Customer loyalty through augmented reality apps: quality attributes, market differences, and trust as a mediator

Wenxuan Shi, Farlane S. Rumokoy & Björn Frank

Published online: 11 Mar 2025.

Submit your article to this journal

Article views: 3135

View related articles

View Crossmark data

Citing articles: 6 View citing articles

Routledge
Taylor & Francis Group

Check for updates

Customer loyalty through augmented reality apps: quality attributes, market differences, and trust as a mediator

Wenxuan Shi ⓘ , Farlane S. Rumokoy ⓘ and Björn Frank ⓘ*

Faculty of Commerce, Waseda University, Tokyo, Japan

Since limited trust is a major barrier to consumer adoption of products and services, this research examines how augmented reality (AR) apps can be designed for different market segments to effectively increase consumer trust and thereby loyalty. Its originality lies in examining the behavioral impact of a previously unexplored set of AR app quality attributes, and in comparing this impact across previously unexplored dimensions of consumer markets. Using the statistical software packages SPSS and AMOS, this research analyzes data collected from 1661 consumers in China and Japan using random sampling. The results suggest that the AR app quality dimensions of interactivity, system quality, product informativeness, and reality congruence positively influence consumer trust in a firm's digital marketing content, which in turn drives consumer loyalty. The effect of product informativeness is stronger for consumers with more e-commerce experience. A comparison of consumer markets with higher (China) and lower (Japan) digital competitiveness suggests that market digital competitiveness amplifies the effect of system quality and attenuates the effect of reality congruence. These findings guide practitioners in the design of trust-building AR apps and expand marketing scholars' understanding of trust formation.

KEYWORDS: Augmented reality; brand loyalty; trust; reality congruence; system quality; product informativeness; digital competitiveness; e-commerce experience

1. Introduction

Lack of trust is a major barrier to consumer adoption of products and services, especially in contexts with low tangibility of offerings such as e-commerce platforms (Aljifri et al., 2003). Despite years of extensive research on trust formation, the literature still lacks a definitive solution for building trust in e-commerce transactions (Kassim & Asiah Abdullah, 2010). Given the prevailing low levels of trust in e-commerce, it is imperative to increase consumer trust in digital content in order to stimulate consumer purchases. In this article, we argue that augmented reality (AR), as a novel form of presenting digital content, is a powerful digital marketing tool that offers a way to increase the tangibility of products and foster trust. This, in turn, has the potential to be a catalyst for increased sales (Yaoyuneyong et al., 2016) and customer loyalty. The uniqueness of AR lies in its ability to seamlessly overlay digital marketing content onto the consumer's physical environment in real time, allowing consumers to better evaluate the usefulness of products in their lives (Georgiou & Kyza, 2017).

---

*Corresponding author. Email: frank@waseda.jp Faculty of Commerce, Waseda University, 1-6-1 Nishi-Waseda, Shinjuku-ku, Tokyo 169-8050, Japan

As an example of the marketing benefits of AR, a consumer may want to purchase a chair on an e-commerce platform to match a dining table at home. However, the difficulty in evaluating the chair based on pictures and descriptions (i.e. low tangibility) leads to concerns about the actual fit of the product, that is, low confidence in the ability to evaluate the chair and its fit in the home environment, and thus low trust in the brand's digital content. After receiving the chair, the consumer may find that the chair is the wrong size, leading to low customer loyalty. We propose that a well-designed, high-quality AR smartphone app would solve the problem of low tangibility by allowing the consumer to place a virtual instance of the chair in the home to evaluate the product and its fit in the home environment. This would increase the consumer's confidence in being able to fully evaluate the products offered prior to purchase, thereby increasing consumer trust in the brand's digital content and subsequently customer loyalty.

Incorporating AR into e-commerce strategies has been proposed as a strategic approach to building trust by providing a multifaceted enhancement to the consumer experience (Chylinski et al., 2020). However, despite the recognition of AR as an innovative marketing tool, consumer adoption of AR has been slow (Sahi et al., 2021), mainly because firms lack knowledge about the specific AR designs that effectively address consumer concerns and thus build trust (Alimamy & Al-Imamy, 2022; Han et al., 2019). To address this gap in the literature, our article addresses two research questions: First, how specifically does an AR app need to be designed to foster consumer trust in digital marketing content in a risky environment (e.g. e-commerce, Nepomuceno et al., 2014), thus laying the groundwork for customer loyalty? To address this research question, we develop a novel set of AR app quality attributes that we predict will increase consumer trust and, in turn, loyalty. Second, how do the effects of these AR app quality attributes vary across consumer markets? To address this research question, we examine the moderators of consumer e-commerce experience and market digital competitiveness.

Our research draws on trust theory, which focuses on the predictors and consequences of trust (Mayer et al., 1995) and has been widely used in digital contexts (Lauer & Deng, 2007), because our goal is to examine how different AR app quality attributes affect trust and thus customer loyalty. Our theoretical contributions are to test the predictive validity of trust theory in the new context of AR apps, which aim to enhance the low tangibility of digitally presented products (Aljifri et al., 2003; Chylinski et al., 2020), and to examine market digital competitiveness and consumers' e-commerce experience as new boundary conditions (i.e. moderators) that determine the predictive validity of trust theory in digital contexts.

Because these boundary conditions are at the market level and thus require data from consumer segments in more than one country, we conduct the first multi-country study of the marketing effects of AR. Specifically, we use data from 1661 consumers across different market segments in Japan and China. We chose these two countries because they are two of the three largest consumer markets in the world (Abulaiti et al., 2011; CIA, 2023; Frank et al., 2012) and thus important for practitioners. In addition, they are culturally similar, while they differ significantly in the level of market digital competitiveness as our focal market-level moderator, which is much higher in China than in Japan (IMD, 2023).

2. Conceptual background

2.1. *AR in marketing*

Definition. AR is a technology that has the ability to overlay interactive digital elements (such as computer-generated images, text content, audio, video, and other multimedia

elements) onto the consumer's real-time environment (Javornik, 2016; Milgram et al., 1994). An AR app is a mobile or desktop software application based on AR technology.

Marketing applications of AR. The novel capabilities of AR apps offer marketers new ways to engage customers and enrich their experiences. For example, an AR app can place a digital version of a product, such as a sofa (or clothing), in a real-time video of the consumer's living room (or body), which helps the consumer evaluate the product and its fit with the consumer's needs. In this way, AR apps can allow consumers to quickly try out products virtually without having to visit a physical store (Verhagen et al., 2014). This saves time for consumers and reduces the cost to firms of operating offline showrooms. In reviewing the marketing applications of AR apps, we identified four broad uses of the technology in retail settings: (1) entertaining consumers, (2) educating consumers, (3) helping consumers evaluate product fit, and (4) enhancing consumers' post-purchase consumption experience (Y. C. Tan et al., 2022). AR is believed to increase firm profits by reducing consumer uncertainty, increasing consumer confidence in purchases, and reducing firm operating costs (Hilken et al., 2017).

Literature review: marketing effects of AR. Table 1 summarizes the empirical literature on the marketing effects of AR apps. This literature consistently finds positive effects of AR on various consumer behaviors, such as visit intention (Ahmad et al., 2023; Chung et al., 2015), reuse intention (Anand et al., 2023; H. C. Kim & Hyun, 2016), purchase intention (Barta et al., 2023; Gatter et al., 2021; Haile & Kang, 2020; Poushneh & Vazquez-Parraga, 2017; Pozharliev et al., 2022; Trivedi et al., 2022; Watson et al., 2018), engagement (McLean & Wilson, 2019), and switching behavior (Chen et al., 2021; Nugroho & Wang, 2023; Rauschnabel et al., 2017; Zanger et al., 2022). Thus, AR can be used as a strategic tool to increase sales. In addition, AR positively affects consumers' psychological states such as motivation (Di Serio et al., 2013; Khan et al., 2019), experience (Huang et al., 2019; Y. Wang et al., 2019), attitude (Alimamy & Al-Imamy, 2022; Moriuchi et al., 2021; Papakostas et al., 2023; Rauschnabel et al., 2019), satisfaction (Jessen et al., 2020; Poushneh & Vazquez-Parraga, 2017), usefulness (A. Cheng et al., 2024; Chiu et al., 2021; Christ-Brendemühl & Schaarschmidt, 2021; David et al., 2021; Y. Wang et al., 2019), and value perception (Cranmer et al., 2020; Erdmann et al., 2021; Plotkina et al., 2022; Rumokoy & Frank, 2025; Saleem et al., 2021). Thus, AR can be used to shape consumers' thinking about the brand and its products, with potential benefits in long-term behavior. Furthermore, AR affects customer relationships (K. Y. Wang et al., 2023), allowing brands to grow brand communities.

In addition to these main effects, the literature has identified various mediators of these effects, such as experience quality (Alimamy & Al-Imamy, 2022; A. Cheng et al., 2024; David et al., 2021; Poushneh & Vazquez-Parraga, 2017), technology performance (H. C. Kim & Hyun, 2016; McLean & Wilson, 2019; Y. Wang et al., 2019), positive consumer affection (Anand et al., 2023; Chiu et al., 2021; Haile & Kang, 2020; Watson et al., 2018; Zanger et al., 2022), perceived benefits (Ahmad et al., 2023; Barta et al., 2023; Chen et al., 2021; Erdmann et al., 2021; Gatter et al., 2021; H. C. Kim & Hyun, 2016; Papakostas et al., 2023; Rauschnabel et al., 2019; Rumokoy & Frank, 2025; Trivedi et al., 2022), consumer engagement (Moriuchi et al., 2021), consumer attitude (Ahmad et al., 2023; Plotkina et al., 2022; Saleem et al., 2021), and social benefits (K. Y. Wang et al., 2023). Thus, experience quality, technology performance, positive consumer affection, and perceived benefits are among the reasons for the positive marketing effects of AR. Furthermore, the literature shows that technology characteristics (Huang et al., 2019; Jessen et al., 2020; Nugroho & Wang, 2023; Poushneh & Vazquez-Parraga, 2017), consumer motivation (Ahmad et al., 2023; Gatter et al., 2021; McLean & Wilson, 2019; Watson et al.,

Table 1. Positioning in the empirical literature about the marketing effects of AR.

| Authors (Year) | Setting of study | | | | | Results | |
	Industries	Countries	Sample size	Dependent variable	Effects of independent variables	Mediators of these effects	Moderators of these effects
Di Serio et al. (2013)	Education	Spain	55 (students)	Students' motivation to study course	AR systems/technology (+)	–	–
Chung et al. (2015)	Tourism	South Korea	145	Tourist visit intention	AR attitude/positive feeling about AR (+)	–	–
Kim & Hyun (2016)	Telecom	South Korea	134 (students)	AR reuse intention	System quality (+), information quality (+), service quality (+)	Usefulness (+), telepresence (+)	–
Poushneh & Vazquez-Parraga (2017)	Retail	USA	99	User willingness to buy, user satisfaction	AR apps (+)	User experience (+)	Price-value trade-off (+), user information privacy control (+)
Rauschnabel et al. (2017)	Game	Germany	642	Behavioral intention	AR attitude (+)	–	
Watson et al. (2018)	Fashion	Switzerland	162	Purchase intention	Augmentation effect (+)	Positive affective response (+)	Hedonic motivation (+)
Huang et al. (2019)	Retail	Taiwan	207	Rapport experience	AR services (+)	–	Body surveillance (+), fashion consciousness (+)
Khan et al. (2019)	Education	South Africa	78 (students)	Learning motivation	AR mobile applications (+)	–	–
McLean & Wilson (2019)	Retail	UK	441	Brand engagement	AR mobile applications (+)	Technology attributes (+), subjective norms (n.s.)	Purpose of use (+)
Rauschnabel et al. (2019)	Retail	Germany	201	Changes in brand attitude	Augmentation quality (+)	Consumer inspiration (+)	–
Wang et al. (2019)	Fashion	South Korea	202	Flow experience, decision comfort	AR apps (+)	Spatial presence (+)	–
Cranmer et al. (2020)	Tourism	Germany	15 (managers)	Perceived value	AR systems/technology (+)	–	–

Haile & Kang (2020)	Retail	Korea	188 (students)	Purchase intention	AR mobile applications (+)	Consumer cognition (n.s.), consumer affection (+)	–
Jessen et al. (2020)	Retail	Europe	106	Anticipated satisfaction	AR use (+)	–	Assessment orientation (+)
Chen et al. (2021)	Retail	Taiwan	137	Behavioral response	AR apps (+)	Consumer perception (+)	–
Chiu et al. (2021)	Retail	China	426	Individual net benefits	AR apps (+)	User satisfaction (+), continuance intention to use (+)	–
Christ-Brendemühl & Schaarschmidt (2021)	Retail	Germany	215	Distributive fairness, procedural fairness, price fairness	AR-enabled customer participation (−)	–	–
Erdmann et al. (2021)	Retail	Spain	253 (students)	Perceived value	AR app dimensions (+)	Perceived benefits (+), perceived costs difficulty (−)	–
David et al. (2021) (AR scenario only)	Retail	USA	102	Recommendation intention	AR environmental stimulus (+)	Customer experience (satisfaction) (+)	–
Gatter et al. (2021) (study 3 only)	Retail	Germany	92	Purchase intent	AR feature type (n.s.)	Utilitarian benefits (+)	Autotelic need for touch (+)
Moriuchi et al. (2021)	Retail	USA	68	Attitude toward firm	Attitude toward AR/chatbot (+)	Technology engagement (+)	–
Pozharliev et al. (2022) (study 1 only)	Retail	Europe	60	Willingness to pay	AR advertising (+)	–	–

(Continued)

Table 1. Continued.

| Authors (Year) | Setting of study | | | | Results | | |
	Industries	Countries	Sample size	Dependent variable	Effects of independent variables	Mediators of these effects	Moderators of these effects
Saleem et al. (2021)	Education	Pakistan	133 (students)	E-learning intention	AR apps (+)	Attitude (+), subjective norms (+), perceived behavioral control (+)	–
Trivedi et al. (2022)	Fashion	USA	343	Online impulse buying intention	Perceived augmented quality (+)	Perceived value (+)	Product involvement (n. s.)
Ahmad et al. (2023)	Tourism	China	484	Future destination intention	Augmentation quality (+)	Perceived usefulness (+), AR attitude (+)	Expected enjoyment of destination (+)
Alimamy & Al-Imamy (2022)	Retail	Saudi Arabia	286	Consumer attitudes	Perceived AR app dimensions (+)	Experience quality (+)	–
Anand et al. (2023)	Tourism	India	204	Reuse intention	AR-based apps dimension (+)	User satisfaction (+)	–
Papakostas et al. (2023)	Education	Greece	220 (students)	Attitude towards using AR	Perceived ease of use (+), quality output (+), playfulness (+)	Perceived usefulness (+)	–
Plotkina et al. (2022)	Fashion	France	282 (students)	Perceived brand personality	Perceived AR app experience (+)	Attitude toward the AR app (+)	Consumer characteristics (+)
Zanger et al. (2022)	Retail	Germany	238 (students)	Behavioral responses	AR-based product presentations (+)	Affective responses (+), cognitive responses (+)	–
Barta et al. (2023)	Fashion	USA	256	Prepurchase cognitive dissonance	AR apps (n.s.)	Perceived similarity (+), confusion by overchoice (+)	–
Nugroho & Wang (2023)	Retail	Indonesia	160	Switching behavior	AR systems/technology (−)	Perceived performance risk (−)	Information asymmetry (+)

Wang et al. (2023)	Fashion	Canada	528	Customer-to-customer relationship	Social AR app usage (+)	Shared sense of place (+), social interaction (+), social identity (+)	Extraversion (+)
Cheng et al. (2024)	Tourism	China	295	Perceived ease of use, perceived usefulness	AR quality (+)	Aesthetic experience (+), escapist experience (+)	–
Rumokoy & Frank (2025)	Retail	Indonesia	302	Perceived product value	Perceived AR app performance (+)	AR app-product evaluation fit (+)	AR knowledge (−), e-commerce knowledge (+), conscientiousness (−), openness (+)
This article (2025)	Retail	China, Japan	1661	Brand loyalty	AR app quality attributes: interactivity (+), system quality (+), product informativeness (+), reality congruence (+)	Brand online trust (+)	E-commerce experience (+), market digital competitiveness (−/+)

Notes: (+)/(−)/(n.s.): positive/negative/non-significant effect.

2018), consumer characteristics (Plotkina et al., 2022; Rumokoy & Frank, 2025; K. Y. Wang et al., 2023), and e-commerce knowledge (Rumokoy & Frank, 2025) moderate the marketing effectiveness of AR. Thus, the effectiveness of AR varies across contexts.

Our study extends this literature by not only demonstrating that AR has general marketing benefits, but also by being the first study to identify the specific quality dimensions of AR apps that drive their success in increasing customer loyalty as a behavioral marketing outcome. Furthermore, our study is the first to suggest a role for trust as a mediator of the marketing effects of AR. In addition, we conduct the first cross-country study on the effects of AR and identify new moderators of the marketing effects of AR (e-commerce experience, market digital competitiveness).

2.2.   *The problem of low trust in online shopping*

Effects of trust on consumer behavior. Consumer trust is a consumer's belief in the truthfulness of information (e.g. marketing content), the reliability of processes (e.g. delivery), and the ability of a firm to deliver on its promises and provide a satisfactory experience in an economic transaction (Hu et al., 2022; Merriam-Webster, 2023). Trust is very important in high-risk consumption contexts, such as in e-commerce, where anonymous sellers, who are often difficult to contact, can easily spread untrue content and renege on their promises (Oliveira et al., 2017). In such contexts, trust helps reduce consumers' perceptions of risk, giving them confidence that future problems are unlikely to occur and encouraging them to purchase products (D. J. Kim et al., 2008). Thus, by increasing consumer trust, firms can increase the likelihood that consumers will make initial purchases, engage in repeat transactions, and develop ongoing relationships with the firm (Kassim & Asiah Abdullah, 2010; Pavlou, 2003). Consequently, building and maintaining trust is a central focus for e-commerce firms (Shankar et al., 2002).

The crisis of low online trust. Corporate scandals, online fraud, and violations of consumers' private data have eroded consumers' trust in corporate activities, especially in online environments, and limited their purchasing potential (Acquisti & Grossklags, 2005; Whitty & Buchanan, 2012). Thus, marketers need to find ways are to help rebuild consumers' online trust, that is, trust in the digital marketing content presented by firms in an online environment. Our research objective is to explore how critical AR app quality attributes can play a role in increasing consumers' online trust and, in turn, their loyalty.

2.3.   *Trust theory*

To develop our hypotheses, we build on trust theory (Mayer et al., 1995). It defines trust as the willingness of the trustor (here, the consumer) to be vulnerable to the actions of a trustee (here, a firm or brand), with the expectation that the trustee will take critical actions to justify this trust and that the trustor will have some degree of control over the trustee. In digital marketing, trust theory emphasizes the role of the trustee's (i.e. brand's) trustworthiness attributes (ability, benevolence, and integrity) in shaping the trust of the trustor (i.e. consumer). In this context, ability refers to a brand's perceived capability, which includes the possession of skills, knowledge, competencies, and attributes necessary to perform specific tasks (Smith & Barclay, 1997). Benevolence denotes a brand's perceived desire to benefit consumers beyond self-interest (Mayer et al., 1995), reflecting benign motives and genuine concern. Integrity represents a brand's perceived commitment to principles acceptable to consumers, including keeping promises, following rules, and preventing the exploitation of loopholes that could

compromise consumers' rights and interests (Isaeva et al., 2020). In addition, consumer characteristics and experiences may moderate this trust formation process (Y. T. Hung et al., 2004; Mayer et al., 1995). Once formed, trust then increases the trustor's willingness to take risks (Mayer et al., 1995), such as the consumer's willingness to repurchase from the same brand, that is, customer loyalty (Hu et al., 2022). In our research, we argue that AR enhances the tangibility of the brand's digital marketing content, thereby improving consumers' perceptions of the brand's ability, integrity, and benevolence (trustworthiness factors), resulting in higher trust and, in turn, loyalty.

2.4.   *Intended contributions of this research*

Our article aims to make three theoretical contributions to the literature on the marketing effects of AR and trust theory. First, it is the first article to examine how AR affects the formation of consumer trust, which is a key driver of product adoption, especially in online contexts (Aljifri et al., 2003). As outlined in our literature review, numerous previous studies report positive effects of AR apps on various consumer behaviors and market contexts. Given the perceived risks consumers face in the digital marketplace, brand online trust emerges as a critical component for firms seeking to increase consumer purchases and loyalty. Our research extends trust theory (Mayer et al., 1995) to the AR app context by being the first to highlight the crucial role of brand online trust (S. W. Hung et al., 2012) in mediating the effects of AR app quality attributes on customer loyalty. That is, while previous studies often consider customer satisfaction as the key mediator of the effect of quality on customer loyalty, we argue that brand online trust plays a crucial mediating role in the context of AR apps for e-commerce transactions, where overcoming low trust is key to commercial success (Shankar et al., 2002).

Second, we develop a unique set of AR app quality attributes that we predict will be effective in increasing consumer trust and, through mediation, consumer loyalty. That is, we argue that not all AR apps, but only well-designed AR apps that achieve high quality on critical attributes, effectively increase consumer trust and loyalty. From a theoretical perspective, since trust theory considers trustworthiness factors as antecedents to trust formation (Mayer et al., 1995), we examine the role of our proposed set of critical AR app quality attributes in strengthening trustworthiness factors and thereby increasing trust. Thus, we extend trust theory by integrating critical AR app quality attributes into trust formation.

Third, we examine the variation of these effects across market segments and conduct the first cross-country study of the effects of AR. In doing so, we explore the previously neglected moderating role of consumer e-commerce experience and market digital competitiveness. As only a limited number of moderators of the mechanisms of trust theory have been examined (Y. T. Hung et al., 2004), we extend trust theory by exploring the effects of micro-market environments and individual characteristics on trust formation, thus identifying new boundary conditions for the predictive validity of trust theory.

From a practical perspective, our research aims to guide firms in designing AR apps that can increase consumer trust and loyalty in different markets.

3.   Hypotheses
3.1.   *Conceptual model: AR as a way of building consumer trust and loyalty*

Based on trust theory (Mayer et al., 1995), we argue that AR helps firms build consumer trust by increasing the tangibility of digital marketing content. The tangibility increases

consumers' perceived ability, benevolence, and integrity (trustworthiness factors) of a brand, which contributes to brand online trust and, thereby, loyalty. Thus, a design of AR apps that succeeds in increasing tangibility in a way that resembles an offline experience with a product will lead to higher trust in the digital content (i.e. online trust). Moreover, we argue that the effectiveness of AR apps in building trust depends on consumer needs and thus varies across consumer segments. Figure 1 presents the research framework of our study, which predicts the main effects of AR app quality attributes on consumer trust and, through mediation, on brand loyalty and predicts differences across consumer market segments.

3.2. *The trust-building role of different AR app quality attributes*

Interactivity. The interactivity of an AR app is the extent to which users can actively engage in real-time modifications of the structure and content of a mediated environment (Steuer, 1992). Interactivity not only serves as a source of entertainment for users (Tian & Frank, 2024), but also provides them with the ability to personalize information within a three-dimensional virtual model (Fiore et al., 2005; Herbas Torrico & Frank, 2019). Previous studies have shown that users derive more satisfaction from interacting with virtual objects than from handling or observing physical objects (Li et al., 2001). AR interactivity plays a critical role in facilitating consumers' comprehensive examination of virtual products, allowing them to view virtual products from multiple perspectives and conveniently position them in their immediate environment. Such virtual interactivity is similar to how consumers would touch, move, and interact with actual physical products in their environment and is likely to make the virtual representation of the product appear tangible (Z. Cheng et al., 2022). This increased product tangibility mitigates consumers' lack of product knowledge and helps them understand not only the benefits of the product, but also its weaknesses. Therefore, it enhances consumers' perceptions of the focal brand' ability to provide a superior product without having to hide anything (Tomlinson & Schnackenberg, 2022), its integrity to act in the consumer's interest (Isaeva et al., 2020), and its benevolence to benefit consumers beyond its self-interest to quickly close
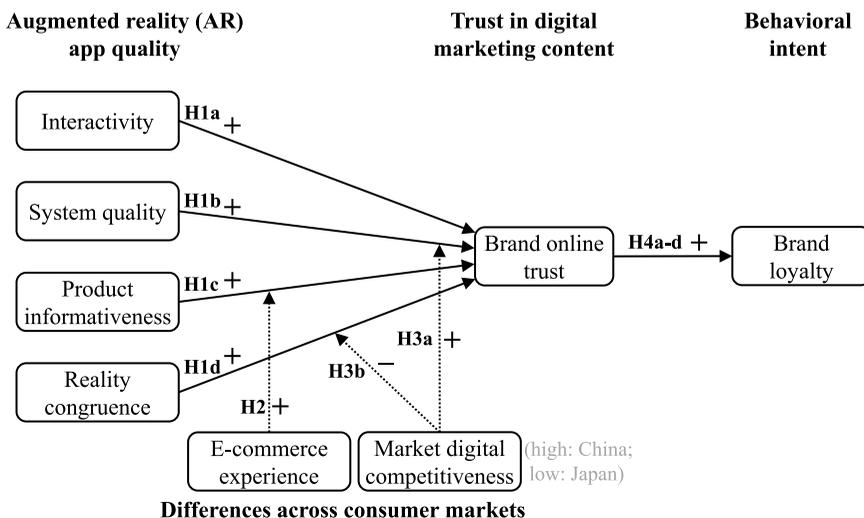

Figure 1. Conceptual framework and hypotheses.

a sale (C. W. Tan et al., 2008). In turn, trust theory (Mayer et al., 1995) predicts that a consumer's perception of the brand's ability, integrity, and benevolence will lead to consumer trust in the digital product information provided by the brand (i.e. brand online trust).

H1a: The interactivity of an AR app has a positive effect on brand online trust.

System quality. System quality refers to the speed and reliability of an AR app, ensuring its proper functioning and usability (DeLone & McLean, 2003). High system quality allows consumers to efficiently navigate the AR app, effectively acquire product information, and perceive a seamless fusion between the virtual stimuli and the real environment presented in the AR app (Hilken et al., 2017), making the virtual product information appear tangible. In contrast, low system quality leads to unrealistic delays and app crashes that disrupt the experience, limiting the potential of the AR app to increase tangibility (Hilken et al., 2017). As explained above, tangibility increases consumers' perceptions of the ability, integrity, and benevolence of the brand delivering the digital marketing content (C. W. Tan et al., 2008), which trust theory predicts will increase brand online trust (Mayer et al., 1995).

H1b: The system quality of an AR app has a positive effect on brand online trust.

Product informativeness. Product informativeness is the wealth of information about a focal product conveyed by the AR app. It provides consumers with information relevant to purchase decisions. Prior research reports that AR apps are perceived as valuable due to the information they provide (Olsson et al., 2013). Higher product informativeness in the AR app leads to richer and clearer information about a product, thereby reducing information asymmetry and making the product appear more tangible (Walters et al., 2012). As explained above, tangibility increases consumers' perceptions of the ability, integrity, and benevolence of the brand delivering the digital marketing content (C. W. Tan et al., 2008), which trust theory predicts will increase brand online trust (Mayer et al., 1995).

H1c: The product informativeness of an AR app has a positive effect on brand online trust.

Reality congruence. Reality congruence is the ability of an AR app to create a realistic mediated environment by integrating the sensory experiences associated with real-world objects and the non-sensory experiences of imaginary objects to form a distinct, vivid mental image for the individual (Steuer, 1992). Such a seamless, realistic integration of the virtual product with the consumer's own environment enables consumers to more effectively evaluate how a product fits with their needs in their natural environment, such as their home or daily life (Lee, 2004). Moreover, such realism is associated with a more visually accurate product presentation with benefits such as clarity, detail, sharpness, and well-defined features (Flavian et al., 2017; Griffith & Gray, 2002; Yim et al., 2017), which make the product appear more tangible and help consumers evaluate the product (Orús et al., 2017). As explained above, tangibility increases consumers' perceptions of the focal brand's ability, integrity, and benevolence (C. W. Tan et al., 2008), which trust theory predicts will increase brand online trust (Mayer et al., 1995).

H1d: The reality congruence of an AR app has a positive effect on brand online trust.

3.3. *The effects of augmented reality app quality on trust: differences across consumer segments*

E-commerce experience. E-commerce experience is the cumulative psychological impact of customer engagement across multiple touchpoints with online shopping environments (Bleier et al., 2019; Novak et al., 2000; Rose et al., 2012; Trevinal & Stenger, 2014).

Consumers with extensive e-commerce experience use their accumulated knowledge to skillfully imagine and evaluate whether digital information about products meets their needs (Jeong & Yeu, 2023), thereby strengthening the effect of product informativeness on the perceived tangibility of the presented product-related brand. This skill stems from their continuous practice and learning from past mistakes in inferring product characteristics from digital information (Bleier et al., 2019). In turn, as explained above, this increased tangibility would enhance consumers' perception of the focal brand's ability, integrity, and benevolence (C. W. Tan et al., 2008), which trust theory predicts will then lead to increased brand online trust (Mayer et al., 1995). Thus, we posit that consumers with more e-commerce experience have a greater ability to perceive digital product information as tangible, thereby enhancing the trustworthiness attributes of the presented product-related brand, allowing these consumers to trust and rely on the brand more.

> **H2:** The product informativeness of an AR app has a stronger positive effect on brand online trust for consumers with more e-commerce experience.

Market digital competitiveness. Market digital competitiveness is the extent to which firms compete in a consumer market (such as a national market) by offering superior digital solutions, which means offering more digital products or services and making more concerted efforts to ensure their system quality (Chi, 2018; Qin et al., 2022). In such a competitive market environment, consumers become accustomed to firms that offer digital apps with superior system quality (Shahid et al., 2022). Thus, we posit that they become less tolerant of AR apps with inferior system quality as they perceive superior alternatives, making system quality a more important factor in the formation of tangibility perceptions that lead to perceptions of the focal brand's ability, benevolence, and integrity (C. W. Tan et al., 2008) and thus to trust as predicted by trust theory (Mayer et al., 1995).

> **H3a:** The system quality of an AR app has a stronger positive effect on brand online trust for consumers in a market with higher digital competitiveness.

Similarly, in markets with high digital competitiveness, where consumers have become accustomed to using superior digital solutions, they accept the digital world as a familiar reality connected to the reality of the offline world (Mo et al., 2015; Zhao et al., 2015). Thus, AR app reality congruence is likely more important for increasing consumer perceptions of product tangibility for consumers from less digitally competitive environments, whereas consumers from more digitally competitive environments may still be able to make valid inferences from digital content with lower reality congruence, thanks to their familiarity with and experience in relating digital content to the real world. As explained, tangibility would then increase consumers' perceptions of the focal brand's ability, integrity, and benevolence (C. W. Tan et al., 2008), which trust theory predicts will increase brand online trust (Mayer et al., 1995).

> **H3b:** The reality congruence of an AR app has a weaker positive effect on brand online trust for consumers in a market with higher digital competitiveness.

3.4.   *The effect of AR app quality on brand loyalty: mediation by brand online trust*

In H1a-d, we argue that our focal AR app quality attributes (i.e. interactivity, system quality, product informativeness, and reality congruence) increase brand online trust. In turn, trust theory predicts that trust increases the consumer's (i.e. trustor's) willingness to take risks in dealing with the brand (i.e. the trustee) (Mayer et al., 1995), such as to repurchase products from that brand, that is, brand loyalty (Chaudhuri & Holbrook,

2001; Hu et al., 2022). Therefore, we posit that brand online trust mediates the effects of our focal AR app quality attributes on consumers' brand loyalty.

> **H4a:** Brand online trust mediates the effect of the interactivity of an AR app on brand loyalty.
>
> **H4b:** Brand online trust mediates the effect of the system quality of an AR app on brand loyalty.
>
> **H4c:** Brand online trust mediates the effect of the product informativeness of an AR app on brand loyalty.
>
> **H4d:** Brand online trust mediates the effect of the reality congruence of an AR app on brand loyalty.

4. Methodology

4.1. *Measures*

We conducted a survey about consumers' actual experiences with AR apps for real brands. It measured our focal variables using 7-point Likert-type multi-item scales and additional control variables using objective data. Table 2 lists all measures and their literature sources.

4.2. *Data collection and sample*

We conducted an online survey that asked consumers to choose one of multiple brands, watch a video about the AR app of that brand (Amazon: AR view feature in Amazon app; Ikea: Ikea Place app; iStaging: iStaging Interior Design app; Easyhome: Unity AR Foundation app), and then try out the AR app. Our survey used multiple brands because the perceived quality of AR apps varies both between brands offering different AR apps and between consumers who differ in their subjective experience with the same AR app. We used several attention checks to ensure that respondents were not bots, were actually watching the video, were using the AR app, and were reading our questions before answering them. The attention checks included a requirement to upload a screenshot of the respondent using the AR app. Only respondents who passed all attention checks qualified for inclusion in our data. We developed the questionnaire in English and translated it into Chinese/Japanese and back for review. Due to the anonymous and non-invasive nature of our study, our university did not require ethics approval. Informed consent was obtained from all subjects.

After conducting pre-surveys in both countries to refine the scales and optimize the text, we recruited participants for our main survey from recognized online panels with nationwide geographic reach across all consumer segments that pay respondents a nominal fee: Credamo in China (Tian & Frank, 2024) and Yahoo Crowdsourcing in Japan (Park et al., 2022). By using random sampling in these established online panels, all respondents within these nationwide panels in Japan and China had an equally fair chance of being selected. This approach ensured a representative sample that also matched the actual user base of AR apps (Sharma, 2017). Our data collection resulted in a final sample of 1661 respondents (China: 330; Japan: 1331). Specifically, 300 is a good sample size and 1000 is an excellent sample size (Comrey & Lee, 2013; Gorsuch, 2014). Based on these recommendations, we collected data from more than 300 respondents in China in mid-February 2023. After validating the results, to enhance the validity of our statistical analysis, we collected data from more than 1300 respondents in Japan in late February and early March 2023. Taking advantage of the opportunity to collect more data in Japan (1331 instead of only 330) in no way reduces the validity of our analysis, but

Table 2.   Measures.

QUESTIONNAIRE (7-point Likert-type scales; anchors: completely disagree/agree)

E-commerce experience (Rumokoy & Frank, 2025; Thong et al., 2002)
1.   I have purchased many products on e-commerce.
2.   I often purchase products on e-commerce.
3.   I spend time purchasing products on e-commerce.

Interactivity (Rumokoy & Frank, 2025; Yim et al., 2017)
1.   I can smoothly interact with the virtual product presentation in the AR app for insights about the looks of the product.
2.   I can smoothly interact with the virtual product presentation in the AR app for insights into whether it meets my needs.
3.   The level of my interaction with the virtual product presentation in the AR app is outstanding.

System quality (Rumokoy & Frank, 2025; Yim et al., 2017)
1.   The AR app is responsive to my requests and provides good results.
2.   The AR app performs its functions quickly and efficiently.
3.   The AR app has reliable quality (i.e. runs without errors).
4.   The AR app works smoothly and precisely.

Product informativeness (Rumokoy & Frank, 2025; Yim et al., 2017)
1.   The AR app shows the product information I expected.
2.   The AR app provides detailed information about the products.
3.   The AR app provides complete information about the products.
4.   The AR app provides product information that helps me in my purchasing decision.
5.   The AR app provides information to compare products.

Reality congruence (Rumokoy & Frank, 2025; Yim et al., 2017)
1.   The AR app presents the product design realistically.
2.   The AR app presents products as if they were real.
3.   The product design shown by the AR app is the same as in reality.
4.   The product design shown by the AR app is visually similar to reality.
5.   The product design shown by the AR app matches reality.

Brand online trust (Thong et al., 2002)
1.   I trust the digital marketing content provided by this brand.
2.   I feel comfortable relying on the digital marketing content provided by this brand.
3.   I feel safe relying on the digital marketing content provided by this brand.

Brand loyalty (second-order factor extracted from purchase intent and AR word of mouth)
Purchase intent (Hausman & Siekpe, 2009; pooled: $\alpha = .94$, AVE $= .84$; China: $\alpha = .88$, AVE $= .72$; Japan: $\alpha = .93$, AVE $= .82$)
1.   I will soon buy products from this brand.
2.   I intend to buy products from this brand in the near future.
3.   I will likely buy products from this brand in the next 6 months.
AR word of mouth (Goyette et al., 2010; pooled: $\alpha = .97$, AVE $= .92$; China: $\alpha = .89$, AVE $= .73$; Japan: $\alpha = .97$, AVE $= .91$)
1.   I will recommend this AR app to others.
2.   I will recommend that others try out this AR app.
3.   I will tell others that this AR app is great.

OBJECTIVE MEASURES

Female gender: 1: female; 0: male.
Age: specific age of respondent.
Purchase frequency: number of purchases from this brand in the past 12 months

Table 3. Correlations and descriptive statistics of multi-item constructs.

Variables		Pooled data (China and Japan)							China							Japan						
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
1	Interactivity																					
2	System quality	.72							.52							.64						
3	Product informativeness	.66	.80						.47	.58						.56	.75					
4	Reality congruence	.62	.81	.79					.52	.67	.64					.51	.76	.73				
5	E-commerce experience	.42	.38	.40	.37				.41	.29	.19	.29				.23	.18	.20	.17			
6	Brand online trust	.58	.68	.68	.69	.37			.45	.61	.60	.58	.16			.47	.58	.59	.61	.19		
7	Brand loyalty	.61	.66	.67	.64	.47	.75		.49	.59	.55	.58	.26	.63		.47	.52	.54	.51	.27	.68	
Descriptive statistics:																						
	Mean	4.66	4.90	4.79	5.05	4.73	4.82	4.38	6.06	5.97	5.87	6.05	6.31	5.78	5.76	4.31	4.64	4.53	4.81	4.34	4.59	4.04
	Standard deviation	1.38	1.08	1.06	1.05	1.57	1.06	1.24	.67	.65	.71	.63	.59	.71	.82	1.29	1.00	.97	.98	1.48	.99	1.08
	Cronbach's α	.94	.95	.94	.94	.95	.96	.82	.79	.83	.86	.86	.76	.85	.72	.93	.94	.93	.93	.94	.96	.73
	AVE	.85	.82	.76	.76	.87	.88	.69	.56	.56	.55	.55	.54	.66	.56	.83	.81	.73	.73	.86	.88	.58
	Maximum shared variance	.52	.65	.64	.65	.22	.57	.57	.27	.44	.41	.44	.16	.39	.39	.41	.58	.57	.58	.07	.47	.47
	Number of measurement items	3	4	5	5	3	3	6	3	4	5	5	3	3	6	3	4	5	5	3	3	6

Notes: All correlations are significant at $p < .05$. Sample size: 1661 (China: 330; Japan: 1331).

rather increases the power to test our hypotheses. For example, if the true correlation between two variables is .1, then the probability of detecting it (i.e. the statistical power) at $p < .05$ is 44.2% in a sample of 330 respondents, which increases to 95.5% in a sample of 1331 respondents (University of Vienna, 2025).

Due to the established nature and national coverage of the panels used, the samples from Japan and China had a similar distribution, reflecting their respective populations. Overall, ages ranged from 15 to 87 years, with the mean age (44 years) close to the mean age of China and Japan (45 years) (World Population Review, 2024). The samples were 42.4% female, which is consistent with the higher male interest in technologies such as AR (Frank et al., 2015, 2021) and the male population surplus in China (CIA, 2023). A comparison of means (see Table 3) shows that the quality of AR apps appears to be much higher in China than in Japan, which is consistent with the digital competitiveness of the market in China being much higher than in Japan (IMD, 2023). For these and all other analyses in our research, we used the statistical software packages SPSS 29.0 and AMOS 24.0.

4.3. *Data validity*

Convergent and discriminant validity. Our analysis uses three datasets: China, Japan, and a pooled China–Japan dataset. As shown in Table 3 (and in Table 2 for the first-order factors underlying the second-order factor of brand loyalty), the constructs in all three datasets consistently satisfy standard criteria for convergent validity. Specifically, average variance extracted (AVE) > .5, Cronbach's α > .7, and composite reliability (CR) > .7 (Hair et al., 2010). The constructs also consistently fulfill the standard criteria for discriminant validity, as all AVE values surpass the maximum squared correlations between the focal variable and all other constructs (Fornell & Larcker, 1981; Hair et al., 2010).

Moreover, confirmatory factor analysis (CFA) confirms the model fit adequacy in the following datasets: China ($\chi^2/df = 1.36$, CFI = .98, GFI = .91, AGFI = .89, RMSEA = .03, upper limit of the 90% RMSEA confidence interval (UCI) = .04), Japan ($\chi^2/df = 4.12$, CFI = .98, GFI = .93, AGFI = .91, RMSEA = .05, UCI = .05), and the pooled dataset ($\chi^2/df = 4.73$, CFI = .98, GFI = .93, AGFI = .91, RMSEA = .05, UCI = .05). These values align with established criteria for a satisfactory fit: $\chi^2/df < 5$, CFI $\geq$ .95, GFI $\geq$ .90, AGFI $\geq$ .85, RMSEA $\leq$ .07, and UCI $\leq$ .1 (Hair et al., 2010; Schermelleh-Engel et al., 2003).

Common method variance (CMV). To reduce the potential for CMV, we combined multi-item scales with objective measures and used multiple attention checks to ensure that only focused respondents who read our questions carefully, one at a time, were able to complete the questionnaire. To test for CMV, we used Harman's single-factor test (Podsakoff et al., 2003). In all datasets, a single factor accounts for well below 50% of the variance, indicating that CMV does not compromise our results. Moreover, consistent with the approach of Darley and Lim (2018), we compared the fit of a CFA model in which all indicators loaded on a single factor to another CFA model that included several distinct factors. If method variance is the primary source of covariance among the measures, a single-factor CFA model will adequately fit the data. However, a single-factor CFA model of our pooled data showed a poor (Hair et al., 2010) fit (pooled data: $\chi^2/df = 61.31$, CFI = .62, GFI = .45, AGFI = .37, RMSEA = .19, and UCI = .19), which was significantly worse than the model fit of our multi-factor CFA model ($\chi^2/df = 4.73$, CFI = .98, GFI = .93, AGFI = .91, RMSEA = .05, UCI = .05). This suggests that CMV would not seriously bias our results (Podsakoff et al., 2003).

5.   Results

5.1.   *Hypothesis tests*

Model structure. To test H1 to H3, we used moderated regression analysis, which is an ideal method for testing the combined effects of independent and moderating variables and allows the inclusion of single-item objective measures as control variables (Hair et al., 2010), on three datasets from a total of 1661 consumers (China, Japan, and pooled China–Japan data). Brand online trust is the dependent variable. Independent variables include the four dimensions (H1a–d) of AR app quality (interactivity, system quality, product informativeness, and reality congruence), e-commerce experience and its interaction with product informativeness (H2), market digital competitiveness (1: China; 0: Japan; only in the pooled dataset) and its interaction with system quality and reality congruence (H3a/b). Control variables include consumer gender (1: female; 0: male), age, and purchase frequency (number of purchases from the focal brand in the past 12 months). All variables were standardized prior to calculating the interaction terms. Multicollinearity is not an issue as all variance inflation factors are less than 5, well below the established cutoff of 10 (Akinwande et al., 2015; Mason & Perreault, 1991).

Table 4 presents the results of the hypothesis tests (H1–H3). The independent variables explain 55.7%, 51.2%, and 44.3% (adjusted R^2) of the variance in brand online trust in the pooled China–Japan analysis and in separate analyses for China and Japan, respectively.

Table 4.   The effect of AR quality attributes on brand online trust.

Independent variables	Country		
	Pooled	China	Japan
	β	β	β
Control variables:			
Intercept	−.036[†]	−.018	−.008
Female gender (1: female; 0: male)	−.010	−.077	.000
Age	.020	.151***	.022
Purchasing frequency	.078***	.030	.091***
E-commerce experience	.031	−.037	.027
Market digital competitiveness (1: China; 0: Japan)	.028		
AR app quality dimensions:			
Interactivity (H1a: +)	.107***	.067	.111***
System quality (H1b: +)	.152***	.290***	.097*
Product informativeness (H1c: +)	.245***	.272***	.223***
Reality congruence (H1d: +)	.271***	.159**	.308***
Differences across consumer markets:			
E-commerce experience × Product informativeness (H2: +)	.044**	.095*	.041*
Market digital competitiveness × System quality (H3a: +)	.105**		
Market digital competitiveness × Reality congruence (H3b: −)	−.071*		
Fit statistics:			
Adjusted R^2	.557	.512	.443

Notes: [†]$p < .1$; *$p < .05$; **$p < .01$; ***$p < .001$ (two-sided). Sample size: 1661 (China: 330; Japan: 1331). All variables standardized before calculating interaction terms.
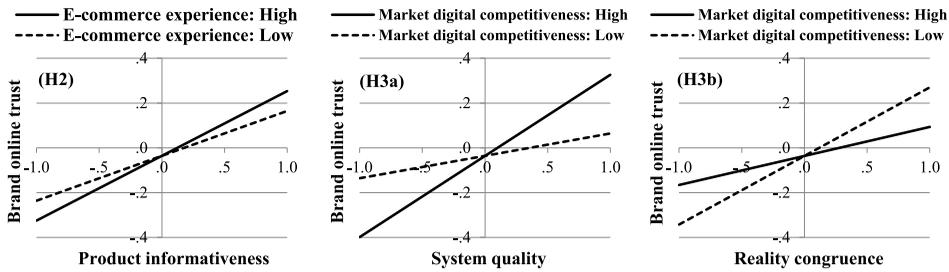
Figure 2. Interaction plots for hypothesized moderating effects.

Main effects. As shown in Table 4, virtually all AR app quality attributes have positive effects on brand online trust (supporting H1a–d): interactivity ($\beta_{Pooled} = .107$, $\beta_{JP} = .111$, both $p < .001$), system quality ($\beta_{Pooled} = .152$, $\beta_{CN} = .290$, both $p < .001$; $\beta_{JP} = .097$, $p < .05$), product informativeness ($\beta_{Pooled} = .245$, $\beta_{CN} = .272$, $\beta_{JP} = .223$; all $p < .001$), and reality congruence ($\beta_{Pooled} = .271$, $p < .001$; $\beta_{CN} = .159$, $p < .01$; $\beta_{JP} = .308$, $p < .001$). As an exception, the effect of interactivity (H1a) on brand online trust in China is not significant ($\beta_{CN} = .067$, $p > .10$), but our follow-up analyses in the pooled dataset confirm that this effect is not statistically different from the significant positive effect of interactivity in Japan. In addition, power analysis (University of Vienna, 2025) shows that a presumably identical result would have led to significant ($p < .05$) support for H1a in China if the Chinese sample size had matched the Japanese sample size (1331). Of the four AR app quality attributes, interactivity appears to have the weakest effect.

Moderating effects. As shown in Table 4, the consumers' e-commerce experience positively moderates the effect of product informativeness and consumers' online trust in the pooled analysis ($\beta = .044$, $p < .01$) as well as in the separate analyses for China ($\beta = .095$, $p < .05$) and Japan ($\beta = .041$, $p < .05$), supporting H2. The analysis of the pooled China–Japan data shows that market digital competitiveness (i.e. China as compared with Japan) positively moderates the effect of system quality on brand online trust ($\beta = .105$, $p < .01$) and negatively moderates the effect of reality congruence ($\beta = -.071$, $p < .05$). Thus, H3a and H3b are supported. Figure 2 visualizes these moderating effects based on at least marginally significant coefficients.

The mediating role of brand online trust. Consistent with our conceptual model (see Figure 1) and supporting H4a–d, further analyses show that brand online trust mediates all supported hypothesized effects on customer loyalty. Specifically, the AR app quality attributes have a significant positive overall effect on brand loyalty: interactivity ($\beta_{Pooled} = .155$, $p < .001$; $\beta_{CN} = .140$, $p < .01$; $\beta_{JP} = .176$, $p < .001$), system quality ($\beta_{Pooled} = .096$, $p < .01$; $\beta_{CN} = .253$, $p < .001$; $\beta_{JP} = .072$, $p < .10$), product informativeness ($\beta_{Pooled} = .231$, $p < .001$; $\beta_{CN} = .166$, $p < .01$; $\beta_{JP} = .248$, $p < .001$), and reality congruence ($\beta_{Pooled} = .174$, $\beta_{CN} = .206$, $\beta_{JP} = .186$, all $p < .001$). These effects become significantly weaker when brand online trust is added as a predictor, which strongly influences customer loyalty ($\beta_{Pooled} = .452$, $\beta_{CN} = .272$, $\beta_{JP} = .509$, all $p < .001$). Following Baron and Kenny's (1986) approach, we provide more details on the direct and indirect (i.e. mediated by brand online trust) effects of the AR app quality attributes on brand loyalty for our pooled dataset. Interactivity has significant direct ($\beta = .108$, $p < .001$) and indirect ($\beta = .048$, $p < .001$) effects on brand loyalty, indicating partial mediation (supporting H4a). System quality has only a significant indirect ($\beta = .069$; $p < .001$) effect, but no direct effect, on brand loyalty, indicating full mediation (supporting H4b). Product

informativeness has significant direct ($\beta = .123$, $p < .001$) and indirect ($\beta = .111$, $p < .001$) effects on brand loyalty, indicating partial mediation (supporting H4c). Finally, reality congruence has only a significant indirect ($\beta = .123$; $p < .001$) effect, but no direct effect, on brand loyalty, indicating full mediation (supporting H4d). Taken together, these results fully support the mediating role of brand online trust (H4a–d). They also suggest that interactivity and product informativeness have additional direct, unmediated effects on brand loyalty, possibly due to the hedonic and utilitarian value derived from interactivity and product information (Tian & Frank, 2024).

5.2. *Robustness tests*

Squared independent variables. To test our hypotheses for non-linearity, we conducted a robustness test by adding squared terms of all non-binary independent and moderating variables to the regression models. Adding these terms does not alter the conclusions of the hypothesis tests (significance, direction).

 Formative, rather than reflective, measures. As a further robustness test, we operationalized all multi-item constructs as the mean of their items (i.e. an index) rather than as factors. The conclusions of these analyses are identical to those of our hypothesis tests (significance, direction).

 Same sample size per country. We replicated the results using a random subsample of only 330 (instead of 1331) respondents in Japan, matching the sample size in China. The results remain consistent in significance and direction with those obtained from the larger sample of 1331 respondents in Japan.

 Bootstrap method for mediation. Following Tian and Frank's (2024) approach, we tested the mediation effect of brand online trust using the PROCESS 4.1 macro embedded in the SPSS software package. We employed Model 4 for the mediation analysis, setting a 95% confidence level for confidence intervals and using 5000 bootstrap samples for the bias-corrected bootstrap confidence intervals (Hayes, 2017). The results consistently indicate that brand online trust mediates the effect of AR app quality dimensions on brand loyalty across all of our datasets, supporting H4a–d.

6. Discussion

6.1. *Summary of research*

As an innovative way to present digital content, AR is emerging as a powerful digital marketing tool, providing a means to enhance the tangibility of products (Chylinski et al., 2020) and foster trust in e-commerce. Despite the recognition of the innovative potential of AR, consumer adoption has been slow (Sahi et al., 2021), largely due to a lack of knowledge among firms about specific AR designs that effectively address consumer concerns and foster trust (Alimamy & Al-Imamy, 2022; Han et al., 2019). While the AR literature has analyzed various psychological outcomes of AR use (see Table 1), our study is original in that it examines how AR use affects consumer trust, how a unique comprehensive set of AR app quality attributes affects behavioral outcomes, and how e-commerce experience and market digital competitiveness moderate this mechanism. In doing so, we guide firms in designing AR apps that can increase consumer trust and loyalty in different markets and extend trust theory (Mayer et al., 1995) by demonstrating its predictive validity in the context of AR apps and identifying new boundary conditions to its predictive validity as captured by our moderators (e-commerce experience, market digital competitiveness). We analyzed data from 1661 consumers across different market segments in

Japan and China, which we selected due to their status as two of the largest consumer markets in the world (Abulaiti et al., 2011; Frank, 2024; Frank et al., 2013) and their marked differences in market digital competitiveness (China: high; Japan: low; IMD, 2023). Our empirical evidence shows that our focal AR app quality attributes (interactivity, system quality, product informativeness, and reality congruence) increase brand online trust (supporting H1a–d). Moreover, we find that e-commerce experience positively moderates the effect of the product informativeness of an AR app on brand online trust (supporting H2). In addition, market digital competitiveness positively moderates the effect of the system quality of an AR app, and negatively moderates the effect of the reality congruence of an AR app, on brand online trust (supporting H3a–b). Moreover, consumers' brand online trust positively affects brand loyalty (supporting H4) and significantly mediates the effects of our four focal AR app quality attributes on brand loyalty (supporting H4a–d). Thus, our results support our hypotheses and highlight the effectiveness of our set of AR app quality attributes in driving brand online trust and brand loyalty.

6.2. *Theoretical implications*

Mayer et al.'s (1995) trust theory is a widely accepted framework for understanding the formation of trust. Our study extends this trust theory and AR-related research in three important ways.

First, trust theory was developed as an organizational theory, but has been used in other fields. We extend the scholarly understanding of the predictive validity of trust theory from the organizational domain (i.e. relationships between firms) to the marketing domain (i.e. relationships between consumers and firms), transitioning from offline trust to online trust (S. W. Hung et al., 2012). In particular, compared to an offline environment, trust in online shopping platforms (D. J. Kim et al., 2008) and in the technical capabilities of vendors for online purchases (S. W. Wang et al., 2015) tends to be weaker. This is problematic because trust is critical for mitigating consumer-perceived risks associated with e-commerce (Aljifri et al., 2003). Without trust, consumers perceive increased risks associated with issues such as fraud, data security, or dissatisfaction with product quality, resulting in hesitation to purchase (D. J. Kim et al., 2008).

Second, we extend knowledge of the antecedents of trust theory in the context of digital apps. We highlight how a unique set of critical AR app quality attributes effectively enhance tangibility, which subsequently influences the trust formation mechanisms outlined in trust theory. Specifically, we show that multiple dimensions of AR app quality (i.e. interactivity, system quality, product informativeness, and reality congruence), through their role in making product information appear more tangible, enhance the trustworthiness factors (ability, benevolence, and integrity) as antecedents of trust formation, help firms build brand online trust, and thereby generate brand loyalty. Specifically, by making products appear more tangible, AR apps reduce the information asymmetry between a firm and a consumer in a remote online location. As a result, consumers gain confidence in their ability to assess whether the products offered meet their needs and thus perceive higher levels of brand ability, benevolence, and integrity, increasing their trust in the brand's digital marketing content, which strengthens their loyalty.

Third, our research examines the moderating effects of different macro-market environments and consumers' personal characteristics on trust formation, thereby identifying boundary conditions for the predictive validity of trust theory. In particular, our study is original in exploring the moderating role of e-commerce experience and market digital

competitiveness in trust formation. E-commerce experience strengthens the effect of AR app product informativeness on brand online trust, and market digital competitiveness strengthens the effect of system quality and weakens the effect of reality congruence. Since these variations are smaller than the main effects and do not reduce them to zero for any consumer segment, trust theory retains predictive validity across all consumer segments, but its predictive validity is higher for consumer segments with more e-commerce experience. Given the conflicting stronger positive and weaker negative moderating effects of market digital competitiveness, the predictive validity of trust theory appears to be stronger overall for markets with higher digital competitiveness.

Furthermore, as shown in Table 1, our study extends the marketing literature on AR in three ways. First, it is among the limited number of articles (e.g. Ahmad et al., 2023; A. Cheng et al., 2024; H. C. Kim & Hyun, 2016; Trivedi et al., 2022; Papakostas et al., 2023; Rauschnabel et al., 2019) that have examined the effects of AR app quality attributes. It provides the most holistic set of four critical quality attributes, while previous studies have only captured a subset of them. Second, it is the first study to highlight the critical role of brand online trust as a mediator in an e-commerce context, whereas previous literature has examined effects on other dependent variables (e.g. Anand et al., 2023; Barta et al., 2023; Chen et al., 2021; Chiu et al., 2021; Chung et al., 2015; Cranmer et al., 2020; David et al., 2021; Di Serio et al., 2013; Erdmann et al., 2021; Haile & Kang, 2020; Khan et al., 2019; Pozharliev et al., 2022; Saleem et al., 2021; Zanger et al., 2022) and other mediators (e.g. Alimamy & Al-Imamy, 2022; Moriuchi et al., 2021; Papakostas et al., 2023; Rauschnabel et al., 2019). Third, it examines the moderators of e-commerce experience and market digital competitiveness, whereas previous literature has examined other moderators (e.g. Ahmad et al., 2023; Gatter et al., 2021; Huang et al., 2019; Jessen et al., 2020; McLean & Wilson, 2019; Nugroho & Wang, 2023; Plotkina et al., 2022; Poushneh & Vazquez-Parraga, 2017; Trivedi et al., 2022; K. Y. Wang et al., 2023; Watson et al., 2018). Thus, our study has a unique positioning and contribution that is consistent with the importance of overcoming the problem of low trust in e-commerce to build lasting customer relationships (Whitty & Buchanan, 2012).

6.3. *Managerial implications*

This research provides critical insights for marketing managers regarding the pivotal role of AR apps in digital media marketing. Our findings strongly support the notion that AR apps serve as a significant aid to consumers by facilitating convenient product testing without the need to physically visit specific locations or stores. Through AR technology, consumers can virtually evaluate a myriad of products using their electronic devices. The study finds that consumers' use of a well-designed AR app leads to a significant increase in brand online trust and, as a result, brand loyalty. Thus, AR apps not only provide value to consumers but also benefit their respective brands and firms.

Our study elucidates the principles of designing effective AR apps that foster consumer trust and loyalty and outlines the quality dimensions that are critical to this end. Interactivity emerges as a key factor in facilitating consumers' comprehensive product examination, allowing them to examine items from multiple perspectives and conveniently position them in their immediate environment. The system quality of an AR app ensures smooth and error-free operation, which enhances the consumer's ability to evaluate the product smoothly and thereby building trust. Improving the product informativeness of the AR app leads to richer and clearer information, which mitigates information asymmetry. Thus, we argue that a high level of product informativeness is beneficial for firms

seeking to build consumer trust in the e-commerce domain, especially for consumers with extensive e-commerce experience. Finally, reality congruence reflects the ability of an AR app to seamlessly merge digital product information with the consumer's environment so that it appears like a real product in its natural setting (Lee, 2004). Therefore, we encourage managers to invest in a robust IT infrastructure that will facilitate their entry into e-commerce and utilize AR app technology with a seamless and error-free system for effective operationalization within the e-commerce retail sector.

As two of the three largest consumer markets in the world, China and Japan are of great importance to practitioners (Abulaiti et al., 2011). We show that AR apps are highly effective in building consumer trust and loyalty in these important markets, but we find differences in the AR app quality characteristics that matter most to consumers in China and Japan. While system quality is most important to consumers in China, reality congruence is most important to consumers in Japan. The background of these market differences is that the Chinese market has a much higher digital competitiveness than the Japanese market (IMD, 2023). As a result, Chinese consumers are more accustomed to high system quality of AR apps, leading to a lower tolerance for inferior quality, and are more likely to accept digital information as a new form of reality, reducing the importance of its congruence with offline reality.

6.4.   *Limitations and directions for future research*

Several limitations warrant consideration in the context of our research and present opportunities for future research. First, our sample size within each country is somewhat limited. A larger sample size would increase the power and representativeness of our statistical tests. Second, we collected data from only two countries, even though these markets are among the most important for practitioners (Tian & Frank, 2024). Subsequent research could target additional countries to enrich the diversity of perspectives and experiences. Third, future research could look for more moderators that might determine the importance of different dimensions of AR app quality. Fourth, future research could seek to replicate our findings using different methods, such as laboratory and field experiments.

6.5.   *Conclusion*

Using consumer data from China and Japan, we find a consistent positive effect of multiple dimensions of AR app quality (interactivity, system quality, product informativeness, and reality congruence) on consumers' brand online trust and, through mediation, their brand loyalty. Consumers' e-commerce experience strengthens the effect of product informativeness, while market digital competitiveness strengthens the effect of system quality and weakens the effect of reality congruence. Therefore, the integration of well-designed AR apps into e-commerce services becomes a powerful catalyst for overcoming consumers' lack of trust in digital content, thus promoting brand loyalty.

Disclosure statement

No potential conflict of interest was reported by the author(s).

ORCID

Wenxuan Shi http://orcid.org/0009-0002-0834-293X
Farlane S. Rumokoy http://orcid.org/0009-0008-4974-7558
Björn Frank http://orcid.org/0000-0003-3047-6504

References

Abulaiti, G., Frank, B., Enkawa, T., & Schvaneveldt, S. J. (2011). How should foreign retailers deal with Chinese consumers? A cross-national comparison of the formation of customer satisfaction. *Journal of Marketing Channels*, *18*(4), 353–373. https://doi.org/10.1080/1046669X.2011.613323

Acquisti, A., & Grossklags, J. (2005). Privacy and rationality in individual decision making. *IEEE Security and Privacy Magazine*, *3*(1), 26–33. https://doi.org/10.1109/MSP.2005.22

Ahmad, H., Butt, A., & Muzaffar, A. (2023). Travel before you actually travel with augmented reality: Role of augmented reality in future destination. *Current Issues in Tourism*, *26*(17), 2845–2862. https://doi.org/10.1080/13683500.2022.2101436

Akinwande, M. O., Dikko, H. G., & Samson, A. (2015). Variance inflation factor: As a condition for the inclusion of suppressor variable(s) in regression analysis. *Open Journal of Statistics*, *5*(7), 754–767. https://doi.org/10.4236/ojs.2015.57075

Alimamy, S., & Al-Imamy, S. (2022). Customer perceived value through quality augmented reality experiences in retail: The mediating effect of customer attitudes. *Journal of Marketing Communications*, *28*(4), 428–447. https://doi.org/10.1080/13527266.2021.1897648

Aljifri, H. A., Pons, A., & Collins, D. (2003). Global e-commerce: A framework for understanding and overcoming the trust barrier. *Information Management & Computer Security*, *11*(3), 130–138. https://doi.org/10.1108/09685220310480417

Anand, K., Arya, V., Suresh, S., & Sharma, A. (2023). Quality dimensions of augmented reality-based mobile apps for smart-tourism and its impact on customer satisfaction & reuse intention. *Tourism Planning & Development*, *20*(2), 236–259. https://doi.org/10.1080/21568316.2022.2137577

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, *51*(6), 1173–1182. https://doi.org/10.1037/0022-3514.51.6.1173

Barta, S., Gurrea, R., & Flavian, C. (2023). Using augmented reality to reduce cognitive dissonance and increase purchase intention. *Computers in Human Behavior*, *140*, Article 107564. https://doi.org/10.1016/j.chb.2022.107564

Bleier, A., Harmeling, C. M., & Palmatier, R. W. (2019). Creating effective online customer experiences. *Journal of Marketing*, *83*(2), 98–119. https://doi.org/10.1177/0022242918809930

Chaudhuri, A., & Holbrook, M. B. (2001). The chain of effects from brand trust and brand affect to brand performance: The role of brand loyalty. *Journal of Marketing*, *65*(2), 81–93. https://doi.org/10.1509/jmkg.65.2.81.18255

Chen, J. V., Ruangsri, S., Ha, Q. A., & Widjaja, A. E. (2021). An experimental study of consumers' impulse buying behaviour in augmented reality mobile shopping apps. *Behaviour & Information Technology*, *41*(15), 3360–3381. https://doi.org/10.1080/0144929X.2021.1987523

Cheng, A., Ma, D., Pan, Y., & Qian, H. (2024). Enhancing museum visiting experience: Investigating the relationships between augmented reality quality, immersion, and TAM using PLS-SEM. *International Journal of Human-Computer Interaction*, *40*(17), 4521–4532. https://doi.org/10.1080/10447318.2023.2227832

Cheng, Z., Shao, B., & Zhang, Y. (2022). Effect of product presentation videos on consumers' purchase intention: The role of perceived diagnosticity, mental imagery, and product rating. *Frontiers in Psychology*, *13*, Article 812579.

Chi, T. (2018). Understanding Chinese consumer adoption of apparel mobile commerce: An extended TAM approach. *Journal of Retailing and Consumer Services*, *44*, 274–284. https://doi.org/10.1016/j.jretconser.2018.07.019

Chiu, C. L., Ho, H. C., Yu, T., Liu, Y., & Mo, Y. (2021). Exploring information technology success of augmented reality retail applications in retail food chain. *Journal of Retailing and Consumer Services*, *61*(3), Article 102561. http://doi.org/10.1016/j.jretconser.2021.102561

Christ-Brendemühl, S., & Schaarschmidt, M. (2021). Customer fairness perceptions in augmented reality-based online services. *Journal of Service Management*, *33*(1), 9–32. http://dx.doi.org/10.1108/JOSM-01-2021-0012

Chung, N., Han, H., & Joun, Y. (2015). Tourists' intention to visit a destination: The role of augmented reality (AR) application for a heritage site. *Computers in Human Behavior*, *50*, 588–599. https://doi.org/10.1016/j.chb.2015.02.068

Chylinski, M., Heller, J., Hilken, T., Keeling, D. I., Mahr, D., & de Ruyter, K. (2020). Augmented reality marketing: A technology-enabled approach to situated customer experience. *Australasian Marketing Journal*, *28*(4), 374–384. https://doi.org/10.1016/j.ausmj.2020.04.004

CIA. (2023). *The world factbook*. https://www.cia.gov/the-world-factbook/

Comrey, A. L., & Lee, H. B. (2013). *A first course in factor analysis*. Psychology Press.

Cranmer, E. E., tom Dieck, M. C., & Fountoulaki, P. (2020). Exploring the value of augmented reality for tourism. *Tourism Management Perspectives*, *35*, Article 100672. https://doi.org/10.1016/j.tmp.2020.100672

Darley, W., & Lim, J. S. (2018). Mavenism and e-maven propensity: Antecedents, mediators and transferability. *Journal of Research in Interactive Marketing*, *12*(3), 293–308. https://doi.org/10.1108/JRIM-01-2018-0008

David, A., Senn, W. D., Peak, D. A., Prybutok, V. R., & Blankson, C. (2021). The value of visual quality and service quality to augmented reality enabled mobile shopping experience. *Quality Management Journal*, *28*(3), 116–127. https://doi.org/10.1080/10686967.2021.1920868

DeLone, W. H., & McLean, E. R. (2003). The DeLone and McLean Model of information systems success: A ten-year update. *Journal of Management Information System*, *19*(4), 9–30. http://doi.org/10.1080/07421222.2003.11045748

Di Serio, Á., Ibáñez, A., & Kloos, C. D. (2013). Impact of an augmented reality system on students' motivation for a visual art course. *Computers & Education*, *68*(1), 586–596. https://doi.org/10.1016/j.compedu.2012.03.002

Erdmann, A., Mas, J. M., & Arilla, R. (2021). Value-based adoption of augmented reality: A study on the influence on online purchase intention in retail. *Journal of Consumer Behaviour*, *22*(4), 912–932. https://doi.org/10.1002/cb.1993

Fiore, A. M., Kim, J., & Lee, H. H. (2005). Effect of image interactivity technology on consumer responses toward the online retailer. *Journal of Interactive Marketing*, *19*(3), 38–53. https://doi.org/10.1002/dir.20042

Flavian, C., Gurrea, R., & Orus, C. (2017). The influence of online product presentation videos on persuasion and purchase channel preference: The role of imagery fluency and need for touch. *Telematics and Informatics*, *34*(8), 1544–1556. https://doi.org/10.1016/j.tele.2017.07.002

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

Frank, B. (2024). Consumer preferences for artificial intelligence-enhanced products: Differences across consumer segments, product types, and countries. *Technological Forecasting and Social Change*, *209*, Article 123774. https://doi.org/10.1016/j.techfore.2024.123774

Frank, B., Abulaiti, G., & Enkawa, T. (2012). What characterizes Chinese consumer behavior? A cross-industry analysis of the Chinese diaspora in Japan. *Marketing Letters*, *23*, 683–700. https://doi.org/10.1007/s11002-012-9171-8

Frank, B., Abulaiti, G., Herbas Torrico, B., & Enkawa, T. (2013). How do Asia's two most important consumer markets differ? Japanese–Chinese differences in customer satisfaction and its formation. *Journal of Business Research*, *66*(12), 2397–2405. https://doi.org/10.1016/j.jbusres.2013.05.026

Frank, B., Enkawa, T., Schvaneveldt, S. J., & Herbas Torrico, B. (2015). Antecedents and consequences of innate willingness to pay for innovations: Understanding motivations and consumer preferences of prospective early adopters. *Technological Forecasting and Social Change*, *99*, 252–266. https://doi.org/10.1016/j.techfore.2015.06.029

Frank, B., Herbas-Torrico, B., & Schvaneveldt, S. J. (2021). The AI-extended consumer: Technology, consumer, country differences in the formation of demand for AI-empowered consumer products. *Technological Forecasting and Social Change*, 172, Article 121018. https://doi.org/10.1016/j.techfore.2021.121018

Gatter, S., Maack-Huttl, V., & Rauschnabel, P. A. (2021). Can augmented reality satisfy consumers' need for touch? *Psychology & Marketing*, 39(3), 508–523. https://doi.org/10.1002/mar.21618

Georgiou, Y., & Kyza, E. A. (2017). The development and validation of the ARI questionnaire: An instrument for measuring immersion in location-based augmented reality settings. *International Journal of Human-Computer Studies*, 98, 24–37. https://doi.org/10.1016/j.ijhcs.2016.09.014

Gorsuch, R. L. (2014). *Factor analysis: Classic edition*. Routledge.

Goyette, I., Ricard, L., Bergeron, J., & Marticotte, F. (2010). E-WOM scale: Word-of-mouth measurement scale for e-services context. *Canadian Journal of Administrative Sciences*, 27 (1), 5–23. https://doi.org/10.1002/cjas.129

Griffith, D. A., & Gray, C. C. (2002). The fallacy of the level playing field. *Journal of Marketing Channels*, 9(3–4), 87–102. https://doi.org/10.1300/J049v09n03_05

Haile, T. T., & Kang, M. (2020). Mobile augmented reality in electronic commerce: Investigating user perception and purchase intent amongst educated young adults. *Sustainability*, 12(21), 9185–9126. https://doi.org/10.3390/su12219185

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis* (7th ed.). Pearson.

Han, D. I. D., Dieck, M. C. T., & Jung, T. (2019). Augmented reality smart glasses (ARSG) visitor adoption in cultural tourism. *Leisure Studies*, 38(5), 618–633. https://doi.org/10.1080/02614367.2019.1604790

Hausman, A. V., & Siekpe, J. S. (2009). The effect of web interface features on consumer online purchase intentions. *Journal of Business Research*, 62(1), 5–13. https://doi.org/10.1016/j.jbusres.2008.01.018

Hayes, A. F. (2017). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. Guilford Publications.

Herbas Torrico, B., & Frank, B. (2019). Consumer desire for personalisation of products and services: Cultural antecedents and consequences for customer evaluations. *Total Quality Management & Business Excellence*, 30(3-4), 355–369. https://doi.org/10.1080/14783363.2017.1304819

Hilken, T., De Ruyter, K., Chylinski, M., Mahr, D., & Keeling, D. I. (2017). Augmenting the eye of the beholder: Exploring the strategic potential of augmented reality to enhance online service experiences. *Journal of the Academy of Marketing Science*, 45(6), 884–905. https://doi.org/10.1007/s11747-017-0541-x

Hu, Y., Frank, B., & Lu, Z. (2022). Market success through recycling programs: Strategic options, consumer reactions, and contingency factors. *Journal of Cleaner Production*, 353, Article 131003. https://doi.org/10.1016/j.jclepro.2022.131003

Huang, T.L., Mathews, S., & Chou, C.Y. (2019). Enhancing online rapport experience via augmented reality. *Journal of Services Marketing*, 33(7), 851–865. https://doi.org/10.1108/JSM-12-2018-0366

Hung, S. W., Cheng, M. J., & Chen, P. C. (2012). Reexamining the factors for trust in cultivating online customer repurchase intentions: The moderating effect of perceived waiting. *International Journal of Human-Computer Interaction*, 28(10), 666–677. https://doi.org/10.1080/10447318.2011.654201

Hung, Y. T., Dennis, A. R., & Robert, L. (2004, 5-8 January). Trust in virtual teams: Towards an integrative model of trust formation. In *Proceedings of the 37th Annual Hawaii International Conference on System Sciences, 2004* (p. 11). IEEE. https://doi.org/10.1109/HICSS.2004.1265156

IMD. (2023). *IMD world digital competitiveness ranking 2023*. https://www.imd.org/centers/wcc/world-competitiveness-center/rankings/world-digital-competitiveness-ranking/

Isaeva, N., Gruenewal, K., & Saunders, M. N. K. (2020). Trust theory and customer services research: Theoretical review and synthesis. *The Service Industries Journal*, 40(15-16), 1031–1063. https://doi.org/10.1080/02642069.2020.1779225

Javornik, A. (2016). Augmented reality: Research agenda for studying the impact of its media characteristics on consumer behaviour. *Journal of Retailing and Consumer Services*, 30, 252–261. https://doi.org/10.1016/j.jretconser.2016.02.004

Jeong, J. E., & Yeu, M. (2023). Can mental imagery enhance review helpfulness and product evaluation? The role of contextual background and mental simulation. *Journal of Research in Interactive Marketing*, *17*(6), 959–974. https://doi.org/10.1108/JRIM-08-2022-0237

Jessen, A., Hilken, T., Chylinski, M., Mahr, D., Heller, J., Keeling, D. I., & de Ruyter, K. (2020). The playground effect: How augmented reality drives creative customer engagement. *Journal of Business Research*, *116*(1), 85–98. https://doi.org/10.1016/j.jbusres.2020.05.002

Kassim, N., & Asiah Abdullah, N. (2010). The effect of perceived service quality dimensions on customer satisfaction, trust, and loyalty in e-commerce settings: A cross cultural analysis. *Asia Pacific Journal of Marketing and Logistics*, *22*(3), 351–371. https://doi.org/10.1108/13555851011062269

Khan, T., Johnston, K., & Ophoff, J. (2019). The impact of an augmented reality application on learning motivation of students. *Advances in Human-Computer Interaction*, *2019*, Article 7208494. https://doi.org/10.1155/2019/7208494

Kim, D. J., Ferrin, D. L., & Rao, H. R. (2008). A trust-based consumer decision-making model in electronic commerce: The role of trust, perceived risk, and their antecedents. *Decision Support Systems*, *44*(2), 544–564. https://doi.org/10.1016/j.dss.2007.07.001

Kim, H. C., & Hyun, M. Y. (2016). Predicting the use of smartphone-based augmented reality (AR): Does telepresence really help? *Computers in Human Behavior*, *59*, 28–38. https://doi.org/10.1016/j.chb.2016.01.001

Lauer, T. W., & Deng, X. (2007). Building online trust through privacy practices. *International Journal of Information Security*, *6*(5), 323–331. https://doi.org/10.1007/s10207-007-0028-8

Lee, K. M. (2004). Presence, explicated. *Communication Theory*, *14*(1), 27–50. https://doi.org/10.1111/j.1468-2885.2004.tb00302.x

Li, H., Daugherty, T., & Biocca, F. (2001). Characteristics of virtual experience in electronic commerce: A protocol analysis. *Journal of Interactive Marketing*, *15*(3), 13–30. https://doi.org/10.1002/dir.1013

Mason, C. H., & Perreault, W. D., Jr. (1991). Collinearity, power, and interpretation of multiple regression analysis. *Journal of Marketing Research*, *28*(3), 268–280. https://doi.org/10.1177/002224379102800302

Mayer, R. C., Davis, J. H., & Schoorman, F. D. (1995). An integrative model of organizational trust. *Academy of Management Review*, *20*(3), 709–734. https://doi.org/10.2307/258792

McLean, G., & Wilson, A. (2019). Shopping in the digital world: Examining customer engagement through augmented reality mobile applications. *Computers in Human Behavior*, *101*, 210–224. https://doi.org/10.1016/j.chb.2019.07.002

Merriam-Webster. (2023). *Trust.* https://www.merriam-webster.com/dictionary/trust/

Milgram, N. W., Head, E., Weiner, E., & Thomas, E. (1994). Cognitive functions and aging in the dog: Acquisition of nonspatial visual tasks. *Behavioral Neuroscience*, *108*(1), 57–68. https://doi.org/10.1037/0735-7044.108.1.57

Mo, Z., Li, Y. F., & Fan, P. (2015). Effect of online reviews on consumer purchase behavior. *Journal of Service Science and Management*, *8*(3), 419–424. https://doi.org/10.4236/jssm.2015.83043

Moriuchi, E., Landers, V. M., Colton, D., & Hair, N. (2021). Engagement with chatbots versus augmented reality interactive technology in e-commerce. *Journal of Strategic Marketing*, *29*(5), 375–389. https://doi.org/10.1080/0965254X.2020.1740766

Nepomuceno, M. V., Laroche, M., & Richard, M.-O. (2014). How to reduce perceived risk when buying online: The interactions between intangibility, product knowledge, brand familiarity, privacy and security concerns. *Journal of Retailing and Consumer Services*, *21*(4), 619–629. http://dx.doi.org/10.1016/j.jretconser.2013.11.006

Novak, T. P., Hoffman, D. L., & Yung, Y. F. (2000). Measuring the customer experience in online environments: A structural modeling approach. *Marketing Science*, *19*(1), 22–42. https://doi.org/10.1287/mksc.19.1.22.15184

Nugroho, A., & Wang, W. T. (2023). Consumer switching behavior to an augmented reality (AR) beauty product application: Push-pull mooring theory framework. *Computers in Human Behavior*, *142*, Article 107646. https://doi.org/10.1016/j.chb.2022.107646

Oliveira, T., Alhinho, M., Rita, P., & Dhillon, G. (2017). Modelling and testing consumer trust dimensions in e-commerce. *Computers in Human Behavior*, *71*, 153–164. https://doi.org/10.1016/j.chb.2017.01.050

Olsson, T., Lagerstam, E., Karkkainen, T., & Vaananen-Vainio-Mattila, K. (2013). Expected user experience of mobile augmented reality services: A user study in the context of shopping

centres. *Personal and Ubiquitous Computing*, *17*(2), 287–304. https://doi.org/10.1007/s00779-011-0494-x

Orús, C., Gurrea, R., & Flavián, C. (2017). Facilitating imaginations through online product presentation videos: Effects on imagery fluency, product attitude and purchase intention. *Electronic Commerce Research*, *17*(4), 661–700. https://doi.org/10.1007/s10660-016-9250-7

Papakostas, C., Troussas, C., Krouska, A., & Sgouropoulou, C. (2023). Exploring users' behavioral intention to adopt mobile augmented reality in education through an extended technology acceptance model. *International Journal of Human-Computer Interaction*, *39*(6), 1294–1302. https://doi.org/10.1080/10447318.2022.2062551

Park, J., Velasco, C., & Spence, C. (2022). 'Looking sharp': Price typeface influences awareness of spending in mobile payment. *Psychology & Marketing*, *39*(6), 1170–1189. https://doi.org/10.1002/mar.21651

Pavlou, P. A. (2003). Consumer acceptance of electronic commerce: Integrating trust and risk with the technology acceptance model. *International Journal of Electronic Commerce*, *7*(3), 101–134. https://doi.org/10.1080/10864415.2003.11044275

Plotkina, D., Dinsmore, J., & Racat, M. (2022). Improving service brand personality with augmented reality marketing. *Journal of Services Marketing*, *36*(6), 781–799. https://doi.org/10.1108/JSM-12-2020-0519

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, *88*(5), 879–903. https://doi.org/10.1037/0021-9010.88.5.879

Poushneh, A., & Vazquez-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

Pozharliev, R., Angelis, M. D., & Rossi, D. (2022). The effect of augmented reality versus traditional advertising: A comparison between neurophysiological and self-reported measures. *Marketing Letters*, *33*(1), 113–128. https://doi.org/10.1007/s11002-021-09573-9

Qin, Y., Omar, B., & Musetti, A. (2022). The addiction behavior of short-form video app TikTok: The information quality and system quality perspective. *Frontiers in Psychology*, *13*, Article 932805. https://doi.org/10.3389/fpsyg.2022.932805

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

Rauschnabel, P. A., Rossman, A., & tom Dieck, M. C. (2017). An adoption framework for mobile augmented reality games: The Go. *Computers in Human Behavior*, *76*, 276–286. https://doi.org/10.1016/j.chb.2017.07.030

Rose, S., Clark, M., Samouel, P., & Hair, N. (2012). Online customer experience in e-retailing: An empirical model of antecedents and outcomes. *Journal of Retailing*, *88*(2), 308–322. https://doi.org/10.1016/j.jretai.2012.03.001

Rumokoy, F. S., & Frank, B. (2025). Retail value creation through augmented reality: The role of task-technology fit, consumer knowledge, and personality. *Journal of Retailing and Consumer Services*, *84*, Article 104173. https://doi.org/10.1016/j.jretconser.2024.104173

Sahi, A. M., Khalid, H., Abbas, A. F., & Khatib, S. F. A. (2021). The evolving research of customer adoption of digital payment: Learning from content and statistical analysis of the literature. *Journal of Open Innovation: Technology, Market, and Complexity*, *7*(4), Article 230. https://doi.org/10.3390/joitmc7040230

Saleem, M., Kamarudin, S., Shoaib, H. M., & Nasar, A. (2021). Influence of augmented reality app on intention towards e-learning amidst COVID-19 pandemic. *Interactive Learning Environments*, *31*(5), 3083–3097. https://doi.org/10.1080/10494820.2021.1919147

Schermelleh-Engel, K., Moosbrugger, H., & Müller, H. (2003). Evaluating the fit of structural equation models: Tests of significance and descriptive goodness-of-fit measures. *Methods of Psychological Research Online*, *8*(2), 23–74.

Shahid, S., Islam, J. U., Malik, S., & Hasan, U. (2022). Examining consumer experience in using m-banking apps: A study of its antecedents and outcomes. *Journal of Retailing and Consumer Services*, *65*, Article 102870. https://doi.org/10.1016/j.jretconser.2021.102870

Shankar, V., Urban, G. L., & Sultan, F. (2002). Online trust: A stakeholder, perspective, concepts, implications, and future directions. *Journal of Strategic Information Systems*, *11*(3-4), 325–344. https://doi.org/10.1016/S0963-8687(02)00022-7

Sharma, G. (2017). Pros and cons of different sampling techniques. *International Journal of Applied Research*, 3(7), 749–752.

Smith, J. B., & Barclay, D. W. (1997). The effects of organizational differences and trust on the effectiveness of selling partner relationships. *Journal of Marketing*, 61(1), 3–21. https://doi.org/10.1177/002224299706100102

Steuer, J. (1992). Defining virtual reality: Dimensions determining telepresence. *Journal of Communication*, 42(4), 73–93. https://doi.org/10.1111/j.1460-2466.1992.tb00812.x

Tan, C. W., Benbasat, I., & Cenfetelli, R. T. (2008, 7-10 January). Building citizen trust towards e-government services: Do high quality websites matter? In *Proceedings of the 41st Annual Hawaii International Conference on System Sciences (HICSS 2008)* (p. 217). IEEE. https://doi.org/10.1109/HICSS.2008.80

Tan, Y. C., Chandukala, S. R., & Reddym, S. K. (2022). Augmented reality in retail and its impact on sales. *Journal of Marketing*, 86(1), 48–66. https://doi.org/10.1177/0022242921995449

Thong, J. Y. L., Hong, W., & Tam, K. Y. (2002). Understanding user acceptance of digital libraries: What are the roles of interface characteristics, organizational context, and individual differences. *International Journal of Human-Computer Studies*, 57(3), 215–242. https://doi.org/10.1016/S1071-5819(02)91024-4

Tian, Y., & Frank, B. (2024). Optimizing live streaming features to enhance customer immersion and engagement: A comparative study of live streaming genres in China. *Journal of Retailing and Consumer Services*, 81, Article 103974. https://doi.org/10.1016/j.jretconser.2024.103974

Tomlinson, E. C., & Schnackenberg, A. (2022). The effects of transparency perceptions on trustworthiness perceptions and trust. *Journal of Trust Research*, 12(1), 1–23. https://doi.org/10.1080/21515581.2022.2060245

Trevinal, A. M., & Stenger, T. (2014). Toward a conceptualization of the online shopping experience. *Journal of Retailing and Consumer Services*, 21(3), 314–326. https://doi.org/10.1016/j.jretconser.2014.02.009

Trivedi, J., Kasilingam, D., Arora, P., & Soni, S. (2022). The effect of augmented reality in mobile applications on consumers' online impulse purchase intention: The mediating role of perceived value. *Journal of Consumer Behaviour*, 21(4), 896–908. https://doi.org/10.1002/cb.2047

University of Vienna. (2025). *Sample size calculator*. https://homepage.univie.ac.at/robin.ristl/samplesize.php

Verhagen, T., van Nes, J., Feldberg, F., & van Dolen, W. (2014). Virtual customer service agents: Using social presence and personalization to shape online service encounters. *Journal of Computer-Mediated Communication*, 19(3), 529–545. https://doi.org/10.1111/jcc4.12066

Walters, G., Sparks, B., & Herington, C. (2012). The impact of consumption vision and emotion on the tourism consumer's decision behavior. *Journal of Hospitality & Tourism Research*, 36(3), 366–389. https://doi.org/10.1177/1096348010390815

Wang, K. Y., Ashraf, A. R., Thongpapanl, N. T., & Nguyen, O. (2023). Influence of social augmented reality app usage on customer relationships and continuance intention: The role of shared social experience. *Journal of Business Research*, 166, Article 114092. https://doi.org/10.1016/j.jbusres.2023.114092

Wang, Y., Ko, E., & Wang, H. (2019). Augmented reality (AR) app use in the beauty product industry and consumer purchase intention. *Asia Pacific Journal of Marketing and Logistics*, 34(1), 110–131. https://doi.org/10.1108/APJML-11-2019-0684

Wang, S. W., Ngamsiriudom, W., & Hsieh, C. H. (2015). Trust disposition, trust antecedents, trust, and behavioral intention. *The Service Industries Journal*, 35(10), 555–572. https://doi.org/10.1080/02642069.2015.1047827

Watson, A., Alexander, B., & Salavati, L. (2018). The impact of experiential augmented reality applications on fashion purchase intention. *International Journal of Retail & Distribution Management*, 48(5), 433–451. https://doi.org/10.1108/IJRDM-06-2017-0117

Whitty, M. T., & Buchanan, T. (2012). The online romance scam: A serious cybercrime. *Cyberpsychology, Behavior, and Social Networking*, 15(3), 181–183. https://doi.org/10.1089/cyber.2011.0352

World Population Review. (2024). *Median age by country 2024*. https://worldpopulationreview.com/country-rankings/median-age

Yaoyuneyong, G., Foster, J., Johnson, E., & Johnson, D. (2016). Augmented reality marketing: Consumer preferences and attitudes toward hypermedia prints ads. *Journal of Interactive Advertising*, 16(1), 16–30. https://doi.org/10.1080/15252019.2015.1125316

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

Zanger, V., Meibner, M., & Rauschnabel, P. A. (2022). Beyond the gimmick: How affective responses drive brand attitudes and intentions in augmented reality marketing. *Psychology & Marketing*, *39*(7), 1285–1301. https://doi.org/10.1002/mar.21641

Zhao, Y., Deng, S., & Zhou, R. (2015). Understanding mobile library apps continuance usage in China: A theoretical framework and empirical study. *Libri*, *65*(3), 161–173. https://doi.org/10.1515/libri-2014-0148