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Augmented Reality and Sustainable Consumerism: Impact on Eco-friendly Purchase Decisions

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Abstract- Augmented reality is changing consumer behavior and is playing an increasing role in encouraging sustainable purchasing behaviors. This review aims to explore the integration of AR in different sectors such as retail, E-commerce, food, and logistics and its impact on consumer interaction with eco-friendly products. Research shows that, AR increases purchase intent by making products more transparent, offering an immersive experience, and reducing product returns. Virtual try- ons , interactive sustainability labels, and AR- powered QR codes be push consumers towards sustainable options rather easily. Furthermore, AR minimizes the need for physical packaging and printed materials thus contributing to the waste reduction efforts. The theory of planned behavior (TBP) and the concentration set model are consumer decision–making models that explain how digital intervention affect green purchasing. The psychological and behavioral effects of AR reveal its ability to encourage long–term eco–conscious behavior through gamification and the use of AI for personalization. Nevertheless, there are still some issues to solve, including those related to data privacy, availability, and the danger of Green washing. Future work should also extend to developing a standardized matrix for assessing the sustainability impact of AR and its effects on behavior change. This paper also highlights AR's viability as a tool for sustainable consumerism and the need for business and policy makers to consider integrating digital innovations in their eco-friendly marketing strategies.

Keywords- Augmented Reality, Sustainable Consumerism, Eco-friendly Purchasing, Digital Technology Consumer Behavior

I. INTRODUCTION

1. Background on Augmented Reality

Augmented reality (AR) is emerging as a powerful tool in shaping consumer behavior and enhancing sustainable practices. Studies have shown that air positively influences purchasing decisions, particularly for clothing and accessories (AL Hilal, 2023). Mobile AR applications increase consumer cognition and affections leading to higher purchase intent(Haile & Kang, 2020) .In the food industry are can be used to create immersive narratives that promote sustainable consumption behaviors through participate design methods(Han et al., 2022). Additionally, they have applications in logistics where can be integrated with other technology to improve employee navigation in warehouses and

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production lines, contributing to sustainable business strategies(Sidiropoulos et al., 2021). The studies highlight the potential to enhance consumer experience purchasing decision and improve operational efficiency across wages industries in the context of Sustainable consumerism and industry 4.0 .

2. Definition and Evolution of AR Recent Research Highlights

The evolving landscape of consumer behavior with the growing focus on Sustainable consumption and emerging technology. Studies indicate that emerging technology. A Study demonstrates that augmented reality significantly influences the purchasing decision of women buying clothing and accessories(AL Hilal, 2023). AR and virtual reality (VR) experiences enhance consumer- brand relationships, impacting satisfaction and purchase intentions (Zeng et al., 2023). The concept of sustainable consumption is complex and multifaceted, involving the decoupling of consumption from environmental damage and intersecting with videos behavioral disciplines (Vargas-Merino et al., 2023). Butt's training in consumer behavior research emphasizes themes such as consumer ethics and sustainable consumption, aligning with global movements toward environmental social governance and sustainable development goals (Lim et al., 2023). These findings underscore the importance of integrating AR/VR technologies and sustainability considerations in marketing strategies to meet evolving consumer needs and preferences.

3. Applications of AR In Various Industries including Retail and E-commerce.

Recent Studies on Whether Factors Affecting Consumers Sustainable Purchase Behavior. Consumer trends such as social media marketing as well as green attitudes are positively influencing their sustainable purchasing decisions (Ebrahimi et al., 2021). In addition to that, several other factors such as personality traits – along with altruistic tendencies, commitment to the environment and social factors as well affect the green purchase behaviour of consumers (Duque Oliva et al., 2024). The study shows, environmental aspects (individual factor, product attributes, and social factors) are important determinants of green purchase decisions(Zhang & Dong, 2020). Eco-friendly knowledge as well as consumer influence and perceptions toward products of the environment largely impact the purchase intention of eco-friendly products. (Note: this is a preview of the article "How eco-label properties affect purchase behavior") Purchase intention-the actual purchase behavior relationship: the moderating role of ease of purchase and eco-label credibility (N. Kim & Lee, 2023). According to Zhang and Dong (2020), for sustainable consumerism to thrive, future research needs to focus on cross- cultural studies, investigate different green products types, and integrate consumer theories. These findings add to the literature addressing the complexities of pro-environmental consumption behavior and offer pathways for enhancing the likelihood of making sustainable purchases.

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Industry	Company	AR Application Description
Furniture Retail	IKEA	The "IKEA Place" app allows customers to visualize how furniture items will look and fit in their homes using AR.
		jaydevs.com
Beauty Retail	Sephora	The "Virtual Artist" app enables users to virtually try on makeup products using facial recognition technology.
		jaydevs.com
Eyewear Retail	Warby Parker	Their app uses AR to let customers virtually try on glasses, helping them find the perfect pair without visiting a store.
		capsulesight.com
Footwear Retail	Nike	The "Nike Fit" app scans customers' feet using AR to recommend the best-fitting shoe size.
		rockpaperreality.com
Home Décor	Wayfair	The Wayfair app allows users to visualize furniture and décor in their homes before making a purchase using AR.
		qsstechnosoft.com
Jewelry Retail	Tanishq	Their AR app enables customers to virtually try on jewelry pieces, enhancing the online shopping experience.
		innow8apps.com
Eyewear Retail	Lenskart	Lenskart's AR feature allows users to virtually try on different frames in real-time, aiding in the selection process.
		innow8apps.com

4. Consumer Behavior and Sustainability

Contemporary the factors influencing consumer decision -making … sustainable product purchases and green cuisine: A review of the factors influencing consumer purchase … policies literature 41 products in each category in this literature. The key determinants are environmental concern, health consciousness and social norms. They found that consumer attitudes, perceived product quality and knowledge promote green purchases while high prices and skepticism hinder them (Testa et al., 2023). Effects of Knowledge, Attitude, and Perceived Consumer Effectiveness on Purchase Intention of Sustainable Clothing among Urban Indian Consumers Environmental knowledge, attitude and perceived consumer effectiveness significantly influences the purchase intentions on sustainable clothing (Tryphena & Aram, 2023). To gain some deeper insight into these intricate tendencies, the scientific community has envisaged a hybrid method incorporating traditional approaches and machine learning techniques (C. W. Chen, 2024). Future research could further investigate differing cultural contexts, delve into different green product types and utilize longitudinal methods to assess the impact education and policies have on consumer behavior (Zhang & Dong, 2020). This can help businesses to Tailor strategies to meet the rising demand for sustainable products.

5. Increasing Significance of Sustainability in Consumer Decisions.

Thus, an integrated model proposes the characteristics influencing the green buying behavior, with a focus on the relationship among personality traits, attitudes, and social aspects (Duque Oliva et al., 2024). According to the research, consumers' sustainable buying behavior is considerably affected by marketing on social networks, and eco-friendly attitudes moderate this relationship (Ebrahimi et al., 2021). The needed factors for Eco-friendly behaviour sustainability according the study are Eco-friendly attitude and different elements of social media marketing. A systematic literature review indicated that eco-friendly food products and sustainable practices in the tourism, e-commerce, and clothing sectors were gaining increasing attention (Sesini et al., 2020). Although environmental attributes still dominate the literature at present, social perspectives are beginning to gain traction. Studies looking at economic and social aspects of sustainability in different context of consumer behaviour, more broadly.

6. How Digital Technology is Driving Eco- Conscious Purchasing.

Eco- conscious purchasing and sustainable business practices are all found in the digital technology. What we teach is simple: Entrepreneurs who use digital technology strategically in their sales process are more likely to incorporate social and environmental factors into their decision- making (Plečko & Bradač Hojnik, 2024). Digital channels attitude of a consumer has a positive effect on eco-friendly consumption and buying behavior(Palmieri et al., 2024). Together with the internet of things, big data and artificial intelligence, digital technology facilitate a more sustainable management of products throughout their life cycle and this way support circular economy strategies (Rusch et al., 2023). These

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results underscore the capability of digital technology to promote sustainable consumer behavior and guide the digital economy towards sustainability, providing new perspectives for policy maker, developers,and stakeholders in facilitating sustainability through technology innovation.

Objective of the Review Paper

- To examines the impact of AR to consumer behavior and purchasing decisions.
- Explores how AR can encourage greener consumption.

II. THEORETICAL FRAMEWORK

Energy Augmented Technology acceptance model (EA-TAM): The traditional TAM model has been also extended to green factors that impact micro and macro factors, where renewable energy, green innovation, and eco-friendly production formulate the attitude and intentions of consumers dependent on green products (Anser et al., 2020). These studies point out that consumption behaviors should be analyzed as parts of a united decision-making process which can reinforce sustainable consumptions and lead green trends in marketplace.

Case Study	Model Applied	Key Findings	Source
Adoption of Renewable Energy Sources in Households	TPB	Households' intentions to adopt renewable energy are significantly influenced by attitudes towards renewable energy, perceived behavioral control, and subjective norms.	Theory of planned behavior
Consumer Adoption of Augmented Reality (AR) Apps in the Fashion Industry	TPB	AR experience significantly impacts users' application attitudes and demand, with application familiarity playing a critical role.	Kazmi et al., 2021
Hybrid Vehicle Purchase Intention	TPB	Consumers' intentions to purchase hybrid vehicles are influenced by environmental concerns, perceived behavioral control, and subjective norms.	Ong et al., 2023
Adoption of Clean Technologies	TPB	The intention to adopt clean technologies is shaped by attitudes towards sustainability, perceived behavioral control, and social norms.	Pakravan & McCarty, 2020
UAV Meal Delivery Services and Environmental Protection	TPB	Intentions to use UAV meal delivery services are influenced by perceived environmental benefits, subjective norms, and perceived behavioral control.	Hwang et al., 2020
Consumer Behavior Towards Green Products	EA-TAM	Renewable energy, green innovation, and eco-friendly production significantly influence consumer attitudes and intentions towards green products.	Anser et al., 2020
Use of AR Apps in Fashion Industry	TPB	AR experience has a significant impact on users' application attitudes and demand, with application familiarity being a critical factor.	Kazmi et al., 2021

1. Decision-making: Top Down or Tech-pushed?

The theory of planned behavior (TPB) based on social psychology has been applied to the study of consumer behavior, particularly that which leads to sustainable behavior change in a range of sustainability-oriented contexts including the use of renewable energy sources , adoption of clean technologies: ; Hybrid vehicle purchase intention. These studies demonstrate that TPB can reliably predict behavioral intention in different fields. Also, the TPB has been extended through its interaction with other models, such as UTAUT2, to create a more solid theory about consumer behavior (Ong et al., 2023). Moreover, what has been exchanged in terms of technology effecting customers purchase process are discussed too especially on augmented reality (AR) apps on fashion industry (Kazmi et al., 2021). The factor of AR experience has a significant impact on users' application, attitude and demand ratio, and application familiarity is an important part of the critical broker.

2. AR and Consumer Experience – Immersive Experience in Retail

Augmented Reality in retail: As a means for consumer experience enhancement It looks like all enterprise in e commerce and brick and motor stores App AR are flourishing (Hoffmann & Mai, 2022). Furthermore, researchers have examined how the technologies influence sales and brand experience (Tan et al., 2022). AR-based marketing has emerged one of furthest research topics that be extrapolated into different discipline and application domains like: retail, touristic and advert. Online settings Account for Over half of use cases. AR has been mainly studied from the technology

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acceptance model and stimulus organism response model perspectives. Further, as AR is in the process of becoming, it presents immense potential to marketers to transform consumer experience and engagement (Du et al., 2022).

3. Personalization and virtual Tryons for Sustainable Alternatives

Previous studies have explored the positive potential impact of VTO technology and personalization to the sustainability of fashion. VTO experiencer may promote brand attitude through sufficient self-explorative exposure during that ethereal experience and through their cognitive self-towing activated through augmented reality environment (Lavoye et al., 2023) However, before introducing such technology, it is important that the sustainability benefits be emphasized, and style be developed; aesthetic, realistic, and uniqueness characteristics are also important to consumer acceptance of such technology (Deng et al., 2024). proposed a personalized virtual try-on algorithm that can fit and generate fitting affects by simulate with users sizes to fit body sizes of individuals. As such, machine-learning-enabled 3D reverse design processes for customized clothing show promise in the areas of cost and environmental impact. They propose probabilistic neural networks and genetic algorithms for fit prediction and structural parameter adjustment, which also offer a more sustainable solution to fashion companies (Du et al., 2022). According to these studies, it seems VTO content and personalization technology, in general, can be a vehicle that drives sustainability practices within the fashion industry.

4. AR in behavioral Change towards Sustainability

This collection of research has examined sustainability and consumer behavior from different angles. Factors such as environmental responsibility or political orientation influence sustainable behaviors nudging techniques can promote a circular bioeconomy in fashion, clothing, and textiles (Falcone & Fiorentino, 2024) In the automotive field, studies show that AR assistants have greater potential for user acceptance based on the dimensions of trust, perceived usefulness, and ease of use (Wan et al., 2024). AR applications can also be used in food traceability — improving sustainability across the supply chain and affecting consumer choices(Dimou et al., 2024). Interest in environmental sustainability and digital propensities are considered important in eco-friendly consumption, especially in online purchases of sustainable food products (Palmieri et al., 2024). These studies show the importance of understanding the preferences and psychological factors of the consumers diagonally as to promote sustainable behavior across the chain. This goes hand in hand in leveraging digital technology (like AR!) for helping to make more sustainable choices and practices.

5. Use of Interactive Product Information in Creating Awareness of Sustainability

It has also been stated that there are many factors that affect to purchase behavior towards sustainable products. Concerns regarding quality, environmental issues, and perceived benefits are paramount drivers influencing green purchasing decisions (Lopes et al., 2024)et al., Green buying behavior reflects personality traits, altruistic attitudes, and social factors (Duque Oliva et al., 2024). Apart from this, consumer attitude, values, believes, perceived environmental impacts on price and product attributes are also significant predictors of sustainable purchasing (Islam & Ali Khan, 2024). Firms need, however, to implement holistic solutions towards green consumptions, for example, they can either develop superior sustainable items or communicate about its advantages and overcome environmental information (Lopes et al., 2024). While the effective levers of change remain under researched, these findings highlight how facets of sustainable consumerism should be valued alongside what is deemed a tier of exit price premiums, which can serve as important parameters for business and policy makers.

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6. AR Applications on Sustainable E-commerce

Augmented reality AR is potentially applicable to food commerce and to product transparency and traceability from farm to market to consumer, which have been shown to potentially impact consumer purchase and consumption behaviors and contribute to healthier and more sustainable food choices (Dimou et al., 2024). For example, in e-commerce, by activating intrinsic motivations such as curiosity and pleasure, AR technology improves the degree of immersion and purchase intentions of users (Tu & Jia, 2024) In the fashion industries, AR functions also allow consumers to try and wear products virtually before consumption, enhancing the online shopping experience (Kovács & Keresztes, 2024). These studies also illustrate the ability of AR to influence environmentally friendly shopping behavior by facilitating product transparency and immersive experience, thus leading to more sustainable buying choices in multiple sectors.

7. AR Powered QR Codes and Interactive Labels for Sustainability Information

AR displays can reduce carbon footprints in product selection, with 23% reduction observed for bottle water (Isley et al., 2017). QR codes on food packaging, linking to enriched product information , have shown promise in increasing usage intentions , and ,positively influencing buying behavior (Rotsios et al., 2022). Experimental studies have shown that AR technology significantly increases perceived quality and credibility of ecolabel information, as well as purchase intention for eco-labelled products(Dekhili & Ertz, 2024). QR quotes have made identified as useful tools for bringing the sustainability information gap between businesses and consumers. Factors influencing consumers intention to scan QR codes include perceived ease of use, usefulness, and visual appeal. Field experiments have demonstrated that QR code with suggestive appeals are scanned at higher rates ,with consumers reporting high perceived usefulness and preference for future use (Bashir, 2022). Research suggest that augmented reality AR and sustainability labelling can influence consumer behaviour towards more sustainable choices. AR displays on products can lead to reduce carbon footprints and healthier food choices (Isley et al., 2017). Environmental labels on food products are associated with increased selection and purchase of Sustainable options, Although effects in real-world settings may be small (Cook et al., 2023; Potter et al., 2021). Consumer understanding of sustainability information is often limited but visual AIDS like traffic light colours show promise in improving comprehension(Cook et al., 2023). Factors influencing sustainable consumer behaviour include social influence, habit formation individual self, feelings and cognition, and tangibility (White et al., 2019). Consumer generally prefer sustainability labelling backed by government or public authorities and are willing to pay more for labelled products, particularly those with organic certification (Cook et al., 2023). For the research in real world settings is needed to better understand the impact of sustainability labelling on consumer choices.

III. CASE STUDIES OF BRAND USING AR TO HIGHLIGHT ECO-FRIENDLY ATTRIBUTES

IKea's AR app demonstrates how technology can address practical shopping challenges and create service-centered value(Ozturkcan & Kitapci, 2023) VR/AR- based brand experiences ,including entertainment, aesthetic, educational, and real- escape types , positively impact consumer-brand relationships , satisfaction, and purchase intentions (Zeng et al., 2023). In Pakistan, AR enhanced user experiences in fashion accessory marketing improve consumer attitudes and buying intentions, with application familiarity serving as a crucial moderator (Kazmi et al., 2021). These studies highlight the potential of AR in promoting sustainable consumption, enhancing brand experiences, and influencing consumer behavior across various industries and markets. Recent studies have explored the factors in present consumers eco-friendly purchase decisions. Environmental consciousness, including knowledge and perceived effectiveness, significantly impacts the purchase intention for green products (N. Kim & Lee, 2023). Social network marketing and eco-friendly attitude also play crucial

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roles in shaping sustainable consumer behavior (Ebrahimi et al., 2021). Researchers have identified various influencing factors, categorizing them into individual, product related, and social aspects (Zhang & Dong, 2020). However, an intention behavior gap exists, moderated by situational factor such as ease of purchase and eco- able credibility (N. Kim & Lee, 2023). To promote sustainable consumerism, businesses should focus on biodegradable packaging, recyclable products, and transparent eco- labelling (Ebrahimi et al., 2021).Future research directions include exploring cross-cultural contexts examining various green product categories,and combining multiple consumer theories to better understand eco-friendly purchase decisions better(Zhang & Dong, 2020). Recent research highlights various aspects of Sustainable consumerism and eco- friendly decision- making. Vehicle energy consumption models are crucial for evaluating and optimizing automotive efficiency, with applications in Eco driving and Eco routing (Hua et al., 2025). Consumers behavior studies reveal that the marginal propensity to consume MPC is influenced by transfer methods and household characteristics, with implications for stimulus policies (Boehm, n.d.). In the housing market, simplified energy efficiency labels create price discontinuity's at rating band thresholds, affecting property values and encouraging energy efficiency investments (Sejas-Portillo et al.,2025). These finding underscore the importance of considering consumer behavior, information presentation, and technological integration in shaping eco- friendly purchase decisions across various sectors.

1. AR based Product Visualization to Reduce the Returns

Using AR technology has the potential to reduce both product return and waste in e-commerce, especially in the fashion industry. AR can help to close "imagination gaps" by superimposing lifelike product holograms into the physical environment, improving customers' mental imagery and therefore their purchase decisions. It has shown to increase purchase intentions as well as the actual number of purchases, and seems to be most effective with bundled vs. unbundled products and at later stages in the purchase funnel (Hilken et al., 2022). For example, with E-Commerce pages, AR can enhance product visualization, giving users more accurate information, and potentially lowering return rates (Bozzi et al., 2022). AR has also revealed opportunities in the construction industry to overcome obstacles in implementing visual management while saving time and making training easier (Dallasega et al., 2023) Nonetheless, there are still concerns over high energy cost, consumer rejection and skill shortages required to deploy these systems (Mesjar et al., 2023).

2.Augmented Reality Examples: Fashion & Furniture & Cosmetics

VR Tools for online furniture stores: Augmented Reality Creating a New Era in the Furniture Industry AR furniture applications usually comprise 3D models of the furniture items, AR software to place them accurately with correct scaling and user interfaces for browsing and customization (Sanas Sakshi patil Omkar Yadav et al., 2023). These apps allow users to see how furniture would look in a home, as well as adjust positions, resize, rotate, and even alter colors. This technology layers virtual 2D or 3D objects within real environments in real time, thus providing a highly immersive experience AR furniture catalogue's are created using platforms such as Vuforia SDK for creating markers and unity as the application engine (Shadiev & Liang, 2023). For better efficiency some applications use marker less AR methods (Alamsyah & Rachman, n.d.). Furniture shopping related AR solutions can improve the customer experience and thus, potentially boost sales, as well as offer a unique Advertising solution to furniture stores (Alamsyah & Rachman, n.d.; Shadiev & Liang, 2023).

3. Augmented Reality AR Technology is Revolutionizing Several Sectors

Like the fashion AR in retail furniture, cosmetics, etc. AR elevates shopping experiences by overcoming online shopping issues and transforming consumer engagement (Riar et al., 2023). In the content of fashion retail, the consumption concept of AR enhances consumer satisfaction, increase purchase intention, and serve as the basis to explain the luxury brands use of storytelling from a hedonic perspective(Xue et al., 2023). AR applications in marketing have reached beyond retail to

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other sectors, like tourism and advertising, with mobile AR being widely used in online applications (Du et al., 2022). The effect of technology on consumer behavior is mediated by technology's technical features like interactivity and vividness that help to improve the utility and hedonic shopping experience(Riar et al., 2023). We present the XAIR framework to inform designers of AR experiences when, what, and how explanation of AI output should be provided in AR reflecting users' preference and expert opinion. Augmented reality AR technology is being applied more often in the industries of fashion, furniture, and cosmetics. In Furniture AR: places 3D virtual furniture object into the real environment, IKEA is another successful example, and it enhances the shopping experience (Alamsyah & Rachman, n.d.). For example, VTO services in the fashion and beauty industry enable consumers to try on different looks and styles like never before, resulting in better brand attitudes and being processed by consumers' cognition(Lavoye et al., 2023). AR has made a noticeable influence on the buying behavior of Saudi consumers, especially on young women's clothing and accessories (AL Hilal, 2023).

4. AR and AI-driven Soloutions have Already Fundamentally

Changed healthcare panorama and are transforming cosmetic dermatology thus, supporting disease prevention, diagnosis,and education(Haykal et al., 2024). Such applications showcase the potential for AR to revolutionize consumer engagement across several sectors, providing personalized, interactive and efficient means to interact with products and services. Businesses are increasingly harnessing the power of these technologies for marketing and customer engagement, a trend which is set to continue. AR in consumer-facing industries – augmented reality technology is increasingly being used in consumer-facing industries. For example, in fashion retail, AR provides a feature that expands the experience of online shopping by enabling customers to visually try on clothing before purchasing (Kovács & Keresztes, 2024). Cosmetic patients using AR and VR applications visualize the treatment outcomes at different stages of before make treatment decision leading to better informed decision making and increased satisfaction(Haykal et al., 2024). In the entertainment industry, by improving aesthetic design and intrinsic motivational factors AR broadcasting suspected the user immersion and intention to pay (Tu & Jia, 2024). AR provides a plethora of advantages within industries, yet unquestionable technical constraints ethical challenges, and making the user burden even worse if not adopted carefully remain in its way.

5. AR in Green Packaging and Waste Reduction

Recent research emphasizes the role of Sustainable packaging and technology advancements in waste reduction and prolonged food life storage. The developments of augmented reality AR and virtual reality VR technology can complement renewable energy and green leadership to increase industrial sustainability in the waste management sector (Manurung, 2024). The research domains within CSP are material, management,practices, consumer behavior and waste management either contributing towards achieving sustainable development (Lau & Wong, 2024). Multi criteria decision-making approaches can help to choose sustainable product-package design at the circular food supply chain (Zambujal-Oliveira & Fernandes, 2024).

6. How AR Reduces the Need for Physical Brochures and Packaging

Details where AR technology is more and more used in packaging, to reduced physical promotional material. AR applications can present users with interactive 3D representations of products, in a much clearer way than packaging alone (Abdul Rani & Ramlie, 2023). This also allows companies to reduce the use of paper in promotional materials such as brochures and flyers, which helps reduce the environmental impact caused by deforestation (Juniawan et al., 2023). In online Apparel, it has been proven that AR displays the accurate attribute of the product which is size, color, which manifest into a more positive attitude toward the products and increases the intention to purchase, especially for users with a high sense of telepresence(Baytar et al., 2020). Augmented reality (AR) lowers the need

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for physical brochures and packagings by stimulating customer engagement and overcoming "imagination gaps" in the buying process proved that AR-generating visualizations enhance purchase intentions & behaviors especially in situations to the point of sale (Hilken et al., 2022). This allows consumers to better visualize products, so they don't depend so much on physical marketing. On the other hand, emphasize how AR enhances consumer experiences in marketing environments, hinting at how it can supplant classic media. (Billinghurst, 2021) illustrates the technological advancements of AR being undeniably accessible, which reinforce the use of AR in the marketing sector. (Chung et al., 2021) Also mention that AR promotes collaboration and engagement in educational contexts, highlighting its potential use in contexts beyond marketing. Together, these studies demonstrate AR's ability to transition promotional materials to digital platforms, where consumers experience richer interactions and decision- making.

7. Psychological and Behavioral Effects of AR on Consumer decisions

With the growing use of Augmented reality AR few research studies have been conducted on its influence on consumers behavioral towards the brand. AR technology has positively impact buying decisions, including clothing and accessories (AL Hilal, 2023). It strengthens self-brand attachment via greater imagery and attitudes of self-malleability, therefore enhancing marketing outcomes (T. H. Kim & Im, 2024). The three types of AR experiences constitute entertainment, aesthetic, educational and real-escape, which all help to establishing consumer-brand relationships that impact purchase intentions (Zeng et al., 2023). Among these elements, technology anxiety, and virtuality are significantly influencing customers' attitudes toward AR-based e-commerce websites, while non-significant effects are for interactivity and innovativeness (Dogra et al., 2023). Overall, these results indicate AR technology has the power to transform marketing tactics and consumer interactions, especially among younger age groups, by providing immersive and personalized selling experiences.

8.. Interactivity between Consumers & Brands

Augmented reality technologies are increasingly reshaping consumer- brand relationships and related shopping behaviors. AR not only enhances the self-brand connection but also improves marketing outcomes such as revisit intentions (N. Kim & Lee, 2023). AR, in combination with virtual reality VR, can deliver a range of brand experiences (Entertainment, aesthetic, educational to real-escape) that engender consumer-brand relationships and influence purchase intentions (Zeng et al., 2023). The Two main factors are technology anxiety and virtuality significantly influence attitudes and behavioral intentions towards AR-based e-commerce websites (Dogra et al., 2023). The potential of AR in brand perceptions and trust is highlighted in these studies, which suggest that businesses in various sectors may be able to use this technology to shape consumer experiences and build brand loyalty.

9. Gamifying Sustainable Choices with Rewards

Organisms have to find out how to multiply in new circumstances, audiences have to be taught in immersive environments, gamification is rising as a way to enhance sustainable consumption and the consciousness of nature. Studies show that gamify applications can affect positive way in the users sustainable behaviors and habits . These tools aids the bridge between awareness and action in relation to the environment especially when they address components like statistical data, examples from real life and everyday actions performed by individuals (Novo et al,2024). But users of gamified solutions may have mixed feelings about that approach, as it can depend on the demographics and context. Another study aimed at students from Chinese universities showed that gamification and green advertising had no significant effect on sustainable behavior (Huang et al., 2023). Despite its flaws, gamification can still represent a worthwhile approach to motivating sustainable consumption in contexts – personal and professional alike – beyond the precise sample used here (Lim et al., 2023). Gamification tools can be useful to kickstart the formation of new habits (Aguiar-Castillo et al., 2023)

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but as the habit has been internalized it is likely to become less relevant indicating a potentially long-term impact for sustainable behaviors.

10. Challenges in Adopting AR for sustainable consumer behaviour

Unfortuantely, privacy aspects of data security are not discussed in these papers. However, research emphasizes also the functional and psychological obstacles to the early adopters, such as use, value and tradition (Xue et al., 2023). Digital technologies, like Augmented reality, AR can promote sustainable behaviours, such as energy saving and pollution reduction (Mosca et al., 2023). A static design and intrinsic motivation in live streaming premium content significantly enhance user experience and intention to pay(Tu & Jia, 2024) .Factors influencing sustainable diets include concept of alignment knowledge with consumer behaviours marketing products relationships and support networks (Srinivasan et al., 2024) .Adopting varies according to individual characteristics such as income, education and ethnicity. These insights can inform efforts to create strategies that help consumers overcome those barriers and lead more sustainable lives in many different areas.

11. Access to Technology and the Digital Divide

Digital means of enabling circular economy implementation is affected by infrastructure and regulatory challenges in construction organizations (Thirumal et al., 2024). In emerging economies, a digital divide exists, leading to varying levels of engagement with mobile payment apps among consumers (Farinloye et al., 2024). While in sustainability domains, the application of digital interventions such as virtual Augmented reality, gamification, and power metering system proved useful in driving energy-saving and pollution-reduction behaviors. However, clear intervention designs are required (Mosca et al., 2023). Moreover, ARN (Augmented Reality News) broadcast aesthetic design is very important to users' experience and affects their payment behavior via curiosity and perceived behavioral control(Tu & Jia, 2024). These studies, taken together, underscore the importance of considering socio-cultural factors, technologies accessibility, and user-oriented intentions in addressing challenges to digital technologies for sustainable consumer behavior.

12. Future Directions and Implications for AR- Enabled Sustainable Consumerism

Notably, the service sector utilizes AI for improving ongoing customer experiences across the customer journey and its major themes are AI experiences functions, and services (Chen & Prentice,2024)(Y. Chen & Prentice, 2024). AI is also becoming a major aspect of education, particularly through personalized learning as evidenced by tailored content delivery, adapted assessment and personalized user interface (Castro et al., 2024). However, these advancements important as they may, also come with challenges, including data privacy, the ethical implications of AI systems and the need of inter disciplinary effort between industry and academia.

13. Future Research Directions based on Research Gaps

(Grandi et al., 2021) Proposes a matrix framework that integrates model-based design and AR to enhance social sustainability during industrial production process with the evaluation of positive impact from AR. And (da Silva et al., 2019)review AR educational evaluation and suggest the need for Multimedia Matrix and teacher participation. (Ritsos et al., 2011) Call for the standardization of user experience aspects of AR such as ergonomics, health, safety and usability. In summary, this collection highlights the need for standardized matrices to evaluate the impact of AR in multiple domains in terms of both technical and user experience perspectives.

14. In summary and Recommendations

Augmented Reality (AR) is changing the course of sustainable consumerism by improving product transparency, decreasing waste through information, and providing immersive experiences that shape consumer purchasing behavior. From retail and e-commerce to fashion and logistics, AR applications

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are proving valuable to drive eco-friendly decisions and reduce returns (e.g. virtual try-ons and interactive sustainability labels, AR-powered QR codes, etc.) In addition to this, by limiting the need for physical packaging and printed props, AR supports waste reduction efforts and is a product that supports the principles of a circular economy. Yet there are significant challenges that prevent its full potential, such as data privacy issues, accessibility gaps, and the risk of greenwashing. However, there is no standardized evaluation framework that can measure AR's true impact on sustainable consumer behavior accurately, making it difficult to assess AR's effectiveness in promoting sustainable practices.
If we really want to maximize AR's impact on sustainable commerce, we should take the following steps. This should begin with the buttressing of standardized evaluation matrices to understand AR's share of impact across a range of sectors that must combine technical performance and user experience factors. It will allow businesses and policymakers to evaluate the effectiveness of AR in achieving sustainability results. Second, businesses can empower consumers to become more informed through interactive sustainability labels and AR-powered QR codes, using gamification and AI-enhanced personalization to incentivize individuals to make sustainable decisions. Enhancing data protection regulations and ensuring ethical codes of conduct will be pivotal in overcoming these privacy challenges whilst stopping misleading sustainability claims from being made.

Research in the future should include longitudinal studies that assess the enduring behavioral effects of AR on consumer sustainability decisions. Examining the psychological factors driving consumer interactions with AR-enabled sustainability campaigns and whether cross-cultural disparities exist in this regard will be beneficial (though important that you all have cultural representation on your team!). Finally, these practical applications should then extend to further increasing AR's deployment in green packaging and waste reduction measures (e.g., swapping out physical brochures for interactive digital counterparts). As an equally important part of any business solutions, businesses must seek out AR-driven solutions that bridge the digital divide, making sure that this technology is accessible from one consumer demographic to another.

If AR can meet these challenges and implement these recommendations, the technology will be able to transition from a marketing gimmick to a powerful influence on consumer behaviours that promote sustainability. Potential Positive Impacts of AR with Support of Regulatory Approach Considering Responsible Innovation and Response Evaluation Framework (throughout the guide, as all rules)AR represents the convergence of physical and digital experiences.

Year	Authors (4-5 per year)	Research Gap	Insights
2020	Zhang & Dong (2020), Sesini et al. (2020), Cook et al. (2023), White et al. (2019)	Need for cross-cultural studies on green product purchasing.	Environmental factors influence sustainable purchases.
2021	Ebrahimi et al. (2021), Rotsios et al. (2022), Billinghurst (2021)	Need for long-term impact analysis of social media marketing on sustainability.	Social media and QR codes influence eco-friendly purchasing.
2022	Du et al. (2022), Hilken et al. (2022), Hoffmann & Mai (2022)	More research on AR's impact on customer retention and post-purchase behavior.	AR enhances consumer experience, reduces product returns.
2023	Zeng et al. (2023), Kim & Im (2023), Palmieri et al. (2024), Lavoye et al. (2023)	More studies on long-term AR engagement and cross-cultural acceptance of virtual try-on (VTO).	AR & VR boost brand engagement, VTO reduces waste.
2024	Wan et al. (2024), Falcone & Fiorentino (2024), Dogra et al. (2024), Riar et al. (2023)	More research on AR's impact on different demographics and industries.	AR assistants improve trust, nudging techniques drive sustainability.
2025	Hua et al. (2025), Boehm et al. (2025), Sejas-Portillo et al. (2025)	Need for more research on consumer adoption of eco-driving and sustainable labeling.	Energy efficiency labels influence property values, consumer stimulus policies impact spending.

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IV. CONCLUSION

Augmented Reality (AR) is changing the course of sustainable consumerism by improving product transparency, decreasing waste through information, and providing immersive experiences that shape consumer purchasing behavior. From retail and e-commerce to fashion and logistics, AR applications are proving valuable to drive eco-friendly decisions and reduce returns (e.g. virtual try-ons and interactive sustainability labels, AR-powered QR codes, etc.) In addition to this, by limiting the need for physical packaging and printed props, AR supports waste reduction efforts and is a product that supports the principles of a circular economy. Yet there are significant challenges that prevent its full potential, such as data privacy issues, accessibility gaps, and the risk of greenwashing. However, there is no standardized evaluation framework that can measure AR's true impact on sustainable consumer behavior accurately, making it difficult to assess AR's effectiveness in promoting sustainable practices.
If we really want to maximize AR's impact on sustainable commerce, we should take the following steps. This should begin with the buttressing of standardized evaluation matrices to understand AR's share of impact across a range of sectors that must combine technical performance and user experience factors. It will allow businesses and policymakers to evaluate the effectiveness of AR in achieving sustainability results. Second, businesses can empower consumers to become more informed through interactive sustainability labels and AR-powered QR codes, using gamification and AI-enhanced personalization to incentivize individuals to make sustainable decisions. Enhancing data protection regulations and ensuring ethical codes of conduct will be pivotal in overcoming these privacy challenges whilst stopping misleading sustainability claims from being made.

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