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The Impact of Technological Innovations on Consumer Behavior in E-Commerce: A Systematic Review

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ABSTRACT

This study systematically reviews the literature on the impact of technological innovations in e-commerce on consumer behavior, using the SPAR-4-SLR methodology and TCCM framework. It consolidates research across various technologies, including websites, social media, live streaming, AR/VR, and AI. The analysis reveals a growing interest in this field post-2017, with a focus on websites and social media, but highlights a research gap in emerging technologies. Key theoretical frameworks are identified, emphasizing the need for integration to comprehensively understand consumer behavior. The review maps out antecedents, mediators, moderators, and outcomes, stressing the importance of longitudinal studies and advanced analytics. This approach aims to bridge research gaps and suggest future directions, enhancing theoretical and practical understanding of e-commerce technological innovations, and contributing to a more dynamic and consumer-centric e-commerce ecosystem.

KEYWORDS

Technological Innovations, E-Commerce, Consumer Behavior, SPAR-4-SLR, TCCM

INTRODUCTION

E-commerce has fundamentally transformed business operations and consumer behavior since its inception. Initially defined as economic activities conducted through electronic connections (Combe, 2006), e-commerce has evolved into a complex ecosystem driven by technological innovations. The field has undergone several revolutionary shifts, beginning with the World Wide Web (WWW) in the 1990s, which enabled online transactions. Web 2.0 technologies in the early 2000s facilitated platform-based models, exemplified by Amazon and eBay. More recent advancements, including social media, cloud computing, blockchain, and artificial intelligence (AI), have further reshaped

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e-commerce. Despite rapid evolution and extensive research, critical challenges remain. First, existing studies are highly fragmented, typically examining individual technologies or specific development stages (Ngai & Wat, 2002). While websites, social media, and AI have been extensively analyzed, their collective impact on consumer behavior remains unclear. Second, emerging technologies introduce new complexities. For example, popularity-based access control models in cloud computing raise novel privacy concerns (Kumar et al., 2023), while blockchain-based smart contracts are transforming transaction recording and security (Das et al., 2024). Additionally, innovations such as 3D point cloud technology create new consumer interaction paradigms requiring systematic investigation. Third, the cultural and demographic dimensions of technology adoption in e-commerce remain largely unexplored, despite their critical role in shaping consumer behavior across diverse markets. This systematic review aims to address these gaps through the following objectives:

- Synthesize fragmented research on technological innovations in e-commerce.
- Develop an integrated theoretical framework combining established models such as the technology acceptance model (TAM), stimulus-organism-response (S-O-R), and information systems success (ISS).
- Analyze the collective influence of various technologies on consumer behavior.
- Examine cultural and demographic factors affecting technology adoption.
- Identify methodological advancements needed for future research.

This paper provides a comprehensive systematic review of technologies shaping consumer behavior, including consumer information access and shopping experiences in e-commerce. By synthesizing findings across technological stages and innovations, it seeks to offer a holistic understanding of e-commerce evolution and its impact on consumer behavior. This approach will help identify research gaps and suggest future directions to enhance the e-commerce ecosystem. The study addresses the following research questions:

- RQ1: What is the current state of knowledge on the adoption and impact of various e-commerce technologies on consumer behavior?
- RQ2: What major theoretical frameworks are used to analyze the impact of technological innovations in e-commerce on consumer behavior?
- RQ3: What key antecedents, mediators, moderators, and outcomes have been identified in research on technological innovations in e-commerce and their effects on consumer behavior?
- RQ4: What gaps exist in current research, and what future directions can advance the study of technological innovations in e-commerce?

This study examines how technological evolution—from websites and social media to AI, augmented reality (AR), virtual reality (VR), and live streaming, and live streaming—has transformed consumer engagement in e-commerce. Key theoretical models, including TAM, S-O-R, and the ISS model, explain consumer adoption and behavior. Factors such as trust, engagement, decision-making, and personalization significantly shape consumer responses. However, research gaps persist, including limited integration of multiple technologies, a lack of cross-cultural studies, and insufficient longitudinal research. These insights enhance both theoretical understanding and practical advancements in the e-commerce ecosystem.

TECHNOLOGY REVOLUTION AND E-COMMERCE

E-commerce has evolved significantly since its inception. Early definitions focused on basic electronic transactions, describing it as the use of computer networks to facilitate business

operations. As technology advanced, definitions broadened to include additional aspects. While studies emphasize different elements, they consistently identify "electronic information technology" and "business activities" as core components (Zwass, 1996).

The evolution of e-commerce can be traced through key technological stages. In the Pre-Web Era (pre-1990s), studies defined e-commerce as the use of computer networks to facilitate business transactions, primarily the electronic buying and selling of goods and services with suppliers, customers, and competitors. In the early Web Era (1990s–2000s), Wigand (1997) introduced definitions from an information exchange perspective, stating, "Electronic commerce is a wide variety of business-related transactions, but at its core is the data used for conducting day-to-day business operations with suppliers and customers" (p. 12). Similarly, Clarke emphasized, "Electronic commerce has been used to describe a wide variety of business-related transactions, but at its core is the data used for conducting day-to-day business operations with suppliers and customers" (p. 23).

Wigand (1997) further elaborated, defining e-commerce as "the seamless application of information and communication technology from its point of origin to its endpoint along the entire value chain of business processes conducted electronically, aimed at accomplishing a business goal" (p. 12). In the Web 2.0 Era (2000s–2010s), Zwass (2003) examined the commerce, collaboration, communication, connection, and computation aspects of e-commerce, highlighting opportunities for innovation, information sharing with business partners, business process transformation, and the delivery of information system services.

Websites

The emergence of websites was a pivotal technological advancement in the early internet era. Before the 1990s, companies exchanged digital information through electronic data interchange, which required mutual agreements. The early 1990s marked the commercialization of the internet, making open computer technology and connectivity more affordable for individuals and businesses. This led to the development of the WWW (Zwass, 1996). As e-commerce expanded across industries, websites emerged as integral tools for managing business operations. The advent of the WWW, along with powerful search engines, transformed the Web into a rich information resource (Laudon & Traver, 2017). Businesses began reaching potential customers by providing online marketing information and product catalogs. After the mid-1990s, websites became central to e-commerce, with studies proposing various innovations for conducting business online. Technological advancements have since driven websites through the Web 1.0 and Web 2.0 phases, while research on Web 3.0 applications is becoming increasingly prevalent, signaling the potential emergence of the Web 3.0 era (Combe, 2006).

Websites have profoundly transformed consumer behavior and the shopping experience. The WWW revolutionized commerce by turning consumers into computer users and replacing physical stores with digital storefronts (Koufaris et al., 2001). This shift has fundamentally changed how people access information and make purchasing decisions. For instance, a key benefit of the Web is its ability to provide extensive information, enabling complex, non-linear, and non-directed consumer queries, enhancing decision-making (Koufaris et al., 2001; Lohse & Spiller, 1998). Additionally, consumers can make more informed purchasing decisions based on the information they find online (Hoque & Lohse, 1999).

Social Media

The definitions of social media in prior research are inconsistent. Most definitions converge on the idea that social media encompass digital technologies emphasizing user-generated content and interaction (Kaplan & Haenlein, 2010; Terry, 2009). Some studies define social media based on message directionality (Kent, 2010), while others exemplify interaction modes through platforms like Facebook and Twitter (Howard & Parks, 2012). Despite numerous definitions, a formal, concise, and universally accepted definition remains absent (Carr & Hayes, 2015). Addressing this gap, Carr and Hayes (2015) defined social media as "Internet-based channels that allow users to

opportunistically interact and selectively self-present, either in real-time or asynchronously, with both broad and narrow audiences who derive value from user-generated content and the perception of interaction with others" (p. 50), a definition adopted in this review.

Various forms of social media, including social networking sites, have seen increasing commercial use across industries. With their rising popularity and commercial success, the term "social commerce" emerged in 2005, representing a new form of e-commerce (Yadav et al., 2013). Social media and social commerce have significantly influenced consumer behavior (Yadav & Pavlou, 2014). For example, online reviews serve as a crucial information source for consumer decision-making (Hajli, 2015), and research suggests that social media enables consumers to engage with brands in novel ways (Edelman, 2010).

Live Streaming

Live streaming is a primarily synchronous form of social media. Live streaming shopping integrates real-time social interaction into e-commerce, embodying attributes of social commerce. It operates in two ways: live streaming embedded within e-commerce platforms, such as Amazon Live Style Code, Taobao.com, and JD.com, or e-commerce integrated into live streaming platforms like Live.me and Livby (Wongkitrungrueng et al., 2018). Generally, live streaming platforms enable real-time recording and broadcasting on smart devices across various domains, including video games, sports, and social media (Li et al., 2022).

Live streaming on social media has evolved into live streaming commerce (LSC), a subset of e-commerce that merges real-time social interaction with digital marketing. As a dynamic e-commerce format, LSC enhances the shopping experience with interactive elements such as live chat and video, providing consumers with engaging, immersive opportunities to discover and purchase products (Cai & Wohn, 2022, 2023). By integrating live video content with chat interaction, LSC enables users to broadcast, view live streams, and participate in synchronous discussions. It has gained traction as a direct selling channel, significantly boosting online traffic and sales. Notably, LSC customers are both consumers and content creators, influencing peers' purchasing decisions. Businesses increasingly leverage LSC to enhance customer engagement, promote products, facilitate transactions, and improve online shopping experiences (Cai & Wohn, 2022, 2023). LSC has established itself as a unique and popular online shopping format, operating through three major channels:

- E-commerce sites or mobile apps integrating LSC features, such as Amazon and Taobao;
- LSC platforms incorporating commercial activities, such as Douyu and Live.me;
- Social media or social networking sites incorporating LSC features to facilitate sales, such as Facebook and Instagram.

Live streaming has influenced consumer behavior by providing platforms for entertainment, opinion sharing, information gathering, and purchase decision-making. Additionally, it has transformed marketing strategies for promotion, advertising, and customer relationship management (Li et al., 2022). For example, live streaming offers consumers a more immersive shopping experience. Compared to traditional online and mobile commerce, LSC enhances product presentation through live demonstrations and real-time interactions between consumers and streamers. This format enables consumers to make more informed purchasing decisions by accessing richer product information beyond text and images (Cai & Wohn, 2022, 2023). Furthermore, consumer emotions are influenced by elements within LSC. Xu and Siegrist (2021) found that streamer attractiveness, parasocial interaction, and information quality play a crucial role in shaping viewers' cognitive and emotional states.

VR and AR

VR is a relatively novel technology that enables users to experience 3D environments simulating artificially created spaces (Lanier & Biocca, 1992). These computer-generated environments feature

interactive properties and are experienced from a first-person perspective (Lanier & Biocca, 1992), creating the illusion of presence in an alternate setting (Rejeb et al., 2023).

AR, an innovative tool that overlays virtual objects—such as images, text, and sounds—onto the user's real environment, has emerged as one of the most promising technological advancements in recent years. AR enhances the "physical environment with computer-generated perceptual information, leveraging visual, auditory, haptic, somatosensory, and olfactory modalities" (Roggeveen & Sethuraman, 2018), offering a highly immersive experience that requires less imagination than vivid web-based product presentations. By incorporating AR-based product presentations into e-commerce platforms, retailers can enhance customer value and create exceptional experiences across multiple touchpoints in the customer journey (Heller et al., 2019; Lemon & Verhoef, 2016).

In its early stages, VR was costly to develop and primarily used in small-scale, professional applications, with limited consumer accessibility (Rejeb et al., 2023). For instance, VR was employed in professional settings as a methodological or intervention tool for training social skills (Howard & Gutworth, 2020), treating anxiety and related disorders (Carl et al., 2019), and facilitating physical rehabilitation (Howard, 2017). However, advancements in VR technology have made it more affordable, accessible, and user-friendly for a broader range of applications. From a technological standpoint, VR continues to improve, offering increasingly realistic virtual environments at a lower cost (Castelvecchi, 2016; Lombart et al., 2020). The development of head-mounted displays has been particularly transformative, shifting VR use from professional applications to widespread consumer adoption (Desai et al., 2014; De Pace et al., 2018; Fox et al., 2009).

VR has evolved rapidly and is increasingly used in consumer research, particularly in behavior change studies, following the introduction of head-mounted displays (Rejeb et al., 2021). In one study, participants in an immersive virtual store purchased more fruits and vegetables than those in a physical store (Lombart et al., 2020). Pizzi et al. (2019) found that participants spent more time in front of shelves in a VR supermarket than in a real-life supermarket. Additionally, purchase intention for outdoor clothing was significantly higher among participants who viewed an advertisement in VR compared to those who viewed the same ad in 2D on a mobile device.

AI

AI originated in the 1950s as the use of computers to perform tasks previously exclusive to humans. By the 1990s, AI encompassed statistical machine translation, chess-playing computers, and expert systems capable of diagnosing illnesses or managing supply chains. However, progress remained limited. Over the past two decades, a fundamental shift in approach has redefined AI (Cukier, 2021).

Traditional hand-coded, logic-based AI systems failed to scale, yielding minimal performance improvements. In contrast, machine learning, which relies on statistical methods rather than explicit rules, has achieved significant advancements by leveraging large datasets to train algorithms. This approach enables AI to infer solutions probabilistically rather than deterministically (Cukier, 2021). Additionally, machine learning systems do not rely on predefined variables but instead identify key features through a process known as "feature extraction." As a result, these systems excel in handling high-dimensional, unstructured data, reducing human intervention and enhancing efficiency (Cukier, 2021).

AI, embedded in products and services, enhances customer experiences while presenting unique challenges for marketers. Functioning as an "intermediate good," AI powers products much like electricity or microprocessors. Consumers interact with AI through its integration into products, improving performance in speed, scale, accuracy, and cost efficiency (Cukier, 2021). AI has been widely applied in various forms, including chatbots (Park & Lee, 2022), smart speakers (Ling et al., 2021), and music biometrics (Rodgers et al., 2021). These applications interact directly with consumers in service ecosystems, utilizing technologies such as natural language processing, voice recognition, image recognition, and deep learning (Kietzmann et al., 2021). They assist consumers throughout the buying journey by providing recommendations, promotional content,

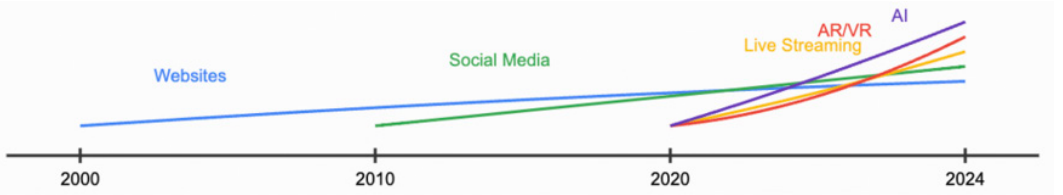
information, and support services (Klaus & Zaichkowsky, 2020). Over the past decade, voice assistants and smart speakers have gained widespread popularity (Poushneh, 2021).

Advancements in AI over the last two decades have significantly reshaped consumer behavior. In this fast-evolving marketplace, consumer needs, preferences, and behaviors are continually changing (Jain et al., 2024; Kshetri et al., 2024). Close interactions with AI agents can influence consumer emotions, either positively or negatively (Filieri et al., 2022). Additionally, research indicates that brand commitment plays a crucial role in evaluating AI-enabled customer experiences, particularly among consumers with prior brand interactions (Longoni et al., 2021).

The evolution timeline in Figure 1 highlights three key characteristics of e-commerce technology development. (a) Progressive integration has characterized each technological phase, with new innovations building upon and enhancing prior capabilities rather than replacing them. For example, social media platforms integrated website functionalities, live streaming incorporated social media features, AR/VR technologies improved visual interfaces, and AI capabilities became embedded across all platforms. (b) Accelerating innovation cycles have also shaped this evolution, as the time between major technological advancements has significantly decreased. Early website development from 2000 to 2010 progressed gradually, whereas social media integration between 2010 and 2015 saw faster adoption. More recent technologies from 2015 to 2024 have been deployed and integrated at an unprecedented pace. Lastly, (c) cross-technology synergies demonstrate how modern e-commerce platforms increasingly converge multiple technologies. This integration has created sophisticated and interconnected digital ecosystems, enhancing user experiences and operational efficiency. This evolutionary timeline reveals key patterns in e-commerce technology development:

- Sequential emergence: Technologies have emerged in an overlapping sequence, with each innovation building upon and enhancing prior capabilities.
- Accelerating integration: More recent technologies (2020–2024) exhibit greater interdependence, particularly in how AI, AR/VR, and live streaming complement one another.
- Technological v=convergence: The integration of these technologies has led to sophisticated and comprehensive e-commerce solutions. Websites have evolved from static pages to dynamic, AI-powered platforms. Social media is now deeply embedded with e-commerce functionalities. Live streaming incorporates AR/VR capabilities, enhancing social commerce. AI has been leveraged to refine, integrate, and enhance all existing platforms with new functionalities and features.

Figure 1. Evolution and integration of e-commerce technologies

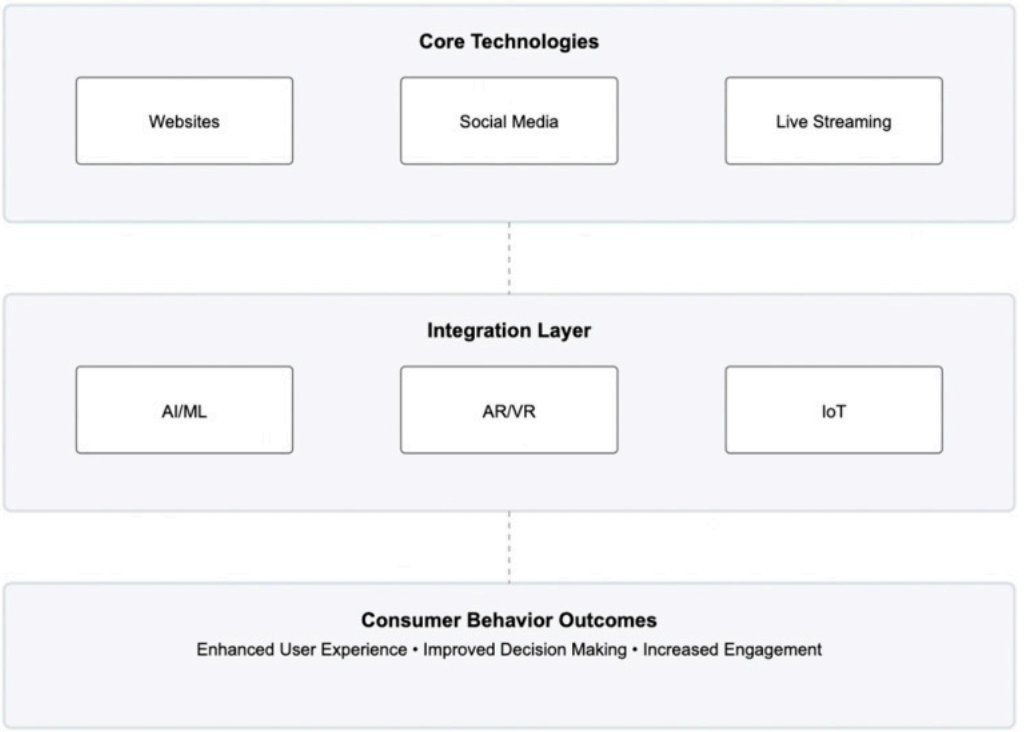


Note. AR = augmented reality; VR = virtual reality; AI = artificial intelligence.

The integration framework in Figure 2 illustrates how these technologies function collectively within modern e-commerce systems. This integration has several key implications. First, the combination of technologies enables more immersive and personalized shopping experiences, thereby enhancing user engagement. Second, the integration of AI with other technologies improves

recommendation systems, decision support, and overall decision-making processes. Lastly, a multi-technology approach fosters more engaging and interactive shopping environments, enriching consumer experiences and increasing business adaptability in a rapidly evolving digital landscape.

Figure 2. Technology integration framework



Note. AR = augmented reality; VR = virtual reality; AI = artificial intelligence; ML = machine learning; IoT = Internet of Things.

We propose a unified theoretical framework that integrates three major theoretical perspectives: S-O-R, TAM, and the ISS model. The S-O-R model, as outlined in Table 1, forms the foundation of this framework by explaining how technological features influence consumer behavior. This model highlights the relationship between external stimuli (technological attributes), internal organismic processes (consumer perceptions and emotions), and behavioral responses (purchase decisions and engagement). By incorporating TAM and the Information Systems Success Model, this framework provides a comprehensive approach to understanding technology adoption, user experience, and the impact of digital innovations on consumer behavior in e-commerce.

Table 1. Stimulus-organism-response framework

Stimulus (S)	Organism (O)	Response (R)
Technological interfaces	Cognitive processing	Purchase decisions
Artificial intelligence-powered recommendations	Emotional responses	Engagement behaviors
Augmented reality/ virtual reality displays	Trust perceptions	Technology adoption
Social media integration	Technology anxiety	Brand loyalty
Blockchain-enabled security features		

METHODOLOGY

We conducted a systematic literature review on e-commerce and consumer behavior in the context of emerging technological innovations. Most of these reviews employed the scientific procedures and rationales for systematic literature reviews (SPAR-4-SLR) paradigm, utilizing methods such as the theory, context, characteristics, and methodology (TCCM), the antecedents, decisions, and outcomes (ADO), or a combination of both to structure analyses. Additionally, some reviews incorporated bibliometric analysis, text analysis, and machine learning techniques, demonstrating the methodological diversity in this field. This body of research highlights various approaches and insights into consumer behavior. Bhukya and Paul (2023) conducted a hybrid systematic literature review using the TCCM framework to examine social influence in consumer behavior, while Ayalew and Zewdie (2022) identified key determinants of online consumer behavior through systematic and content analysis. Das et al. (2024) investigated impulsive buying in social commerce using SPAR-4-SLR and fuzzy-set qualitative comparative analysis (fsQCA) methods. Xu and Siegrist (2021) validated VR as a tool for studying consumer behavior in food research. Vieira et al. (2022) reviewed technological innovations in consumer behavior, emphasizing the need for complementary theories. Massa and Ladhari (2023) analyzed AR in marketing, proposing an integrative framework.

Ghorbani et al. (2022) explored digital brand personality perceptions using the TCCM framework, while Wolf (2023) examined device-mediated customer behavior on the internet. Güngör and Çadırcı (2022) applied bibliometric and machine learning methods to understand digital consumer behavior, and Singh and Basu (2023) reviewed online shopping behavior, suggesting future research directions. Kumar, Dhingra, and Falwadiya (2023) conducted a systematic review on Internet of Things (IoT) adoption, proposing a future research agenda that highlights key factors influencing adoption and identifies significant research gaps. Collectively, these reviews enhance the understanding of consumer behavior in response to technological advancements and propose comprehensive frameworks for future research.

However, as summarized in Table 2, existing reviews on e-commerce often focus on individual technological advancements rather than providing a comprehensive analysis across all major technologies and stages since the inception of e-commerce. For example, Bhukya and Paul (2023) conducted a hybrid review on social influence in consumer behavior using the TCCM framework. Manish Das et al. (2024) examined impulsive buying in social commerce through SPAR-4-SLR and fsQCA analysis. Similarly, Massa and Ladhari (2023) reviewed AR in marketing using the SPAR-4-SLR and the TCCM framework, while Wolf (2023) analyzed device-mediated customer behavior using SPAR-4-SLR and a framework combining ADO and TCM.

Table 2. List of review papers on consumer behavior in e-commerce

Title	Author/Year	Method	Summary
Social influence research in consumer behavior: What we learned and what we need to learn? – A hybrid systematic literature review	Bhukya and Paul (2023)	Theory, context, characteristics, and methodology	The researchers conducted a hybrid systematic literature review to provide an overview of social influence research in consumer behavior, employing bibliometric analysis. It evaluates theories, contexts, characteristics, and methodologies in the field, offering implications for scholars and practitioners and providing directions for future research.
What factors determine the online consumer behavior in this digitalized world? a systematic literature	Ayalew and Zewdie (2022)	Systematic review and content analysis	This study investigated the determinants of online consumer behavior using a systematic review strategy. Data were analyzed through content analysis, and a descriptive research design was employed to present findings.
High and Low Impulsive Buying in Social Commerce: A SPAR-4-SLR and fsQCA Approach	Das et al. (2024)	Scientific procedures and rationales for systematic literature reviews and fuzzy-set qualitative comparative analysis.	This study identified and examined factors shaping impulsive buying behavior in social commerce. It offers a comprehensive assessment of consumer behavior on social commerce platforms and suggests strategies for enhancing sales and platform features to encourage impulsive purchases.
The application of virtual reality in food consumer behavior research: A systematic review	Xu and Siegrist (2021)	Systematic review	This study reviewed literature on VR applications in food and consumer behavior research. It assessed the validity of VR for studying consumer behavior, analyzing its use in food sensory evaluation, purchasing behavior, and inducing psychological and physiological responses.
Consumer behavior towards technological innovations: a systematic review	Vieira et al. (2022)	Research front and Intellectual base	This review examined technological innovations in consumer behavior research. It highlights a trend toward hybrid theoretical models, suggesting that existing theories fail to fully explain factors driving consumer adoption of new technologies.
Augmented reality in marketing: Conceptualization and systematic review	Massa and Ladhari (2023)	Scientific procedures and rationales for systematic literature reviews protocol and theory, context, characteristics, and methodology framework	This study analyzed the use of AR in marketing, classifying different AR applications based on triggers and augmentation types. It proposes an integrative framework exploring antecedents, consequences, mediators, and moderators of the AR experience.
Consumers' brand personality perceptions in a digital world: A systematic literature review and research agenda	Ghorbani, Karampela and Tonner (2022)	Scientific procedures and rationales for systematic literature reviews protocol and theory, context, characteristics, and methodology framework.	This study systematically reviewed 107 peer-reviewed journal articles on digital brand personality perceptions. It synthesizes research findings from various digital contexts and proposes a conceptual framework for digital brand personality.

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Table 2. Continued

Title	Author/Year	Method	Summary
Device-mediated customer behaviour on the internet: A systematic literature review	Wolf (2023)	Scientific procedures and rationales for systematic literature reviews protocol and theory, context, methodology, and ADO framework.	This systematic review examined research on device-mediated customer behavior. It synthesizes existing studies, identifies research gaps, and proposes a conceptual framework outlining the relationship between device characteristics, decision-making processes, and behavioral outcomes.
Understanding digital consumer: A review, synthesis, and future research agenda	Güngör and Çadırcı (2022)	Bibliometric analysis and machine learning algorithms	This study analyzed digital consumer behavior research over 20 years using 74 marketing journals. It employs bibliometric analysis and machine learning algorithms to track key topics and their evolution, highlighting how digitalization has become integral to mainstream consumption patterns.
Online consumer shopping behaviour: A review and research agenda	Singh and Basu (2023)	Scientific procedures and rationales for systematic literature reviews protocol and theory, context, characteristics, and methodology framework.	This review examined theoretical perspectives, research contexts, study characteristics, and methodologies in online shopping behavior research. It recommends future research directions, emphasizing the need for combined theoretical approaches and exploration of novel constructs such as online experiential luxury and second-hand product markets.

Note. AR = augmented reality; VR = virtual reality; SPAR-4-SLR = scientific procedures and rationales for systematic literature reviews; fsQCA = fuzzy-set qualitative comparative analysis.

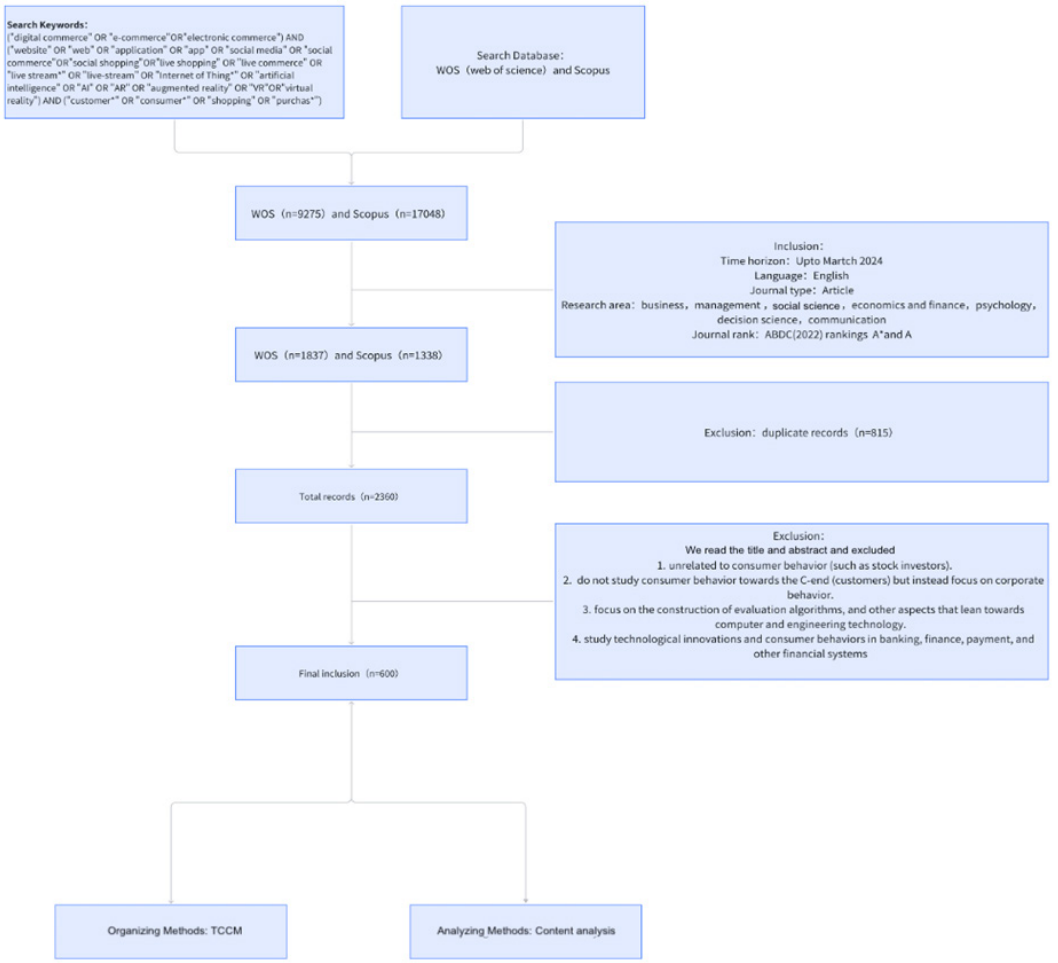
Our review aims to address this gap by conducting a comprehensive examination of key technologies, ranging from websites and social media to live commerce and emerging innovations such as VR and AI. This review provides a holistic overview of the evolution of e-commerce technologies and their impact on consumer behavior. By integrating multiple methodologies and theoretical frameworks, we seek to present a cohesive analysis that captures the dynamic nature of technological advancements and their influence on consumer behavior.

Systematic literature reviews provide a valuable synthesis and assessment of existing research when conducted rigorously, making them a prominent methodology in leading management journals (Paul et al., 2021). While the Preferred Reporting Items for Systematic Reviews and Meta-Analyses protocols (Moher et al., 2009; 2015) establish general reporting standards, they offer limited guidance for justifying review decisions within the management domain. To address this limitation, Paul et al. (2021) introduced the SPAR-4-SLR protocol, specifically designed for management and business research. Unlike Preferred Reporting Items for Systematic Reviews and Meta-Analyses protocols' reporting focus, SPAR-4-SLR consists of three stages—assembling, arranging, and assessing—further divided into six substages that outline procedural steps and rationales for each phase. Given its relevance to this field and its emphasis on procedural transparency, we adopted SPAR-4-SLR to ensure a rational and well-justified literature review.

In the assembling stage, we defined the research domain, research question, source type, and source quality to compile relevant literature. We selected two well-established and widely accessible academic databases, Web of Science and Scopus. Our search focused on academic journals due to their rigorous peer-review processes. The search keywords included: ("digital commerce" OR

"e-commerce") AND ("internet" OR "mobile commerce" OR "social media" OR "live commerce" OR "social commerce" OR "live stream*" OR "Internet of Things" OR "artificial intelligence" OR "AI" OR "AR" OR "VR") AND ("customer*" OR "consumer*" OR "consumer behavior"), where the asterisk (*) represented any character, any group of characters, or no character. Boolean operators (AND, OR, NOT, NEAR, and W/n) were also applied. To ensure source quality, we retained only journals ranked ABS/AJG 2, 3, 4, and 4* and indexed in Web of Science or Scopus (Q1/Q2/Q3) with an impact factor ≥ 1. Articles that were assembling reviews or outside the time scope of 1985–2024 were excluded. The search retrieved 9,275 articles from Web of Science and 17,048 from Scopus. After eliminating 815 duplicate records, a total of 2,360 articles were considered. The detailed procedures guiding our research are illustrated in Figure 3, which depicts the assembling, arranging, and assessing stages.

Figure 3. Flowchart of assembling, arranging, and assessing



Note. WOS = Web of Science; TCCM = theory, context, characteristics, and methodology.

During the arranging stage, we coded the articles based on publication date, journal, and technical background, categorizing them using the TCCM framework (Paul & Rosado-Serrano, 2019). This

classification focused on theoretical foundations, research contexts, key characteristics, and methodological approaches. In the purification stage, we applied exclusion criteria, removing articles that did not address consumer behavior or did not consider it as an outcome variable. Papers were evaluated based on their title, abstract, and full text, resulting in the exclusion of 1,760 articles and leaving 600 for analysis.

In the assessing stage, we conducted bibliometric and content analyses to evaluate and synthesize findings, identifying the strengths and limitations of the reviewed literature. Bibliometric analysis involved manual screening to present publication trends by year and journal through tables and graphs. Content analysis, structured within the TCCM framework, examined theoretical models, research contexts, study characteristics, and methodological approaches, with findings reported through tables and text. Finally, we identified research gaps, discussed limitations, and outlined future research directions.

DESCRIPTIVE ANALYSIS

We conducted a descriptive analysis of the included articles, revealing that the first publications on consumer behavior in e-commerce appeared in 2002, as depicted in Figure 4. Since then, the number of published articles has generally increased, with a notable surge after 2017. The publication volume peaked in 2023, with 89 articles, while as of May 2024, 42 related articles have already been published. This trend reflects a growing research interest in consumer behavior within the e-commerce domain.

Figure 4. Number of papers published across the years

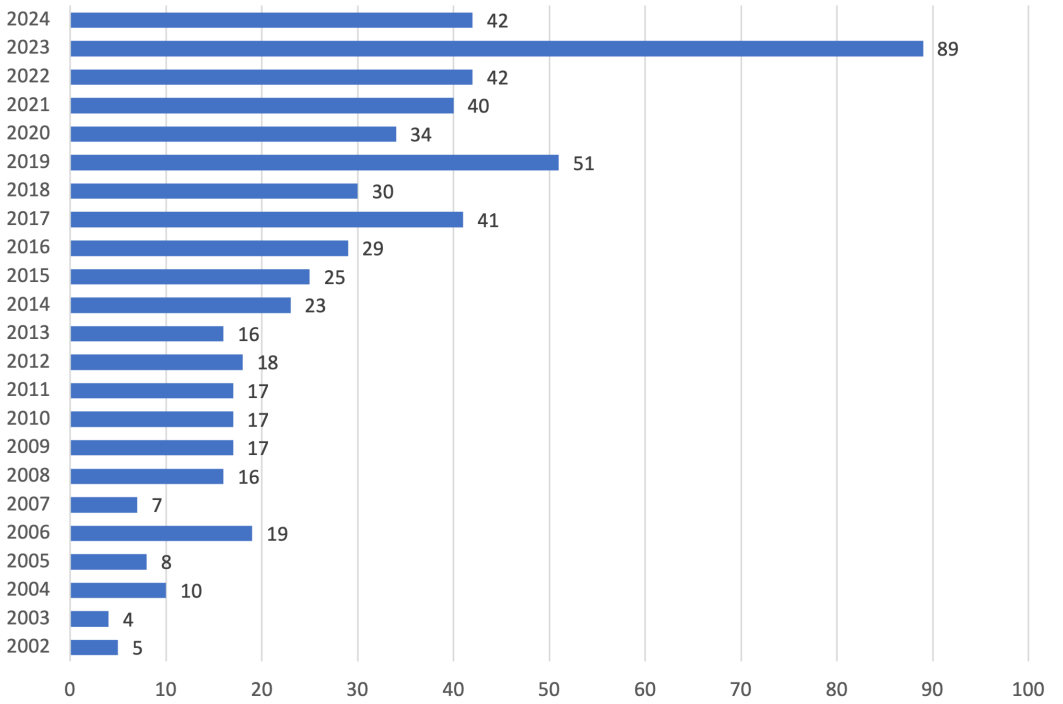
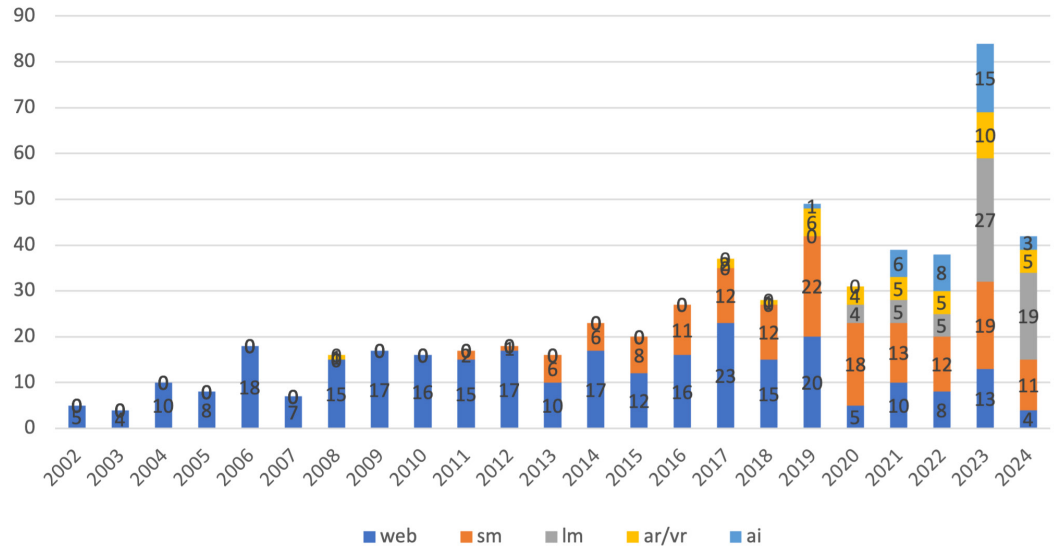


Figure 5 illustrates the publication trends for different e-commerce technologies over time. From 2002 to 2010, research primarily focused on websites, with a steady increase in publications.

After 2011, social media gained prominence, with the number of related studies rising annually and maintaining popularity through 2024. Research on live streaming emerged around 2020, experiencing rapid growth, particularly in 2021 and 2023. Studies on AR and VR technologies appeared around 2017, while AI-related research began in 2019, both showing an upward trajectory but remaining less prevalent than websites and social media. Overall, the figure highlights a shift from well-established technologies to emerging areas such as live streaming, AR, VR, and AI. The increasing number of publications integrating multiple technologies underscores a growing research focus on technological innovations and their impact on consumer behavior in e-commerce.

Figure 5. Number of papers on each technology published across the years



Note. sm = social media; lm = live stream ar = augmented reality; vr = virtual reality; ai = artificial intelligence.

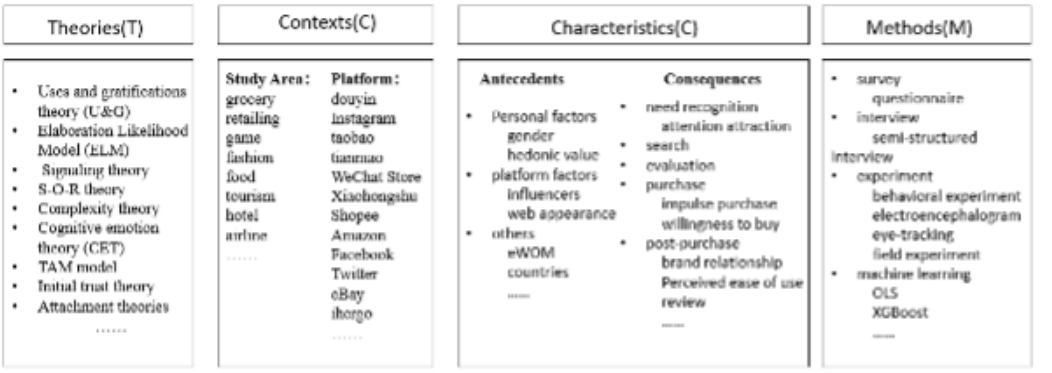
The journals identified in Figure 6 each published more than 10 articles included in our review. The top three are Journal of Retailing and Consumer Services, Computers in Human Behavior, and International Journal of Information Management, with 90, 60, and 39 articles, respectively. Most of these journals are top-tier publications in consumer behavior and e-commerce, underscoring their credibility and influence in the field.

Figure 6. Number of related articles published in each journal

CONTENT ANALYSIS

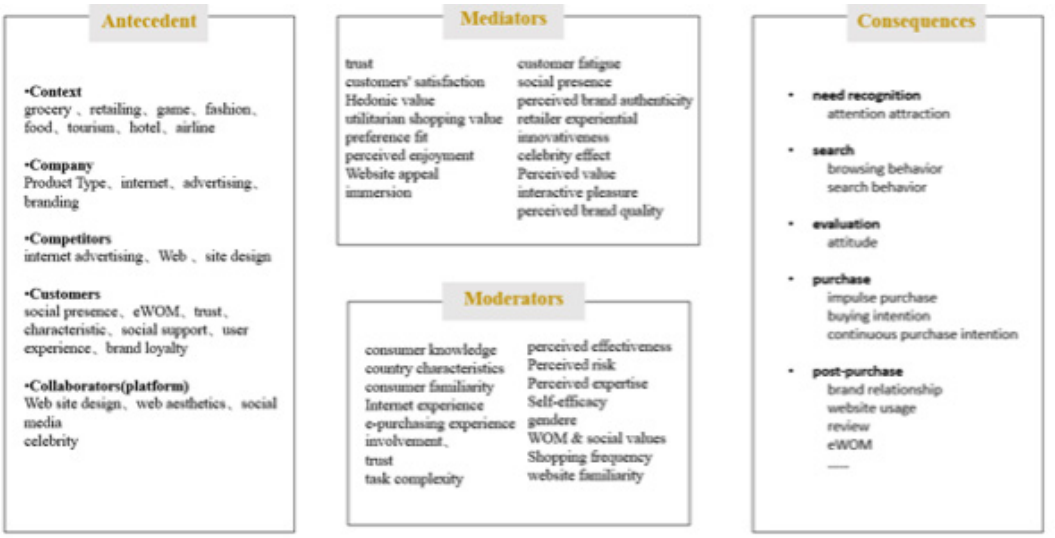
We applied the TCCM framework to conduct a content analysis of the selected studies. Figures 7 and 8 provide a summary of the framework, outlining key insights related to theory, contexts, characteristics, and methodology within the reviewed literature.

Figure 7. Theory, context, characteristics, and methodology (TCCM) framework part 1



Note. S-O-R = stimulus-organism-response; TAM = technology acceptance model; OLS = Ordinary Least Squares ; eWOM = Electronic Word of Mouth; XGBoost = Extreme Gradient Boosting.

Figure 8. Theory, context, characteristics, and methodology (TCCM) framework part 2



Note. WOM = Word of Mouth; eWOM = Electronic Word of Mouth.

Theory

The literature on consumer behavior applies a wide range of theories to support research. Our analysis of the included articles identifies several frequently used theoretical models, including the S-O-R model, TAM, ISS model, and the uses and gratifications (U&G) theory. Table 3 presents the five most commonly applied theories for each technological context.

Key insights from prior research indicate that various theories have been extensively utilized to examine consumer behavior in e-commerce. The S-O-R model is particularly prominent across multiple technological contexts, including websites, social media, live streaming, AR/VR, and AI. This model explains how external stimuli, such as technological features, influence internal psychological states, including emotions and beliefs, which subsequently drive behavioral responses such as purchasing decisions.

Table 3. Crosstab summary of theories

Theory	Website	Social media	Live streaming	Augmented reality/ virtual reality	Artificial intelligence
Stimulus-organism-response model	8+	13+	14+	3+	3+
Technology acceptance model	4+			3+	
Uses and gratifications theory			3+		2+
Information systems success	5+			1+	1+
Signaling theory	3+	2+			
Social learning theory		4+			
Social capital theory		1+			
Social power theory		1+			
Trust transfer theory		2+			

continued on following page

Table 3. Continued

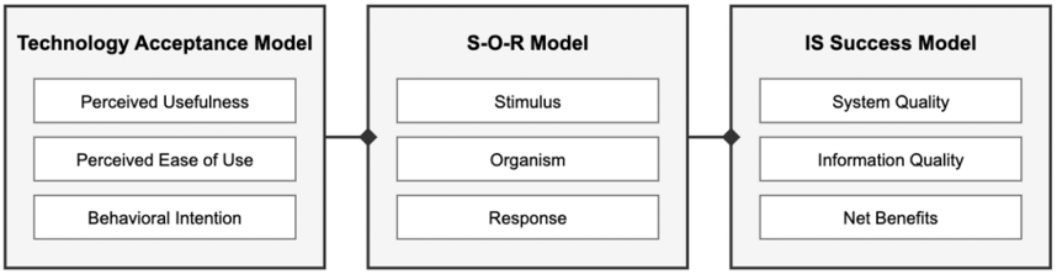
Theory	Website	Social media	Live streaming	Augmented reality/ virtual reality	Artificial intelligence
Self-determination theory				1+	1+
Consumption value theory				1+	
Social response and commitment theory					1+
Expectation-confirmation model	3+				
Heuristics systematic model	2+				
Trust model	2+				
Elaboration likelihood model			2+		
Attitude-behavior-context framework			2+		

The TAM is primarily applied to websites and AR/VR, examining how perceived ease of use and perceived usefulness shape users' acceptance of technology. The ISS model, frequently used in website and AR/VR studies, evaluates information system success based on system quality, information quality, and user satisfaction. The U&G theory, commonly employed in live streaming and AI research, focuses on how individuals use media to fulfill specific needs and desires. Each technological context also incorporates theories tailored to its unique characteristics. For instance, social media research often relies on social theories such as social learning theory and social capital, reflecting the inherently interactive nature of these platforms.

By analyzing theories across technological contexts, we find that various models have been widely applied. The S-O-R model is particularly prevalent across websites, social media, live streaming, AR/VR, and AI. This model explains how external stimuli, such as technological features, influence internal states, including emotions and beliefs, which subsequently drive behavioral responses such as purchasing behavior.

The integrated framework in Figure 9 illustrates key relationships between theoretical models in explaining consumer behavior in e-commerce. The S-O-R model serves as the foundational structure, demonstrating how technological stimuli influence consumer responses through cognitive and emotional processes. TAM clarifies the specific mechanisms of technology adoption, particularly how perceived ease of use and usefulness shape behavioral intentions. The ISS model further contributes by emphasizing the role of system quality, information quality, and service quality in determining user satisfaction and overall benefits. Integrating these theories provides several advantages. It enables more comprehensive coverage of consumer behavior factors, leading to a deeper understanding of the interaction between technological and behavioral elements. This, in turn, strengthens the theoretical foundation for analyzing emerging technology adoption in e-commerce.

Figure 9. Integrated consumer behavior framework



Note. S-O-R = stimulus-organism-response; IS = information systems.

Context

From 2002 to 2010, nearly all articles focused on consumer behavior within the context of websites, showing a steady increase in publication volume. After 2011, research on social media began emerging, with a consistent upward trend, establishing it as a prominent research topic through 2024. Live streaming studies appeared in 2020 and have since experienced significant growth. In terms of publication volume, research on websites remains the most extensive, followed by social media and live commerce.

This trend reflects the chronological emergence of these technologies, with websites developing first, followed by social media, and live streaming as a more recent paradigm. The rise in research on AR/VR and AI since 2019 indicates growing interest; however, their publication volumes remain relatively low compared to other technologies. This may be due to their early-stage development in e-commerce, where, despite their potential, they have yet to achieve widespread, disruptive impact.

Characteristics

This comprehensive framework for understanding consumer behavior in technological innovations illustrates the interplay between antecedents, mediators, moderators, and consequences. Antecedents, including context, company attributes, competitor strategies, customer characteristics, and platform collaborations, establish the foundation for consumer behavior. Mediators such as trust, customer satisfaction, perceived value, and social presence explain how these antecedents shape consumer outcomes. Moderators, including consumer knowledge, internet experience, and perceived risk, influence the strength of these relationships. Consequences encompass the entire consumer journey, from need recognition and search to evaluation, purchase, and post-purchase behaviors. This framework highlights the complexity of consumer behavior, emphasizing the importance of accounting for multiple interdependent factors to enhance the understanding and prediction of consumer actions in digital environments.

Cultural and Demographic Factors in Technology Adoption

Our analysis indicates that cultural and demographic factors play critical roles in shaping consumer behavior across different technological contexts. These factors act as key moderators in the technology adoption process, influencing how consumers engage with various e-commerce technologies. Cultural factors affect technology adoption in several ways. Regional variations are evident, with Asian markets exhibiting higher adoption rates of LSC and mobile payments, while Western markets show a stronger preference for traditional e-commerce websites. Middle Eastern markets display unique patterns in social commerce adoption, whereas emerging markets demonstrate distinctive trends in mobile commerce usage.

Collectivist societies exhibit a stronger inclination toward social commerce and group buying, whereas individualistic cultures show higher adoption rates of personalized AI recommendations.

High-context cultures engage more with visual technologies such as AR/VR, while trust formation—a critical factor in e-commerce transactions—varies significantly across cultural contexts. Consumer behavior also differs across demographic age groups. Generation Z (18–24) shows a strong preference for social commerce and live streaming. Millennials (25–40) display high adoption rates across all technology platforms. Generation X (41–56) tends to favor traditional e-commerce websites, while baby boomers (57+) are increasingly adopting AI-assisted shopping.

High-income users are typically early adopters of AR/VR technologies, while middle-income consumers frequently utilize comparative shopping tools. Lower-income users, in contrast, rely more on mobile commerce and social platforms. Higher educational attainment correlates with faster adoption of new technologies, with individuals from technical education backgrounds exhibiting greater trust in AI recommendations and heightened awareness of security and privacy concerns. A significant digital divide persists between urban and rural users in e-commerce transactions. Urban consumers demonstrate higher adoption rates of advanced technologies, whereas rural users exhibit distinct mobile commerce usage patterns due to its accessibility. Regional technology infrastructure also plays a crucial role in shaping technology preferences. Developed markets prioritize integrated omnichannel experiences, while emerging markets predominantly follow a mobile-first approach to e-commerce. Additionally, developing markets are experiencing a rapid surge in mobile payment adoption.

The interplay between cultural and demographic factors shapes distinct adoption patterns. Young users in Asian markets exhibit the highest adoption rates of live streaming, while higher-income users in Western markets lead in AR/VR adoption. Educational background influences technology adoption differently across cultures, affecting trust, awareness, and engagement with emerging technologies. Moreover, adoption patterns evolve uniquely across demographic groups, reflecting variations in technological preferences and usage behaviors.

This comprehensive understanding of cultural and demographic factors yields several key observations. From a strategic perspective, localized technology deployment must account for cultural adaptation in user interfaces, necessitating demographic-specific feature development. Cultural sensitivity should be embedded in user interface design, incorporating age-appropriate technology features and income-conscious platform structures. Implementing e-commerce platforms requires a phased rollout strategy based on demographic readiness, accompanied by targeted training and support. These findings underscore the importance of integrating cultural and demographic considerations into technology adoption research and practice, suggesting that future studies should systematically incorporate these variables into their frameworks and methodologies. Table 4 depicts the approaches adopted to collect data.

Table 4. Crosstab summary of data collection, methodology and technology

Data Collection	Website	Social media	Augmented reality/ virtual reality	Live stream	Artificial Intelligence
Survey	93	75	7	34	12
Experiment	48	19	15	8	8
Platform Data and Clickstream Data	25	15	1	3	
Interview	2	5	1	0	1
Research Method					
Structural equation modeling	32	13	5	10	2
Partial least squares structural equation modeling	4	18	1	6	4

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Table 4. Continued

Data Collection	Website	Social media	Augmented reality/ virtual reality	Live stream	Artificial Intelligence
Primary lateral sclerosis	2	4	1		
Fuzzy-set Qualitative Comparative Analysis	3	4		3	
Artificial neural network				2	

The rapid evolution of e-commerce technologies and the increasing complexity of consumer behavior necessitate more sophisticated analytical approaches. While traditional methods such as surveys and experiments remain valuable, emerging analytical techniques provide new opportunities for deeper insights. This section explores several advanced methodological approaches that enhance research in this field. Big data analytics has become a crucial tool for understanding complex consumer behavior patterns in e-commerce. Real-time data processing capabilities now allow researchers to analyze live commerce interactions and consumer feedback instantaneously (Kumar et al., 2023). For instance, stream processing techniques have been successfully applied to live streaming events, offering insights into immediate purchase decisions and engagement patterns.

The integration of data from multiple platforms has become increasingly important, as cross-platform data synthesis can uncover deeper consumer behavior patterns that may not be evident when analyzing individual platforms in isolation (Das et al., 2024). Machine learning techniques have significantly improved the analysis and prediction of consumer behavior. Supervised learning applications have demonstrated strong potential in forecasting purchase patterns and customer churn, with recent studies achieving prediction accuracies exceeding 85% based on behavioral indicators (Li et al., 2022). Unsupervised learning methods have proven effective for customer segmentation and pattern discovery, with clustering algorithms identifying previously unknown consumer segments based on behavioral similarities. Network analysis methods have also gained relevance with the rise of social commerce and interconnected shopping experiences. Social network analytics have uncovered key patterns in influence networks and viral marketing dynamics, offering deeper insights into consumer interactions and purchasing behaviors.

Recent research has demonstrated that mapping consumer interaction networks enhances the understanding of product recommendation effectiveness and user engagement patterns (Wolf, 2023). These methods have been particularly valuable in analyzing the spread of shopping trends and the impact of social influence on purchase decisions. Advanced visualization techniques have evolved to improve the interpretation and communication of complex behavioral patterns. Interactive visualizations now facilitate dynamic customer journey mapping and real-time behavior tracking. The emergence of immersive analytics, leveraging VR and AR technologies, has introduced new possibilities for data exploration and analysis. These tools have proven especially effective in examining spatial aspects of online shopping behavior and multi-dimensional interaction patterns (Singh & Basu, 2023). Integrating these advanced analytical methods with traditional approaches has resulted in more robust research designs, offering deeper insights into consumer behavior and technological adoption in e-commerce.

Mixed-method approaches that integrate qualitative insights with quantitative analysis have become increasingly prevalent. Studies combining machine learning analysis of large-scale behavioral data with in-depth qualitative interviews have provided a more comprehensive understanding of consumer decision-making processes (Güngör & Çadırcı, 2022). However, the implementation of these advanced methods presents several challenges. Technical requirements demand substantial computing infrastructure and specialized analytical expertise. Ensuring data quality becomes

increasingly critical as the scale and complexity of analysis expand. Ethical considerations, particularly concerning privacy protection and data security, must also be carefully addressed. These challenges emphasize the need for careful planning and the adoption of robust methodological frameworks when applying advanced analytical approaches in consumer behavior research.

In data collection methods, surveys remain the most widely used approach. Following surveys, experiments are frequently employed, with online experiments being the most common. Some studies also utilize laboratory experiments, including Electroencephalography (EEG)and eye-tracking techniques. Additionally, platform data collection has gained traction, involving methods such as scraping website or app data and analyzing clickstream data. Interviews are the least commonly used method, typically conducted in semi-structured or focus group formats. However, interviews are rarely employed in isolation and are usually combined with surveys or experiments to provide deeper insights.

Regarding data modeling and processing methods, structural equation modelling (SEM) is the most frequently used approach, followed by partial least squares structural equation modeling and fsQCA. Many studies integrate SEM with fsQCA or partial least squares models to enhance analytical depth. Additionally, regression models, including linear and logistic regression, are commonly employed. A smaller number of studies utilize machine learning models such as artificial neural networks and Markov models, primarily for analyzing platform data.

For different technological contexts, surveys are widely used in studies on websites, social media, and live streaming, with AI following closely behind. In contrast, AR/VR studies more commonly rely on experiments due to the challenges of capturing immersive experiences through online surveys and the need for reliable data from controlled experimental setups. Platform data is used less frequently in AI, live streaming, and AR/VR research compared to websites and social media. This discrepancy may stem from technical difficulties in directly obtaining and analyzing data from live streaming, AR, and AI platforms. Overall, the trend reflects a strong preference for surveys and experiments across most technologies, while advanced data processing methods such as SEM and machine learning models are increasingly applied to maximize the insights gained from collected data.

RESEARCH GAPS AND FUTURE DIRECTION

Current research on technological innovations in e-commerce often relies on isolated theoretical frameworks, resulting in a fragmented understanding of consumer behavior. Studies frequently apply the S-O-R model, TAM, IS success model, and U&G theory independently rather than integrating them for a more comprehensive perspective (Bhukya & Paul, 2023; Paul et al., 2021). Additionally, there is limited application of emerging theories that could better capture the complexities of newer technologies such as AI, AR, and VR. Future research should prioritize integrating multiple theoretical frameworks to examine the combined effects of different technologies on consumer behavior. Developing new theoretical models or adapting existing ones to account for the dynamic interactions between multiple technologies and consumer responses will provide more holistic insights into the evolving landscape of e-commerce.

Most studies focus on single technologies, overlooking the broader context in which multiple technologies interact to shape consumer behavior in e-commerce. Research has predominantly examined websites and social media, while newer technologies such as live streaming, AR/VR, and AI remain underexplored (Li et al., 2022). Additionally, the role of cultural and demographic factors in technology adoption and consumer behavior has not been sufficiently investigated. Future research should explore how combinations of technologies, including social media, AI, AR, and VR, collectively influence consumer behavior within the e-commerce ecosystem. It is also essential to conduct studies across diverse cultural and demographic groups to understand how these variables mediate the adoption and impact of technological innovations. A broader contextual approach will

provide a more inclusive understanding of consumer behavior across various settings, offering deeper insights into the interplay between multiple technologies and consumer decision-making.

Research on technological innovations in e-commerce often lacks longitudinal studies that track changes in consumer behavior over time. This limitation hinders a deeper understanding of the long-term effects of technology adoption (Ngai & Wat, 2002; Tan et al., 2019). Additionally, the impact of emerging technologies such as AR, VR, and AI remains underexplored, as these technologies are still in the early stages of development within e-commerce (Li et al., 2022). Future research should incorporate longitudinal designs to capture the evolution of consumer behavior with sustained technology use, providing insights into long-term adoption patterns. Expanding the focus on emerging technologies will also be essential to understanding their unique characteristics and potential influence on consumer decision-making, helping to bridge existing knowledge gaps.

From a methodological perspective, many studies rely heavily on surveys and experiments, with limited application of advanced data analytics and machine learning techniques (Ayalew & Zewdie, 2022; Xu & Siegrist, 2021). This narrow methodological approach restricts the depth of insights that can be derived. Moreover, existing research often remains confined within disciplinary silos, lacking integration across fields. Future research should employ advanced analytical techniques such as big data analytics, machine learning, and social network analysis to uncover deeper consumer behavior patterns. Adopting multidisciplinary approaches that integrate methodologies from marketing, information systems, psychology, and other relevant fields will offer a more comprehensive understanding of the impact of technological innovations on consumer behavior in e-commerce.

By addressing the identified gaps through the TCCM framework, future research can develop a more integrated, comprehensive, and nuanced understanding of how technological innovations in e-commerce influence consumer behavior. This approach will strengthen both theoretical and practical knowledge while offering actionable insights for practitioners seeking to optimize the implementation and impact of these technologies.

DISCUSSION

This study makes several significant theoretical and practical contributions. It introduces a unified conceptual framework that integrates multiple theoretical perspectives, including S-O-R, TAM, and ISS, to explain consumer behavior across different technological contexts. By moving beyond single-technology perspectives, this study provides the first comprehensive analysis of how various technologies interact to influence consumer behavior. Additionally, it expands the understanding of how cultural and demographic factors moderate technology adoption and usage patterns in e-commerce. Furthermore, it highlights the potential of advanced analytical methods, such as big data analytics, machine learning, and network analysis, for studying consumer behavior in e-commerce, offering new methodological directions for future research.

Theoretical Implications and Contributions

This study systematically synthesizes existing literature on the impact of technological innovations in e-commerce on consumer behavior, contributing to the current body of knowledge in several key ways. First, it consolidates fragmented research across different technological stages and innovations, offering a comprehensive overview of how e-commerce technologies such as websites, social media, live streaming, AR/VR, and AI influence consumer behavior (Li et al., 2022). Second, it provides a detailed descriptive analysis of the literature, highlighting publication trends over time and the distribution of studies across various technologies and journals. Third, the study identifies and evaluates key theoretical frameworks applied in this domain, including the S-O-R model, TAM, ISS model, and U&G theory, offering insights into their applicability and limitations (Bhukya & Paul, 2023; Paul et al., 2021). Fourth, it develops a conceptual framework structured around antecedents, mediators, moderators, and outcomes, enhancing the understanding of factors shaping

consumer behavior in the context of technological innovations. Finally, the study identifies research gaps and proposes future research directions, guiding scholars toward more integrative and comprehensive studies in this evolving field.

Practical Implications and Contributions

This study not only advances theoretical understanding but also provides practical implications for e-commerce practitioners. First, it presents a holistic perspective on integrating various technologies to enhance consumer engagement and satisfaction, enabling e-commerce platforms to optimize their technological investments. Second, it highlights the importance of cultural and demographic factors in technology adoption, encouraging managers to tailor strategies to diverse consumer segments (Li et al., 2022). Third, by identifying key antecedents, mediators, moderators, and outcomes, the study offers actionable insights for improving customer experience through targeted interventions, such as fostering trust, enhancing satisfaction, and mitigating perceived risks. Fourth, its analysis of emerging technologies like AR, VR, and AI highlights both their potential and associated challenges, guiding practitioners in leveraging these innovations for competitive advantage. Lastly, the study underscores the need for longitudinal and multidisciplinary approaches, recommending that businesses adopt advanced data analytics and machine learning techniques to gain deeper insights into consumer behavior and predict future trends.

CONCLUSION

This study is essential as it addresses the fragmented nature of existing research on the impact of technological innovations in e-commerce on consumer behavior. By systematically reviewing the literature, it provides a comprehensive understanding of how various technologies, including websites, social media, live streaming, AR/VR, and AI, influence consumer behavior. Following the SPAR-4-SLR methodology (Paul et al., 2021) and employing the TCCM framework (Paul & Rosado-Serrano, 2019), this study organizes and analyzes the literature, identifies key research gaps, and suggests future directions to advance the field.

To address the first research question regarding the current state of knowledge, our analysis reveals a growing interest in e-commerce consumer behavior research, with a notable increase in publications after 2017 and a peak in 2023. Studies on websites, social media, and live streaming have significantly expanded, while research on emerging technologies such as AR/VR and AI remains in its early stages but shows promising growth.

For the second research question on major theoretical frameworks, our findings identify dominant theories, including the S-O-R model, TAM, ISS model, and U&G theory. These theories are applied across different technological contexts, offering insights into how external stimuli influence consumer behavior through internal states and perceived usefulness.

In response to the third research question, our study maps key antecedents, mediators, moderators, and outcomes in the literature. Antecedents include factors such as context, company attributes, and platform collaborations. Mediators, including trust and customer satisfaction, explain the relationship between antecedents and consumer outcomes, while moderators such as consumer knowledge and perceived risk influence the strength of these relationships. The consequences encompass various stages of consumer behavior, from need recognition to post-purchase actions.

Lastly, the fourth research question highlights several gaps in current research. There is a need to integrate multiple theoretical frameworks to provide a more comprehensive understanding of how different technologies interact to influence consumer behavior. Longitudinal studies are essential for capturing behavioral changes over time. Emerging technologies such as AR, VR, and AI require more in-depth exploration to assess their full potential. Additionally, future research should incorporate cultural and demographic diversity to generate more inclusive insights. Methodologically, advanced

data analytics and multidisciplinary approaches are necessary to uncover deeper consumer behavior patterns.

By addressing these gaps and pursuing the suggested future directions, this study aims to advance both theoretical and practical understanding of technological innovations in e-commerce and their impact on consumer behavior. Ultimately, these insights will contribute to the development of a more dynamic and consumer-centric e-commerce ecosystem.

LIMITATIONS

This study, while comprehensive, has several limitations. First, the literature search was restricted to publications indexed in Web of Science and Scopus with an impact factor of ≥1, focusing on RQ1 and RQ2 categories to ensure high-quality sources. This exclusion criterion may have limited the scope of the review by omitting potentially relevant studies from other databases such as EBSCO, Google Scholar, and ScienceDirect. Second, although this study provides a detailed list of antecedents, mediators, moderators, and outcomes, further investigation is needed to determine the specific significance and interactions of these variables across different technological contexts. Third, while the review covers well-established technologies in e-commerce, such as websites and social media, emerging technologies like AR, VR, and AI receive comparatively less attention, highlighting the need for future research to explore their evolving role in consumer behavior.

To address these limitations and advance the field, future research should consider several directions. First, expanding the scope of the literature review to include additional databases such as EBSCO, Google Scholar, and ScienceDirect could provide a more comprehensive understanding of the topic. Second, future studies should explore the significance and interactions of identified variables across different technological contexts, utilizing advanced statistical and machine learning methods to uncover deeper insights. Third, there is a need for more focused research on the impacts of emerging technologies such as AR, VR, and AI on consumer behavior, given their nascent yet rapidly evolving role in e-commerce.

COMPETING INTERESTS

The authors of this publication declare there are no competing interests.

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