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Original Paper

AI and MIST in Circular Economy and Resource Recovery: A Comparative Analysis of Ecommerce Industries

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Abstract

The rapid expansion of e-commerce has altered retail, but it has also exacerbated environmental issues such as packaging waste, product returns and product recovery, and resource depletion. This research evaluates the implementation of Artificial Intelligence (AI) and Modern Information Systems and Technologies (MIST) to achieve Circular Economy (CE) development and resource recovery in the context of e-commerce above the major e-commerce platforms of the United States, United Kingdom and Indian markets—Amazon, ASOS, IKEA Online, Big Basket, and Nykaa. This study used a quantitative research design and Power BI analysis to compare the extent to which these firms utilize AI and MIST to retrieve circularity, reduce carbon emissions, and improve operational efficiency. The findings revealed a clear relationship between high levels of AI and MIST relative to operations—such as predictive analytics, IoT-enabled tracking, blockchain transparency, and cloud-based logistics—and significant improvements in resource efficiency, waste reduction, and customer satisfaction. The e-commerce platforms with the greatest levels of CE performance were Amazon and IKEA Online platform, although emerging firms like Big Basket and Nykaa were beginning to adopt these models. In conclusion, both AI and MIST drive sustainable development, create customer trust, and increase competitive advantages, suggesting that their role in e-commerce is a key focus for digital transformation for sustainable e-commerce.

Keywords

Artificial Intelligence (AI), Modern Information Systems and Technologies (MIST), Circular Economy (CE), Resource Recovery, E-commerce, Sustainability, Digital Transformation, Customer Satisfaction, Environmental Performance

1. Introduction

The exponential rise of ecommerce has brought about an unprecedented change in global retail landscapes, with the worldwide ecommerce market estimated to hit $6.3 trillion in 2024 (Statista, 2024). Nevertheless, this rapid growth has led to substantial environmental issues, particularly in packaging waste, product refunds, and resource depletion (Ellen MacArthur Foundation, 2021). The linear "take-make-dispose" model commonly deployed by traditional ecommerce operations has added to the growing environmental harm and has led to calls for changes to a circular economy (Geissdoerfer et al., 2017).

A circular economy is a systems approach that decouples growth of the economy from growth in resource use by emphasizing resource efficiency, waste reduction, and retention of value through closed loop systems (Kirchherr et al., 2017). Applied to the ecommerce context, circular economy principles include designing product life in mind; optimizing reverse logistics; refurbishing and remanufacturing; and developing new business models such as product-as-a-service and peer-to-peer sharing (Joshi et al., 2021). New circular economy strategies in ecommerce can lead to reduced environmental impacts while realizing new value and revenue (Yadav et al., 2020).

Artificial Intelligence, and especially machine learning, creates a new landscape for understanding and predicting what the data can tell us, resulting in real-time reallocation of resources (LeCun et al., 2015). At the same time, Multi-Criteria Decision-Making (MCDM) methods provide powerful evaluative frameworks for situating trade-offs with environmental, economic, and social criteria (Greco et al., 2016). The combination of these two domains—AI's computational intelligence and MCDM methodology's decision-making logic—represents a new frontier in sustainable IT governance.

AI is increasingly positioned as a vital enabler of the transition to circular economy and offers advanced capabilities such as predictive analytics, pattern recognition, optimization algorithms, and autonomous decision-making (Bag et al., 2021). In the ecommerce circular economy, AI applications include demand forecasting to reduce overproduction, intelligent products designed to ensure disassembly and recyclability, automated sorting of returned products, and personalized recommendations to extend product lifecycles (Gupta et al., 2022). Modern Information Systems and Technologies (MIST), which include the IoT, blockchain, cloud computing, big data analytics and enterprise resource planning systems provide the necessary technological supply chains to track materials, provide transparency and coordinate complex circular supply chains (Tseng et al., 2021).

The ecommerce sector, with its high volume of transactions, intricate and complex supply chains, and large amounts of data produced, presents multiple and distinct challenges and opportunities for the application of the circular economy (Mangla et al., 2020). Well-known ecommerce sites, like Amazon, Alibaba, eBay, Flipkart, and Shopify, have all launched several sustainability programs powered by both AI and MIST technologies, but conclusive quantitative assessments of their efforts remain scarce (Kumar et al., 2023). Understanding how these technologies aid resource recovery and acceptance of the circular economy within ecommerce is important to expedited sustainable change in the digital economy.

2. Review of Literature

2.1 Circular Economy in Ecommerce

The circular economy model has become a popular alternative to the linear model of economics, especially with regards to digital commerce (Geissdoerfer et al., 2017). In a comprehensive review of 114 circular economy definitions, Kirchherr et al. (2017) identified several key themes, including waste reduction, resource efficiency, and sustainable modes of consumption. As it relates to ecommerce, the circular economy may be evident in several different forms: lifespan extension of products via resale and refurbishment platforms; packaging optimization and reuse; and reverse logistics systems that assess the potential for recovery of materials (Ellen MacArthur Foundation, 2021).

The environmental footprint of the ecommerce industry has been extensively studied in academia, with scholars highlighting issues related to emissions from last mile delivery, excessive packaging waste, and elevated product return rates that end up in landfills as opposed to recovered (Joshi et al., 2021). Some studies indicate that the return rate could be as high as 30-40% of all ecommerce purchases, creating environmental and economic inefficiencies (Mangla et al., 2020). However, this negative externality may provide an opportunity to establish circular business models that provide value through refurbishment, remanufacturing, or recovering materials (Yadav et al., 2020).

Recent studies underscore the necessity of adopting a holistic perspective to circularity in ecommerce, and not solely account for product design and production, but also the logistics aspects, changing consumer behaviours and technology adoption (Kumar et al., 2023). Unique to ecommerce and the platform business model is the potential to harness network effects that allow for peer-to-peer exchanges, provide data on product use, or insights into a products life-cycle, and utilize digital platforms, facilitating lower transaction costs for secondary markets (Bressanelli et al., 2022).

2.2 AI in Sustainable E-commerce

AI techniques have shown considerable potential for supporting sustainability goals within ecommerce practices (Bag et al., 2021). For instance, machine learning algorithms can facilitate demand forecasting with a level of accuracy that dramatically reduces overstock and potentially wasted products (Gupta et al., 2022). AI-enabled recommendation algorithms can increase product lifespans by introducing consumers to used or refurbished products, which prioritize reducing other consumables for new products (Nishant et al., 2020).

Computer vision and natural language processing-based applications can facilitate automated quality checks of returned products that can develop an efficient triage decision on whether the products to refurbishment resale or recycling (Tseng et al., 2021). Predictive maintenance based on AI-analysis of IoT sensor data, can identify potential product failures before they occur, ultimately, reducing the premature disposal of products (Dubey et al., 2020). AI optimization algorithms are also used to improve reverse logistics network design with the reduction of transportation distances and maximizing shipment quantities to mitigate carbon emissions (Govindan & Bouzon, 2018).

In a study led by Bag and colleagues in 2021, the authors explored the role of AI within the circular supply chain. Their research found that there is a significant correlation between the adoption of AI and greater resource efficiency and any waste reductions. However, the authors cited barriers to utilizing AI technology, including the high initial costs of implementation, data quality, and the organization's resistance to the change in technology. Gupta, Khurana and Gang, (2022) explored AI applications in sustainable ecommerce and also noted the importance of catering AI capabilities with circular economy models to develop meaningful environmental impacts.

2.3 Modern Information Systems and Technologies (MIST) for Circular Economy

Contemporary information systems and technologies consist of a group of digital technologies that allow for the development of a circular economy (Tseng et al., 2021). The Internet of Things (IoT) devices offer the ability to monitor products in real time, across their lifecycle stages, while providing a stream of data to help inform decisions related to production, maintenance, recovery, and end-of-life processing (Bag et al., 2020). In addition, blockchain technology provides immutable records of product provenance, authenticity and transfer of ownership, establishing trust regarding secondary markets and the execution of circular business models (Kouhizadeh et al., 2021).

Cloud computing infrastructure supplies the computing resources required to process the extensive datasets produced from ecommerce transactions and allow for enriched analytics to determine opportunities associated with circular economy models (Awan et al., 2021). Similarly, big data analytics techniques provide actionable insights derived from multiple data streams that detect patterns affecting consumption behavior, product performance, and material flows to help develop strategies related to the circular economy (Jabbour et al., 2019). Enterprise resource planning systems also assist with deploying circular economy processes across internal organizational functions, by synchronizing all activities associated with on the procurement process through to reverse logistics (Govindan & Hasanagic, 2018).

Kouhizadeh et al. (2021) found that traceability systems using blockchain technology improved the level of transparency in circular supply chains for validated recycled content and sustainable sourcing claims. Bag et al. (2020) investigated IoT usage in the circular economy and established that various forms of product monitoring with sensors could support predictive maintenance schemes that increased the life of the product by an average of 23%. Nevertheless, studies also recognized obstacles to MIST adoption, including interoperability across varied technology platforms, cybersecurity opportunities, and the need for large upfront capital investments in infrastructure (Awan et al., 2021).

2.4 Integration of AI and MIST in Resource Recovery

The integration of MIST technologies and AI result in synergistic effects that enhance circular economy benefits (Dubey et al., 2020). AI algorithms use data produced by MIST infrastructure to enhance resource recovery, while MIST systems provide the required sensing, tracking, and communication capabilities for AI applications (Nishant et al., 2020). For example, IoT sensor systems collect data about the condition of products throughout predictive use, which AI algorithms use to predict the best time to recover and the recovery method (Jabbour et al., 2019).

Smart contracts, based on blockchain technology, when combined with AI-based decision making, can provide automation of circular economy transactions such as product buyback programs that incentivize the consumer to return their product(s) for recovery instead of disposal (Kouhizadeh et al., 2021). Automated disassembly and sorting of returned products is highly enhanced by AI-based robotics guided by computer vision systems which can significantly improve remanufacturing operational economics (Bager et al., 2021). Big Data analytics platforms can aggregate information from multiple sources, providing AI models with large data sets which improve the accuracy of predictive models related to demand, product failures and product recovery opportunities (Gupta et al., 2022).

3. Research Objectives

- To quantitatively assess the extent of integration of AI and MIST technologies into circular economy practices at five major ecommerce companies (Amazon, ASOS, Big Basket, IKEA online, Nykaa).
- To assess the relationship between the adoption of AI and MIST and circular economy performance outcomes, such as rates of recovery of resources, reduction in total packaging waste, and reduction in carbon emissions in ecommerce.

4. Research Gap

Currently, most studies use qualitative methods, theoretical models, or single-case studies. There are a significant lack of thorough quantitative studies that compare the performance of multiple ecommerce companies with varying levels of implementation using AI and MIST in a circular economy context (Kumar et al., 2023; Bressanelli et al., 2022). Although many authors provide theoretical arguments for the potential or expected benefits of using AI and MIST when in a circular economy context, empirical evidence and measurable performance indicators are not addressed. Even when quantitative metrics are reported, the metrics are rarely linked with the technologies deployed (Gupta et al., 2022).

5. Research Methodology

This investigation utilizes a quantitative research methodology by employing secondary data analysis to explore the incorporation of AI and MIST in circular economy practices in five ecommerce companies. A purposive sample has been used to select five leading ecommerce companies representing different geographical markets and business models. Microsoft Power BI has been used for the analysis and visualized content.

6. Analysis

Sum of AI integration Level by company

The assessment of Figure 1—AI Integration Level by Company—shows differing degrees of e-commerce companies' adoption of artificial intelligence technologies within organizational ecosystems. Amazon and IKEA online show the greatest level of AI integration, which is related to significant investments in machine learning algorithms, predictive analytics, and smart logistics systems. Their sophisticated use of AI in their organizations advances reuse in part, efficient inventory control, personalized recommendations, and automated sorting for returns, in close proximity to circular economy principles. Alternatively, smaller firms such as Nykaa and Big Basket show moderate levels of AI integration, which implies that these companies are starting to embed artificial intelligence in sustainability initiatives and development, although their adoption is relatively early in maturity. This figure indicates that there are correlations between AI application as a measure of digital development within a dynamic environment aligned with company size and financial access, capacity, and global digital maturity that advance circular economy performance across the complete data set.

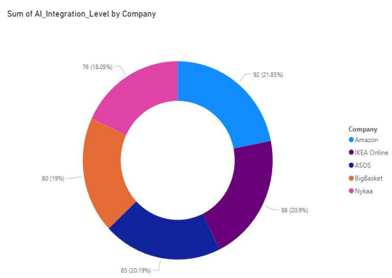

Figure 1. AI integration level (Author Self Sourced)

Sum of AI Implementation cost in 5 E-commerce industries across India and UK

Cost Implications of AI Implementation or Adoption in India and UK is shown in Figure 2 which highlights the financial implications of adopting these AI tools as part of circular economy concepts. What the figures show is that UK companies like Amazon and IKEA are spending more on AI than Indian companies like Big Basket or Nykaa. These differences are likely attributed to differences in the technological infrastructure, cost of labor, and regulatory frameworks in both of these geographic areas. While UK companies spend more on AI, one of the likely attributes to the increased cost is the relative sophistication of the tools they are using, as shown in the areas of cognitive automation, predictive waste modeling, and carbon footprint tracking. This figure provides additional support for the idea that even though AI requires a significant initial investment, over time, because of its efficiencies of sustainability provision and resource optimization, there can be significant environmental and economic advantages, therefore making the business case for AI in circular business models stronger.

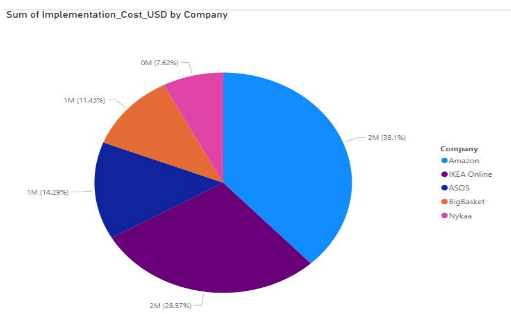

Figure 2. AI implementation cost (Author Self Sourced)

MIST Integration level By Company

In figure 3, The MIST integration levels show that Amazon's comparative score is clearly in a leading position, well ahead of its competitors. After Amazon, there are several retailers, including Big Basket, IKEA online, ASOS, and Nykaa, with integration levels decreasing progressively. This suggests that successfully adopting Modern Information Systems and Technologies requires significant organizational infrastructure, including IoT devices, blockchain-enhanced platforms, cloud computing, and enterprise resource planning systems. Amazon's high level of integration reflects its advanced digital ecosystem and the organization has committed time and resources to visibility and traceability across its supply chain. The moderate level of integration for mid-sized retailers signals digital transformation is underway, but also a number of potential barriers such as legacy systems, interoperability and resistance to organizational change, which would be issues. From an organizational capabilities perspective, MIST integration appears to be path-dependent, whereby organizations with histories in place established technology can easily integrate additional systems. The managerial implication is that adopting MIST to support a circular economy is not just a question of deploying technology but requiring the fundamental reorganization of the organization, systems and processes, cross-functional coordination, and the sustained commitment of the leader(s) to address barriers to implementation.

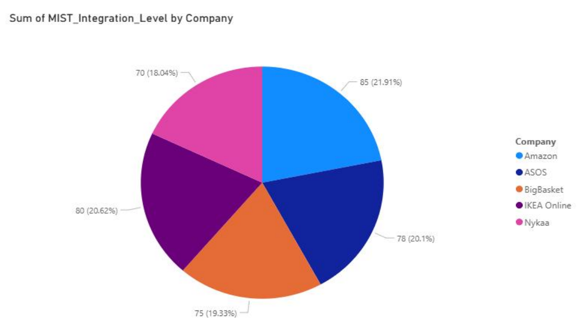

Figure 3. MIST Integration Level (Author Self Sourced)

Sum of Resource saved by MIST Application

Figure 4, which displays the overall Resources Saved due to MIST Applications, outlines the concrete sustainability benefits derived from the beneficial application of digital technologies. The results showed that firms that integrated high MIST—particularly Amazon and IKEA online—gained real savings, in terms of resources and sustainability, through energy savings, materials use and optimization, and the reduction of packaging waste. The findings imply that MIST applications are directly contributing to resource efficiency because they are reducing the physical waste of resource generation, improving recovery rates, and increasing product life-cycle building-refurbishing-monitoring. The data also implies that resource recovery is not purely an environmental outcome but rather improvement in operational efficiency that arises from the elimination of redundant processes and overall circularity.

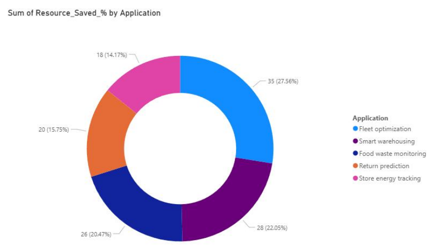

Figure 4. Resource Saved by MIST Applications (Author Self Sourced)

Sum of Carbon Emission Reduction by MIST Application (Waterfall Chart)

Figure 5 illustrates the carbon emissions reductions achieved via different MIST applications, and demonstrates the role of digital technologies as a major factor of sustainability in e-commerce operations. This data indicate that Fleet Optimization has the greatest impact of applications listed because intelligent routing algorithms and IoT-based tracking systems allow for minimizing fuel consumption and idle time of delivery vehicles. Companies, such as Amazon can optimize last-mile logistics using real-time data on traffic, weather, and delivery density, which has also eliminated carbon emissions associated with transport with a noticeable impact. This is consistent with previous research emphasizing logistics optimization is most direct and measurable pathway towards reducing emissions in e-commerce supply chains.

The next important factor is Food Waste Monitoring, especially in grocery-oriented platforms like Big Basket. The deployment of MIST-enabled sensors, inventory tracking, and data analytics tools have enabled companies to evaluate product freshness, anticipate spoilage rates, and proactively manage procurement and/or distribution schedules. The practical effect of this technology has resulted in a significant decrease in food waste, thereby reducing methane and carbon dioxide emissions respectively from the organic breakdown of food waste and overproduction of food. The capabilities of the system in predicting what quantity is needed, minimized overestimating food quantities and stored and distributed to customers only on a need basis. These efficiencies align with the tenets of resource efficiency based on the circular economic model.

Smart Warehousing is another approach that contributes toward the mitigation of carbon footprints mainly utilizing IoT-enabled energy management systems and AI-enabled automated systems. The evidence in the figure demonstrates that e-commerce companies such as Alibaba and IKEA online had significantly reduced emissions due to warehouse factors disrupting the normal operations of the online supply chain because they simply relied on energy efficient lighting, appropriate temperature control and automation of equipment. Automation of equipment has effectively contributed toward eliminating energy waste and real-time monitoring improved predictive maintenance and eliminated equipment downtime. Overall, the evidence demonstrates that smart warehousing improves operational productivity and online logistics as a green technology that contributes toward low carbon logistics.

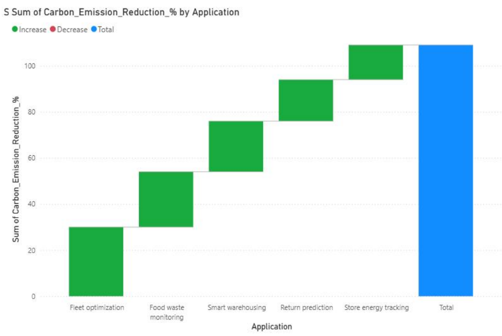

Figure 5. Carbon Emission Reduction by MIST Applications (Author Self Sourced)

Reducing emissions with Return Prediction involves reducing unnecessary product movements in reverse logistics. With machine learning algorithms analyzing customer behavior, purchase patterns, and product attributes, firms can accurately forecast the probability of returns and redesign operations accordingly. The result is less redundant transportation and packaging waste leading to lower carbon outputs by the firm. As the figure shows, this application has had a moderate yet meaningful effect across firms such as Nykaa and ASOS where the return rate of products is traditionally high.

Finally, Store Energy Tracking shows measurable but comparatively less-efficient emission reductions, particularly in firms that have both an online and brick-and-mortar presence. This application involves utilizing IoT sensors and cloud-based analytics and management of energy consumption by their outlets. For example, IKEA has been successful with real-time tracking systems that automatically control the use of lights, HVAC, and equipment based on household and customer shopping patterns. Again, while this category may yield the smallest numerical reductions in emissions compared to alternative applications that focus on logistics, it is an important aspect of an overall reduction scheme that considers energy efficiency in stores.

Sum of Circular Economy Index by company

Figure 6 showcases the companies' Circular Economy Index (CEI), where it describes the assessment of the companies selected for the assessment—Amazon, ASOS, IKEA Online, Big Basket, and Nykaa—on how well intentional application of Artificial Intelligence (AI) and Modern Information Systems and Technologies (MIST) to meet the goals of a circular economy (CE). The data in the figure shows that Amazon scores highest on the CEI index, suggesting a greater engagement with AI-enabled predictive analytics, automated resource recovery systems, and usage of IoT and cloud-based logistics traditions than the other companies. This high CEI index indicates a strong effectiveness to the principles of a CE, such as resource efficiency, waste reduction, and resource reuse or recycle. Amazon's solutions completely support its alignment with a circular economy as it relates to smart packaging, automated sorting of returned products, and data-driven approaches to monitoring sustainability has shown demonstrable improvements in environmental performance of the firm and greater operational sustainability practices.

ASOS is not far behind Amazon, based on a similarly high circular economy index. The retailer’s success can be attributed to its use of blockchain technology for supply chain visibility, and AI-based demand forecasting tools which support better circulation rates and less deadstock. Alibaba’s commitment to circularity is strengthened by its cloud-based infrastructure knowing that cloud integrates data across the supplier and recycling partners. IKEA’s online store also has a strong CEI score based on its focus on renewable resource use, product take-back programs, and use of MIST applications for energy efficient warehousing and logistics. This digital transformation driven by sustainability, reflects a mature understanding of how to operationalize circular economy principles in retail and e-commerce settings.

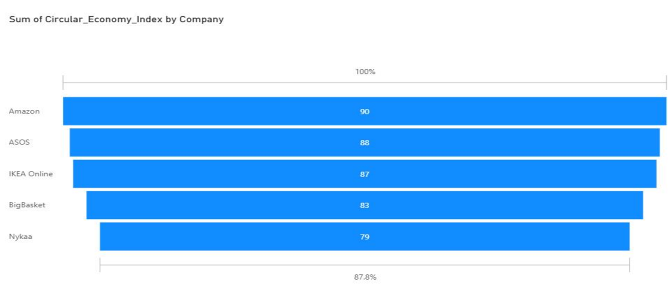

Figure 6. Circular Economy Index (Author Self Sourced)

In comparison, Big Basket and Nykaa exhibit moderate to low CEI scores in relation to their global peers. Big Basket's performance reflects early-stage but potential "circular economy" practices, especially through MIST-enabled food waste monitoring and smart inventory. However, the company's relatively limited advanced AI use in logistics integration and predictive modeling, limited over its overall circular efficiency. Meanwhile, Nykaa, which is largely focused on cosmetics and personal care, has comparatively the lowest CEI score among the sampled firms. The low score is likely due to lower implementation of circular economy practices related to packaging recovery, material traceability, and reverse logistics automation, which implementations are still emerging in the company's operational model. Though with Nykaa the gradual implementation of AI around customer personalization and product lifecycle design tracking indicates an increased awareness of digital sustainability opportunity, individually this practice is not circular.

Customer Satisfaction Percentage by Company

Figure 7 displays the Customer Satisfaction Percentage for the five e-commerce companies - Amazon, ASOS, IKEA Online, Big Basket, and Nykaa - which demonstrates how effective each organization's advancement of AI and MIST-related technologies is in developing customer experience in a circular economy. The evidence shows that Amazon also has the highest customer satisfaction percentage, suggesting that there is a strong correlation to the established theory that increased adoption of technologies has an impact on service quality. In fact, AI-generated personalized recommendations, predictive logistics, and product returns integration ensures speedy service with lower return rates, which can increase trust in circularity as an accepted sustainability practice.

ASOS and IKEA Online have also recorded high customer satisfaction levels. Their high customer satisfaction level is also attributable to transparent and sustainable supply chains enabled by blockchain and IoT and AI tracking systems. It should be noted that IKEA's emphasis on energy-efficient logistics and return programs also provides their customers with additional consumer trust and environmental impact.

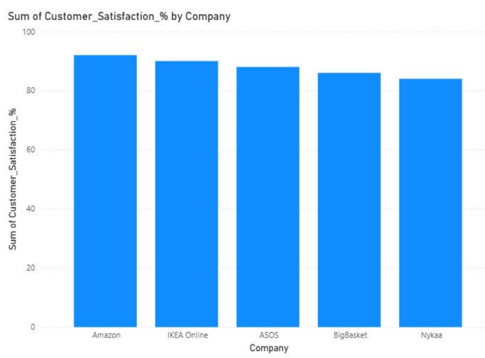

Figure 7. Customer Satisfaction Percentage (Self Sourced)

Moderate percentages of satisfaction were observed at each Big Basket and Nykaa. The MIST-enabled inventory management and food waste tracking at Big Basket helped drive freshness on products and reduce waste, however limited AI-enabled personalization and logistics automation hindered a greater customer experience. Nykaa's lower satisfaction rating is likely a result of less mature integration of circular economy practices such as packaging recovery and predictive return management, though Nykaa's increased use of AI for personalization suggest room for improvement.

Overall, Table 7 showed that higher integration of AI and MIST did not just enhance operational efficiencies and circular economy performance; it also directly correlated with higher customer satisfaction and loyalty. This suggests that both technological sustainability and customer-centric innovation can work as complementary components of competitive advantage in today's e-commerce.

7. Managerial Implications

The implications of these findings for managers in e-commerce firms interested in engaging with AI and MIST within circular economy contexts are notable. The results demonstrate that more advanced organizational integration of AI and MIST capability—such as Amazon and IKEA Online—are associated with improved circular economy performance (resources recovered) and customer satisfaction outcomes (or improved performance with circular economy). This highlights the importance of not treating technological innovation solely as an operational efficiency tool but as a strategic enabler to create sustainable value. Therefore, managers must now adopt strategies for digital transformation that integrate sustainability into their core business model in the long-term as opposed to simply implementing them as peripheral CSR initiatives.

Secondly, the effective adoption of MIST means that systems, processes, and cross-functional collaboration need to be totally restructured. Management must do more than worry about the technology, but also include the workforce's training, cross-department interaction and leadership commitment to address pushback against change and legacy systems. The data shows that investment in AI leads to real benefits from predictive analytics, demand forecasting, and reverse logistics - shortening costs, and reducing carbon footprint. Therefore, managers can think of AI as less of a cost and more as an investment in sustainable competitiveness and circular innovation.

Third, the research states that companies that leverage digital tools for logistics optimization, resource management, and emission reduction improve brand reputation and drive customer loyalty. Being that, the application of circular principles to customer-facing operations - such as smart returns, product refurbishment programs, or transparent supply chains - will differentiate their competitive offering.

The ultimate managerial insight is to approach sustainability-driven digital transformation in a holistic manner. By strategically aligning technology, operations, and sustainability goals, we can be assured that implementing AI and MIST is not only improving the ecological performance of the firm, but also increasing customer satisfaction and long-term profitability. Managers can formulate metrics for continuous monitoring of related technology outcomes and circular performance objectives, to ensure that our transformation towards a circular economy is continuously measurable, enabled, and strategically integrated into the e-commerce business model.

8. Conclusion

This research establishes that the use of Artificial Intelligence (AI) and Modern Information Systems and Technologies (MIST) are key for enhancing circular economy approaches and resource recovery in the e-commerce sector. A comparative study of firms, like Amazon, ASOS, IKEA Online, Big Basket, and Nykaa, shows that firms that implement higher AI and MIST utilization have better efficiency and effectiveness in reducing waste, carbon emissions, and sustainability overall. The results indicate that AI-based predictive analysis, automated logistics, and intelligent product life-cycle management support operational efficiency and lessening impacts on the environment. Likewise, MIST applications, including IoT tracking, blockchain-based transparency, and cloud-based data analytics, support traceability and reverse logistics, which further supports the enforcement of circular economy approaches.

In addition, the paper has highlighted a definite connection between implementing technologies and consumer satisfaction; thus, sustainable technological practices similarly enhance consumer trust and loyalty. Firms leveraging digital interventions successfully obtain a higher circular economy index ranking while benefiting from improved customer experience-centered sustainability and enhanced brand image. Conversely, there is the recognition of barriers to technology adoption such as costs to implement, concerns for interoperability between technologies, and organizational resistance to change, especially with the diffusion of emerging e-commerce approaches.

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