Pak. j. life soc. Sci. (2025), 23(1): 8314-8342 E-ISSN: 2221-7630;P-ISSN: 1727-4915

Pakistan Journal of Life and Social Sciences

www.pjlss.edu.pk

https://doi.org/10.57239/PJLSS-2025-23.1.00648

RESEARCH ARTICLE

Gamification Strategies to Enhance Environmental Awareness in Sustainable Retail: A Systematic Literature Review

Suwicha Wittayakom[1*], Nattaphat Wisetpanich[2], Chaba Bainyam[3], Maneerat Tangthansup[4]

[1,2] School of Business Administration, Bangkok University, Pathum-thani, Thailand

[3] Faculty of Business Administration, Panyapiwat Institution of Management, Nonthaburi, Thailand

[4] Chinese Graduate School, Panyapiwat Institution of Management, Nonthaburi, Thailand

ARTICLE INFO

Received: Jan 23, 2025

Accepted: Mar 19, 2025

Keywords

Gamification
Environmental Awareness
Sustainable Retail
Consumer Engagement
Systematic Literature Review

***Corresponding Author:**

suwicha.w@bu.ac.th

ABSTRACT

This research systematically reviews the application of gamification strategies to promote environmental awareness within sustainable retail, a growing area aimed at fostering eco-conscious consumer behaviour. The study identifies a limited number of studies directly addressing the intersection of gamification, environmental awareness, and sustainable retail. To address this gap, the analysis categorizes research into three themes: Gamification and Environmental Awareness, Gamification and Sustainable Retail, and Environmental Awareness and Sustainable Retail. From an initial database search, 78 relevant studies were selected through a structured screening process. Results indicate that specific gamification elements—such as points, badges, rewards, and social incentives—effectively engage consumers in sustainable behaviours by appealing to motivations of achievement and competition. Additionally, advanced technologies like AI and blockchain enhance these strategies by personalizing user experiences and ensuring transparency in eco-friendly practices. The findings underscore the potential of gamification to deepen consumer engagement and foster sustainable retail practices, though challenges related to user retention and intrinsic motivation remain. This study provides a foundation for future research to explore integrative gamification frameworks, aiming to establish gamified sustainability as a viable approach for long-term environmental impact in retail contexts.

INTRODUCTION

In recent years, sustainable retail has become a transformative approach that integrates environmental, social, and economic considerations into core business practices. This shift represents a broader trend in which companies strive to meet the increasing demand for responsible operations that benefit not only shareholders but also communities and the environment (Li *et al*., 2024). Sustainable retail is no longer a niche concept but has become an imperative in the face of mounting environmental challenges and evolving consumer expectations. The overarching aim of sustainable retail is to reduce the environmental footprint of retail operations, promote ethical sourcing, and enhance the well-being of communities, employees, and the ecosystems that businesses rely upon (Vadakkepatt *et al*., 2021).

The retail industry, as one of the largest sectors globally, significantly impacts the environment through its energy consumption, waste generation, and resource usage. Traditional retail practices often involve high levels of energy consumption, extensive packaging, and a dependency on non-renewable resources, which together contribute to issues like pollution, deforestation, and greenhouse gas emissions. These environmental impacts are prompting retailers to rethink their practices and adopt more sustainable strategies that prioritize efficiency and resource conservation. The shift towards sustainable retail also aligns with broader sustainability objectives, such as those outlined in the United Nations' Sustainable Development Goals (SDGs),

particularly goals on responsible consumption and production, climate action, and protecting terrestrial ecosystems (Bilińska-Reformat *et al*.,2019).

For consumers, environmental awareness is an increasingly critical factor influencing purchasing decisions. Studies show that a growing number of consumers, especially younger generations, prefer to support brands that demonstrate a commitment to sustainability and social responsibility (Majhi, 2022). As environmental consciousness rises, retailers are not only expected to operate responsibly but also to foster awareness and encourage sustainable behaviours among their customers. Retailers can contribute to this shift by offering products with minimal environmental impact, using eco-friendly packaging, and promoting circular economy principles such as recycling and reuse. At the same time, integrating sustainability into retail operations can reduce costs through energy efficiency and waste reduction, providing a competitive advantage. Retailers who emphasize sustainability often enjoy a stronger brand reputation and higher levels of consumer trust, which can lead to long-term loyalty and profitability (Sinha & Chaudhuri, 2014).

However, achieving environmental awareness and promoting sustainable practices within the retail sector is not without challenges (Stefańska & Śmigielska, 2016). Regulatory pressures and stakeholder expectations are increasing, with governments imposing stricter environmental standards. Non-compliance can lead to legal repercussions, financial penalties, and reputational risks. Investors and stakeholders are also incorporating Environmental, Social, and Governance (ESG) criteria into their decision-making processes, pushing companies to align their operations with sustainability principles. Retailers are thus compelled to navigate these pressures by innovating in sustainable practices and finding effective ways to communicate their efforts to consumers and stakeholders alike.

One promising strategy that has emerged in recent years is gamification. Gamification, defined as the application of game design elements in non-game contexts, has shown substantial potential for enhancing environmental awareness within the retail sector. By leveraging game mechanics like points, badges, leaderboards, and rewards, gamification can create engaging and motivating experiences for consumers. Gamification taps into intrinsic human motivations such as achievement, competition, and social interaction, which can make learning about environmental issues enjoyable and memorable. This is especially important as long-term behaviour change often requires ongoing engagement, which gamification can facilitate (Sailer & Homner, 2020).

The application of gamification to environmental awareness serves multiple purposes (Froehlich, 2014). First, it makes complex environmental concepts accessible to a broader audience. Scientific information related to sustainability can be dense and difficult for consumers to digest. Gamified experiences simplify these complex topics, presenting them in interactive, user-friendly formats that enhance understanding and retention. For instance, a gamified mobile app might educate consumers on the impact of plastic use by allowing them to track their plastic consumption and rewarding them for using alternative materials. This interactive approach can foster a deeper understanding of environmental issues and empower consumers to make informed, eco-friendly decisions.

Additionally, gamification fosters active participation and experiential learning (Shiralkar, 2016). Unlike passive forms of environmental education, such as reading or watching videos, gamification requires users to actively engage with content, make decisions, and witness the outcomes of their actions. This experiential approach allows users to develop a stronger sense of personal responsibility towards environmental stewardship. By creating a safe space for users to experiment with sustainable behaviours, gamification can help individuals internalize and adopt these practices in real life.

Moreover, gamification has the power to drive collective action by fostering a sense of community and shared purpose (Riar *et al*., 2022). Social features, such as collaborative challenges or peer-to-peer interactions, can create a supportive environment where individuals feel part of a larger movement toward sustainability. For example, retailers might introduce team-based challenges where consumers compete or collaborate to reduce their carbon footprints, with rewards for groups that achieve the highest reductions. This collective aspect can amplify the impact of

individual efforts and inspire consumers to adopt sustainable practices as part of a shared goal, leading to more significant environmental outcomes.

In practical terms, gamification in the retail sector can take many forms (Insley & Nunan, 2014). For example, retailers can create gamified loyalty programs that incentivize customers to make eco-friendly purchases or participate in sustainability initiatives. Interactive mobile applications and online platforms offer a channel for consumers to engage with sustainability-related games, such as quizzes on sustainable practices or simulations that demonstrate the environmental impact of different shopping behaviours. In physical retail spaces, in-store gamification elements—such as eco-friendly scavenger hunts, sustainability challenges, or quizzes—can add an educational component to the shopping experience, promoting environmental consciousness while making shopping enjoyable.

METHODOLOGY

This study utilized the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines to systematically review literature on gamification strategies aimed at enhancing environmental awareness within sustainable retail. PRISMA provides a well-structured framework commonly used in fields like medicine and public health, known for its effectiveness in reducing bias and ensuring transparency in the literature review process (Moher *et al*., 2009). Its rigorous and standardized approach can also be extended to social sciences research, where structured question formulation and systematic source identification are essential for generating comprehensive reviews. PRISMA's guidelines offer a clear path for replicable research synthesis, making it an appropriate choice for this study's goals.

To address the diverse aspects of this research, the literature review was divided into three primary phases, focusing on the intersection of Gamification and Environmental Awareness, Environmental Awareness and Sustainable Retail, and Gamification and Sustainable Retail. This phased approach allowed for a more nuanced understanding of each individual relationship before synthesizing the findings across these themes.

The first phase of the review focused on literature examining how gamification can be used to enhance environmental awareness. Studies selected in this phase were analysed to identify the types of gamification elements (e.g., points, badges, leaderboards) that have been effective in raising environmental consciousness and encouraging sustainable behaviours.

In the second phase, the review cantered on studies exploring the role of environmental awareness within the sustainable retail sector. Articles in this phase were reviewed to understand how awareness impacts consumer choices, how retailers promote sustainability, and the effectiveness of various strategies in fostering eco-friendly consumer behaviour.

The final phase reviewed studies that investigate the use of gamification in sustainable retail. This included identifying gamification strategies that retailers use to engage consumers in sustainability practices, such as rewarding eco-friendly purchases or promoting circular economy initiatives.

The literature search was conducted on Scopus due to its extensive coverage of high-quality, peer-reviewed research across multiple disciplines, ensuring a robust foundation of sources. The search terms included combinations of keywords such as "Gamification," "Environmental Awareness," and "Sustainable Retail," focusing on studies published between 2019 and October 2024 to capture recent trends and findings. This search initially yielded 161 articles.

Following the search, each article's abstract was reviewed to determine its relevance to the study's objectives. The inclusion criteria required studies to address one or more of the following themes: gamification and environmental awareness, environmental awareness and sustainable retail, or gamification in sustainable retail. Articles that did not meet any of these criteria were excluded from further analysis.

Each article was independently reviewed and rated based on relevance: 1 (not suitable), 2 (possibly suitable), and 3 (suitable). Articles rated as "1" were excluded, while those rated as "2" or "3" proceeded to full-text analysis. Discrepancies in ratings were discussed among the

researchers to ensure consistency in article selection. This filtering process resulted in a final set of 78 articles, from which data were systematically extracted.

Data extraction focused on identifying the types of gamification strategies, outcomes related to environmental awareness and behaviour change, and the challenges or limitations encountered in implementation. Each phase was analysed for key variables, including study design, target audience, primary gamification elements, and reported impacts on consumer behaviour or environmental awareness. After completing the three phases, a thematic synthesis was conducted to integrate insights from each area, highlighting overarching trends, effective strategies, and potential challenges in using gamification for environmental sustainability in retail.

Research Objectives:

To conduct a systematic literature review on gamification strategies used to promote environmental awareness in sustainable retail, providing an in-depth overview of relevant studies and findings.

To evaluate the effectiveness of gamification strategies in influencing consumer attitudes, intentions, and behaviors toward environmentally friendly choices, identifying how these strategies contribute to sustainable consumer practices.

To analyze the types of gamification elements and their impact on user engagement within sustainable retail contexts, exploring how specific design elements enhance consumer interaction and participation.

To identify challenges and limitations in implementing gamification within sustainable retail and to develop practical recommendations for retailers seeking to integrate gamification into their environmental sustainability efforts.

Table 1: Keyword to search articles

Databases	Keywords to search
Scopus	TITLE-ABS-KEY(“Gamification”) AND (“Sustainable Retail”)
Scopus	TITLE-ABS-KEY(“Gamification”) AND (“Environment Awareness”)
Scopus	TITLE-ABS-KEY(“Sustainable Retail”) AND (“Environment Awareness”)

Table 2: Screening criteria

Criteria	Specifications
Type of Publication	Articles
Language	English only
Timeframe	Five years (2019 – 2024 (October))
Accessibility	Full text
Focus of finding	Gamification strategies to enhance environment awareness Environment awareness in sustainable retail Gamification strategies in sustainable retail

RESULTS

The systematic literature review on Gamification Strategies to Enhance Environmental Awareness in Sustainable Retail uncovered a limited number of studies addressing all three key areas of gamification, environmental awareness, and sustainable retail together. Due to this shortage, the analysis was segmented into three paired themes to broaden the scope: Gamification and Environmental Awareness, Gamification and Sustainable Retail, and Environmental Awareness and Sustainable Retail. By examining each pairing individually, the researchers created a focused approach that facilitates a deeper analysis of each domain, which will be synthesized in the Discussion section.

Following a structured search within the Scopus database and applying specific inclusion and exclusion criteria, a total of 78 articles were identified across the three categories: Gamification and Environmental Awareness (33 articles), Gamification and Sustainable Retail (5 articles), and Environmental Awareness and Sustainable Retail (40 articles). This methodical grouping provides a foundation to investigate the unique contributions and interactions within each domain, offering insights into the distinct ways these themes are approached in sustainable retail contexts.

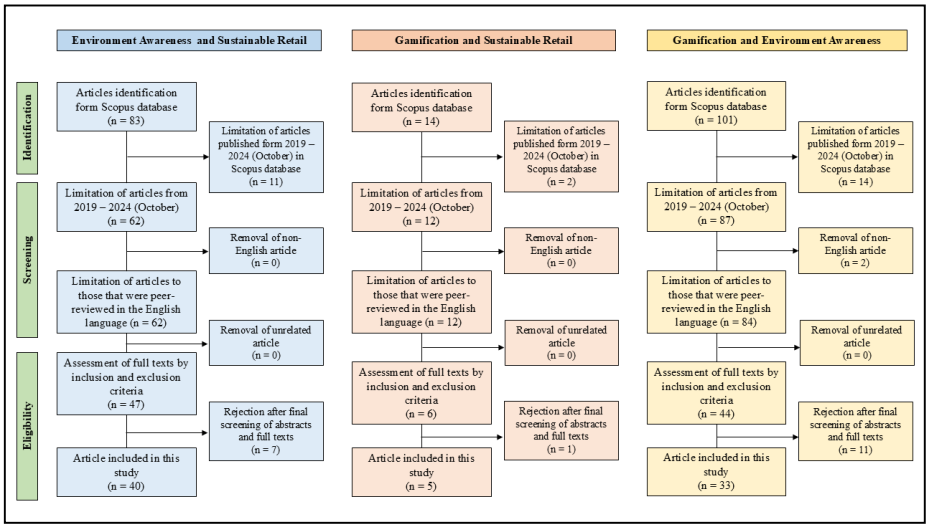

Figure 1: PRISMA flowchart for the process of the study selection

Gamification

The findings from a systematic analysis of relevant articles on the application of gamification strategies within the sustainable retail sector. The review focused on understanding the objectives, tools, gamification elements, types of strategies, consumer responses, success metrics, and challenges associated with implementing gamification to promote environmental awareness and sustainable consumer behaviours.

The analysis of articles on gamification within sustainable retail reveals diverse approaches and outcomes, highlighting the evolving role of gamification in promoting environmental awareness and fostering sustainable consumer behaviours. Table 3 provides a detailed description and comparison of key studies, showcasing how gamification strategies are being applied across various retail contexts to drive sustainable practices.

In each study, specific gamification strategies were employed to engage consumers and encourage eco-friendly behaviours. Zhao *et al*. (2019) implemented social incentives and game-based interactions within social commerce, creating a community-driven approach to sustainability. Meanwhile, Malcahy *et al*. (2021) focused on traditional gamification elements such as points, badges, and rewards to encourage energy-saving behaviours among consumers, showing the effectiveness of immediate rewards in changing behaviour. Wang *et al*. (2023) employed in-store gamified experiences in the fashion retail sector, enhancing customer engagement and fostering brand loyalty. Saarijärvi *et al*. (2024) leveraged gamified brand engagement to promote sustainable food practices, blending digital and in-store experiences. Finally, Behl *et al*. (2024) explored the use of points and rewards within the supply chain, integrating gamification with advanced technologies like AI and Blockchain to promote green practices in logistics.

Each study addressed a distinct sustainability focus: from environmental awareness (Malcahy *et al*., 2021) and sustainable food practices (Saarijärvi *et al*., 2024) to green supply chain management (Behl *et al*., 2024). This diversity in focus reflects the adaptability of gamification to various facets of sustainability, with each study targeting specific audiences. For example, Zhao *et al*. (2019) targeted social media and e-commerce users, whereas Behl *et al*. (2024) focused on

supply chain employees, tailoring the gamification strategies to meet the distinct needs and preferences of these audiences.

The studies also addressed various behavioural outcomes. Malcahy *et al*. (2021) reported enhanced consumer knowledge, attitudes, and energy-saving behaviours, while Wang *et al*. (2023) noted increased store footfall and brand loyalty in the fashion sector. Across the studies, gamification consistently led to improved engagement, whether by boosting customer involvement in sustainable practices or increasing productivity among employees in the supply chain.

However, each study faced unique challenges. For example, Zhao *et al*. (2019) encountered platform quality and trust issues in the social commerce environment, while Wang *et al*. (2023) noted the difficulty in balancing consumer preferences within space limitations.

A key component of each gamification strategy was technological integration. Platforms such as mobile applications (Malcahy *et al*., 2021) and social media (Zhao *et al*., 2019) were instrumental in enabling gamified interactions, with many studies utilizing analytics to personalize and optimize user experiences. Behl *et al*. (2024) took technological integration further by incorporating AI and Blockchain, highlighting the potential for advanced technologies to support long-term environmental and operational goals.

The long-term impacts varied across studies but consistently indicated positive effects on sustainability. Malcahy *et al*. (2021) found that their gamification strategy led to sustainable energy usage behaviours, whereas Saarijärvi *et al*. (2024) observed enhanced brand loyalty and in-store engagement. These results underscore the potential of gamification not only to influence immediate behaviours but also to foster lasting consumer relationships with sustainable brands.

Overall, the analysis in Table 3 illustrates the versatility of gamification in promoting sustainable practices across various retail sectors. By adapting strategies to suit specific industries, target audiences, and sustainability goals, gamification offers a promising approach to foster environmental responsibility and enhance brand loyalty in the context of sustainable retail.

Gamification and Environmental Awareness

The following analysis investigates how gamification strategies are applied to enhance environmental awareness and promote sustainable behaviour among consumers and stakeholders. Gamification, a compelling and interactive approach, has increasingly been used to inspire environmentally responsible actions and foster long-term ecological awareness. This analysis identifies and explores the types of gamification strategies utilized, their impact on user engagement and environmental awareness, the specific target audiences reached, and the platforms or tools employed to deliver these experiences.

Additionally, this section delves into the challenges and limitations encountered in implementing gamification for environmental goals, as well as the success factors that contribute to sustainable impact. By examining these elements across multiple studies, the analysis aims to present a nuanced understanding of gamification's effectiveness in promoting environmental awareness and behavioural change. The summarized findings are presented in Table 4, organized to emphasize patterns, innovations, and unique challenges within the literature, offering insight into gamification's potential role in advancing environmental sustainability.

The studies reviewed showcase a diverse array of gamification strategies, each tailored to encourage environmental responsibility and awareness. For instance, holistic gamified designs in eco-tourism (Polo Peña *et al*., 2024) and narrative-driven role-playing (Rodríguez *et al*., 2020) immerse users in experiences that simulate real-world environmental impact. Other strategies include eco-feedback systems, such as in higher education (Calitz, Cullen, & Odendaal, 2020), and mobile applications that incorporate rewards and social incentives, like Ant Forest (Li *et al*., 2024). Additionally, models like mGEECO in ecotourism (Rosmadi et al., 2024) and ICT platforms for public buildings (Franco, 2020) demonstrate innovative applications of gamification through social engagement and user feedback.

Gamified experiences effectively enhance engagement and environmental awareness, as reflected across studies. Recycling behaviours and climate awareness, for example, are boosted by platforms like Edcraft (Cheng *et al*., 2021) and immersive VR applications (Esmaeili & Thwaites, 2021), which allow users to visualize and understand their environmental impact. Ant Forest, with its reward system, has been especially successful in promoting pro-environmental habits (Chen, 2024). These examples illustrate that when gamification is implemented thoughtfully, it can foster meaningful behavioural shifts and sustained environmental awareness (Yang *et al*., 2024).

Gamification strategies are designed for varied audiences, from children and students to general users and professionals in specific fields. For instance, young children are engaged through tools like DoItRight, which uses gamified rewards to build eco-friendly habits (Alfahid *et al*., 2021). Ant Forest and LIFE-AMDRYC4, on the other hand, cater to urban residents and agricultural professionals (Hernández-Pérez *et al*., 2023). In academic contexts, gamified tools are used to cultivate sustainability awareness in both primary and tertiary students, contributing to environmentally conscious learning environments (Ricoy & Sánchez-Martínez, 2022).

Platforms and tools in these studies include mobile applications, VR experiences, web interfaces, and ICT systems. Ant Forest utilizes social media features to merge environmental contributions with gamified rewards (Chen, 2024), while LIFE-AMDRYC4 uses VR to simulate sustainable practices in agriculture (Hernández-Pérez *et al*., 2023). Other tools like ClassCraft and eco-feedback applications create tailored learning experiences for different age groups, enabling users to interact with environmental content in innovative ways (Sipone *et al*., 2021; Calitz, Cullen, & Odendaal, 2020).

Implementing gamified strategies faces several challenges, including technical limitations, cultural adaptability, and engagement retention. VR and AR applications, like PEAR, encounter technical constraints and user engagement challenges (Wang *et al*., 2021). Additionally, achieving alignment between CSR and user satisfaction, as in Ant Forest, can be difficult (Li *et al*., 2024). Furthermore, educational tools must align with curricula while keeping users engaged over time (Stock *et al*., 2024), highlighting the need for careful design and consideration of audience-specific factors (Pivec & Hsu, 2020).

Key success factors in gamified environmental programs include the use of reward systems and social recognition, which make sustainable behaviours socially rewarding and enduring, as seen in Ant Forest (Chen, 2024). Programs that incorporate real-world data or cultural adaptability, like eco-feedback platforms, promote consistent behaviour changes and reinforce habit formation (Calitz, Cullen, & Odendaal, 2020). Narrative-driven tools targeting younger audiences, such as Gamers4Nature, foster knowledge retention and help instill sustainable habits that may persist into adulthood (Beça *et al*., 2022). Collectively, these success factors underline the potential of gamification to drive long-term environmental awareness and behavioural shifts.

Sustainable Retail and Environmental Awareness

Sustainable retailing has become a core focus as businesses across sectors, from fashion to groceries, integrate eco-friendly practices to align with consumer expectations and regulatory standards. By examining current literature, this review analyses the Types of Retail Businesses and Sustainability Practices to understand the sector-specific approaches toward minimizing environmental impact, including waste reduction, energy efficiency, and responsible sourcing. It also explores how Environmental Awareness Campaigns and Customer Engagement play a crucial role, with retailers actively promoting sustainable habits, such as recycling and choosing eco-friendly products, to educate and engage consumers.

The Outcomes and Impact of Sustainable Practices are highlighted to assess measurable results, such as waste reduction and shifts in consumer behaviour toward sustainable choices. In addition, this review considers Challenges and Success Factors, identifying obstacles like cost and supply chain constraints while showcasing effective strategies retailers employ to overcome them. Looking toward the future, Future Goals and Long-Term Trends in retail sustainability, including goals like carbon neutrality and circular economy models, are examined to illustrate

the sector's role in advancing global environmental goals. Table 5 presents a comprehensive analysis based on these focus areas, offering insights into how sustainable retail contributes to environmental awareness and long-term ecological responsibility.

Retail sectors such as home appliances, grocery, floral, food packaging, and fast-food industries have integrated various sustainable practices, including 3R principles (Reduce, Reuse, Recycle), carbon reduction in supply chains, and the adoption of upcycled products. For instance, the home appliances sector's 3R practices, as described by Karagiannopoulos *et al*. (2024), exemplify efforts to minimize waste and foster green consumerism. Similarly, Vona (2023) and Phang *et al*. (2021) illustrate energy-efficient behaviours in grocery and energy retail, and other studies focus on using local, organic sourcing in floral and food sectors to reduce environmental impact.

Environmental awareness campaigns are essential in fostering consumer engagement, as demonstrated in efforts to encourage eco-friendly purchasing habits, recycling, and sustainable consumption behaviours. Campaigns in floral retail, for example, emphasize composting and local sourcing to promote sustainability (Etheredge *et al*., 2024). In addition, sectors like upcycled craft beer retail (Goodman-Smith *et al*., 2023) and smart energy hubs (Sheikhi *et al*., 2021) engage consumers through educational and promotional initiatives that emphasize the environmental benefits of sustainable practices.

Sustainable retail practices have positively influenced consumer behaviour, enhancing the willingness to adopt environmentally conscious choices. For instance, consumer engagement in energy-efficient practices has led to reduced home energy consumption (Vona, 2023), while discount promotions for suboptimal food have encouraged eco-conscious buying behaviors (Huang *et al*., 2021). Many studies report heightened customer satisfaction and increased acceptance of sustainable options, which, in turn, drive loyalty and long-term customer engagement in sustainable practices.

Retailers face challenges such as cost constraints, consumer skepticism, and the complexity of maintaining green supply chains. For example, infrastructure limitations hinder widespread composting adoption in the floral industry (Etheredge & Waliczek, 2020), while balancing sustainability with consumer expectations remains a significant challenge in the fast-food sector (Liu & Jiang, 2024). Success in implementing sustainable practices often relies on targeted, consumer-friendly approaches, as shown in gender-sensitive campaigns for eco-conscious retailing (Marin-Garcia *et al*., 2022), which enhance customer satisfaction through tailored sustainability strategies.

Future trends emphasize the need for circular economy practices, fair-trade expansion, and enhanced eco-awareness programs in retail. Goals include promoting sustainable consumer habits, integrating digital transformation with ESG goals, and establishing green logistics models to reduce carbon footprints. For example, the adoption of slow-delivery options in e-commerce and organic agriculture for medicinal plants reflects the ongoing shift towards environmentally responsible practices in retail. These strategies underscore a broader objective to achieve long-term environmental impact and resilience within sustainable retail frameworks.

In summary, sustainable retail practices are instrumental in raising environmental awareness among consumers, although challenges such as infrastructure costs, consumer education, and balancing economic viability remain. Future initiatives and strategic implementations aim to solidify these efforts, promoting a sustainable retail environment that aligns with global environmental goals.

DISCUSSION

This systematic review investigates the potential of gamification to promote environmental awareness and foster sustainable practices within retail, addressing each research objective through segmented analyses and critical examination of findings. While research connecting gamification, environmental awareness, and sustainable retail in an integrated framework is sparse, the structured analysis highlights the unique roles each pairing plays in advancing eco-friendly consumer behaviour and retailer strategies.

Gamification Strategies in Sustainable Retail

To provide a comprehensive foundation, this study categorizes existing literature into three focal pairings: Gamification and Environmental Awareness, Gamification and Sustainable Retail, and Environmental Awareness and Sustainable Retail. This structure allows for a focused exploration of each relationship, revealing distinct applications of gamification across retail settings and target audiences. For example, while gamification in environmental awareness often includes educational tools aimed at cultivating eco-friendly behaviours, its use in sustainable retail largely emphasizes incentives to drive consumer engagement in sustainable purchasing and consumption. Through this approach, the study offers a clearer view of how gamification currently enhances environmental goals in retail, paving the way for future integrated research that bridges all three areas.

Evaluating the Effectiveness of Gamification on Consumer Attitudes, Intentions, and Behaviours

The literature reveals that gamification strategies—such as rewards, points, and social incentives—effectively influence consumer attitudes and behaviours towards sustainable choices. Immediate rewards in retail settings, for example, have been shown to motivate actions like recycling, energy saving, and responsible purchasing. Retailers leveraging points and badges, particularly in energy-efficient retail sectors, demonstrate that consumers are more likely to adopt environmentally friendly behaviours when gamified incentives are present. However, the analysis also reveals variability in gamification's effectiveness depending on the duration and type of motivation. While extrinsic rewards create initial engagement, they often lack the depth required for long-term behaviour change, underscoring a need for more complex gamification models that blend intrinsic and extrinsic motivators. This finding highlights an area for future research: exploring strategies that not only prompt immediate eco-friendly actions but also foster sustained environmental responsibility.

Analysis of Gamification Elements and Their Role in User Engagement

The study identifies various gamification elements—such as points, badges, leaderboards, and personalized challenges—that contribute uniquely to user engagement in sustainable retail. Points and rewards are widely implemented to promote short-term engagement, effectively appealing to consumers' desires for immediate gratification. Social competition, facilitated through leaderboards, fosters a sense of community and accountability, encouraging consumers to track and compare their actions with peers. This approach has proven effective in sustainable practices related to energy savings and waste reduction, as it motivates consumers through collective social pressure. However, an overemphasis on competitive elements can discourage less-engaged users, suggesting that leaderboards be used alongside other inclusive gamification strategies.

Personalized challenges stand out as particularly effective in fostering emotional connections to sustainability. By tailoring challenges to individual consumer behaviours or sustainability goals, such as setting personalized carbon-reduction targets, retailers can build stronger, more meaningful engagement. For instance, in fashion retail, personalized milestones related to sustainable purchasing choices help consumers recognize the tangible impact of their actions. Furthermore, educational game mechanics play a critical role in enhancing consumer understanding of sustainable practices. Through simulations that visualize real-world environmental impacts, consumers can gain a deeper comprehension of their actions, making them more likely to support sustainable brands. This variety in gamification elements aligns with the objective of analysing user engagement, demonstrating the importance of contextual and personalized elements in effective gamification.

Implementation Challenges and Recommendations for Retailers

Despite the promise of gamification in promoting sustainable behaviours, several challenges limit its efficacy. First, sustaining long-term engagement through gamification remains difficult, especially when extrinsic rewards are the primary motivator. Studies reveal that once rewards diminish or lose novelty, consumer interest often wanes, indicating that extrinsic motivators

alone may be insufficient. Additionally, gamification strategies often face high implementation costs, particularly in developing and maintaining digital infrastructures like mobile apps or VR interfaces. Smaller retailers or those with limited resources may find these costs prohibitive, highlighting a need for scalable gamification solutions that are accessible across different retail environments.

To address these challenges, retailers are encouraged to adopt a hybrid gamification model that combines extrinsic rewards with intrinsic motivators, such as storytelling or community-building features that tap into consumers' values and identities. For instance, narrative-driven content in gamification can create meaningful connections by portraying environmental challenges and highlighting the consumer's role in addressing them. Retailers should also consider lower-cost options, such as in-store gamified displays, badges, or collective eco-challenges, which offer simpler but impactful methods for engaging consumers. Additionally, integrating gamification into employee training and supply chain management can strengthen sustainable practices internally, building a culture of environmental responsibility throughout the retail process.

Gaps and Future Research Directions

This review identifies several significant gaps that highlight potential areas for further investigation. First, research integrating gamification, environmental awareness, and sustainable retail remains fragmented, with studies often focusing on isolated or paired themes. This limitation restricts the ability to understand how gamification can holistically drive sustainable retail practices. Future studies should aim to develop comprehensive models that assess gamification's influence on both consumer-facing and operational sustainability efforts, examining these themes in an integrated framework that captures their collective impact.

A second gap is the limited focus on intrinsic motivators in gamification design. While extrinsic rewards are commonly used, few studies explore the role of intrinsic factors—such as a sense of responsibility, satisfaction, or ethical alignment—in fostering lasting environmental behaviours. Future research should investigate how narrative-based gamification and community-cantered designs can cultivate intrinsic motivations, creating deeper emotional connections with sustainability goals that encourage habitual eco-friendly practices.

Lastly, the absence of longitudinal studies poses a notable gap in understanding gamification's long-term impact on sustainable behaviour. Current literature emphasizes immediate or short-term effects, but little is known about whether gamified interactions can lead to sustained environmental habits. Longitudinal studies could provide valuable insights into whether initial engagement evolves into enduring behaviours, revealing strategies that support long-term sustainability. Additionally, future research should evaluate the scalability of gamification across various retail sectors, identifying approaches that make gamification accessible and adaptable, even for smaller retailers with limited resources.

CONCLUSION

This review underscores the significant potential of gamification to enhance environmental awareness and promote sustainable retail practices. Key gamification strategies—including rewards, social competition, personalized challenges, and educational mechanics—show positive results in fostering eco-friendly behaviours and increasing consumer engagement. The addition of advanced technologies, such as artificial intelligence and blockchain, provides new opportunities for personalized, transparent, and adaptive gamified experiences that can strengthen consumer trust in sustainable practices.

For retailers, implementing gamification thoughtfully and in alignment with environmental values offers a promising pathway to meet growing consumer expectations for sustainability while building loyalty and improving brand reputation. However, identified challenges emphasize the importance of sustainable engagement models, the balance of extrinsic and intrinsic motivators, and scalability across different retail sectors. Future research should aim to integrate gamification, environmental awareness, and retail sustainability more comprehensively, exploring how combined strategies influence long-term behaviour change and sustainability outcomes.

In conclusion, gamification presents an innovative tool to drive sustainable retail practices, foster environmental responsibility, and enhance consumer loyalty. Addressing the current gaps in gamification research through integrative and longitudinal studies will be vital to unlocking its full potential in the pursuit of sustainable retail and environmental goals, ultimately supporting a transition toward a more sustainable economy.

REFERENCES

Bai, S., & Wang, Y. (2022). Green Investment Decision and Coordination in a Retailer-Dominated Supply Chain Considering Risk Aversion. *Sustainability (Switzerland)*, *14*(20).

Barska, A., & Wojciechowska-Solis, J. (2020). E-consumers and local food products: A perspective for developing online shopping for local goods in Poland. *Sustainability (Switzerland)*, *12*(12).

Beça, P., Aresta, M., Santos, R., Veloso, A. I., & Gomes, G. (2022). Students as Game Creators. Easing the game construction process by using a toolkit to game design. *Interaction Design and Architecture(S)*, *53*, 128–143.

Behl, A., Sampat, B., Gaur, J., Pereira, V., Laker, B., Shankar, A., Shi, Y., & Roohanifar, M. (2024). Can gamification help green supply chain management firms achieve sustainable results in servitized ecosystem? An empirical investigation. *Technovation*, *129*.

Bilińska-Reformat, K., Kucharska, B., Twardzik, M., & Dolega, L. (2019). Sustainable development concept and creation of innovative business models by retail chains. *International Journal of Retail & Distribution Management*, *47*(1), 2–18.

Calitz, A., Cullen, M., & Odendaal, F. (2020). Creating Environmental Awareness using an Eco-Feedback Application at a Higher Education Institution. *Southern African Journal of Environmental Education*, *36*(2).

Cao, D., Li, J., Liu, G., & Mei, R. (2021). Can decentralization drive green innovation? A game theoretical analysis of manufacturer encroachment selection with consumer green awareness. *Processes*, *9*(6).

Cao, X., Hu, M., Wen, H., & Huang, K. (2024). Green supply chain decision-making and coordination considering consumer's environmental mindset and fairness concerns in the context of sustainable development. *Environment, Development & Sustainability*, *26*(11), 28485–28517.

Capellán-Pérez, I., Álvarez-Antelo, D., & Miguel, L. J. (2019). Global sustainability crossroads: A participatory simulation game to educate in the energy and sustainability challenges of the 21st century. *Sustainability (Switzerland)*, *11*(13).

Chang, H. H., & Su, J. W. (2022). Sustainable consumption in Taiwan retailing: The impact of product features and price promotion on purchase behaviors toward expiring products. *Food Quality and Preference*, *96*.

Chen, M., & Bashir, R. (2022). Role of e-commerce and resource utilization for sustainable business development: goal of economic recovery after Covid-19. *Economic Change & Restructuring*, *55*(4), 2663–2685.

Chen, Y. (2024). Gaining in Giving: Unveiling Continuous Engagement Intentions with the Chinese Pro-Environmental Gamification Ant Forest. *International Journal of Human-Computer Interaction*, 1–17.

Cheng, K. M., Koo, A. C., Mohd Nasir, J. S., & Wong, S. Y. (2021). Playing Edcraft at Home: Gamified Online Learning for Recycling Intention during Lockdown. *F1000Research*, *10*.

Dey, B. K., Seok, H., & Chung, K. (2024). Optimal Decisions on Greenness, Carbon Emission Reductions, and Flexibility for Imperfect Production with Partial Outsourcing. *Mathematics (2227-7390)*, *12*(5), 654.

Dietl, M., Voigt, S., & Kuhn, H. (2024). From rush to responsibility: Evaluating incentives on online fashion customers' willingness to wait. *Transportation Research Part D: Transport and Environment*, *133*.

Esmaeili, H., & Thwaites, H. (2021). Addressing environmental awareness through immersive VR experiences, gamification and hypothetical scenario development. *Virtual Creativity*, *11*(2), 223–236.

Etheredge, C. L., & Waliczek, T. M. (2020). Perceptions of Environmental Health and Willingness to Compost Fresh Cut Floral Waste by Retail Flower Shop Owners. *HortTechnology*, *30*(6), 751–760.

Etheredge, C. L., Waliczek, T. M., & Delprince, J. (2024). Comparison of United States Consumers' Perceptions and Willingness to Pay for Sustainable Environmental Practices in the Retail Floral Industry Based on Geographical Regions. *HortTechnology*, *34*(3), 241–251.

Feltrero, R., Junguitu-Angulo, L., & Osuna-Acedo, S. (2023). Deploying SDG Knowledge to Foster Young People's Critical Values: A Study on Social Trends about SDGs in an Educational Online Activity. *Sustainability*, *15*(8).

Fogelholm, M., Vepsäläinen, H., Meinilä, J., McRae, C., Saarijärvi, H., Erkkola, M., & Nevalainen, J. (2024). The dynamics in food selection stemming from price awareness and perceived income adequacy: a cross-sectional study using 1-year loyalty card data. *The American Journal of Clinical Nutrition*, *119*(5), 1346–1353.

Franco, A. (2020). Balancing user comfort and energy efficiency in public buildings through social interaction by ICT systems. *Systems*, *8*(3), 1–16.

Froehlich, J. E. (2014). GAMIFYING GREEN: GAMIFICATION AND ENVIRONMENTAL SUSTAINABILITY. In S. P. Walz & S. Deterding (Eds.), *The Gameful World: Approaches, Issues, Applications* (pp. 563–596). The MIT Press.

Golnar, M., & Beškovnik, B. (2023). Green Perspective of General Container Service vs. Dedicated Container Service from Asia to Northern Adriatic. *Nase More*, *70*(4), 202–209.

Goodman-Smith, F., Bhatt, S., Grasso, S., Deutsch, J., & Mirosa, M. (2023). Consumer acceptance of upcycled craft beer: a New Zealand case study. *Frontiers in Nutrition*, *10*.

Görçün, Ö. F., Aytekin, A., & Korucuk, S. (2023). Fresh food supplier selection for global retail chains via bipolar neutrosophic methodology. *Journal of Cleaner Production*, *419*.

Hernández-Pérez, M., Pérez-Sirvent, C., Martínez Sánchez, M.-J., & Jordán González, E. (2023). Visualizing Climate Change through LIFE-AMDRYC4: A VR Mobile-Based Video Game to Educate Adult Audiences on Sustainable Agricultural Practices. *Applied Environmental Education and Communication*, *22*(2), 91–106.

Hsu, C.-L. (2022). Applying cognitive evaluation theory to analyze the impact of gamification mechanics on user engagement in resource recycling. *Information and Management*, *59*(2).

Huang, M., Mohamad Saleh, M. S., & Zolkepli, I. A. (2023). The Moderating Effect of Green Advertising on the Relationship between Gamification and Sustainable Consumption Behavior: A Case Study of the Ant Forest Social Media App. *Sustainability (Switzerland)*, *15*(4).

Huang, W. S., Kuo, H. Y., Tung, S. Y., & Chen, H. S. (2020). Assessing Consumer Preferences for Suboptimal Food: Application of a Choice Experiment in Citrus Fruit Retail. *Foods*, *10*(1), 15.

Insley, V., & Nunan, D. (2014). Gamification and the online retail experience. *International Journal of Retail & Distribution Management*, *42*(5), 340–351.

Janssens, K., Lambrechts, W., Van Osch, A., & Semeijn, J. (2019). How consumer behavior in daily food provisioning affects food waste at household level in the Netherlands. *Foods*, *8*(10).

Jiang, L., Chen, Y., Wang, X., Guo, W., Bi, Y., Zhang, C., Wang, J., & Li, M. (2022). New insights explain that organic agriculture as sustainable agriculture enhances the sustainable development of medicinal plants. *Frontiers in Plant Science*, *13*.

Kakadellis, S., Woods, J., & Harris, Z. M. (2021). Friend or foe: Stakeholder attitudes towards biodegradable plastic packaging in food waste anaerobic digestion. *Resources, Conservation & Recycling*, *169*.

Karagiannopoulos, P. S., Manousakis, N. M., & Psomopoulos, C. S. (2024). "3R" Practices Focused on Home Appliances Sector in Terms of Green Consumerism: Principles, Technical Dimensions, and Future Challenges. *IEEE Transactions on Consumer Electronics, Consumer Electronics, IEEE Transactions on, IEEE Trans. Consumer Electron*, *70*(1), 96–107.

Koers, L., Steffens, S., Tamerus, S., & Forslund, H. (2024). Product-as-a-service from B2C retailers' perspective: a framework of challenges and mitigations. *International Journal of Retail & Distribution Management*, *52*(13), 62–78.

Li, Q., Watts, E. M., & Zhu, C. (2024). Retail investors and ESG news. *Jacobs Levy Equity Management Center for Quantitative Financial Research Paper*.

Liu, C., & Jiang, M. (2024). Green Messaging in the Fast-Food Industry: The Role of Responsibility, Obligation, and Values in Driving Eco-Conscious Behavior. *Sustainability (Switzerland)*, *16*(19).

Liu, L., Wu, C., Zhao, Q., & Wang, L. (2024). Research on pricing strategies for competitive green supply chain based on corporate social responsibility. *RAIRO: Operations Research (2804-7303)*, *58*(4), 3569–3596.

Zi-Yu Liu, Shaikh, Z. A., & Gazizova, F. (2020). Using the Concept of Game-Based Learning in Education. *International Journal of Emerging Technologies in Learning*, *15*(14), 53–64.

Lopes, L., Soares, S., Schreurs, S., & Licour, C. (2024). Developing competencies through flow, gamification and cultural integration: an analysis of the potential of games in teaching/learning. *Radiation Effects and Defects in Solids*, *179*(1–2), 3–13.

Majhi, R. (2022). Behavior and perception of younger generation towards green products. *Journal of Public Affairs*, *22*(1).

Man, L. I., Abdullah, Z., Syed Alsagoff, S. A., & Ibrahim, R. (2024). Fostering CSR Sponsorship in China: A Conceptual Framework for Cultivating Sustainable Behavior among Ant Forest App Users via Internet Platforms. *IBIMA Business Review*, *2024*.

Marín-García, A., Gil-Saura, I., & Ruiz-Molina, M.-E. (2022). Do innovation and sustainability influence customer satisfaction in retail? A question of gender. *Economic Research-Ekonomska Istrazivanja*, *35*(1), 546–563.

Marín-García, A., Gil-Saura, I., Ruiz-Molina, M.-E., & Fuentes-Blasco, M. (2023). Relationship sustainability-store equity across segments of retail customers. *International Journal of Retail & Distribution Management*, *51*(3), 366–385.

Mastamet-Mason, A., & More, C. J. M. (2023). Perceived Environmental Implications of Clothing Maintenance Among Consumers in Gauteng Province, South Africa. *Academic Journal of Interdisciplinary Studies*, *12*(2), 105–125.

Mei, B., & Yang, S. (2019). Nurturing environmental education at the tertiary education level in China: Can mobile augmented reality and gamification help? *Sustainability (Switzerland)*, *11*(16).

Merlino, V. M., Borra, D., Bargetto, A., Blanc, S., & Massaglia, S. (2020). Innovation towards sustainable fresh-cut salad production: Are Italian consumers receptive? *AIMS Agriculture and Food*, *5*(3), 365.

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ: British Medical Journal*, *339*(7716), 332–336.

Mulcahy, R. F., McAndrew, R., Russell-Bennett, R., & Iacobucci, D. (2021). "Game on!" Pushing consumer buttons to change sustainable behavior: a gamification field study. *European Journal of Marketing*, *55*(10), 2593–2619.

Novo, C., Zanchetta, C., Goldmann, E., & de Carvalho, C. V. (2024). The Use of Gamification and Web-Based Apps for Sustainability Education. *Sustainability (Switzerland)*, *16*(8).

Pal, B., Mandal, A., & Sana, S. S. (2024). A closed-loop green supply chain with retailers' competition and product recycling in the green environment under the cap-and-trade policy. *Green Finance*, *6*(1), 117–161.

Pavlenko, T., Argyropoulos, D., Arnoult, M., Engel, T., Gadanakis, Y., Griepentrog, H. W., & Paraforos, D. S. (2024). Stimulating awareness of Precision Farming through gamification: The Farming Simulator case. *Smart Agricultural Technology*, *9*(100529-).

Phang, I. G., K.P.D. Balakrishnan, B., & Ting, H. (2021). Does sustainable consumption matter? Consumer grocery shopping behaviour andthe pandemic. *Journal of Social Marketing*, *11*(4), 507–522.

Pivec, M., & Hsu, J. L. (2020). Motivation for change gamification as a tool for supporting sustainable behaviour. *Traditiones*, *49*(1), 93–108.

Polo Peña, A. I., Fernández Ruano, M. L., & Frías Jamilena, D. M. (2024). The Role of Gamified Environmental Interpretation in Boosting Destination Perceived Value. *Tourism & Management Studies*, *20*(2), 55–68.

Prajapati, D., Dipen, P., Malik, S., & Mishra, D. K. (2021). Understanding the preference of individual retail investors on green bond in India: An empirical study. *Investment Management & Financial Innovations*, *18*(1), 177–189.

Rai, H. B. (2023). Urban warehouses as good neighbors: Findings from a New York City case study. *Transportation Research Interdisciplinary Perspectives*, *19*.

Relvas, T., Mariano, P., Santana, P., & Almeida, S. M. (2024). A serious game for raising air pollution perception in children. *Journal of Computers in Education*.

Riar, M., Morschheuser, B., Zarnekow, R., & Hamari, J. (2022). Gamification of cooperation: A framework, literature review and future research agenda. *International Journal of Information Management*, *67*.

Ricoy, M.-C., & Sánchez-Martínez, C. (2022). Raising Ecological Awareness and Digital Literacy in Primary School Children through Gamification. *International Journal of Environmental Research and Public Health*, *19*(3).

Rodríguez, I., Puig, A., Tellols, D., & Samsó, K. (2020). Evaluating the effect of gamification on the deployment of digital cultural probes for children. *International Journal of Human - Computer Studies*, *137*.

Rosmadi, A., Zhou, W., & Xu, Y. (2024). Meaningful Gamification in Ecotourism: A Study on Fostering Awareness for Positive Ecotourism Behavior. *Sustainability (Switzerland)*, *16*(19).

Saarijärvi, H., Närvänen, E., Nevalainen, J., Sparks, L., Erkkola, M., & Fogelholm, M. (2024). From transactions to transformations: exploring transformative food retailing. *International Review of Retail, Distribution and Consumer Research*, *34*(1), 104–121.

Schinkel, J. (2019). Review of policy instruments and recommendations for effective food waste prevention. *Proceedings of Institution of Civil Engineers: Waste and Resource Management*, *172*(3), 92–101.

Sailer, M., & Homner, L. (2020). The Gamification of Learning: a Meta-analysis. *Educational Psychology Review*, *32*(1), 77–112.

Shahzad, M. F., Xu, S., Rehman, O., & Javed, I. (2023). Impact of gamification on green consumption behavior integrating technological awareness, motivation, enjoyment and virtual CSR. *Scientific Reports*, *13*(1).

Sheikhi, A., Khazeni, S., Rayati, M., & Ashourizadeh, A. (2021). Bi-level equilibrium of energy retailer–smart energy hub game in integrated energy market. *IET Smart Grid*, *4*(3), 284.

Shi, P., Han, K., & Hou, R. (2023). Modeling and analysis of a sustainable supply chain with fairness concerns and green-sensitive consumer demand. *Management Decision*, *61*(5), 1298–1319.

Shiralkar, S. (2016). *It through experiential learning: Learn, deploy and adopt it through gamification*. Apress.

Sinha, R., & Chaudhuri, R. (2014). Green retailing: environmental strategies of organized retailers and competitive advantage. *International Postgraduate Business Journal*, *6*(1), 115-119.

Sipone, S., Abella-García, V., Barreda, R., & Rojo, M. (2019). Learning about sustainable mobility in primary schools from a playful perspective: A focus group approach. *Sustainability (Switzerland)*, *11*(8).

Sipone, S., Abella-García, V., Rojo, M., & Dell, olio, L. (2021). Using classcraft to improve primary school students' knowledge and interest in sustainable mobility. *Sustainability (Switzerland)*, *13*(17).

Stefańska, M., & Śmigielska, G. (2016). New Challenges Facing Retail and Marketing – Sustainable Consumption and Innovations of Trade Enterprises. *Polityki Europejskie, Finanse i Marketing*, *16(65)*.

Stock, A., Stock, O., Mönch, J., Suren, M., Koch, N. N., Rey, G. D., & Wirzberger, M. (2024). BeeLife: a mobile application to foster environmental awareness in classroom settings. *Frontiers in Computer Science*, *5*.

Summerhayes, L., Baker, D., & Vella, K. (2024). Food diversity and accessibility enabled urban environments for sustainable food consumption: a case study of Brisbane, Australia. *Humanities and Social Sciences Communications*, *11*(1).

Sun, Q., Li, Y., & Hong, A. (2024). Integrating ESG into Corporate Strategy: Unveiling the Moderating Effect of Digital Transformation on Green Innovation through Employee Insights. *Systems*, *12*(5), 148.

Tancredi, C., Presta, R., & Di Lorenzo, V. (2024). Promoting sustainable behaviors through mobile apps: SBAM design guidelines. *Multimedia Tools and Applications*, *83*(30), 74021–74052.

Thor, D., & Karlsudd, P. (2020). Teaching and Fostering an Active Environmental Awareness Design: Validation and Planning for Action-Oriented Environmental Education. *Sustainability*, *12*(8), 1–17.

Vadakkepatt, G. G., Winterich, K. P., Mittal, V., Zinn, W., Beitelspacher, L., Aloysius, J., Ginger, J., & Reilman, J. (2021). Sustainable Retailing. *Journal of Retailing*, *97*(1), 62-80.

Verza, M., Ceccacci, A., Frigo, G., Mulazzani, L., & Chatzinikolaou, P. (2024). Legumes on the Rise: The Impact of Sustainability Attributes on Market Prices. *Sustainability (Switzerland)*, *16*(7).

Vona, G. (2023). Analysis of retail customers in the field of environmentally conscious behavior with respect to home, mobility, heating and cooling, and governance. *Regional Statistics*, *13*(5), 925–950.

Wang, J., Qiao, L., Zhu, G., Di, K., & Zhang, X. (2024). Research on the driving factors and impact mechanisms of green new quality productive forces in high-tech retail enterprises under China's Dual Carbon Goals. *Journal of Retailing and Consumer Services*, *82*.

Wang, K., Tekler, Z. D., Cheah, L., Herremans, D., & Blessing, L. (2021). Evaluating the effectiveness of an augmented reality game promoting environmental action. *Sustainability (Switzerland)*, *13*(24).

Wang, M., Marsden, J., Oguz, E., & Thomas, B. (2023). Exploring Sustainable Retail Experiences: Shall We Make It Fashionable? *Sustainability (Switzerland)*, *15*(23).

Yang, H., Hu, Z., & Li, D. (2024). Exploring the effect of green gamification on users' low-carbon awareness: a cognitive dissonance perspective. *Behaviour & Information Technology*, *43*(7), 1446–1470.

Zawieska, J., Obracht-Prondzyńska, H., Duda, E., Uryga, D., & Romanowska, M. (2022). In Search of the Innovative Digital Solutions Enhancing Social Pro-Environmental Engagement. *Energies (19961073)*, *15*(14).

Zhang, D., Frei, R., Wills, G., Gerding, E., Bayer, S., & Senyo, P. K. (2023). Strategies and practices to reduce the ecological impact of product returns: An environmental sustainability framework for multichannel retail. *Business Strategy & the Environment (John Wiley & Sons, Inc)*, *32*(7), 4636–4661.

Zhao, W., Wang, A., & Chen, Y. (2019). How to maintain the sustainable development of a business platform: A case study of Pinduoduo Social Commerce Platform in China. *Sustainability (Switzerland)*, *11*(22).

Zou, H., Xiao, J., Lou, Y., Liao, D., Deng, H., & Jiang, J. (2024). A low-carbon supply chain pricing mechanism considering CSR under carbon cap-and-trade policy. *PLoS ONE*, *19*(10), 1–23.

APPENDIX

Table 3: Description of Gamification and Sustainable Retail Articles

Category	Zhao *et al.*, 2019	Malcahy *et al.*, 2021	Wang *et al.*, 2023	Saarijärvi *et al.*, 2024	Behl *et al.*, 2024
Research Title	How to Maintain the Sustainable Development of a Business Platform: A Case Study of Pinduoduo Social Commerce Platform in China	Game on! Pushing consumer buttons to change sustainable behaviour: A gamification field study	Exploring Sustainable Retail Experiences: Shall We Make It Fashionable?	From transactions to transformations: Exploring transformative food retailing	Can gamification help green supply chain management firms achieve sustainable results in servitized ecosystem?
Gamification Strategy	Social incentives, game-based interaction	Points, badges, rewards	In-store gamified experiences	Gamified engagement for brand experience	Points, rewards, gameful experiences
Sustainability Focus	Social commerce sustainability	Environmental awareness	Sustainable retail experiences	Sustainable food practices	Green supply chain management
Target Audience	Social media and e-commerce users	General consumers	Fashion consumers	Retail consumers	Supply chain employees
Industry Focus	E-commerce	Energy consumption	Fashion retail	Food retail	Supply chain and logistics
Behavioural Outcomes	Increased user engagement through gamification	Enhanced knowledge, attitudes, behavioural intentions, and bill savings	Increased store footfall, brand love	Active participation, emotional connection	Higher motivation, productivity
Challenges	Platform quality and trust issues	Cost and complexity in measuring outcomes	Consumer preferences and space limitations	Competition with online platforms	Integrating gamification with servitization
Technological Integration	Social network integration	App-based gamification with analytics	In-store tech for sensory engagement	Integration with online & physical platforms	Digital tech like AI and Blockchain
Long-term Impact	Strengthened user loyalty through sustained interaction	Improved sustainable behaviours across energy usage	Reinforced brand loyalty	Enhanced in-store engagement and loyalty	Improved environmental and operational outcomes

Table 4: Description of Gamification and Environmental Awareness Articles

Research Title	Author & Year	Types of Gamification Strategies Used	Impact on Engagement and Environmental Awareness	Target Audience of Strategies	Platforms or Tools Used	Challenges and Limitations of Gamification	Success Factors and Long-Term Impact
The Role of Gamified Environmental Interpretation in Boosting Destination Perceived Value	Polo Peña *et al.*,2024	Holistic design for gamified environmental interpretation	Increased engagement and perceived destination value	Tourists	ICT-based gamified environmental interpretation program	Design complexity and cost of holistic gamified experiences	Improved destination sustainability and competitiveness
Playing Edcraft at Home: Gamified Online Learning for Recycling	Cheng *et al.*, 2021	Gameful experience with online learning modules (Edcraft)	Enhanced recycling intention and motivation among youth	Youth (students)	Edcraft online learning platform	Limited by lockdown constraints and brief engagement period	Enhanced long-term recycling behaviours

Intention during Lockdown							
Fostering CSR Sponsorship in China: A Conceptual Framework for Cultivating Sustainable Behavior among Ant Forest App Users	Li *et al*., 2024	Gamified CSR via social rewards and incentives (Ant Forest App)	Raised sustainable behaviour awareness	Ant Forest App users (general public)	Ant Forest mobile app	Balancing CSR goals with user engagement; technical limitations	Increased sustainable behaviour and CSR commitment
Applying cognitive evaluation theory to analyze the impact of gamification mechanics on user engagement in resource recycling	Hsu, 2022	Gamification mechanics for need satisfaction (self-presentation, points, competition)	Positive impact on intrinsic motivation and recycling engagement	Taiwan residents	Recycle bank website	Need satisfaction not equally impactful for all users	Positive reinforcement of recycling behaviour; effective rewards
Evaluating the effect of gamification on the deployment of digital cultural probes for children	Rodríguez *et al*., 2020	Role-play, narrative, and reward-based tasks	Moderate increase in children¶€s awareness about energy use	Primary school children	Digital Cultural Probe app	Non-significant differences between gamified and non-gamified versions	Moderate improvement in energy awareness in children
Stimulating awareness of Precision Farming through gamification: The Farming Simulator case	Pavlenko *et al*., 2024	Serious game (Farming Simulator) with precision farming features	Increased awareness and adoption interest in precision farming	Students, scientists, general public	Farming Simulator video game	Lack of sustained engagement; potential knowledge gaps	Potential for knowledge transfer in precision farming
Students as game creators: easing the game construction process by using a toolkit to game design	Beca *et al*., 2022	Toolkit-based game creation for environmental education	Increased engagement in game design and environmental awareness	Upper-secondary and undergraduate students	Gamers4Nature Toolkit	Skill limitations among students; need for accessible design tools	Engagement in game design and environmental education

Creating Environmental Awareness using an Eco-Feedback Application at a Higher Education Institution	Calitz, Cullen, & Odendaal (2020)	Eco-feedback and behavioural change theory	Increased awareness on campus environmental impact	Higher education students	Eco-feedback application	Limited engagement beyond app use	Sustainable behaviours encouraged on campus
Developing competencies through flow, gamification and cultural integration	Lopes *et al.*, 2024	Flow-based gamification with escape room-style game	Improved learning motivation and social integration	University and high school students	Escape room-style digital game	Need for technological adaptation and cultural integration	Developed competencies for environmental careers
In Search of the Innovative Digital Solutions Enhancing Social Pro-Environmental Engagement	Zawiesk a, 2022	Green digital solutions and gamified nudges	Enhanced urban climate resilience engagement	Urban residents	Digital app concept for green cities	Difficulty in sustaining social participation	Built climate resilience in urban populations
Exploring the effect of green gamification on users' low-carbon awareness: a cognitive dissonance perspective	Yang *et al.*, (2024)	Green gamification (visibility of achievements, competition, interactivity)	Increased low-carbon awareness and cognitive dissonance	General public using green apps	Ant Forest (green gamification app)	Variation in user cognitive dissonance and engagement levels	Sustained awareness and behaviour change in users
BeeLife: a mobile application to foster environmental awareness in classroom settings	Stock *et al.*, 2024	Gamified levels and nature-based activities	Increased engagement in environmental awareness activities	Children aged 9-12	Mobile app for classroom use	Classroom integration challenges and limited reach	Enhanced knowledge retention in children
Gaining in Giving: Unveiling Continuous Engagement Intentions with the Chinese	Chen, 2024	Gamified environmental contributions (rewards for eco-friendly tasks)	High continuous engagement and pro-environmental habits	Alipay users in China	Ant Forest platform	Complex motivations; not all users are equally engaged	Pro-environmental habits encouraged through rewards

Pro-Environmental Gamification Ant Forest							
Addressing Environmental Awareness through Immersive VR Experiences, Gamification, and Hypothetical Scenario Development	Esmaeili & Thwaites ,2021	Immersive VR experiences with hypothetical scenarios	Raised awareness and immersive impact on environmental issues	General public and event attendees	VR setup with interactive scenarios	Effectiveness dependent on user immersion and engagement levels	Effective in raising impactful environmental awareness
Motivation for Change: Gamification as a Tool for Supporting Sustainable Behaviour	Pivec & Hsu, 2020	Co-creation workshops, interviews, and game mechanics	Encouraged sustainable behaviours through awareness and co-creation	Mixed cultural groups, primary and secondary school students	Workshops and interviews with game components	Cultural adaptation of gamification elements and engagement continuity	Development of culturally specific sustainable habits
DoItRight: An Arabic Gamified Mobile Application to Raise Awareness about the Effect of Littering among Children	Alfahid *et al.*,2021	Gamified mobile application for children focusing on rewards for anti-littering behaviours	Increased awareness among children on littering impacts	Children aged 6-12	DoItRight mobile app	Technical limitations for interaction and app adaptability	Increased awareness and long-term eco-friendly habits in children
Promoting sustainable behaviors through mobile apps: SBAM design guidelines	Tancredi *et al.*, 2024	Mobile app design with gamified nudges for sustainable habits	Enhanced pro-environmental behaviours via mobile app nudges	General public using mobile applications	SBAM (Sustainable Behaviour Applications for Mobile) guidelines and app prototype	Sustained motivation and scalability of app usage	Sustained engagement through app-guided habits
A serious game for raising air pollution perception in children	Relvas *et al.*, 2024	Serious game about air pollution monitoring with customizable features	Improved air pollution perception and environmental responsibility	Children aged 7-9 in elementary schools	Problems in the Air game (Unity)	Technical constraints in school settings and limited reach	Enhanced knowledge of air pollution impacts
Impact of gamification on	Shahzad *et al.*, 2023	Gamification with rewards,	Promoted green consumptio	University students in China	Green consumption app for	Variable motivation levels and	Increased technological awareness

green consumption behavior integrating technological awareness, motivation, enjoyment and virtual CSR		points, and competition for green consumption behaviour	n behaviour among university students		university students	technological awareness among students	and eco-friendly behaviours
Raising Ecological Awareness and Digital Literacy in Primary School Children through Gamification	Ricoy & Sanchez-Martinez ,2022	Gamified educational interventions with digital tools for ecological habits	Enhanced ecological awareness and digital literacy in primary school children	Primary school children in Spain	Tablets and educational gamification tools	Need for family involvement and continued ecological habits outside school	Long-term retention of ecological habits and improved digital literacy
Using ClassCraft to Improve Primary School Students' Knowledge and Interest in Sustainable Mobility	Sipone *et al.*, 2021	ClassCraft platform with environmental, economic, and social activities	Increased knowledge and interest in sustainable mobility	Primary school students	ClassCraft platform	Limited focus on economic and social dimensions	Improved sustainability knowledge across domains
Evaluating the Effectiveness of an Augmented Reality Game Promoting Environmental Action	Wang *et al.*, 2021	Augmented reality game with geolocation features	Improved climate change awareness and sustainable behaviours	General public	PEAR AR game	Technical limitations and user misconceptions	Behavioural change toward climate action
The Moderating Effect of Green Advertising on the Relationship between Gamification and Sustainable Consumption Behavior	Huang *et al.*, 2023	Gamification with green advertising and social media app (Ant Forest)	Mixed effects on sustainable consumption; moderated by advertising	Chinese youth (Ant Forest app users)	Ant Forest social media app	Lack of connection between gamification and sustainable behaviour	Potential for increased green consumption
Deploying SDG Knowledg	Feltrero *et al.*, 2023	Online educational tool	Enhanced critical thinking on	Young Europeans	BotBusters educational tool	Complexity of SDGs and	Enhanced SDG understandi

e to Foster Young People's Critical Values: A Study on Social Trends about SDGs in an Educational Online Activity		focused on SDG knowledge and news verification	SDGs among young Europeans			user engagement	ng and responsible behaviour
The Use of Gamification and Web-Based Apps for Sustainability Education	Novo *et al.*, 2024	Gamified web app for ecological behaviour (GoBeEco)	Bridged awareness-action gap in sustainability habits	General public in Portugal	GoBeEco web app	Sustained behaviour change requires continual app usage	Positive impact on personal ecological behaviours
Meaningful Gamification in Ecotourism: A Study on Fostering Awareness for Positive Ecotourism Behavior	Rosmadi *et al.*, 2024	Meaningful gamification model (mGEECO) for ecotourism	Increased ecotourism responsibility and positive environmental intentions	Ecotourists in China	mGEECO model for ecotourism	Diverse motivations among ecotourists; difficulty in measuring long-term impact	Increased environmental responsibility among tourists
Learning about Sustainable Mobility in Primary Schools from a Playful Perspective: A Focus Group Approach	Sipone *et al.*, 2019	Gamified activities designed around sustainable mobility in schools	Broadened understanding of social and economic mobility aspects	Primary school students in Spain	Focus group and gamified learning tools	Inconsistent student engagement in social aspects	Engagement in sustainability topics and practices
Global Sustainability Crossroads: A Participatory Simulation Game to Educate in the Energy and Sustainability Challenges of the 21st Century	Capellian-Perez *et al.*, 2019	Participatory simulation game for global sustainability (MEDEAS-World model)	Raised awareness of energy and sustainability issues	General population (workshop participants)	Global Sustainability Crossroads game	Cognitive overload; complexity of simulation content	Enhanced understanding of sustainability challenges

Nurturing Environmental Education at the Tertiary Education Level in China: Can Mobile Augmented Reality and Gamification Help?	Mei & Yang, 2019	Geolocation-based mobile AR scavenger hunt	Enhanced environmental awareness in tertiary students	Tertiary education students	Mobile AR scavenger hunt	Initial resistance to AR technology in education	Promoted sustainable habits and ecological awareness
Teaching and Fostering an Active Environmental Awareness: Design, Validation, and Planning for Action-Oriented Environmental Education	Thor & Karlsudd, 2020	Gamification through digital tokens for environmental awareness	Active engagement in climate and environmental awareness	School children in Sweden	Environmental citizen tokens	Challenges in maintaining student interest	Encouragement of active environmental citizenship
Using the Concept of Game-Based Learning in Education	Liu *et al*., 2020	Game-based learning with video games and interactive elements	Increased motivation and engagement in educational content	Primary school students	Digital video games and learning applications	Potential negative cognitive effects and complex game design requirements	Enhanced learning outcomes and sustained interest in game-based learning
Visualizing Climate Change through LIFE-AMDRYC4: A VR Mobile-Based Video Game	Hernandez-Perez *et al*.,2023	VR-based video game with decision-making for sustainable agricultural practices	Enhanced awareness and critical thinking about climate change and agriculture	Adult audiences in agriculture and environmental fields	Mobile VR application (LIFE-AMDRYC4)	Technical limitations in VR implementation and varying user engagement	Promoted sustainable agricultural practices and environmental awareness
Balancing User Comfort and Energy Efficiency in Public Buildings through Social Interaction by ICT Systems	Franco, 2020	ICT-based gamification with social interaction for energy-saving behaviour	Raised user responsibility for energy use and comfort in buildings	Public building occupants	ICT platforms with user feedback systems for energy management	Conflicting goals between energy efficiency and user comfort	Encouraged energy-efficient behaviours and heightened user accountability in energy use

Table 5: Sustainable Retail and Environmental Awareness Articles

Research Title	**Author & Year**	**Types of Retail Businesses and Sustainability Practices**	**Environmental Awareness Campaigns and Customer Engagement**	**Outcomes and Impact of Sustainable Practices**	**Challenges and Success Factors**	**Future Goals and Long-Term Trends**
3R Practices Focused on Home Appliances Sector in Terms of Green Consumerism: Principles, Technical Dimensions, and Future Challenges	Karagiannopoulos *et al*., 2024	Home appliances sector implementing 3R (Reduce, Reuse, Recycle) practices	Consumer education on recycling and sustainable use of home appliances	Enhanced green consumerism and adoption of 3R principles among consumers	Consumer participation in recycling and adherence to green practices	Long-term adoption of sustainable home appliance use and waste reduction
A Low-Carbon Supply Chain Pricing Mechanism considering CSR under carbon cap-and-trade policy	Zou *et al*., 2024	Supply chain optimization to lower carbon emissions and implement sustainable pricing	Awareness programs emphasizing carbon reduction in supply chain choices	Lower carbon emissions and improved transparency in pricing	Balancing economic viability with environmental sustainability in pricing	Achieving long-term carbon neutrality through low-carbon pricing mechanisms
Analysis of Retail Customers in the Field of Environmentally Conscious Behavior with respect to home, mobility, heating and cooling, and governance	Vona, 2023	Environmentally conscious behaviour in retail customers	Energy-efficient behaviours encouraged	Eco-aware choices in home energy use	Regional economic factors affecting eco-behaviour	Focused campaigns on eco-awareness
Assessing Consumer Preferences for Suboptimal Food: Application of a Choice Experiment in Citrus Fruit Retail	Huang *et al*., 2021	Suboptimal food retail in citrus fruit	Campaigns promoting discounted pricing for imperfect produce	Increased willingness to buy suboptimal foods when discounted	Consumer preferences for appearance and freshness; need for clear labelling	Encourage buying suboptimal foods to reduce waste
Bi-level Equilibrium of Energy Retailer Smart Energy Hub Game in Integrated Energy Market	Sheikhi *et al*., 2021	Smart energy hubs in energy retail	Consumer choices impacting energy use	Sustainable energy market configurations	High cost of smart energy infrastructure	Enhanced smart energy systems for retail

Can Decentralization Drive Green Innovation? A Game Theoretical Analysis of Manufacturer Encroachment Selection with Consumer Green Awareness	Cao *et al*., 2021	Green supply chain in decentralized structures	Consumer awareness driving innovation	Decentralized models increase innovation	Trade-offs in decentralized green strategies	Sustainable models in decentralized chains
Comparison of United States Consumers' Perceptions and Willingness to Pay for Sustainable Practices in Floral Retail Industry Based on Geographical Regions	Etheredge *et al*., 2024	Floral retail using local sourcing and composting to promote sustainability	Regional marketing highlighting eco-friendly practices to increase awareness	Increased willingness to pay for sustainable attributes in floral retail	Varied willingness to pay depending on region and demographic factors	Expansion of fair-trade and composting practices in floral retail
Consumer acceptance of upcycled craft beer: a New Zealand case study	Goodman-Smith *et al*., 2023	Upcycled food, using surplus food for craft beer production	Awareness campaigns on environmental benefits of upcycling, in-store promotions	Increased acceptance of upcycled products	Taste and price remain challenges; in-store promotions enhance acceptance	Promote upcycled products as a sustainable food option
Do Innovation and Sustainability Influence Customer Satisfaction in Retail?	Marin-Garcia *et al*., 2022	Various retail sectors combining innovation and sustainable practices to boost customer satisfaction	Gender-sensitive campaigns targeting satisfaction with sustainability efforts	Increased customer satisfaction tied to sustainable innovations	Diverse customer needs based on gender affecting satisfaction outcomes	Gender-sensitive approaches in sustainable and innovative retail practices
Does sustainable consumption matter? Consumer grocery shopping behaviour and the pandemic	Phang *et al*., 2021	Grocery retail focusing on sustainable consumption behaviours (SCBs)	Campaigns around responsible and mindful consumption during COVID-19	Increased awareness and shifts in purchasing behaviour during the pandemic	Behavioural shifts influenced by crisis; limitations in consistent engagement	Build resilience in consumer sustainable consumption habits
E-Consumers and Local Food Products: A Perspective for Developing	Barska & Wojciechowska-Solis, 2020	Online shopping for local food in Poland	Promotion of local food with low environmental impact	Increased access to local food through e-commerce	High prices and low consumer awareness	Growth of online local food markets in Poland

Online Shopping for Local Goods in Poland						
Food diversity and accessibility enabled urban environments for sustainable food consumption: a case study of Brisbane, Australia	Summerhayes *et al*., 2024	Urban food retail environment diversification	Campaigns on sustainable food consumption through urban accessibility and diversity	Improved access to affordable and nutritious food	Limited retail options and accessibility challenges in urban areas	Transform urban environments to support sustainable consumption
Friend or foe: Stakeholder attitudes towards biodegradable plastic packaging in food waste anaerobic digestion	Kakadellis *et al*., 2021	Food packaging sector using biodegradable plastic for circular waste management	Engagement with stakeholders on biodegradable packaging and its compatibility with waste digestion systems	Mixed attitudes towards biodegradable plastics' compatibility with current waste processing infrastructure	Infrastructure limitations in anaerobic digestion systems and varying stakeholder support	Potential for legislative support and public education to increase biodegradable packaging acceptance
Green Investment Decision and Coordination in a Retailer-Dominated Supply Chain Considering Risk Aversion	Bai & Wang, 2022	Green investments in a retailer-led supply chain	Green supply chain practices to increase awareness	Increased consumer surplus and improved social welfare	Risk aversion and cost-sharing models for green investment	Expansion of green investments with risk reduction strategies
Green Messaging in the Fast-Food Industry: The Role of Responsibility, Obligation, and Values	Liu & Jiang, 2024	Fast-food retail with sustainable packaging	Social media campaigns highlighting responsibility and obligation	Enhanced eco-conscious behaviour among fast-food customers	Balancing sustainability with fast-food convenience expectations	Promote sustainable packaging and reduce single-use plastics
Green Perspective of General Container Service vs. Dedicated Container Service from Asia to Northern Adriatic	Golnar & Beskovnik, 2023	Container shipping with focus on green logistics for retail supply chains	Awareness initiatives targeting sustainable logistics in container shipping	Reduced greenhouse gas emissions through optimized container shipping	Operational efficiency versus carbon footprint in container logistics	Expansion of green logistics models and energy-efficient container shipping
Green Supply Chain Decision-making and Coordination Considering	Cao *et al*., 2024	Green supply chain management	Greenness levels affecting demand	Cost-sharing improves green cooperation	Fairness in profit distribution for greenness	Balanced green supply chain contracts

Consumer's Environmental Mindset and Fairness concerns in the context of sustainable development						
How Consumer Behavior in Daily Food Provisioning Affects Food Waste at Household Level in The Netherlands	Janssens *et al*., 2019	Household-level food retail and grocery management	Campaigns on reducing food waste and responsible household provisioning	Reduction in household food waste	Consumer purchasing habits drive waste; need for more awareness programs	Promote food planning practices to reduce waste
Innovation towards sustainable fresh-cut salad production: Are Italian consumers receptive?	Merlino *et al*., 2020	Fresh-cut salad production adopting sustainable and local sourcing	Communication on sustainability of fresh-cut salads through packaging	Increased consumer preference for sustainable fresh-cut products	Disparity between consumer preferences and sustainability claims by producers	Increase in consumer awareness towards sustainable and locally sourced food
Integrating ESG into Corporate Strategy: Unveiling the Moderating Effect of Digital Transformation on Green Innovation	Sun *et al*., 2024	Corporate ESG with digital transformation	Employee insights on ESG and innovation	Enhanced green innovation through ESG	Balancing ESG and digital innovation costs	Increased integration of ESG with digital
Legumes on the Rise: The Impact of Sustainability Attributes on Market Prices	Verza *et al*.,2024	Market for sustainable legumes in Italy	Organic certification and origin labelling for legumes	Higher prices for sustainable food attributes in legumes	Consumer preference varies with sustainability attributes	Enhanced market competitiveness for sustainable food in Italy
Modeling a Sustainable Supply Chain with Fairness and Green Consumer Demand	Shi *et al*., 2023	Retail supply chain management emphasizing fair pricing and green production	Awareness efforts on fair pricing and environmentally friendly options	Greater consumer satisfaction and loyalty towards green products	Balancing fairness with profitability in sustainable supply chains	Enhanced fair trade and green supply chain transparency
Optimal Decisions on Greenness, Carbon Emission Reductions, and Flexibility for Imperfect Production with Partial Outsourcing	Dey *et al*., 2024	Eco-friendly production with partial outsourcing	Eco-friendly product preferences	Higher profits with green flexibility	Imperfect production leading to rework needs	Higher adoption of eco-friendly production

Perceptions of Environmental Health and Willingness to Compost Fresh Cut Floral Waste by Retail Flower Shop Owners	Etheredge & Waliczek, 2020	Floral retail focused on composting floral waste	Collaboration with Master Gardener programs for composting initiatives	Increased composting adoption among floral shops	Education on composting benefits; need for certification programs	Encourage composting practices within floral industry
Product-as-a-service from B2C Retailers' Perspective: A Framework of Challenges and Mitigations	Koers *et al*., 2024	Product-as-a-service for B2C retailers	Service-based retail challenges	Mitigation strategies for service products	High costs of B2C service transition	Wider B2C service adoption in retail
Research on Pricing Strategies for Competitive Green Supply Chain Based on Corporate Social Responsibility	Liu *et al*., 2024	Competitive supply chain with CSR focus	CSR influence on green product demand	CSR-driven retail strategies benefit sales	Intense competition affects pricing strategies	Enhanced CSR adoption in competitive markets
Review of Policy Instruments for Effective Food Waste Prevention	Schinkel, 2019	Food retail implementing policies aimed at reducing food waste	Public campaigns on food waste prevention targeting retailers and consumers	Reduced food waste and improved resource efficiency	Diverse regional policies impact uniform food waste reduction success	Global alignment on food waste policies and consumer education
Role of E-commerce and Resource Utilization for Sustainable Business Development: goal of economic recovery after Covid-19	Chen & Bashir, 2022	E-commerce for sustainable recovery	Digital channels enhancing eco-awareness	Increased multi-channel retail adoption	High demand on digital infrastructure	Permanent digital shift in retail post-COVID
Strategies and practices to reduce the ecological impact of product returns: An environmental sustainability framework for multichannel retail	Zhang *et al*., 2023	Multichannel retail managing sustainable returns	Consumer education on environmental impact of product returns	Reduction in ecological impact through improved returns management	High costs and logistics of sustainable returns management; need for frameworks	Develop circular economy practices for returns

Sustainable consumption in Taiwan retailing: The impact of product features and price promotion on purchase behaviors toward expiring products	Chang & Su, 2022	Taiwanese retail stores promoting discounted expiring food items to reduce waste	Discount campaigns and special expiring food areas in stores to promote purchase and reduce waste	Increased purchase intention for discounted expiring food, positively impacting food waste reduction	Consumer skepticism about the quality of expiring food; effectiveness depends on consumer awareness	Enhancing public understanding of suboptimal food safety and expiration practices in retail
The dynamics in food selection stemming from price awareness and perceived income adequacy	Fogelholm *et al*., 2024	Grocery retail with a focus on sustainable food selection linked to income adequacy	Use of loyalty card data to study price sensitivity and food choices in response to sustainable pricing	Lower-income customers more price-aware but less likely to select healthier food groups	Economic constraints limit access to healthier, environmentally friendly foods among lower-income groups	Consider pricing adjustments to support affordable sustainable diets for low-income groups
Understanding the Preference of Individual Retail Investors on Green Bond in India: An Empirical Study	Prajapati *et al*., 2021	Green bonds for sustainable investments	Influences of ESG rating and tax incentives	Improved investor interest in green bonds	Low investor awareness of green bonds	Growth in green investment awareness
Urban warehouses as good neighbors: Findings from a New York City case study	Rai, 2023	Urban warehousing for proximity logistics in e-commerce	Community engagement for urban warehouse integration with local neighbourhoods	Improved urban quality of life with sustainable urban warehouse practices	Balancing logistics efficiency with neighbourhood compatibility	Advancement of proximity logistics for sustainable urban retail delivery
A closed-loop green supply chain with retailers' competition and product recycling in the green environment under the cap-and-trade policy	Pal *et al*., 2024	Competitive green supply chain with product recycling	Recycling incentives and buy-back programs	Increased product recovery and reduced emissions	High competition and cap restrictions	Greater focus on closed-loop models and emissions caps
Fresh food supplier selection for global retail chains via bipolar neutrosophic methodology	Gorcun *et al*., 2023	Global fresh food retail chains	Sustainable selection criteria for fresh food suppliers	Enhanced quality and sustainability in fresh food chains	Cold chain infrastructure and logistics costs	Long-term partnerships for sustainable food logistics
From rush to responsibility: Evaluating	Dietl *et al*., 2024	Online fashion retail in Germany	Incentives for eco-friendly	Reduced environmental impact	Balancing delivery speed and	Expansion of slow-delivery

incentives on online fashion customers' willingness to wait			delivery choices	via delayed deliveries	sustainability incentives	options in e-commerce
New insights explain that organic agriculture as sustainable agriculture enhances the sustainable development of medicinal plants	Jiang *et al*., 2022	Organic agriculture for medicinal plants	Promoting organic products for health and sustainability	Improved biodiversity and higher farmer income	Maintaining organic standards and economic viability	Expansion of organic agriculture for medicinal plants
Perceived Environmental Implications of Clothing Maintenance Among Consumers in Gauteng Province, South Africa	Mastamet-Mason & More, 2023	Clothing maintenance practices in South Africa	Eco-fashion and sustainable clothing maintenance awareness	Improved clothing care awareness, reduced water usage	Limited consumer knowledge on eco-friendly practices	Higher eco-awareness in clothing maintenance
Relationship sustainability -store equity across segments of retail customers	Marin-Garcia, 2023	Food retail establishments and store equity	Social sustainability and customer perception in stores	Increased store equity through social sustainability	Differentiating sustainability efforts across segments	Targeted sustainability strategies by customer segments
Research on the driving factors and impact mechanisms of green new quality productive forces in high-tech retail enterprises under China's Dual Carbon Goals	Wang *et al*., 2024	High-tech retail with green productivity focus in China	Environmental policy responses and consumer awareness	Enhanced green productivity in high-tech retail	High R&D costs and stringent environmental regulations	Sustained green productivity through policy and innovation