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Task-technology synergy of augmented reality retail technology features: a meta-analysis

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Abstract

Purpose – The integration of augmented reality retail technology (ARRT) in retailing industry has emerged as a key driver for transforming the consumer experiences and driving online sales. However, inconsistent findings in the existing research literature highlight the need for subsequent research efforts. The purpose of this study is to examine how augmented reality (AR) features like interactivity, flow experiences, augmentation and consumer engagement, contribute to retailer's success in the online marketplaces.

Design/methodology/approach – This meta-analysis study uses the theoretical lens of task-technology fit to synthesize and analyze the empirical results of existing AR studies published until March 2024.

Findings – All ARRT features examined in this study directly impacted online buyers' purchase intention. Moderators' analysis only partially supported the hypotheses proposing a significant difference in the effect size of ARRT features on purchase intention based on the country's GDP per capita and innovation level. While GDP per-capita moderated three relationships, innovation level moderated four out of six interactions studied.

Originality/value – This meta-analysis enhances the existing ARRT literature by using the task-technology fit theoretical framework, offering a dual perspective encompassing customers and businesses. Unlike popular technology innovation theories and models, such as Unified Theory of Acceptance and Use of Technology and technology acceptance model, which predominantly focus on consumers, this perspective provides concrete directions for designing AR-enabled retail platforms that meet the task requirements of both consumers and retailers.

Keywords Augmented reality retail technology, Retailing and marketing, Task-technology fit, Purchase intention, Meta-analysis

Paper type Research paper

Sinergia Tarea-Tecnología de la realidad aumentada en el comercio minorista: Un Meta-Análisis

Resumen

Objetivo – La integración de la Tecnología de Realidad Aumentada en el Comercio Minorista (ARRT, por sus siglas en inglés) ha surgido como un factor clave para transformar las experiencias de los consumidores y

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fomentar las ventas en línea. Sin embargo, los hallazgos inconsistentes en la literatura de investigación actual destacan la necesidad de más esfuerzos de investigación para comprender cómo características de RA, como por ejemplo la interactividad, las experiencias de flujo, la aumentación y el compromiso del consumidor, contribuyen al éxito de los minoristas en los mercados en línea.

Diseño/metodología/enfoque – Este estudio de meta-análisis utiliza el marco teórico de ajuste tarea-tecnología para sintetizar y analizar los resultados empíricos de estudios de RA publicados hasta marzo de 2024.

Resultados – Todas las características de ARRT examinadas en este estudio impactaron directamente en la intención de compra de los compradores en línea. El análisis de moderadores solo apoyó parcialmente las hipótesis que proponían una diferencia significativa en el tamaño del efecto de las características de ARRT sobre la intención de compra, en función del PIB per cápita y el nivel de innovación del país. Mientras que el PIB per cápita moderó tres relaciones, el nivel de innovación moderó cuatro de las seis interacciones estudiadas.

Originalidad/valor – Este meta-análisis mejora la literatura existente de ARRT al emplear el marco teórico de ajuste tarea-tecnología, ofreciendo una perspectiva dual que abarca a consumidores y empresas. A diferencia de las populares teorías y modelos de innovación tecnológica, como la Teoría Unificada de Aceptación y Uso de Tecnología (UTAUT) y el Modelo de Aceptación de Tecnología (TAM), que se centran predominantemente en los consumidores, esta perspectiva proporciona orientaciones concretas para diseñar plataformas de comercio minorista habilitadas para RA que satisfagan los requisitos de tareas tanto de consumidores como de minoristas.

Palabras clave Tecnología de realidad aumentada en el comercio minorista,
Comercio y marketing minorista, Ajuste tarea-tecnología, Intención de compra, Meta-análisis
Tipo de artículo Trabajo de investigación

增强现实零售技术功能的任务-技术协同效应：一项元分析

摘要

目的 – 增强现实零售技术（ARRT）的整合已成为零售行业转变消费者体验、推动在线销售的重要驱动力。然而，现有研究文献中的不一致发现表明，需要进一步研究来深入理解增强现实功能（如交互性、流体验、增强效果和消费者参与度）如何在推动零售商在线市场成功中发挥作用。

设计/方法/途径 – 本研究以任务-技术契合理论为视角，对截至2024年3月发表的增强现实相关实证研究进行了元分析，以系统整合和深入分析现有研究成果。

结果 – 研究中考察的所有ARRT功能均直接影响在线买家的购买意向。调节效应分析部分支持了假设，即ARRT功能对购买意向的效应大小因国家人均GDP和创新水平而异。具体而言，人均GDP对三种关系起到调节作用，创新水平则调节了六种关系中的四种。

原创性 – 本项元分析运用任务-技术契合理论框架，深化了现有ARRT文献，通过顾客与企业双重视角提供洞见。不同于以统一技术接受与使用理论（UTAUT）和技术接受模型（TAM）等为代表的流行技术创新理论和模型，这一视角为设计符合消费者和零售商任务需求的AR零售平台提供了切实的指导。

关键词 增强现实零售技术，零售与营销，任务-技术契合，购买意向，元分析
文章类型 研究型论文

1. Introduction

Augmented Reality (AR) has gained significant attention from the consumers and businesses seeking to enhance online purchasing experiences (Kumar *et al.*, 2022). AR is defined as one area of the mixed-reality continuum that enhances the real-world environment with digital information and objects thereby creating a more immersive and interactive experience for the users (Arena *et al.*, 2022; Riar *et al.*, 2021). In the context of online retailing, Augmented Reality Retail Technology (ARRT) offers value addition by addressing consumer behavior challenges in online shopping, such as difficulties in understanding complex product features and evaluating quality through text and images alone (Huang, 2019).

Several global companies, such as Amazon, Walmart and Ikea, offer AR applications on their retail platforms, enabling consumers to project virtual images of products in their real-life

surroundings. For example, a consumer purchasing a sofa from Ikea can use an AR application to visualize how the sofa would appear and fit in their living room (real-life environment) – an experience not available on traditional online retail platforms (Riar *et al.*, 2021). This aspect of enabling the personalized, immersive and interactive buying experience for the consumers has led to the growing popularity of ARRT among the major online retailing platforms (Rauschnabel *et al.*, 2019) and researchers (Kumar *et al.*, 2022). Statistically, AR market size is expected to reach USD 198 billion globally with more than 1.73 billion users by 2025 (Statista, 2021). Over time, AR related research has evolved from understanding the technological components to its business case in the context of online retailing (Scholz and Duffy, 2018).

The focus of this study is to examine the impact of key ARRT attributes – specifically augmentation, interactivity, flow experience, engagement, perceived ease of use and perceived usefulness – on consumer purchase intentions (Abrar, 2018; Hilken *et al.*, 2018; Khan, 2019). Existing literature consistently highlights that purchase intention is a closer predictor of actual buying behavior than variables like attitude or satisfaction (Chiu *et al.*, 2014). Therefore, online retailers must understand consumers' purchase intentions and predict their future buying behavior on the platforms using ARRT.

However, contradictory findings regarding features such as interactivity, perceived ease of use and flow experience highlight the influence of contextual factors, including a country's economic development (Chauhan *et al.*, 2023). For example, consumers in high-GDP per capita countries are likely to prefer ARRT features like interactivity and flow experience to fulfill their psychological and self-actualization needs. Contrarily, consumers in low-GDP per capita countries are likely to focus on fulfillment of basic physiological needs (Blut and Wang, 2020). This raises questions about the effectiveness of ARRT features across different economic contexts (Uribe *et al.*, 2022).

The evolving ARRT literature necessitates a comprehensive analysis of the published findings. Existing ARRT literature reviews and meta analysis have focused on specific areas like ARRT system technologies and media features, leaving significant information gaps (Parekh *et al.*, 2020). Gupta and Chauhan (2023) argue that meta-analysis is more beneficial than systematic reviews, especially when there is a need for reconciling the conflicting research findings. Existing meta studies like Fan *et al.* (2022) and Kumar *et al.* (2022) focused on narrow range of ARRT features like augmentation and interactivity, lacking a broader quantitative synthesis on how various ARRT features impact consumer purchase decisions in the online settings as well as the moderating influence of country-level economic and development variables on different conceptual relationships.

A thorough synthesis will reveal patterns and relationships that individual studies might miss, providing a clearer picture of ARRT's overall effectiveness. A detailed quantitative literature review can offer evidence-based practical recommendations on which features are most effective in driving purchase decisions, helping retailers optimize their AR strategies and investments. Additionally, this meta-analytic study would identify research gaps and inconsistencies, guiding future studies to build a more cohesive understanding of ARRT's effectiveness in the online retail environment.

2. Literature review

2.1 Augmented reality

E-commerce, a competitive area, presents challenges for online merchants and consumers, driving shops to improve their digital operations (Rask and Dholakia, 2001). A fundamental challenge is reproducing the offline buying experience in the virtual arena, notably, the inability to physically inspect things before purchasing, raising worries about quality and attractiveness (Lu and Smith, 2007). Dissatisfied customers exacerbate the problem by requesting returns or exchanges, which entail additional costs and disappoint customers.

New online environments are emerging to address these difficulties by integrating the natural and virtual worlds using digital technology, as discussed by Lin and Chen (2013).

AR is an innovation in this field that enables online retail systems to provide consumers with sensory control, allowing them a more personalized and interactive buying experience. For example, online customers can customize products in real time, such as changing the color of a piece of clothing or adjusting the features of a car. This level of personalization meets individual preferences, making the online shopping experience tailored to each consumer. It offers a real-time picture of physical products, enriched with digital content, providing a buying experience unlike offline retail (Kung *et al.*, 2002). The immersive aspect of ARRT-enabled online buying, which replicates an in-store experience at home, allows for more informed consumer decisions than traditional online commerce (Scholz and Duffy, 2018). Thus, retailers can use ARRT to bridge the gap between offline and online purchasing, producing an ideal shopping environment with the best features of both milieus (Fan *et al.*, 2020). By offering an embedded virtual experience of the product in a personally relevant environment, AR-enabled online platforms close the gaps between offline and online shopping and offer many advantages over the offline shopping experience. As discussed above, ARRT enables the projection of online products into real-life surroundings where consumers can exercise full physical control and visualize virtual products in real surroundings (Riar *et al.*, 2021). In this way, AR applications extend a sense of embodiment to customers through natural interactivity and physical control over the virtual offering, which goes beyond what is usually possible in a physical shopping environment (Hilken *et al.*, 2018).

Marketers have acknowledged AR's ability to enhance the online buying experience and increase purchase intent (Rese *et al.*, 2014). AR serves as a retail marketing tool, easing the limitations of online selling while boosting virtual interaction and product trials for online consumers. While AR features can help retailers achieve marketing goals, creating a virtual environment is time-consuming and costly, with several technical processes and hardware requirements (Lindner *et al.*, 2017). Knowing which AR features most significantly influence online consumers' purchase intention will be useful, as fostering this is the ultimate goal of marketing efforts.

We use task-technology fit theory to discover the ARRT elements that improve the shopping experience and influence purchase intent, a solid theoretical framework for studying users' behavioral intentions (You *et al.*, 2020).

2.2 Technology-task fit theory

Many studies on technological acceptability use perception-based models. However, researchers contend that more than technological perception is required to predict usage behavior (Afshan and Sharif, 2016). A more accurate technique for predicting behavioral intentions toward technology use is to evaluate the alignment of work requirements and technological characteristics. In 1995, Goodhue and Thompson (1995) proposed the Task-Technology Fit theory (TTF), asserting that evaluating a technology's effectiveness involves studying the relationship between its features and the tasks it supports. TTF combines individual and technological qualities, emphasizing how technological aspects help people and organizations achieve their goals. This theory explains how technology's capabilities can produce desirable behavioral results (Tam and Oliveira, 2016). According to TTF, technology use results in desirable behavioral outcomes (purchase intention in the current context) only when technology features effectively facilitate the tasks that the users (online buyers) wish to perform through that technology (Furneaux, 2011). In an online retail context, tasks that the online consumer expects from AR applications may include more information about the desired product to support purchase decisions through interactive images, texts, audio and customization (Lu and Smith, 2007) (interactivity); augmentation of physical

product world through virtual try-on to experience products' fit, texture, look, scent, or sound and video streaming (Carmigniani *et al.*, 2010); an engaging and fun-filled shopping experience (consumer engagement) (Iqbal and Sidhu, 2017); useful information about product features, variety, quality; and ease with which AR technology can be used (ease of use) (Chung *et al.*, 2015). TTF contends that attaining the organizational goal of fostering online shoppers' purchase intention and achieving desired outcomes depends on how well AR elements enhance the buying experience and overcome decision obstacles in traditional online purchasing (Nassereddine *et al.*, 2020).

Our meta-analysis of existing literature on AR applications in retailing reveals the connections between six extensively studied AR features (interactivity, augmentation, flow experience, engagement, usefulness and ease of use [1]) and online consumers' purchase intention. The stronger the perceived task-technology match, the greater the influence of the AR feature on consumer purchase intent. We define the examined constructs in the following part and speculate about the tested correlations.

3. Hypotheses development

3.1 Interactivity

Interactivity, as defined by Newhagen *et al.* (1995), is a psychological element in technology-mediated environments that reflects users' perception of efficacy and the effectiveness of media devices. However, because interactivity is inherent in all human actions, its notion and meaning might change across situations (Kiousis, 2002). In the context of ARRT, experts describe interactivity as the ability of AR to allow customer involvement in a virtual reality environment. In simpler terms, interactivity in AR refers to its capability to overlay virtual elements on real-world environments, a critical AR feature influencing consumers' purchase intentions (Erdmann *et al.*, 2023). Traditional marketing initiatives frequently need to meet interaction objectives on Internet platforms.

In sales interactions, the emotions conveyed by salespersons play a significant role in promoting products and enhancing service quality. A salesperson's negative mood can sour a customer's shopping experience, so a salesperson should demonstrate positive and pleasant emotions during customer interaction. However, traditional offline retailers may struggle to ensure that salespersons consistently exhibit these desired emotions, which can negatively evaluate products (Edmondson *et al.*, 2019).

In contrast, ARRT's interactivity in the online retail environment enhances promotion by allowing consumers to visualize their experience with a product in a real context, making product assessment independent of salespersons' emotions. Consequently, ARRT's interactivity surpasses traditional offline or online retail interactions, potentially leading to stronger purchase intentions and increased confidence in purchase decisions (Abrar, 2018). Therefore, we propose:

H1. Interactivity is positively related to consumers' purchase intention.

3.2 Augmentation

Interactivity and augmentation are distinct features in digital technology, with augmentation being a prominent aspect of AR (Erdmann *et al.*, 2023). Interactivity revolves around user engagement with the medium or among users, whereas augmentation focuses on how the medium interacts with the surrounding environment. Augmentation of online products through AR-enabled platforms enables a realistic experience of virtual objects/products within real physical settings (Rauschnabel *et al.*, 2019). Higher-quality augmentation, which

smoothly merges virtual and actual surroundings, considerably impacts consumer responses, notably their purchase intention (Watson *et al.*, 2018). By allowing augmented online products (visualization of virtual objects) in real surroundings, ARRT allows customers to evaluate desirable products realistically, giving it a substantial advantage over traditional internet retailing. Thus, the customer can more accurately evaluate product size, features and quality because the interaction with online products happens in their actual surrounding environment (Riar *et al.*, 2021).

The para-authentic product experience enabled by AR augmentation has more potential than traditional internet retailing to induce positive consumer behavior (Parekh *et al.*, 2020). ARRT's augmentation feature excels in authentic appearance verification, outperforming non-AR online retail platforms. This potential, combined with a strong task-technology fit, yields the following hypothesis:

H2. Augmentation is positively related to consumers' purchase intention.

3.3 Consumer engagement

Consumer engagement is typically viewed in two ways: as a unidimensional psychological state or as a multidimensional cognitive, emotional and behavioral state. Most studies adopt the multidimensional approach, examining engagement with various aspects like online platforms, brands and products (Singh and Pandey, 2014).

Engagement, which includes cognitive, affective and behavioral components (Ma *et al.*, 2022), is critical for online retail success, with highly engaged customers showing increased purchase intentions and revenue contributions (Kumar *et al.*, 2010). AR systems, known for their individualized, immersive experiences, have emerged as novel advertising techniques. AR retail apps change how consumers interact with products/brands online, increasing cognitive engagement and nurturing emotional relationships (Hilken *et al.*, 2018). ARRT's engagement elements successfully carry out advertising functions, increasing the influence of customer involvement on purchase intentions (Sung *et al.*, 2021). The alignment of marketing tasks and AR app engagement tools leads to the following hypothesis:

H3. Consumer engagement through ARRT is positively related to consumers' purchase intention.

3.4 Flow experience

Flow experience, a concept introduced by Csikszentmihalyi (1975), is "the holistic sensation that people feel when they act with total involvement" and measures profound focus and engagement. Prior studies have shown that pleasurable Internet shopping leads to stronger purchase intentions (Chen and Lin, 2022). In AR-enabled online retailing, flow experience is critical for providing experiential value and often needs to be improved in traditional online buying (VanNoort *et al.*, 2012). Unlike typical e-commerce, ARRT's flow experience offers a sensory-rich, pleasurable and immersive shopping experience (Hilken *et al.*, 2018). Completing the activity provides pleasure, which increases buying intentions (Suri *et al.*, 2003). Flow adds unique experiential value by improving cognitive and emotional reactions, resulting in positive outcomes such as purchase intention (VanNoort *et al.*, 2012).

Numerous AR studies empirically corroborate this link, demonstrating a positive relationship between flow sensation and purchase intention (Shim *et al.*, 2015; Chen and Lin, 2022). The congruence between consumers' desire for a pleasant purchasing experience and

AR technology's capacity to provide this through flow experience leads to the following hypothesis:

H4. Flow experience is positively related to consumers' purchase intention.

3.5 Perceived usefulness

Perceived usefulness is a key factor in users' intentions to adopt new technology, as consistently suggested in technology adoption literature. It refers to users' belief that a technology or system will enhance their performance (Ho *et al.*, 2023). In the context of ARRT, perceived usefulness relates to consumers' belief in AR apps' utility for online shopping. Numerous studies have shown that the perceived usefulness of technology for selling products or services influences consumer attitudes and purchase intentions (Ho *et al.*, 2023).

AR app features address a critical gap in online shopping by providing a try-on experience, such as AR filters that overlay real-world environments. Virtual try-ons provide utilitarian value, particularly for commodities like shoes, fashion and home décor, allowing online buyers to see how these products appear and eliminating a significant restriction of traditional online shopping (Jai *et al.*, 2021). Furthermore, ARRT improves the purchasing experience by reducing friction, integrating numerous channels and ensuring a consistent experience. These benefits allow customers to more effectively evaluate products, resulting in increased purchase intentions (Poushneh and Vasquez-Parraga, 2017; Ho *et al.*, 2023). By providing this utilitarian value, AR retail apps increase perceived usefulness, match online consumers' utility needs and provide a better task-technology fit than traditional online purchasing without AR services. Based on this, we propose:

H5. Perceived usefulness of ARRT is positively related to consumers' purchase intention.

3.6 Perceived ease of use

Perceived ease of use, an essential predictor of purchase intention in e-commerce studies, signifies consumers' perception of online shopping platforms' user-friendliness (Moslehpour *et al.*, 2018). Extensive evidence from technology adoption and consumer behavior literature supports the positive impact of ease of use on purchase intention (Suri *et al.*, 2003). In the ARRT context, perceived ease of use refers to consumers' belief that AR retail platforms make online shopping tasks straightforward (Chen *et al.*, 2022). ARRT simulates real-world behavior, making it easy for consumers to navigate and enjoy the AR environment, even without prior experience or knowledge (Boardman *et al.*, 2019). Studies have shown that online shopping websites requiring less mental effort to make purchase decisions attract more potential consumers (Niza Braga and Jacinto, 2022). AR retail apps provide easily understandable information, requiring less mental effort and thus, making online shopping effortless.

Furthermore, during online shopping, consumers often seek additional information from peers, social groups and sellers, wanting to know about others' experiences with desired products. AR's ability to facilitate seamless communication among peer groups enhances consumers' confidence in purchase decisions (Khan, 2019). This discussion leads us to believe that a stronger task-technology fit in ARRT enhances perceived ease of use, ultimately boosting purchase intention:

H6. Perceived ease of use of ARRT is positively related to consumers' purchase intention.

3.7 Moderator effects

3.7.1 Moderating effect of gross domestic product per-capita. Consumer behavior research suggests that researchers should consider the moderating influence of a country's GDP per capita when studying customers' preferences and purchasing decisions (Pick and Eisend, 2016). Consumers in low-GDP per capita nations assess products more carefully because they are more vulnerable to poor purchasing judgments (Berry *et al.*, 2010). Their judgments are primarily motivated by the need to reduce technology use's dangers and negative repercussions. Consumers in high-GDP per capita countries, who have more financial resources, strive to meet demands other than essential ones, such as psychological and self-actualization requirements (Blut and Wang, 2020). ARRT, an innovative technology with tremendous capabilities, enables customers in high GDP per capita nations to meet these demands, hence altering their behavior and views (Blut and Wang, 2020). The difference in emphasis on basic requirements between high- and low-GDP per capita countries determines how technological aspects affect behavioral intentions. As a result, the consumer country's GDP per capita will significantly mitigate the association between ARRT features and purchase intention:

H7a. Relationships between ARRT features and purchase intention will be moderated by the GDP per-capita of the consumer's country.

3.7.2 Moderating effect of innovation level. While ARRT is transforming the global online retail industry, a country's innovation level is critical to its ability to influence consumer behavioral results (El Shamy and Hassanein, 2017). Previous meta-analyses have used innovation level as a significant variable to acquire more profound insights into behavioral intentions for technology adoption (Jadil *et al.*, 2021). The amount of innovation is measured using two indicators: innovation input and innovation output, which consider human resources, infrastructure, institutions, market and business sophistication (WIPO, 2021).

Consumers in nations with higher innovation scores are more likely to benefit from innovative technologies, influencing their behavioral intentions (Jadil *et al.*, 2021). Favorable environmental variables in high-innovation countries promote technology adoption and engagement, boosting customers' perceptions of task-technology fit. In our meta-analysis, we quantify the moderating impact of a country's innovation level on the connections in our conceptual model, considering research from countries with very different innovation levels (e.g. the USA - 61.3 and Chile - 35.1) (Uribe *et al.*, 2022). Following is the proposed hypothesis:

H7b. Relationships between ARRT features and purchase intention will be moderated by the innovation level of the consumer's country.

4. Method

Meta-analysis is a commonly used approach for systematically synthesizing and analyzing the results of quantitative studies with similar research objectives. When reconciling discordant results, meta-analysis considers the investigation's effect and sample sizes. Furthermore, if heterogeneity exists, meta-analysis can help identify the moderating variables using logical reasoning and current ideas (King and He, 2005). This study also uses meta-analysis to compute the total effect by statistically combining all of the effects (Borenstein *et al.*, 2011) and to assess the moderating effect of GDP per capita and

innovation level. The following sections detail the process of selecting relevant studies, coding them and conducting statistical analysis.

4.1 Selection of relevant studies

Initially, we thoroughly searched the Scopus database, Google Scholar and the ProQuest Dissertations and Theses Global database, using the following two search strings with the Boolean operator AND. The first search string was ("augmented reality" OR "mixed reality" OR "AR"), while the second search string was ("retail" OR "online retail" OR "consumer behavior" OR "consumer behaviour" OR "customer experience" OR "purchase intention" OR "shopping intention" OR "buying intention"). These two search strings ensured confining the search to publications at the intersection of augmented reality and consumer shopping behavior. We used search terms based on Kumar *et al.*'s (2022) meta-analysis on augmented reality marketing. Furthermore, on the Scopus database, we searched for conference papers and journal articles written in English with search terms within the title, abstract or keywords. We also looked for publications on Google Scholar. We limited our Google Scholar search to the first 20 pages to ensure relevance and efficiency, as these typically contain the most pertinent and widely cited studies (Beel and Gipp, 2009). Prior reviews have also adopted this limit (e.g. Salari *et al*., 2023; Li and Rainer, 2023). Combined with our comprehensive Scopus search, this approach ensured a thorough review while capturing the most relevant publications in the field. As a result, we had 794 publications, including 576 publications from Scopus, 200 publications from Google Scholar and 18 doctoral dissertations from ProQuest (until March 2024).

Following this, two writers independently read the extracted publications' titles, abstracts and keywords. Their objective was to exclude a) books, book chapters, notes, editorials, short surveys, reviews, non-English and duplicate publications; b) publications that did not explicitly explore purchase intention within the context of AR. Subsequently, the writers reviewed the 794 publications' abstracts individually. During this phase, any differences in opinion regarding the relevance of a publication were discussed to reach a consensus. We used Cohen's kappa to assess the level of agreement between two raters (Sun, 2011). It indicates a substantial level of agreement when greater than 0.80. At this stage, we found its value to be 0.94, suggesting a high level of agreement.

Moving forward, both writers meticulously examined full content of each publication. They specifically targeted quantitative publications that explored at least one proposed relationship, provided sample size, correlation coefficients or pertinent statistical data and aligned with the defined constructs. Any discrepancies during this comprehensive review were thoroughly discussed, resulting in a robust inter-rater agreement (Cohen's kappa = 0.92). Out of the filtered publications, 37 were identified as relevant. With one publication housing two studies, the final count of individual studies stood at 38 (Refer Figure 1).

In addition to the rigorous screening and review process, the researchers conducted forward and backward searches through references to identify any potentially overlooked studies. However, no new study was found.

4.2 Coding procedure

We developed a coding protocol to obtain critical data from each trial, using a spreadsheet to record descriptive information such as the author(s) name, title, source, publication year and type (conference paper, journal article or PhD dissertation) and the nation where the study data was collected, sample size and correlation coefficient. Certain studies with different terminology for the same variables were combined to address variations in variable names. For example, Pantano *et al*. (2017) utilized "ease of use" to assess consumers' perceptions of

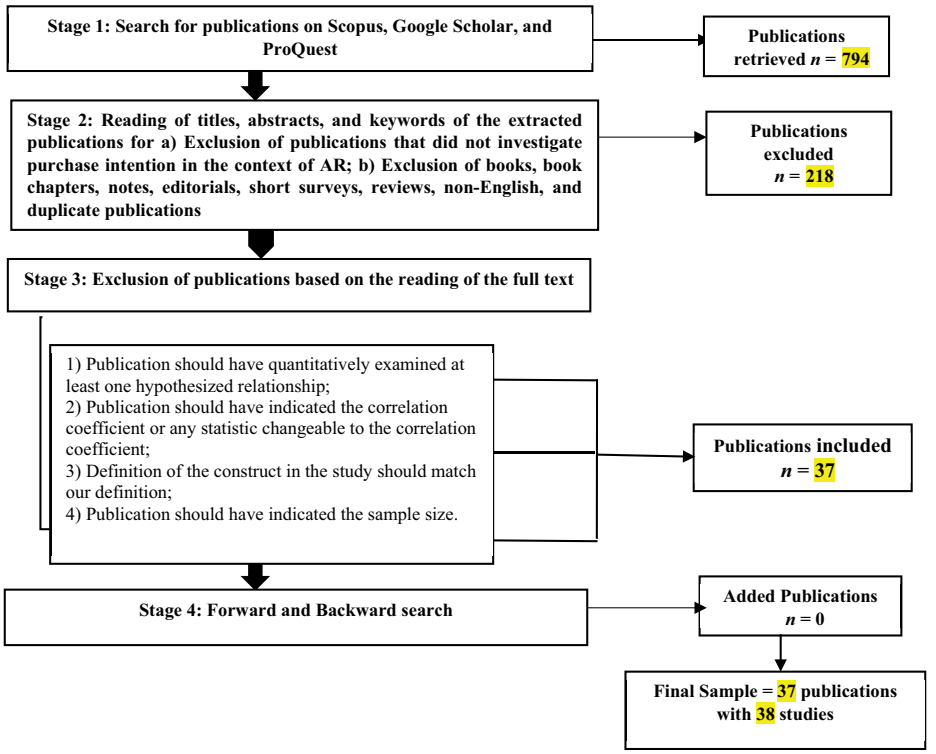

Figure 1. Stages of selection of relevant studies

the convenience of utilizing ARRT for online buying tasks, whereas Calderón-Fajardo *et al.* (2022) used "effort expectancy".

We then considered GDP per capita and innovation level as moderating variables, obtaining GDP per capita statistics from the World Bank Databank (2022). (https://data.worldbank.org/indicator/NY.GDP.PCAP.CD). We derived innovation levels from WIPO's most recent data (2021). The included studies did Median splits on GDP per capita and innovation level values. If a country's GDP per capita fell below the median split, it was classified as a low-GDP per capita country; otherwise, it was classified as a high-GDP per capita country. The same categorization process was applied to innovation levels. The supplementary file includes a summary of the reviewed studies.

4.3 Statistical analysis

The two most popular models used in meta-analysis are the fixed and random-effect models. The fixed-effect model assumes that each study has a single true effect and that outcome fluctuations are due to sampling errors. In contrast, the random-effect model predicts different effects for each study. Given the variation in effect sizes among studies in our data set, we used the random-effect model (Borenstein *et al.*, 2011). This meta-analysis used the correlation coefficient as the effect size metric. The overall effect size was calculated for each relationship. The significance level of the overall effect size was determined through its

p-value (Borenstein *et al.*, 2011). Q and I^2 statistics were calculated to assess heterogeneity across the studies (Huedo-Medina *et al.*, 2006).

5. Results

5.1 Main effects, heterogeneity and publication bias

The significant values of the Q-statistic indicated heterogeneity. Additionally, the values of I^2 statistics were greater than 75%, denoting a high level of heterogeneity among the studies (refer to Table 1). Therefore, our decision to go for the random-effect model was also supported by homogeneity tests.

Based on the magnitude, we categorize the effect size as strong = 0.5, moderate = 0.3, or weak = 0.1 (Cohen *et al.*, 1983). The results shown in Table 1 imply that interactivity, augmentation, consumer engagement, flow experience, perceived usefulness and perceived ease of use have a strong relationship with purchase intention, with perceived ease of use having the strongest relationship, followed by perceived usefulness.

Interactivity positively correlates with purchase intention, supporting *H1* (Effect Size = 0.417, $p < 0.001$). Augmentation also has a positive relationship with purchase intention, supporting *H2* (Effect Size = 0.451, $p < 0.001$). Consumer engagement is positively related to purchase intention; thus, *H3* (Effect Size = 0.482, $p < 0.001$) is supported. Likewise, *H4* (Effect Size = 0.544, $p < 0.001$) is also supported as we observed flow experience positively related to purchase intention. As anticipated, perceived usefulness is positively linked with purchase intention, supporting *H5* (Effect Size = 0.547, $p < 0.001$). Also, *H6* (Effect Size = 0.558, $p < 0.001$) is supported as we found perceived ease of use positively associated with purchase intention.

However, studies with non-significant outcomes have a higher propensity to stay unpublished, threatening the robustness of meta-analysis results. Therefore, publication bias was examined with the help of a fail-safe number for all the relationships. We found the fail-safe number value for all the relationships to be greater than 5 N + 10 (n = number of effect sizes), indicating that the overall effect size is not affected by the effect size of unpublished studies (Rosenthal, 1979). Thus, publication bias is not a concern for the present study.

Additionally, heterogeneity across the studies indicated that possible moderating effects should be analyzed. Next, we describe the results of the analysis of GDP per-capita and innovation level as moderators.

Table 1. Meta-analysis results for direct relationships

Antecedent	No. of studies	Sample size	Combined effect size	Q-statistic	I^2(%)	95% Upper	95% Lower	Fail-Safe no.
INT	15	4549	0.417***	235.920***	0.941	0.444	0.390	270
AUG	10	2189	0.451***	136.480***	0.934	0.494	0.406	113
CE	21	4940	0.482***	268.683***	92.6%	0.499	0.464	742
FE	7	2119	0.544***	154.643***	96.1%	0.605	0.477	66
PU	17	4918	0.547***	211.066***	92.4%	0.565	0.529	840
PEOU	16	4860	0.558***	473.135***	96.8%	0.586	0.529	335

Notes: INT = Interactivity; AUG = Augmentation; CE = Consumer Engagement; FE = Flow Experience; PU = Perceived Usefulness; PEOU = Perceived Ease of Use, Significance levels: ns ($p > 0.05$); *($p < 0.05$); **($p < 0.01$); ***($p < 0.001$)

5.2 Moderating effects

5.2.1 Moderating influence of GDP per-capita. Table 2 shows that the moderating influence of GDP per-capita could be investigated for all the relationships. The significance level of $Q_{between}$ values indicates that GDP per-capita moderates three out of six relationships.

The relationships of augmentation ($Q_{between} = 66.370$, $p < 0.001$), consumer engagement ($Q_{between} = 10.285$, $p < 0.001$) and perceived usefulness ($Q_{between} = 4.471$, $p < 0.05$) with purchase intention differ significantly between low-GDP per capita and high-GDP per capita counties. We also observed that these relationships are stronger in low-GDP per capita countries. Furthermore, GDP per capita did not moderate the relationship of interactivity ($Q_{between} = 2.368$, $p > 0.05$), flow experience ($Q_{between} = 0.108$, $p > 0.05$), and perceived ease of use ($Q_{between} = 0.459$, $p > 0.05$) with purchase intention. Thus, *H7a* is partially supported.

5.2.2 Moderating influence of innovation level. Table 3 shows that the moderating influence of innovation level could be analyzed for five relationships. We could not assess this moderator for flow experience due to the paucity of studies in the low innovation level category. The significance level of $Q_{between}$ values implies that innovation level moderates four relationships.

The relationship of interactivity ($Q_{between} = 9.253$, $p < 0.001$), augmentation ($Q_{between} = 10.341$, $p < 0.001$), perceived usefulness ($Q_{between} = 5.123$, $p < 0.05$) and perceived ease of use ($Q_{between} = 141.33$, $p < 0.001$) with purchase intention differs significantly between countries with low innovation levels and those with high innovation levels. These relationships are stronger in low-innovation-level countries. Furthermore, innovation level did not moderate the relationship of consumer engagement ($Q_{between} = 0.231$, $p > 0.05$) with purchase intention. Thus, *H7b* is partially supported.

6. Discussion and implications

6.1 Discussion and practical implications of main results

Our primary findings show a favorable relationship between all evaluated ARRT characteristics and consumer purchase intentions (*H1–H6*). Among the three extensively

Table 2. Moderating effect of GDP per-capita (*H7a*)

Antecedent	GDP per-capita	No. of studies	Sample size	Combined effect size	95% Upper	95% Lower	$Q_{between}$ value
INT	High	5	1242	0.366***	0.453	0.271	2.368 ^{ns}
	low	9	2534	0.419***	0.464	0.372	
AUG	High	5	1149	0.260***	0.365	0.147	66.37***
	low	5	1040	0.608***	0.677	0.529	
CE	High	12	2622	0.441***	0.474	0.407	10.285***
	low	9	2318	0.532***	0.571	0.491	
FE	High	4	976	0.536***	0.648	0.402	0.108 ^{ns}
	low	3	1143	0.551***	0.694	0.366	
PU	High	7	1770	0.510***	0.557	0.459	4.471*
	low	10	3148	0.572***	0.602	0.542	
PEOU	High	4	890	0.534***	0.654	0.388	0.459 ^{ns}
	low	11	3197	0.560***	0.601	0.516	

Notes: INT = interactivity; AUG = augmentation; CE = consumer engagement; FE = flow experience; PU = perceived usefulness; PEOU = perceived ease of use *Significance levels: ns $p > 0.05$; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$*

Table 3. Moderating effect of innovation level (*H7b*)

Antecedent	Innovation level	No. of studies	Sample size	Combined effect size	95% Upper	95% Lower	$Q_{between}$ value
INT	high	6	1615	0.342***	0.416	0.264	9.253***
	low	8	2161	0.442***	0.491	0.39	
AUG	high	6	1452	0.393***	0.471	0.309	10.341***
	low	4	737	0.538***	0.638	0.421	
CE	high	11	2572	0.475***	0.509	0.439	0.231 ^{ns}
	low	10	2368	0.489***	0.526	0.45	
PU	high	7	1976	0.508***	0.555	0.457	5.123*
	Low	10	2942	0.573***	0.603	0.543	
PEOU	High	5	1285	0.265***	0.393	0.127	141.33***
	Low	10	2802	0.666***	0.702	0.626	

Notes: INT = interactivity; AUG = augmentation; CE = consumer engagement; FE = flow experience; PU = perceived usefulness; PEOU = perceived ease of use *Significance levels: ns $p > 0.05$; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$*

studied ARRT features (interactivity, augmentation and flow experience), interactivity had the lowest effect size (ES = 0.417), followed by augmentation (ES = 0.451) and flow experience (ES = 0.544). These findings are consistent with previous research, which suggests that customers may take ARRT's ability to promote effective interaction, particularly interactivity, for granted because it is a known component of online buying (Kumar *et al.*, 2022). Previous AR studies have also found that interactivity has a limited impact on purchasing decision-making (Poushneh and Vasquez-Parraga, 2017), which may explain why its effect size is smaller than that of flow experience and augmentation.

Consistent with previous findings, these findings shed light on how media features, particularly augmentation and flow experience, provide valuable tasks for online retail consumers using ARRT by creating sensory depth and engrossing, distraction-free focus within a virtual environment (Erdmann *et al.*, 2023). Consumers place a high value on task-technology fit, as seen by the bigger effect sizes found in our study. Consumers prioritize using technology features to learn more about the desired product and make informed purchasing decisions in the rising technology-enabled online shopping context. ARRT's capacity to give vital information (perceived usefulness) and the ease with which AR features help buying decisions (perceived ease of use) create an excellent task-technology fit by addressing these critical requirements. In conclusion, perceived ease of use and utility are significant elements influencing consumers' purchase intentions, while ARRT media features are secondary to consumers' buying decisions.

The findings above are helpful for marketers and retailers using ARRT to increase consumer purchase intention. First, a meta-analysis of the relationships in the conceptual model demonstrates that online customers have a utilitarian attitude toward ARRT. While the AR literature highlights utilitarian and hedonic values as essential motivators for customers' behavioral intentions (Kumar *et al.*, 2022), the core influence on consumers' shopping orientation via ARRT remains unclear. Our findings shed light on this issue, demonstrating that ARRT's utilitarian value-oriented features, such as perceived usefulness and perceived ease of use (*H5* and *H6*), have a stronger positive relationship with consumers' purchase intention than hedonic value-oriented features, such as interactivity, augmentation, consumer engagement and flow experience (*H1* to *H4*).

Second, while ARRT elements in the retail context generate both utilitarian and hedonic value, improving the overall buying experience compared to traditional internet shopping, marketers should avoid focusing too much on hedonic value-creating features; online consumers utilizing ARRT regard utilitarian values as the most necessary and primarily expect the technology to meet this need. They provide a better task-technology match than features that create hedonic value. Marketers should modify their e-marketing and retailing tactics accordingly.

Third, our findings highlight utility as the primary task motivation for customers using ARRT applications. Marketers should stress the benefits and user-friendliness of AR-enabled retail platforms, particularly when consumers seek extensive product information. Marketers should consider their customers' job fulfillment preferences and offer a more personalized AR platform that matches their needs. A better task-technology fit will help merchants convert ARRT users into customers.

Fourth, while utility task-oriented features significantly impact customer purchase intentions, characteristics that facilitate hedonic activities should be noticed; we discovered a substantial positive correlation between such traits and customer purchase intention. Notably, media features such as interaction, flow experience and augmentation contribute to hedonic value in shopping delight (Yim *et al.*, 2017).

6.2 Discussion and practical implication of moderators' analysis

We performed a moderators' analysis to understand the role of country-level economic and developmental factors that are likely to affect the examined relationships in this study. GDP per capita and the country's innovation level were included as potential economic and developmental moderators.

Contrary to our expectations and the claims of previous studies on technology innovation and consumer behavior (e.g. Carrillat *et al.*, 2017), our findings only partially supported the hypotheses proposing a significant difference in the effect size of ARRT features on purchase intention based on the country's GDP per capita. Among the six interactions studied, only three characteristics (augmentation, customer engagement and perceived usefulness) were moderated by the effect of the country's GDP per capita on purchase intention. ARRT's augmentation and customer engagement features had a more significant impact on consumers' purchase intentions in low-income countries than in high-income nations (Table 2). This distinction may emerge from the principal concerns of online consumers in low-GDP per capita nations, where limited financial resources and disposable income drive the desire to reduce the financial risk associated with inappropriate online purchases (Berry *et al.*, 2010). ARRT's ability to integrate virtual products into the real world and engage consumers in AR considerably minimizes the chance of purchasing the incorrect product. The findings indicate that when designing AR platforms for countries with low GDP per capita, platform developers should focus on augmentation and consumer engagement features to assist online retailers in making favorable purchase decisions.

The same was not true for the influence of perceived usefulness on purchase intention; the effect magnitude was higher in the subgroup of customers from low-GDP per capita countries (Table 2). These findings challenge the claim of previous studies that the perceived usefulness of innovative technology gets stronger as the GDP increases because technology enables customers from high GPD countries to satisfy high-end self-fulfillment needs (Blut and Wang, 2020).

These findings have implications for both merchants and platform providers. To reach consumers in low-GDP per capita countries, AR platforms should extend the desired experience even with suboptimal internet connectivity, promoting a move away from traditional online platforms and toward AR-enabled ones. Second, customers from low-GDP

countries usually have limited disposable income, and therefore, they are more concerned about mistaken purchase decisions (Blut and Wang, 2020). Platform developers should continuously research creative approaches to help customers make wise purchase decisions to fulfill their basic shopping needs with limited financial resources.

Furthermore, our findings partially supported the hypothesis that innovation level moderates the impact of ARRT features on consumers' purchase intention. The relationship between four out of six ARRT features and purchase intention showed moderation (interactivity, augmentation, perceived usefulness and perceived ease of use) (see Table 3). The findings of this study support previous studies' assertions that differences in a country's innovation input and output (innovation level) affect the impact of ARRT features on consumer purchase intentions (Jadil *et al.*, 2021). The "lead-lag effect" or "cross-national learning effect" could help explain these results. In some nations, new technologies or innovations are introduced sequentially (Tellis *et al.*, 2009). Developed nations with higher levels of innovation introduce consumers to new technologies before those in low-income countries. Consumers in lower innovation-level countries (developing economies) may encounter innovation later, but they gather, interact, and exchange information across national borders (Kumar, 1998). To some extent, this "cross-national learning effect" bridges the disparities in consumer behavior and purchasing decisions between subgroups with high and low innovation levels.

Table 4 lists the major findings and their associated implications.

6.3 Research and theoretical implications

This meta-analysis adds to the current ARRT literature by utilizing the theoretical framework of task-technology fit, which provides a dual perspective from both customers and businesses. Unlike popular technology innovation theories and models, such as UTAUT and TAM, which predominantly focus on consumers, the theoretical perspective of this study offers more precise guidance for designing AR-enabled retail platforms. This integrated approach goes beyond consumer-centric technology adoption models, offering a broader and more comprehensive theoretical framework.

Table 4. Major findings and implications

Main conclusions	Implications
Perceived ease of use and utility are significant elements influencing consumers' purchase intentions, while ARRT media features (interactivity augmentation, flow experience, consumer engagement) are secondary to consumers' buying decisions	While both hedonic and utilitarian attributes are important, enhancing the utilitarian value of ARRT platforms is crucial for influencing online purchase intention. Consumers prefer technology that provides better product insights and ease of decision-making, favoring ARRT platforms for their task-technology fit
The moderating effect of GDP per capita and a country's innovation level on the relationship between ARRT features (augmentation, customer engagement, perceived usefulness, interactivity and perceived ease of use) and purchase intention is significant. This effect is stronger in developing economies with lower GDP per capita and varies with the country's innovation level	Platform developers in low-GDP countries should focus on practical, accessible solutions for informed purchases. While AR may not meet all needs, creativity is essential. ARRT features are more significant in high-innovation countries, but utilitarian and hedonic attributes remain crucial in developing economies. Despite later exposure to innovation, these consumers quickly adopt new technologies due to cross-national learning

Second, the theoretical approach of this study integrates individual and technological characteristics for examining technology adoption behaviors. Extending the previous works, the framework suggested in this study elucidates how the capabilities of technology can lead to desirable behavioral outcomes, thereby fostering enhanced performance and goal attainment (Tam and Oliveira, 2016). This theoretical framework for understanding technology adoption behaviors provides directions for future empirical research, particularly in developing nations. Third, the findings deviate from long-held assumptions regarding the moderating influence of economic and development factors in the impact of technological characteristics on consumer behavior. The study encourages future investigations to use this integrated theoretical framework to examine why innovation levels do not consistently influence the relationship between ARRT features and customer purchase intention.

Finally, the findings on the moderating influence of GDP per capita point to future research opportunities to investigate the differential responses of consumers from low- and high-GDP per capita nations to ARRT features, as well as reasons for ARRT use in low-GDP countries.

7. Conclusion and limitations

This paper is the first complete study on ARRT, which presents a framework comprising the essential aspects (interactivity, augmentation, flow experience, engagement, utility and ease of use) that influence consumers' purchase intentions while shopping online. Furthermore, it is the first meta-analysis of ARRT, exploring the moderating impact of country-level factors on the connection between ARRT antecedents and consumers' online purchase intention. The study found that interactivity, augmentation, flow experience, engagement, utility and convenience of use all substantially impacted customers' purchase intentions when buying online. The study found that GDP per capita partially moderates the association between three ARRT features and purchase intention, underlining the necessity of understanding GDP per capita for developing effective tactics. However, the innovation level moderator has a less apparent influence on the link between ARRT features and purchase intentions.

The study acknowledges the limits of meta-analytic research, such as focusing primarily on six ARRT traits. Future studies should look into other aspects, including vividness, spatial presence and mental imagery, to improve comprehension. Furthermore, the study highlights potential limits in search term selection and language bias, underlining the necessity for future meta-analyses to include papers published in non-English languages.

Note

1. Some other prominent AR features, such as vividness, spatial presence and mental imagery, could not be included because less than three empirical studies have reported correlation values of these variables with purchase intention.

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Supplementary material

The supplementary material for this article can be found online.

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