) has been widely recognized as a promising solution to this challenge. AR bridge the gap between physical and virtual shopping by enabling customers to virtually interact with products. For instance customers can visualizing products in real contexts and interact with immersive features to refine their decision making (Javornik, 2016). Empirical studies suggests that AR can elevate cognitive & affective engagement, narrows uncertainty, and boost decision confidence (Thakkar et al., 2023; Rauschnabel et al., 2019). Yet, outcomes are not consistent on all AR apps (Sarkis et al., 2025). The effectiveness of AR depends on how customers interact and perceive its core features. Amond these features, AR interactivity has been

indentified as key determinent of experiential value. The literature presents a mixed picture of this construct. Some studies suggest the postive influence of AR interactivity on OCE by increasing customer engagement (Poushneh & Vasquez-Parraga, 2017). Wherease some scholars argue that excessive interactivity increase cognitive load and cause user fatigue leading to poor experiential value (Sheng et al., 2023). These contradictions point out that the impact of AR interactivy on OCE may operate through some underlying psychological mechanism and with certain conditions. For this reason, scholars call for further investigation of the role of AR interactivity in shaping OCE (Javornik, 2016; Yim, Chu, & Sauer, 2017).

Against this backdrop, the formal research question guiding this study is: *How can AR interactivity be leveraged to enhance online customer experience, and under what conditions does it succeed or fail?* To address this question, this study explains that customers are active participants in interactive AR context who can get personalized information and manipulate product visuals to manage their purchase decisions (Fuchs et al., 2010). This AR induced empowerment enrich online customer experience (OCE). It is also important to consider that excessive inetractivity may also have diverse effects on customer empowerments specifically in complex online context (Erensoy et al., 2024). Hence, empowerment plays as a double-edged mechanism, which can mediate both the beneficial and detrimental influences of AR interactivity on OCE. Most previous research has focused on the immediate effects of AR on OCE, without considering psychological processes, such as empowerment, that clarify how interactivity can be translated into experience (Wang, 2024).

Additionally, Users with higer digital literacy can navigate in interactive AR context more effectivley and are more likely to percive self empowerment (Pantano & Gandini, 2017). On the flip side, users with limited set of digital skills may perceive the same interactive features confusing creating frustration rather than empowerment (Rodríguez-Torrico et al., 2019). Accordingly, digital literacy serves as a boundary condition, moderating the pathway from AR interactivity to customer empowerment. These constructs are linked in the Stimulus-Organism-Response (SOR) position, with AR interactive being the stimulus, customer empowerment being the organism, and OCE being the response. The four primary constructs are synthesised in the succeeding sections with the existing critical research. This investigation enhances theoretical knowledge of AR-enabled experiences as interactive ecosystems in which technology, cognition, and emotion converge.

LITERATURE REVIEW

Augmented Reality (AR)

Augmented reality (AR) is an evolving technology, adapting and expanding its applications across multiple fields. The foundational definition describes AR as integrating 3D virtual objects into a natural environment in real-time (Azuma, 1997). Due to technological innovations, AR was redefined as "a technology that combines real and virtual objects in a real environment, facilitating real-time interaction and alignment of these elements" (Azuma, 2001). This refined definition is a foundation for this investigation, resonating with past work (Javornik, 2016) on the essential AR characteristics. Rauschnabel (2019) also supported this definition by highlighting AR as virtual content that can be integrated with the user's perception of the physical world, thereby signifying the role of advanced media in this fusion. The widespread popularity of the Pokémon GO app examines AR's potential to merge virtual experiences with real-world exploration. This app asks the users to search and capture

a virtual object once it appears in the natural environment. Suh & Prophet (2018) further explain that augmented reality is an "immersive technology". It is "a technology that blurs the boundary between the physical and virtual worlds enabling users to experience a sense of immersion". Moniaga & Utami Tjhin (2022) referred to augmented reality as an interactive technology. Customers can virtually interact with products and make more confident purchase decisions because AR offers product 3D visualization, demonstrations, and try-before-you-buy features. For example, in fashion retail, AR can provide digital projection of a product that enables customers to visualize how products (i.e. makeup, cloths, sunglasses etc.) might look on them, resulting in more accurate buying decisions (van Esch et al., 2019a).

AR technology can be used both in online and physical stores. A virtual fitting room with a smart mirror is a type of physical store AR technology that enables customers to visualize a product projected on the mirror without trying it on. AR apps are typically becoming prevalent among smartphone users because of the hasty evolutions in mobile technology (Kim & Forsythe, 2008; Pantano et al., 2017a; Saprikis et al., 2021). customers can easily use it on mobile phones without acquiring any special skills. Smartphones have the necessary tools and features to support a variety of augmented reality applications. Such as fast processors, high-resolution graphics, high-speed internet connection, relatively big touch screens, and built-in sensors (compass, accelerometer, WiFi, GPS, camera) make smartphones a powerful and affordable platform to use AR applications (Bower et al., 2014; Cruz et al., 2019).

Most AR apps are designed to be self-explanatory and user-friendly. Anyone can use them on their smartphones regardless of their level of technical expertise and prior knowledge. Customers only need to have a camera and an internet connection in their smartphones to download an AR app from the Google Play Store. After downloading, they usually start using the app by following on-screen instructions, which may involve pointing the camera at a specific object or location or scanning a code to activate the AR experience. The AR app then superimposes graphics, animations, and virtual content onto the real environment displayed on the mobile screen. This augmented blend can range from immersive game features and virtual furniture in a room to immediate information about proximate locations.

AR Interactivity

AR interactivity refers to the extent to which users can control and manipulate virtual objects or interfaces in the online environment. This is one of the features of AR that creates a difference between it and old-fashioned online media (Pantano et al., 2017). In the context of prevailing technologies, 3D virtual products, comparison systems, and options for virtual recommendations, all are forms of interactive media. Javornik (2016) identified that interactivity can improve the sense of presence among consumers and make the process more engaging, as it allows them to get a response in real-time. According to Pantano (2017, p. 85) interactivity is "the extent to which users can modify and form the content of a mediated environment in real time".

Customer empowerment

Empowerment is defined as the perceived capacity of users to affect, shape, and make independent choices in the consumer process (Zhang et al., 2018). It refers to strategies and processes to improve the level of influence and control that customers have over their interactions, and purchasing decisions.

Online Customer Experience (OCE)

OCE is defined as the cognitive, emotional, and behavioural response of users to interactions on the Internet (Verhoeff et al., 2009; Lemon and Verhoeff, 2016). It has

both utilitarian (perceived usefulness and effectiveness) and hedonic (pleasure and interest) elements (Vakulenko et al., 2019). This study explains OCE as a multidimensional construct, where both cognitive and affective states interplay to transform consumer intentions and subsequent behaviors. Cognitive state is defined as "a component of experiential state that is connected with thinking or conscious mental processes" (Rose et al., 2012, p. 312). Whereas Affective state is defined as "a component of experiential state that involves one's affective system through the generation of moods, feelings and emotions" (Rose et al., 2012, p. 312).

Digital Literacy

Digital literacy is the ability to detect, process, and analyse online data effectively (Rodríguez-Torrico et al., 2017). Following the AR scenario, digital literacy includes both technical (using apps and tools) and interpretive (understanding interactive signals) literacies.

Theoretical Convergence: SOR Framework

The SOR analytical framework (Mehrabian and Russell, 1974) is widely adopted for explaining customer shopping behaviors (Cao, 2024; Banerjee, 2024; Gupta, 2023; Huo, 2023; Pereira, 2023; Kumar, 2023; Talwar, 2023) in numerous retail contexts including omnichannel retailing (Natarajan, 2023; Carvalho, 2023, Sharma, 2024; Muthaffar, 2023) E-retailing using virtual reality reality (Kundi, 2023; Liu, 2023; Sann, 2023; Aw, 2023; Bird, 2023; Soon, 2023; Xu, 2024; Kim, 2023; Khan, 2024), and offline retailing (Xie, 2023). This framework suggests that environmental stimulus (S) affects customers' internal organism (O), which in turn affects their behavior (R). In line with SOR paradigm, this study considers AR interactivity as stimuli, customer empowerment as organism and customer online stands as the behavioral response.

The rationale for employing this model stems from the comprehensive nature of SOR in explaining the impact of environmental cues on consumer behavior. Other theories, such as TAM and its extended forms, basically focus on perceived ease of use and usefulness as the main drivers for technology acceptance and usage intentions. It needs to fully explain the intricate ways through which AR factors influence consumer cognitions, emotions, and necessitating behavior. Herein, the SOR framework enables scholars to delve deeper into consumer psychological mechanisms influenced by AR stimuli, leading to a wide array of consumer responses. Moreover, SOR theory accommodates multiple variables, offering richer insights into the ways AR technologies can reshape online customer experience and behavior.

HYPOTHESES DEVELOPMENT

AR interactivity considerably endorses a paradigm where customers exercise an extraordinary level of control with the virtual representation of the product. It enables customers to view products and virtually place them into their environment, modify features and interact with them as if they were present. Customers can zoom, rotate, and enlarge virtual products to enhance their understanding. By placing virtual products into their environment, customer can analyze how the product would fit in their personal context. This level of contextualization provides control over understanding the practicality and aesthetics of products within the intended environment (Rese et al., 2014), leading to a satisfying shopping journey. For example, a consumer may see a product from various angles in a different environment (Javornik, 2016). They can customize product color, size, or other dimensions based on their preferences. Such experiences form of a sense of customer autonomy, where

they are not just receivers of the information but also active participants of the buying process (Van Kerrebroeck et al., 2017). Considering this iterative process, some critical psychological components, such as manipulability and control, are inherently present in this construct. Based on the discussion above the following hypothesis is formed

H1: AR interactivity significantly and positively enhances customer empowerment.

Customer empowerment has been identified as core antecedent of enriched customer experiences because empowered customers demonstrate deeper processing of virtual information. Li et al. (2023) showcased that empowering strategies (such as personalization) increase overall user experiences by adding perceived usefulness, ease of use, and emotional engagement. Supporting this notion, Chen and Shen (2023) argued that the ability of e-commerce platforms to foster customer trust (affective state) relies upon the mechanism to induce customer self control. AR induced customer empowerment amplifies cognitive experiences by facilitating better product understanding and reducing uncertainty (Bonnin, 2020). At the same time, AR empowerment fosters affective experiences leading to flow, excitement and entertainment (Smink, 2020). The sensory control evokes emotional arousal and immersion leading to pleasurable experiences.

H2: Customer empowerment has a significant, positive impact on the online customer experience (OCE).

Further, Existing research demonstrates that interactive AR features such as virtual try on and 360-degree product visualization supports consumer's cognitive evaluations and improve their decision confidence (Bonnin, 2020). In parallel, AR interactivity escalates affective evaluations such as immersion, and enjoyment (Smink, 2020). hence, we hypothesize that

H3: AR interactivity positively and significantly enhances online customer experiences (OCE).

According to S–O–R framework, AR interactivity operates as a external stimulus that empowers customers' ability to customize, manipulate and visualize products, thereby provoking a stronger feeling of customers' autonomy and agency (Kim et al., 2021). This organismic state—reflected in enhanced sense of competence, —functions as the psychological mechanism through which AR's interactivity transformed into enrich online customer experiences (OCE). As empowered consumers feel more confident in their purchase journey, they perceive better cognitive evaluations and stronger affective reactions. Such interactive empowerment, ultimately lead to overall experiential quality in online retail environments. Hence it is hypothesized that

H4: Customer empowerment mediates the relationship between AR interactivity and OCE.

Technological affordances cannot affect all user categories equally; cognitive readiness and digital abilities must be considered. Recent research, such as Smit et al. (2025), has also incorporated this notion by linking digital literacy to social inclusion and proposing that less-literate consumers may not be entitled to access digital marketplaces. Studies show that digital literacy increases ease of use and self-efficacy, and allows users to find pleasure in complex digital interactions (Pantano & Gandini, 2017). On the other hand, inadequate literacy may turn the concept of interactivity into a source of confusion or frustration, conveying no empowerment or satisfaction. According to Kozyreva et al. (2020), users with high digital abilities perceive interactive signatures as exploratory opportunities, which reinforces

deliberation over perceived control and pleasure. However, Li et al. (2021) argued that less skilled people have difficulty making sense of the same stimulus and feel disempowered as a result. Therefore, the following hypothesis is:

H5: Digital literacy moderates the relationship between AR interactivity and customer empowerment.

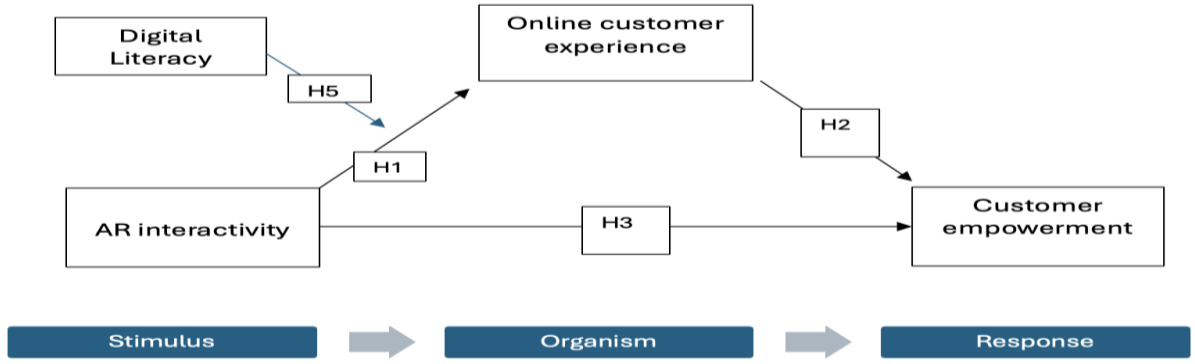

Figure 1.
Research Framework

RESEARCH METHODOLOGY

This study uses a quantitative research method adopting positivist approach. Positivist approach is well suited because the current investigation seeks to outline the relationships among variables using quantitative evidence (Antwi and Hamza, 2015). The methodological use of data collection and statistical verification shows that trust is placed in observable social phenomena rather than subjective connotations.

The deductive method of reasoning is utilized, which commences with theory and empirical testing. The hypotheses were formulated using theoretical propositions already in the literature within the SOR framework. By empirically testing these propositions, the research should validate or revise current theories rather than develop new conceptualisations, and thus it follows a deductive logic more generally applied in the behavioural and marketing sciences.

The research design is both descriptive and causal, as it aims to examine patterns of consumer behaviour in digital commerce and to determine cause-and-effect relationships between variables. The design provides internal validity by controlling for the directional impact of constructs under an analytical condition. The cross-sectional survey was used to collect data, enabling the researcher to obtain participants' perceptions at a single point in time. The survey design was selected because it is an efficient way to gather large volumes of data and is also suitable for structural equation modelling (SEM), which requires quantitative indicators for each construct. Online consumers were the target segment, as they were already accustomed to AR-based shopping experiences, such as mobile shopping and e-commerce platforms with virtual or product visualisation. This is the most prejudiced demographic that will be exposed to AR technology and will form meaningful perceptions about how to be more interactive, feel more empowered, and experience.

The researcher employed a non-probability purposive sampling technique. The sample adheres to the 10-times rule of thumb for Partial Least Squares Structural Equation Modelling (PLS-SEM) and has sufficient statistical power. Recommendation: Because the measurement model of the study includes approximately 30 observed indicators, it was possible to set a target, namely, the target sample group should

consist of 300 respondents, which was consistent with the recommendations by Hair et al. (2019. A structured questionnaire with five sections, including (1) demographic, (2) AR interactivity, (3) customer empowerment, (4) digital literacy, and (5) online customer experience, was used to collect the data. Content validity was ensured by ensuring that all measurement items were derived from previously tested scales.

- AR Interactivity was assessed with an adapted 4 items scale of Pantano et al. (2017) that targets the individual perceptions of control, personalisation, and responsiveness of the AR interface.
- Customer Empowerment employed a 5-item scale developed by Zhang et al. (2018) to assess autonomy, influence, and perceived control during online shopping.
- Online Customer Experience (OCE) is based on the 12 items scale used by Vakulenko et al. (2019) consisting dimensions of affective and cognitive engagement.
- Digital Literacy was assessed with a instrument by Ng (2012) consisting of 7 items.

SmartPLS 4.0 software was used to analyse the data with Partial Least Squares Structural Equation Modelling (PLS-SEM). The reasons why PLS-SEM was chosen are that it is flexible in handling complex models that may include mediation and moderating effects, assumes less about data normality, and aids in testing a theory speculatively (Hair et al., 2019). The analysis was conducted in two steps. Firstly, Measurement Model Testing- to test construct validity and reliability, based on Cronbach's alpha, component reliability, Average Variance Extracted (AVE), and Heterotrait Monomethod Ratio (HTMT). Findings indicated that each construct exceeded the recommended thresholds (AVE > 0.7; AVE > 0.5), demonstrating internal consistency and convergent validity. Secondly, Structural Model testing- testing hypotheses with bootstrapping of 5,000 resamples using path coefficients, t-statistics, and p-values. The standardised root means square residual (SRMR) of 0.09 indicated a good fit, and the NFI of 0.59 indicated a moderate fit that could be acceptable given the model's complexity.

Moreover, the Variance Inflation Factor (VIF) was less than 3, which proves the absence of multicollinearity. Indirect and interaction paths were estimated to determine the mediation (H4) and moderation (H5) effects. The research complied with the university's ethical guidelines for social research. Data collection was voluntary, and informed consent was obtained before the study. Personally identifiable information was not included to ensure anonymity and confidentiality. The respondents were made aware of their right to withdraw at any time without penalty. The data was safely kept in password-secured files by the researcher.

RESULTS AND DISCUSSION

Demographic Analysis

The results are based on survey data from a population of 300 people who were active participants in online stores with the AR feature. It is performed using Partial Least Squares Structural Equation Modelling (PLS-SEM) and proceeds in a sequence of steps to assess the reliability and validity of the measurement model and to identify the causal relationships among the constructs in the structural model. By applying this analytic paradigm, it is possible to obtain both confirmatory and exploratory insights into the relationship between digital literacy and the impact of AR interactivity on empowerment and experiential satisfaction. The sample population falls into the age groups 18-24 years (43%) and 2534 years (38%), indicating that over 80% of the sample

population belongs to the younger consumer group. This is an international pattern, as, according to it, Generation Z and younger millennials are the most inclined toward digital shopping and AR (Pantano & Gandini, 2017). Younger consumers are more receptive to interactive technologies and more demanding of digital personalization experiences. The low percentage of older individuals (only 6% of the entire sample is over 45) may suggest that older generations have not yet been affected by digital inertia or are less technologically self-confident (Rodriguez-Torrico et al., 2019). Consequently, the study's results primarily relate to the behavioural tendencies of digitally active young consumers.

The gender distribution is average, with 187 males (62%) and 113 females (38%). The bias may reflect broader tendencies in technology-based purchasing, since men are most likely to start using immersive technologies (Chen et al., 2024). However, current studies also indicate that gender differences in AR in the shopping experience are decreasing as platforms increasingly feature a greater ratio of inclusive and lifestyle-oriented content (Yim et al., 2017). In terms of education, undergraduates (206, 69%), postgraduates (50, 17%), graduates (37, 12%), and some doctoral degree holders (7, 2%) take the largest proportions. This distribution points to a highly educated sample, which aligns with the finding that people with higher levels of education are better digitally literate and more likely to adopt open retail technologies (Verhoff et al., 2009).

Regarding online purchase behavior, the majority of respondents reported making regular (130, 43) and occasional (89, 30) e-purchases, indicating a tendency toward habitual online purchases. The trend implies a high degree of digital confidence and trust in the e-commerce platforms. Fewer respondents do not shop, 22(7%), 15(5%), and do not shop due to choice, 44(15%), respectively, which made me conclude that they have circumstantial or limited availability on online-based shopping patterns. The high number of frequent online customers demonstrates that the population has already matured in terms of digital consumer behavior, and this is one of the factors to be considered when examining the role of AR as an experience. The most common online shopping platforms are mobile applications (213, 71%), followed by websites (74, 25%). The least popular are other platforms (13, 4). This finding aligns with the mobile-first retail paradigm, in which apps offer better, more engaging AR features that desktop websites cannot (Rauschnabel et al., 2019). The saturation of app usage suggests that participants will become part of retail spaces with a high level of digitisation, enabling the AR features of the digital try-on technology, 3D product visualisation, and interactive product displays.

Table 1.
Demographic Analysis

Variable	Items	Frequency (N)
Age	18-24	129
	25-34	114
	35-44	39
	45-54	15
	55 and above	3
Gender	Male	187
	Female	113
Education	Graduate	37
	Undergraduate	206
	Postgraduate	50
	Doctorate	7
E-Purchase	Regularly	130
	Occasionally	89

	Rarely	22
	Sometimes	15
	Not by choice	44
Purchase Platform	Apps	213
	Website	74
	Others	13

Construct Reliability and Validity

According to Table 2, the constructs had a desirable level of reliability and validity, which proves the strength of the measurement model. Cronbach's alpha (a) was compared to fall in 0.786 to 0.883, which is higher than the recommended 0.70 that represents high internal consistency, which demonstrates that all the scales used have high internal consistency. Customer Experience through AR interactivity (= 0.883) and the Digital Literacy (= 0.870) show a high internal consistency and therefore, their items are consistent with the measurement of their respective constructs. The latter stability aligns with prior studies that have demonstrated the capacity of experiential and cognitive conceptions to elicit high internal consistency in digital consumer research (Vakulenko et al., 2019).

In line with the stability of the constructs, the composite reliability (rho c) ranged from 0.854 to 0.903 and exceeded the 0.70 threshold. This indicates that the indicators work well to capture all the constructs and yield minimal measurement error (Hair, 2014). The highly reliable constructs (rho r 0.877 and rho r 0.854) are AR Interactivity and Customer Empowerment, indicating that perceptions of interactivity and user empowerment are consistently similar across the measurement items.

Convergent validity is also ensured by the value of Shared variance (AVE), which tests the measurement of the proportion of shared variance between the items in a construct and or construct. All the constructs had values exceeding 0.50, except for OCE, which was 0.439, indicating that these constructs explain most of their variance through their indicators (Fornell and Larcker, 1981). To the extent that the AVE of OCE is slightly lower than it should be, it remains acceptable given its high reliability and the multidimensional nature of the customer experience responses. In advanced scale measures such as OCE, loadings of AVE that are slightly lower than the acceptable range are often tolerated, where non-probable loadings that may be supported by plausible factor loadings/discriminate validity (Henseler et al., 2015).

Table 2.
Construct Reliability and Validity

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
AR Interactivity	0.815	0.834	0.877	0.641
Customer Empowerment	0.786	0.790	0.854	0.539
Digital Literacy	0.870	0.881	0.899	0.562
Online Customer Experience	0.883	0.887	0.903	0.439

Discriminant Validity: Heterotrait-monotrait ratio (HTMT)

The Heterotrait-Monotrait (HTMT) ratio criterion was used to assess discriminant validity; this approach is acceptable than traditional Fornell-Larcker comparisons (Henseler et al., 2016). Table 3 suggests that all the HTMTs fall below the same density of 0.85, indicating the empirically unique nature of each construct relative to the others. The

HTMT ratios range from 0.347 to 0.799; the most critical interactions were between Customer Empowerment and OCE and between Digital Literacy and Online Customer Experience (0.758 and 0.799, respectively). The theoretical arguments support the assumption that, for more digitally literate consumers, it would be more convenient to have a sense of AR interactions and be more empowered and satisfied (Rodriguez-Torrico et al., 2019). Similarly, the empowerment conceptually aligns with that of OCE, in which empowered customers enjoy and exert greater control over online transactions (Dong, Evans, and Zou, 2008). The HTMT's least value lies between the AR Interactivity and the moderating term (0.347), indicating a clear distinction between the independent and moderator effects. This increases confidence that there is no threat to model interpretation due to multicollinearity among the constructs and moderating terms.

Table 3.
Heterotrait-monotrait ratio (HTMT) – Matrix

	AR Interactivity	Customer Empowerment	Digital Literacy	Online Customer Experience	Digital Literacy x AR Interactivity
AR Interactivity	1				
Customer Empowerment	0.726	1			
Digital Literacy	0.518	0.599	1		
Online Customer Experience	0.508	0.758	0.799	1	
Digital Literacy x AR Interactivity	0.347	0.386	0.489	0.522	1

Path Coefficient Analysis

The estimated direct paths between the core constructs are reported in Figure 1 and Table 4. Bootstrapped statistics are necessary to test the significance of the findings at standard levels. The relationship between AR Interactivity and Customer Empowerment is positive and statistically significant, with an effect size of 0.412 ($t = 7.657$, $p < 0.001$), supporting H1. This indicates that the more interactive AR features are, the greater the user's perceived control and autonomy during online shopping. This estimate is substantively significant and does not contradict the conceptualization of the interactivity as an experience stimulus in the SOR chain. Interactivity provides raw feedback, personalized visualizations, and adjustable product attributes that, collectively, foster a sense of agency in decision-making and self-efficacy, which consumers perceive as empowerment. The value of 0.412 is moderate to large in behavioral SEM settings, indicating that empowerment is not an incidental effect of interactivity but an intermediate step through which AR technologies become psychologically consequential for individuals.

The second directional relationship between Customer Empowerment and Online Customer Experience, OCE, is also positive and significant ($O = 0.454$, $t = 8.659$, $p < 0.001$), which is in favor of H2. Users who are in control tend to judge their interactions with products and services more positively because they can navigate, tailor the amount of information, and shape the overall buying experience. This result is consistent with the literature on motivation control synthesized in the analysis, which theorizes that empowerment translates into increased enjoyment, clarity, and decision confidence —the primary constituents of OCE. The scale and extent of the same are similar to those in such digital service contexts, suggesting that

empowerment is a strong predictor of experience scores even when the interface is new and technological.

The direct impact of AR Interactivity on OCE is smaller but still significant, with O = 0.133, t = 2.029, p = 0.043, supporting H3 and indicating that the impact of interactivity on experience quality is independent of empowerment. This residual direct effect often encompasses the affective uplift of brightness and presence that might be attributed to the power to transmit. That is, interactive AR may be an inherently positive experience, since its sense of materiality and playful interaction can make it seem more enjoyable and less ambiguous, even before the user internalizes a sense of agency. The comparatively small coefficient is theoretically consistent with a model in which the dominant channel of interactivity's impact is through empowerment, and the direct effect is the resulting parallel hedonic and informational benefits.

Table 4 has two other paths that provide helpful context. The main effect of Digital Literacy on OCE is large and significant (O = 0.579, t = 13.070, p < 0.001), indicating that more digitally capable consumers experience the online space better, holding all other factors constant. Furthermore, a positive association (O = 0.454, t = 8.659, p < 0.001) between OCE and Customer Empowerment indicates a reinforcing loop, in which stronger feelings of agency reciprocate positive experiences.

Despite the SOR sequence theorizing empowerment as an organismic condition that precedes experience, there is an empirical tendency to reciprocate, a reasonable process in digital business, where pleasurable and open communications prove one's ability to operate effectively. This is not inconsistent with the SOR logic but suggests that the response and the organism can evolve together over successive encounters. These direct effects are well supported by the literature reviewed in the study. Empirical and field research have consistently demonstrated that interactivity elevates immersion and perceived diagnostic value, thereby increasing satisfaction and purchase confidence (Javornik, 2016; Yim et al., 2017; Poushneh and Vasquez-Parraga, 2017).

Meanwhile, the smaller AR Interactivity to OCE coefficient aligns with the warning that interactive functionality may place cognitive load, particularly when the design's complexity exceeds users' processing capacities, thereby moderating the net experiential benefit. The current estimates thus align with a reasonable position: interactivity is good but not unrestrained, and empowerment plays a critical role in bridging the gap between stimulus and experience.

There are two theoretical implications of the interactivity-driven empowerment under a SOR perspective. First, the power of H1 and H2 suggests that the organismic state of empowerment is not a peripheral byproduct, but rather the central psychological mediator that directs technological characteristics into experiential effects. Theoretically, interactivity provides the user with instrumental power over verbal form and signification, leading to a feeling of control that is both affectively pleasant and epistemically comforting.

Second, the continuity of a minor direct influence of interactivity on OCE indicates that the vividness of senses and playful interaction provides marginal value that cannot be regulated. Consumer engagement theory would interpret this residual effect as a manifestation of the fact that interactivity triggers both utilitarian and hedonic systems of engagement, with empowerment underpinning the utilitarian evaluative route, and immediacy or presence playing a hedonic uplifting role.

Table 4.
Path Coefficient Analysis

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
AR Interactivity -> Customer Empowerment	0.412	0.411	0.054	7.657	0.000
AR Interactivity -> Online Customer Experience	0.133	0.135	0.066	2.029	0.043
Digital Literacy -> Online Customer Experience	0.579	0.585	0.044	13.070	0.000
Digital Literacy x AR Interactivity -> Online Customer Experience	-0.134	-0.129	0.043	3.154	0.002
Online Customer Experience -> Customer Empowerment	0.454	0.455	0.052	8.659	0.000

Table 5.
Hypotheses Testing Results

Hypothesis	Proposed Relationship	Path Coefficient (β)	t-value	p-value	Decision
H1	AR Interactivity → Customer Empowerment	0.412	7.657	0.000	Accepted
H2	Customer Empowerment → Online Customer Experience	0.454	8.659	0.000	Accepted
H3	AR Interactivity → Online Customer Experience	0.133	2.029	0.043	Accepted
H4	AR Interactivity → Customer Empowerment → Online Customer Experience (Mediation)	Indirect effect significant (based on mediation test)	—	0.000	Accepted
H5	Digital Literacy × AR Interactivity → Online Customer Experience (Moderation)	-0.134	3.154	0.002	Accepted (Negative Moderation)
H6	Digital Literacy → Online Customer Experience	0.579	13.070	0.000	Accepted

Lastly, a pattern of coefficients in which the interactivity pattern would significantly predict empowerment and vice versa would provide a useful indirect effect for H4. The coefficient product in Table 4 ranges from 0.412 to 0.454, indicating a strong mediation effect. This critical estimate concurred with the overall table of the study, which revealed a significant indirect effect for H4 and no non-trivial aggregate effect of interactivity on OCE. This is because the picture of structure is internally consistent, theoretically sound, and practically applicable in the context of SOR structure, as in the study.

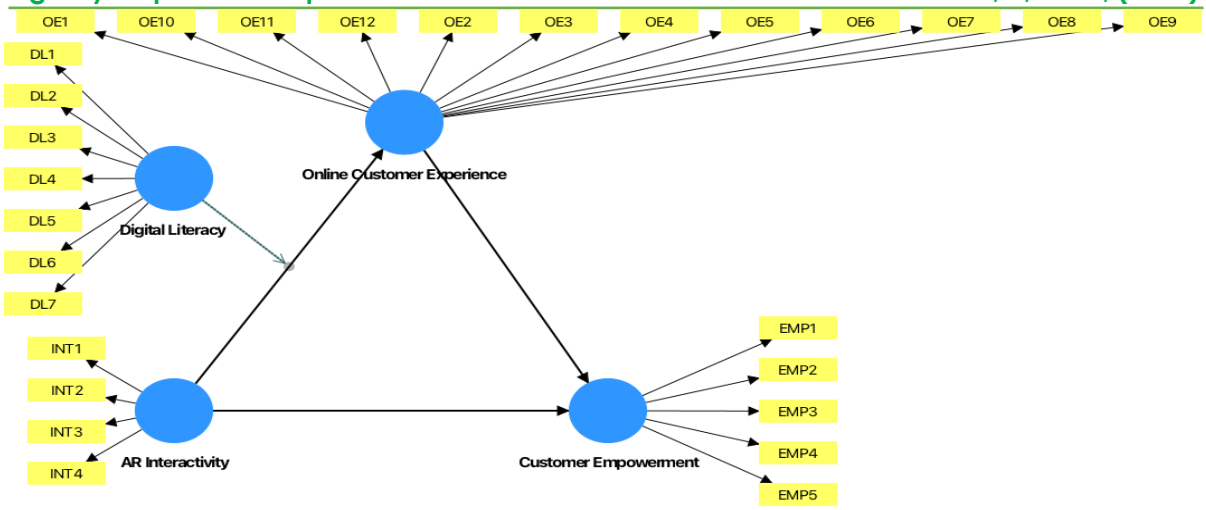

Figure 2.
Path Coefficient Analysis

CONCLUSION AND FUTURE RECOMMENDATIONS

The study aimed to establish the correlation between the OCE and AR in the presence of Customer Empowerment, moderated by Digital Literacy, within the SOR model. The results showed that AR interactivity significantly influenced customer empowerment, supporting the research's original goal: to establish a direct link between technological interactivity and psychological control. The positive effect that empowerment might have had on OCE was also confirmed, as findings indicated that empowerment was a strong and consistent predictor of experience satisfaction and engagement. The third objective, which directly assessed the impact of interactivity on OCE, confirmed a smaller but still significant positive relationship, suggesting that the impact of interactivity on experience quality is independent. The fourth objective, which challenged the empowering role of empowerment, demonstrated that the influence of interactivity was partially reciprocal with OCE's empowerment, confirming its key role as a mediating psychological process. The final objective, to examine digital literacy as a moderator, was achieved, and it was found that literacy affected the strength of interaction, as measured by interactivity level.

In practice, the research provided digital marketers and sellers with useful data to enhance consumers' relationships with AR interfaces. Findings suggested that the interactive aspect of AR itself was not the factor that defined satisfaction; rather, its effectiveness hinges on the creation of customer empowerment and the interface's complexity, given the user's level of digital literacy. Retailers were suggested to adopt adaptive AR experiences (e.g., guided visualisations and layered interfaces) that are not only accessible to skilled users but also to less-literate consumers. By integrating simple controls, clear feedback procedures, and contextualised assistance, brands can become more accessible and deliver higher Experiential Value.

Theoretically, the study resulted in the construction of the SOR framework, which is anchored in the concept of the organism as an important mediator between technological stimuli and experiences. It also contextualized digital literacy as a socio-cognitive condition at the boundary, providing a critical understanding of previous models of online consumer behaviour. By providing scientific confirmation of the role of psychological and cognitive processes in establishing the usefulness of AR in configuring digital experiences, the research filled the gap between the current literature on adopting interactive technology and the experiential marketing

literature. This combination added explanatory power to the SOR theory of technology-mediated settings. However, the study was not without its limitations. Data was gathered via a cross-sectional survey, thereby reducing the possibility of establishing a causal relationship between interactivity, empowerment, and OCE over time. The subjective measures could have introduced bias, leading respondents to overreport their technological competence or satisfaction. In addition, the sample was geographically focused and mainly composed of digitally active young adults, and may not be generalisable to older or less technologically active populations. The analysis also operated solely on AR-enabled retail platforms and did not engage other experiential technologies, i.e., virtual or mixed reality.

Further research is needed to implement longitudinal designs in evaluating the variations of empowerment and experience across time and cross-cultural comparisons to identify how socio-economic and cultural variables mediate the impact of digital literacy. The qualitative approaches, including interviews and exploration of emotional and behavioural details of AR use, would help to improve quantitative findings. This framework could be enhanced with other constructs, including trust, flow, and perceived enjoyment, to give a more detailed view of the creation of experiential values. These recommendations would continue to refine theoretical models and enhance managerial implications of online customer experience based on the psychological and technological determinants.

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REFERENCES

Akaka, M. A., & Schau, H. J. (2019). Value creation in consumption journeys: recursive reflexivity and practice continuity. *Journal of the Academy of Marketing Science*, *47*(3), 499-515. https://doi.org/10.1007/s11747-019-00628-y

Antwi, S. K., & Hamza, K. (2015). Qualitative and quantitative research paradigms in business research: A philosophical reflection. *European journal of business and management*, *7*(3), 217-225.

Cao, J., Lam, K. Y., Lee, L. H., Liu, X., Hui, P., & Su, X. (2023). Mobile augmented reality: User interfaces, frameworks, and intelligence. *ACM Computing Surveys*, *55*(9), 1-36. https://doi.org/10.1145/3557999

Chen, C., Zhang, K. Z., Chu, Z., & Lee, M. (2024). Augmented reality in the metaverse market: the role of multimodal sensory interaction. *Internet Research*, *34*(1), 9-38. https://doi.org/10.1108/INTR-08-2022-0670

Dong, B., Evans, K. R., & Zou, S. (2008). The effects of customer participation in co-created service recovery. *Journal of the Academy of Marketing Science, 36*(1), 123–137. https://doi.org/10.1007/s11747-007-0059-8

Erensoy, A., Mathrani, A., Schnack, A., Elms, J., & Baghaei, N. (2024). Consumer behavior in immersive virtual reality retail environments: A systematic literature review using the

stimuli-organisms-responses (S-O-r) model. *Journal of Consumer Behaviour*, *23*(6), 2781-2811. https://doi.org/10.1002/cb.2374

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*(1), 39–50. https://doi.org/10.1177/002224378101800104

Hair, J. F. (2014). *A primer on partial least squares structural equation modeling (PLS-SEM)*. SAGE Publications.

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European business review*, *31*(1), 2-24. https://doi.org/10.1108/EBR-11-2018-0203

Henseler, J., Hubona, G., & Ray, P. A. (2016). Using PLS path modeling in new technology research: Updated guidelines. *Industrial Management & Data Systems, 116*(1), 2–20. https://doi.org/10.1108/IMDS-09-2015-0382

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science, 43*(1), 115–135. https://doi.org/10.1007/s11747-014-0403-8

Hsu, S. H. Y., Tsou, H. T., & Chen, J. S. (2021). "Yes, we do. Why not use augmented reality?" customer responses to experiential presentations of AR-based applications. *Journal of Retailing and Consumer Services*, *62*, 102649. https://doi.org/10.1016/j.jretconser.2021.102649

Hu, X. (2023). Empowering consumers in interactive marketing: examining the role of perceived control. In *The Palgrave handbook of interactive marketing* (pp. 117-147). Cham: Springer International Publishing.

Javornik, A. (2016). "It's an illusion, but it looks real!" Consumer affective, cognitive, and behavioural responses to augmented reality applications. *Journal of Marketing Management, 32*(9–10), 987–1011. https://doi.org/10.1080/0267257X.2016.1174726

Kim, J. H., Kim, M., Park, M., & Yoo, J. (2021). How interactivity and vividness influence consumer virtual reality shopping experience: the mediating role of telepresence. *Journal of Research in Interactive Marketing*, *15*(3), 502-525. https://doi.org/10.1108/JRIM-07-2020-0148

Kozyreva, A., Lewandowsky, S., & Hertwig, R. (2020). Citizens versus the internet: Confronting digital challenges with cognitive tools. *Psychological Science in the Public Interest*, *21*(3), 103-156. https://doi.org/10.1177/1529100620946707

Lemon, K. N., & Verhoef, P. C. (2016). Understanding customer experience throughout the customer journey. *Journal of Marketing, 80*(6), 69–96. https://doi.org/10.1509/jm.15.0420

Li, X., Zhou, Y., Wong, Y. D., Wang, X., & Yuen, K. F. (2021). What influences panic buying behaviour? A model based on dual-system theory and stimulus-organism-response framework. *International Journal of Disaster Risk Reduction*, *64*, 102484. https://doi.org/10.1016/j.ijdrr.2021.102484

Maier, L., & Baccarella, C. V. (2025). The psychological and behavioral consequences of customer empowerment in new product development: Situational framework, review, and research agenda. *Journal of Product Innovation Management*, *42*(1), 220-252. https://doi.org/10.1111/jpim.12734

Mehrabian, A., & Russell, J. A. (1974). The basic emotional impact of environments. *Perceptual and motor skills*, *38*(1), 283-301. https://doi.org/10.2466/pms.1974.38.1.283

Morrongiello, C., N'Goala, G., & Kreziak, D. (2017). Customer psychological empowerment as a critical source of customer engagement. *International Studies of Management & Organization*, *47*(1), 61-87. https://doi.org/10.1080/00208825.2017.1241089

Ng, W. (2012). Can we teach digital natives digital literacy?. *Computers & education*, *59*(3), 1065-1078.

Panda, S., & Kaur, N. (2024). Empowered minds: Navigating digital seas with emerging information literacy framework. In *Examining information literacy in academic libraries* (pp. 48-82). IGI Global Scientific Publishing.

Pangarkar, A., Arora, V., & Shukla, Y. (2022). Exploring phygital omnichannel luxury retailing for immersive customer experience: The role of rapport and social engagement. *Journal*

of Retailing and Consumer Services, *68*, 103001. https://doi.org/10.1016/j.jretconser.2022.103001
Pantano, E., & Gandini, A. (2017). Exploring the forms of sociality mediated by innovative technologies in retail settings. *Computers in Human Behavior, 77*, 367–373. https://doi.org/10.1016/j.chb.2017.02.036
Pantano, E., Rese, A., & Baier, D. (2017). Enhancing the online decision-making process by using augmented reality: A two country comparison of youth markets. *Journal of Retailing and Consumer Services*, *38*, 81-95. https://doi.org/10.1016/j.jretconser.2017.05.011
Poushneh, A., & Vasquez-Parraga, A. Z. (2017). Discernible impact of augmented reality on retail customer's experience, satisfaction and willingness to buy. *Journal of Retailing and Consumer Services, 34*, 229–234. https://doi.org/10.1016/j.jretconser.2016.10.005
Rauschnabel, P. A., Felix, R., & Hinsch, C. (2019). Augmented reality marketing: How mobile AR-apps can improve brands through inspiration. *Journal of Retailing and Consumer Services, 49*, 43–53. https://doi.org/10.1016/j.jretconser.2019.03.004
Rodríguez-Torrico, P., Cabezudo, R. S. J., & San-Martin, S. (2017). Tell me what they are like and I will tell you where they buy: An analysis of omnichannel consumer behavior. *Computers in Human Behavior, 68*, 465–471. https://doi.org/10.1016/j.chb.2016.11.064
Sarkis, N., Jabbour Al Maalouf, N., Saliba, E., & Azizi, J. (2025). The impact of augmented reality within the fashion industry on purchase decisions, customer engagement, and brand loyalty. *International Journal of Fashion Design, Technology and Education*, 1-10. https://doi.org/10.1080/17543266.2025.2470187
Sheng, N., Yang, C., Han, L., & Jou, M. (2023). Too much overload and concerns: Antecedents of social media fatigue and the mediating role of emotional exhaustion. *Computers in Human Behavior*, *139*, 107500. https://doi.org/10.1016/j.chb.2022.107500
Smit, A., Swart, J., & Broersma, M. (2025). Bypassing digital literacy: Marginalized citizens' tactics for participation and inclusion in digital societies. *new media & society*, *27*(6), 3127-3145. https://doi.org/10.1177/14614448231220383
Thakkar, K. Y., Joshi, B. B., & Kachhela, P. P. (2023). Consumer engagement with augmented reality (AR) in marketing: Exploring the use of ar technology in marketing campaigns and its impact on consumer engagement, brand experiences, and purchase decisions. *Journal of Management Research and Analysis*, *10*(2), 99-105. https://doi.org/10.18231/j.jmra.2023.017
Vakulenko, Y., Shams, P., Hellström, D., & Hjort, K. (2019). Online retail experience and customer satisfaction: The mediating role of last mile delivery. *The International Review of Retail, Distribution and Consumer Research, 29*(3), 306–320. https://doi.org/10.1080/09593969.2019.1598466
Verhoef, P. C., Lemon, K. N., Parasuraman, A., Roggeveen, A., Tsiros, M., & Schlesinger, L. A. (2009). Customer experience creation: Determinants, dynamics and management strategies. *Journal of Retailing, 85*(1), 31–41. https://doi.org/10.1016/j.jretai.2008.11.001
Wang, J. (2024). The Effect of Augmented Reality Interactivity on Consumer Brand Engagement—A Chain Mediating Model. *J. Electrical Systems*, *20*(3), 273-288. https://pdfs.semanticscholar.org/3d93/7e7d60fa66766cee58f408e979793d260033.pdf
Yim, M. Y. C., Chu, S. C., & Sauer, P. L. (2017). Is augmented reality technology an effective tool for e-commerce? An interactivity and vividness perspective. *Journal of Interactive Marketing, 39*(1), 89–103. https://doi.org/10.1016/j.intmar.2017.04.001
Zhang, M., Ren, C., Wang, G. A., & He, Z. (2018). The impact of channel integration on consumer responses in omni-channel retailing: The mediating effect of consumer empowerment. *Electronic commerce research and applications*, *28*, 181-193. https://doi.org/10.1016/j.elerap.2018.02.002