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E-commerce waste management: a systematic review

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ABSTRACT

This paper reviews literature on e-commerce waste management issues and challenges, focusing on potential improvements in Malaysia. It analyzes various sources, including Scopus, Web of Science (WoS), and Google Scholar (GS), using thematic and content analysis based on preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines. The review highlights the surge in packaging and electronic waste due to increased e-commerce activity. In response, Malaysia has introduced policies promoting sustainable practices, such as eco-friendly packaging, e-waste regulations, and circular economy (CE) principles. Growing consumer awareness has also driven demand for sustainable e-commerce options. However, the key challenge is to reduce waste generation rather than just managing it. Achieving this will require significant efforts to minimize excessive manufacturing and packaging. The review aims to provide insights for stakeholders to support effective waste management and foster sustainability in the e-commerce sector.

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1. INTRODUCTION

The rapid growth of e-commerce over the past decade has revolutionized retail, changing the way in which consumers interact with businesses and purchase products. Online retail continues to grow and is expected to account for 25% of the global retail market by 2026, leading to fundamental changes in consumer habits and business strategies [1]. The COVID-19 pandemic accelerated this growth as consumers sought safer and more convenient alternatives to physical stores, leading to a surge in popularity of digital shopping platforms [2]. The digital transformation of retail has brought many benefits: accessibility, flexibility, and economic opportunity, but it has also created complex environmental challenges. The sharp rise in packaging waste, energy consumption, and carbon emissions, particularly associated with e-commerce logistics, has raised serious concerns about sustainability [2]–[4].

Previous studies have analyzed the environmental impacts of e-commerce and traditional shopping, with particular attention to the significant environmental impact of packaging waste generated by online shopping. Despite growing awareness of the environmental impacts of e-commerce, waste generated by e-commerce, particularly packaging waste, remains an important and under-researched issue [3], [5], [6]. Online retailers often rely on single-use packaging, much of which is neither recyclable nor properly disposed of by consumers [3], [5]. Research has demonstrated that misinformation and confusion about recycling methods lead to improper use of packaging materials, thereby harming the environment [7], [8].

In addition, misleading sustainability labels and environmental misinformation strategies such as green-washing tactics on packaging distort consumer perceptions and undermine trust in sustainable products [9]. Although previous studies have made significant contributions to understanding these issues [2], [10]–[12], significant gaps remain in identifying and implementing effective waste management strategies, especially in different regional contexts [2], [10], [12], [13].

To fill this knowledge gap, the study focuses on the case of Malaysia, a fast-growing e-commerce market, but it has yet to address the environmental impact of digital retail development. Malaysia faces serious challenges in waste management, especially the plastic waste problem that has worsened, especially since 2017, when it became the world's largest importer of plastic waste [4]. E-commerce packaging waste management strategies in Malaysia are immature and often lack infrastructure and public awareness [4], [14]. The objective of this study is to analyze the current state of e-commerce waste management in Malaysia and propose possible solutions to reduce its environmental impact. It will concentrate on promoting sustainable packaging practices, increasing recycling rates, and reducing overall waste. This research builds on the latest research in packaging sustainability and environmental performance [2], [5], [7], [9], [12] and is intended to help policymakers, businesses, and consumers create a more sustainable e-commerce ecosystem. This study will not only help in developing regional policies but also provide a basis for other countries facing similar environmental challenges in the digital economy. The next section will discuss approaches to addressing this issue and highlight the importance of improving sustainability practices in e-commerce.

2. PROPOSED METHOD

The research method proposed in this paper is a systematic literature review, conducted in accordance with established guidelines and protocols to ensure a comprehensive and transparent assessment of existing studies. A distinctive feature of this approach is its ability to synthesize a large body of literature and provide a comprehensive analysis of the state of knowledge on a particular topic. Systematic reviews are conducted according to strict frameworks such as the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines, which provide detailed guidance on how to report, appraise, and analyze studies that propose potential interventions [15], [16]. This approach ensures a systematic, replicable, and comprehensive review process and facilitates the identification of key trends, differences, and areas of agreement in the literature.

In addition to the PRISMA framework, systematic review methods have been effectively applied across a variety of disciplines, including collaborations between researchers, industry, and universities, providing valuable information on the dynamics of collaboration [17]. A systematic approach to literature review helps identify common themes and explore different perspectives and findings. The systematic review process not only helps to synthesize existing knowledge but also identifies research gaps that require further investigation. In the context of this study, it will focus on the sustainability of packaging and its recycling practices in the Malaysian market, and help identify effective e-commerce waste management strategies.

This study is based on best practice for systematic reviews using recognized expert guidelines and methods to assure the highest quality of the review process [18]. The aim of this study is to address these academic standards [19] and provide an accurate, evidence-based understanding of the environmental impacts of e-commerce packaging and potential solutions to improve sustainability practices. This systematic approach ensures transparency, reproducibility, and reliability of research, and provides useful information for policymakers, businesses, and consumers. Ultimately, this systematic review contributes to the development of effective strategies to decrease the environmental impact of e-commerce packaging and contributes to the creation of a more sustainable digital retail ecosystem.

3. METHOD

3.1. Identification of relevant literature

A systematic database search was carried out to sort the texts of articles based on the relevance of their abstracts and the reputation of their authors. Figure 1 and Table 1 summarize the review procedure. The main search databases are Scopus, Web of Science (WoS), and Google Scholar (GS), which are among the largest directories of scientific papers, books, and congress reports. The criteria for selecting articles from publications are built on the following strategy: i) relevant issues (e-commerce, history of packaging, packaging materials, new paradigms, last innovations, and waste generation); ii) chronological order (from the late 1990s to 2022); and iii) issues and challenges. The search was performed between 28th December 2022 to 5th January 2023, without date restrictions. An initial Scopus and WoS search yielded 119 records and 69 records, respectively, with GS yielded 17 records to be screened.

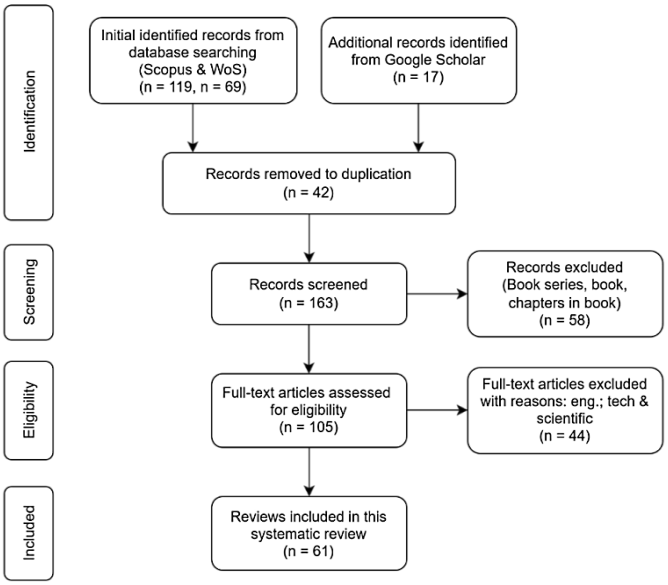

Figure 1. Flow chart of the literature review process

Table 1. The search strings

Database	Search string
Scopus	TITLE-ABS-KEY ((“e-commerce*” OR “online shopping*” OR “e-business*” OR “e-marketing*” OR “e-procurement*” OR “CRM” OR “B2B”) AND (“waste*” OR “plastic*waste*” OR “garbage*” OR “plastic*wilderness*” OR “trash*”) AND (“Asian*” OR “Southeast Asian*” OR “Malaysia” OR “Singapore” OR “Australia” OR “Thailand” OR “Indonesia” OR “India” OR “Brunei” OR “Myanmar” OR “Cambodia” OR “China” OR “Korea” OR “Taiwan”))
WoS	TS=((“e-commerce*” OR “online shopping*” OR “e-business*” OR “e-marketing*” OR “e-procurement*” OR “CRM” OR “B2B”) AND (“waste*” OR “plastic*waste*” OR “garbage*” OR “plastic*wilderness*” OR “trash*”) AND (“Asian*” OR “Southeast Asian*” OR “Malaysia” OR “Singapore” OR “Australia” OR “Thailand” OR “Indonesia” OR “India” OR “Brunei” OR “Myanmar” OR “Cambodia” OR “China” OR “Korea” OR “Taiwan”))

3.2. Screening and selection of studies

The initial stage involved selecting relevant literature and evaluating the abstracts to determine which articles to download for further assessment of eligibility. Studies focusing on various aspects of e-commerce adoption, technology, and sustainability were considered, regardless of author name or journal indexing. Articles with irrelevant abstracts or redundant content were excluded. Additionally, articles written in languages other than English or Malay were not included. After this screening process, a total of 105 articles were assessed for eligibility. Out of these, 61 articles were identified as particularly relevant to the targeted subject matter. Figure 1 presents the flow chart of the literature review process.

3.3. Data extraction

The authors extracted data from the articles included in the study. The focus was on the increasing rate of e-commerce adoption, trends, opportunities, and potential waste generation rates. This was done to identify the paradigms and challenges faced in waste management within this sector.

3.4. Quality assessment

This review is based on the following qualitative criteria:

i) Search for relevant authors listed in Scopus and WoS to ensure the quality of the article. The quality of the Scopus database is characterized by comprehensive research information, up-to-date studies, peer reviews, and systematic data quality (access to official data, indicators, and analytical tools) [20]. On the other hand, articles published in the WoS journal database went through an extensive editorial process to ensure journal quality and a rigorous and comprehensive data quality framework [21]. In addition, there are other articles from GS, which also support the systematic review process [22].

ii) Consistency of results is based on strong evidence from high-quality studies. General data and opinions contained in 70-80% of reviewing articles are considered reliable.

iii) Extract the most important data from each article and document read for critical evaluation and easy identification: title, abstract, date, keywords, relevant data, research contribution (quality, limitations, method, interpretation of results, and impact conclusions).

iv) The researchers also use these questions to select publications:
- Does the publication address e-commerce and sustainability issues, barriers, or challenges?
- Does the publication provide a detailed analysis of e-commerce packaging waste in terms of material and form?
- Does the publication address the positive developments leading to e-commerce waste-related problems?
- Does the publication analyze new logistical opportunities and new materials that reflect the research topic?

In addition, researchers also analyze the methods used. All articles with unreliable data were excluded as ineligible for quality reasons.

3.5. Data synthesis

The data were classified according to the following categories: promotion of eco-friendly packaging, recycling, education, collaboration with waste management companies, waste generating rates and management trends, implementation of e-waste management regulation, promotion of circular economy (CE) principles, and the problem and opportunity. The aspects of the study, inclusive of keywords and databases used to obtain the materials, are shown in Table 1. To identify patterns, clusters, similarities, and relationships within the abstract data, a thematic analysis was conducted, drawing upon the methodologies outlined in [23], [24]. Thematic and content analysis were employed to summarize the findings from related articles, leading to various conclusions [25]. The review indicates that out of 61 articles, only 30 were deemed to align with the objectives by providing the emerging themes.

4. RESULTS AND DISCUSSION

The findings of this study revealed eight main themes (Table 2), which reflect key areas of focus in sustainable e-commerce waste management. These themes include the promotion of eco-friendly packaging (A), recycling (B), education (C), and collaboration with waste management companies (D). Additional themes identified are waste generation rates and management trends (E), implementation of e-waste management regulations (F), promotion of CE principles (G), and existing problems and opportunities (H).

Table 2. Research findings based on the proposed search criteria

No.	Author(s)	Year	Database			Theme						
			GS	Scopus	WoS	A	B	C	D	E	F	G	H
1.	Escursell *et al*. [2]	2021		/		/		/			/	/	/
2.	Pålsson *et al*. [3]	2013		/		/							/
3.	Shvarts [5]	2019	/					/					/
4.	Tu *et al*. [7]	2018		/				/				/	
5.	Monnot *et al*. [11]	2019	/			/			/				
6.	Gregory *et al*. [26]	2019	/								/	/	
7.	Qin and Liu [27]	2022		/						/		/	/
8.	Zhou *et al*. [28]	2016		/									
9.	Lim [29]	2021	/									/	/
10.	Chen *et al*. [30]	2021	/				/	/		/	/	/	
11.	Caiyi *et al*. [31]	2022		/	/	/		/			/	/	/
12.	Guo *et al*. [32]	2021		/	/			/	/	/	/		/
13.	Askari *et al*. [33]	2014	/					/	/		/	/	/
14.	Hou [34]	2021	/				/	/		/			
15.	Lu *et al*. [35]	2020		/	/	/	/	/	/	/	/		
16.	Xie *et al*. [36]	2021		/		/	/	/			/		/
17.	Pinos *et al*. [37]	2022	/			/	/		/	/	/	/	
18.	Sony *et al*. [38]	2019	/				/		/				
19.	Guo *et al*. [39]	2021	/				/	/					/
20.	Lin *et al*. [40]	2022		/			/		/	/			/
21.	Mahat *et al*. [41]	2019	/				/	/		/	/	/	
22.	Zhang *et al*. [42]	2019		/	/		/	/	/	/	/	/	/
23.	Hao [43]	2021		/			/		/		/		/
24.	Haryanti *et al*. [44]	2022		/	/			/					/
25.	Mangiaracina *et al*. [45]	2015	/					/	/				
26.	Zhao *et al*. [46]	2022		/		/			/		/		/
27.	Kim *et al*. [47]	2022	/							/	/		/
28.	Filho *et al*. [48]	2021		/						/			/
29.	Ma *et al*. [49]	2022		/	/					/			
30.	Wang *et al*. [50]	2022		/						/		/	/

4.1. Promotion of eco-friendly packaging

The rapid growth of e-commerce has resulted in a significant increase in packaging waste, causing serious environmental problems [30]–[32]. A promising solution is to substitute traditional plastic packaging materials with sustainable, non-toxic, and environmentally friendly packaging materials such as recycled paper, biodegradable plastic, and other environmentally friendly materials [11], [30], [33], [34]. Unlike traditional approaches, green packaging strategies can reduce pollution and encourage e-commerce platforms to work with green service providers to integrate waste collection and management services [31].

To further encourage usage, incentives such as discounts and exclusive offers can encourage consumers to choose eco-friendly packaging, thereby helping to overcome resistance to eco-friendly materials [35], [36]. Collaborating with packaging suppliers and implementing tools such as life cycle assessment (LCA) will enable continual improvement of packaging design and sustainability [2]. Furthermore, by using data analysis and optimization algorithms, it is possible to reduce excess packaging, minimize waste, and achieve higher productivity compared to traditional packaging methods [11], [37].

Educating consumers about the environmental benefits of sustainable packaging through digital campaigns and social media also plays an important role in changing consumer behavior [7], [31]. This comprehensive strategy spans technology innovation and consumer engagement. It demonstrates a more effective and scalable approach to managing e-commerce waste and stresses the importance of moving towards a greener e-commerce ecosystem.

4.2. Recycling

In recent years, the rapid growth of the e-commerce industry has resulted in an increase in waste generated from online shopping [30], [32]. Numerous effective recycling strategies have been developed to address this problem. The main focus is on the development of innovative recycling systems that use technology to convert packaging waste into non-toxic organic materials, which represents a more sustainable alternative to traditional disposal methods [31], [33]. Consumer-targeted recycling programs that offer discounts or other incentives also have measurable effects, with studies showing a 30% increase in recycling behavior among participants [30].

Collaborative recycling programs between e-commerce platforms and waste management companies will improve the efficiency of material recycling. This is particularly true of commonly used items such as cardboard and bubble wrap [34]. This proactive program demonstrates higher recycling engagement and results compared to passive waste management systems. In addition, consumers are willing to pay a higher price for recycled packaging, which encourages a shift to green materials and increases the economic viability of sustainable alternatives [39], [40].

E-commerce companies can expand their impact by working with manufacturers to reduce excess packaging and encouraging responsible management of product packaging disposal [36], [41]. Moreover, implementing sustainable practices throughout the supply chain, such as reducing energy consumption, using renewable energy, and improving resource efficiency, has been shown to significantly reduce environmental impacts compared to traditional models [37], [42]. A comprehensive strategy combined with third-party recycling partnerships and continuous process improvement can help companies effectively manage e-commerce waste and make a significant contribution to environmental protection [43].

4.3. Education

Education plays a critical role in promoting sustainable waste reduction in the e-commerce sector. To increase environmental responsibility, stakeholders, including governments, need to implement proactive strategies and educate the public about sustainable development [7], [31]. Governments play a major role in promoting cooperation between businesses and consumers and in raising public awareness of environmental issues through policies and public participation [36]. Compared to simple organizational approaches, education can produce long-term changes in behavior and therefore have a more lasting impact.

E-commerce platforms can further support these efforts by integrating educational initiatives into their operations, such as raising awareness of eco-friendly products and promoting environmental awareness through targeted campaigns. Digital channels such as websites and social media are effective tools for disseminating information on recycling, waste reduction, and sustainable consumption habits [7], [41], [44]. Hou [34] believed that sustainable development was linked to technological progress and resource conservation and could be easily achieved through public awareness and participation.

Moreover, raising awareness on topics such as sustainable packaging, renewable energy, and sustainable logistics can have a significant influence on consumer behavior and business practices [5], [35], [45]. Compared to strategies that focus solely on infrastructure or technology, educational programs help strengthen shared responsibility across the value chain. By implementing a comprehensive educational framework, e-commerce companies are the most likely to adopt and support practices that help reduce waste and promote a CE [33].

4.4. Collaboration with waste management companies

Partnering with waste management companies has proven to be an effective strategy for e-commerce businesses looking to reduce waste generation and implement greener practices [32]. Rather than isolated internal efforts, these collaborations can contribute to more comprehensive sustainability outcomes by ensuring that packaging waste is properly managed, recycled, and disposed of [12], [38]. Lu *et al.* [35] highlighted that such collaboration is important in order to address issues such as excessive packaging that is detrimental to the environment in the e-commerce industry. The partnership brings together expertise in reducing environmental impacts and developing scalable, long-term waste management solutions.

Beyond basic waste disposal, waste management companies can also help assess and improve packaging practices. A detailed analysis of packaging materials and their use will enable them to suggest environmentally friendly alternatives, such as biodegradable or recycled materials, as well as ways to improve resource efficiency by reducing packaging volume [3], [5], [33], [40]. Compared to companies operating independently, companies participating in such alliances may benefit from specific strategies that align with corporate social responsibility goals, such as take-back programs or donation schemes for unsold but usable products [11], [37], [46].

In addition, collaboration also brings logistical benefits, helping waste management companies reduce fuel consumption and emissions, improve operational efficiency, and achieve environmental goals by providing guidance on more efficient transportation methods and vehicle use [43], [45]. They also promote sustainability by educating consumers on how to handle packaging and hazardous materials [35], [37]. This integrated approach, which combines waste reduction, improved logistics, and customer education, has proven to be more effective than separate strategies, allowing e-commerce companies to improve their environmental performance and brand reputation.

4.5. Waste generation rates and management trends

The increasing popularity of online shopping has resulted in increased waste, posing serious environmental challenges for the e-commerce sector [47]. Filho *et al.* [48] highlighted that e-commerce waste includes not only packaging materials but also electronic and textile waste, posing challenges to waste management efforts. Kim *et al.* [47] found that online retailers generate 4.8 times more packaging waste than traditional retail stores and could account for more than 10% of global solid waste within the next decade. This shows that the problem is more fundamental than offline retail.

According to a global analysis by [40], [49], e-commerce uses approximately 165 billion units of packaging annually, half of which are single-use plastics. This volume exceeds the amount of packaging used in physical stores, increasing demand for eco-friendly alternatives [27]. As a result, companies are turning to eco-friendly packaging materials, including biodegradable and recyclable materials [34], and some are even exploring the possibility of creating reusable packaging [42]. Companies with closed-loop supply chains that focus on reusing materials rather than disposing of them demonstrate greater resource efficiency and offer a more sustainable alternative to traditional linear models [30].

Electronic waste is another byproduct of e-commerce, but recycling programs are specifically designed to deal with the issue. Retailers offer return and refund programs to encourage shoppers to recycle old electronics and reduce their impact on landfills [35], [41], [50]. These efforts are more efficient than traditional cleaning methods and reflect the industry's tendency to be cyclical. While e-commerce contributes to increased waste, the adoption of sustainable packaging, closed-loop logistics systems, and e-waste collection marks a shift toward more responsible practices and clear progress in reducing the industry's environmental impact. As the industry continues to grow, these innovations must be implemented to ensure long-term sustainability.

4.6. Implementation of e-waste management regulations

To effectively manage e-waste in Malaysia, there is a need to update existing laws to address contemporary issues of environmentally sound waste disposal [33], [41]. Currently, scheduled waste, including e-waste, is regulated under the Environment Quality (Scheduled Waste) Regulations, 2005 [30], [41] while the Solid Waste and Public Cleansing Management Act, 2007 (Act 672) requires source segregation, but only applies in some states and federal territories. As shown by Askari *et al.* [33], these geographic limitations create regulatory gaps, complicate national implementation, and stress the need for more comprehensive e-waste legislation.

To comply with regulations, e-commerce businesses must adhere to the guidelines of the Malaysian Communications and Multimedia Commission and follow systematic compliance procedures. This includes registering with the Department of Environment and ensuring that e-waste is identified, stored safely, and disposed of by certified companies. In addition, companies are encouraged to raise consumer awareness about e-waste recycling, promote sustainable packaging, and offer eco-friendly products [26], [43].

Caiyi *et al.* [31] recommend proactive strategies such as take-back schemes and greater recycling efforts to reduce packaging and electronic waste, and Mahat *et al.* [41] recommend strengthening Malaysia's efforts, which currently remain largely voluntary and fragmented, to align with international best practice.

Government action is also essential to managing e-waste. Measures such as stricter packaging laws and encouraging environmentally friendly manufacturing can significantly reduce waste at source [37], [47]. Incorporating promotional activities into organizational strategies can improve compliance and promote the adoption of responsible recycling practices [26], [42]. Ultimately, a systemic and collaborative e-waste management model that includes regulatory reforms and stakeholder engagement will play a critical role in reducing e-waste and achieving long-term sustainable development of the Malaysian e-commerce industry. This approach could significantly improve Malaysia's waste management and environmental performance compared to global standards.

4.7. Promotion of circular economy principles

Promoting CE principles is critical to sustainable waste management in the e-commerce sector. A key strategy is to create an effective raw material tracking system to reduce waste generation and improve resource efficiency [33]. The sharing economy enhances these efforts by promoting the redistribution of products and shortening their life cycles, which significantly contributes to the reduction of waste [29], [30].

E-commerce players can employ a CE strategy through practical initiatives such as reducing packaging waste, promoting packaging reuse and recycling, and implementing reusable packaging solutions [2], [12]. Take-back and reuse or recycle programs are also effective because they help reduce e-waste by ensuring that discarded or damaged products are repaired, resold, or recycled responsibly [26], [31], [41]. Closed-loop supply chains play an essential role in achieving a CE by sourcing products from suppliers who practice sustainable development and use recycled materials, thereby reducing waste associated with production [12], [27], [37], [42]. In addition, collaboration with waste management companies promotes environmentally responsible disposal practices [11], [50].

Consumer education is another fundamental element of successful CE initiatives. Informed customers are more likely to make environmentally conscious decisions, and e-commerce companies can support this by implementing educational marketing campaigns that encourage CE-compliant behavior [7], [29], [31], [37], [42]. By implementing reusable packaging, take-back and recycling programs, circular supply chains, strategic waste management partnerships, and consumer-focused education, e-commerce can significantly enhance its sustainability efforts. This approach reduces environmental impacts while also creating economic and social benefits, showing the value of CE in promoting sustainable development.

4.8. Problems and opportunities

The rapid growth of e-commerce, especially since the COVID-19 pandemic, has significantly changed consumer purchasing behavior and also substantially increased waste generation [48]. While these changes have increased convenience and economic activity, they have also created significant environmental challenges, such as increased packaging waste and carbon emissions associated with logistics and delivery [29], [31], [40]. One of the principal sources of e-commerce waste is packaging materials such as cardboard boxes, plastic films, and air bags, which often end up in landfills due to improper disposal methods [36]. In addition, the increase in discarded electronic devices will lead to pollution, resource depletion, and greenhouse gas emissions, thereby worsening environmental damage [27], [42], [44].

To address these issues, e-commerce platforms, consumers, and waste management services must work together in order to implement sustainable practices. This includes proper disinfection and disposal of waste left behind by online takeaway orders [32]. However, other challenges remain, including a lack of standardized packaging materials, poor consumer recycling habits, and logistical difficulties in designing packaging that is safe and sustainable [33], [39], [43], [46]. Despite these challenges, promising progress has been achieved, with many companies implementing environmentally friendly policies such as using biodegradable packaging and investing in improved recycling systems [12], [40], [47]. These efforts improve packaging quality and reduce the environmental impact of transportation [28], [43]. Waste management companies are likewise beginning to offer specialized reuse and recycling services, helping to create jobs in the green economy.

Innovative start-ups are playing a vital role by introducing reusable packaging systems and promoting CE business models that move away from traditional linear approaches [3], [5]. This new strategy marks the move towards more comprehensive solutions that balance environmental responsibility and cost effectiveness. In summary, the rise of e-commerce has raised concerns about environmental issues, but it has also opened up opportunities for sustainable innovation. By implementing green practices, innovation, and collaboration among stakeholders, the industry can overcome current challenges and achieve significant improvements. Compared with existing fragmented models, the holistic approach dealt with in this study provides a more robust basis for addressing the environmental impacts of e-commerce on a global scale.

5. CONCLUSION

The rapid growth of e-commerce has resulted in a significant increase in the amount of discarded packaging and e-waste due to consumer demand for convenience and technology. In response, Malaysia has introduced policies encouraging sustainable practices such as eco-friendly packaging, stricter e-waste regulations, and CE principles. Additionally, a growing number of environmentally conscious consumers are pushing retailers to create sustainable e-commerce platforms and eco-friendly packaging. However, the most important takeaway from these results is the need to move from waste elimination to waste prevention and reduce the excessive production and packaging practices associated with modern lifestyles. Achieving this goal requires long-term commitment, but also requires immediate action to reduce the environmental impact of e-commerce. Malaysia is working towards sustainable waste management for e-commerce, but greater collaboration between e-commerce companies, consumers, and waste management companies is needed to accelerate this process and ensure a sustainable future. These results suggest that the Malaysian e-commerce industry needs to take more proactive steps to prevent waste and encourage other types of collaboration to achieve these environmental goals.

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AUTHOR CONTRIBUTIONS STATEMENT

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C : **C**onceptualization
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R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, [MSS], upon reasonable request.

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