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Research Article EAI.EU

Prioritizing IoT-driven Sustainability Initiatives in Retail Chains: Exploring Case Studies and Industry Insights

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Abstract

INTRODUCTION: Prioritizing sustainability initiatives is crucial for retail chains as they integrate Internet of Things (IoT) technologies to drive environmental responsibility. Retail chains have responsibility to establish environmental stewardship when they globally expand in terms of operations, supply chain and offerings. By prioritizing the initiatives retail chains can reduce impacts on environment, resource waster and mitigate risks related to that with the help of concepts like IoT.
OBJECTIVES: This paper aims to explore how IoT can aid in sustainable practices, mitigate risks, and enhance efficiency while addressing challenges, ultimately providing insights for retail chains to prioritize sustainability in the IoT context.
METHODS: The research employs a qualitative approach, focusing on in-depth case studies and analysis of industry reports and literature to explore IoT-driven sustainability initiatives in retail chains. It includes a diverse sample of retail chains, such as supermarkets and fashion retail, selected based on data availability related to their use of IoT for sustainability. The study involves descriptive analysis to present an overview of these initiatives and competitive analysis to identify sustainability leaders and areas for improvement. However, limitations include potential data availability issues and reliance on publicly available sources, with findings reflecting data up to the 2018-2021 timeframe.
RESULTS: The results highlight significant sustainability benefits achieved through IoT integration in various retail chain types. Case studies, such as Sainsbury's and Coca-Cola, demonstrate waste reduction and sustainable practices. Examples from Nordstrom and 7-Eleven showcase energy efficiency improvements. The versatility of IoT technologies across supermarkets, department stores, and convenience stores emphasizes the transformative power of IoT in driving sustainability in the retail industry. The study proposes a prioritization approach, considering key metrics and leveraging frameworks like the Triple Bottom Line, Life Cycle Sustainability Assessment, and Sustainability Framework for effective decision-making and goal alignment in IoT-driven sustainability initiatives.
CONCLUSION: In conclusion, this paper highlights the substantial potential of prioritizing IoT-driven sustainability initiatives in retail chains for positive environmental, social, and economic outcomes. Through case studies, the diverse applications of IoT, such as food waste reduction and energy-efficient lighting, demonstrate tangible benefits. The trend towards sustainable sourcing and materials is evident across various retail chain types. The discussion underscores the need for a systematic approach, utilizing frameworks like the Triple Bottom Line, to align with strategic objectives and optimize resources.

Keywords: Internet of Things (IoT), sustainability, retail chains, prioritization, case studies, industry insights, technology integration

Received on 08 October 2023, accepted on 13 December 2023, published on 18 December 2023

doi: 10.4108/eetiot.4628

1. Introduction

While 64% of executives globally say sustainability is part of their leadership's agenda, actions on sustainability are falling short of ambitions[1]. Retail chains can be classified in many ways like Fashion and Apparel store[2], Quick Service Restaurants, Pharmacy and drug store chains, Convenience stores, Supermarket/grocery stores, Electronic and mobile wear chains, Jewellery Retail chains,

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footwear chains, etc., These chains are spreading across different demographics to meet the needs of consumer. In the context of sustainability these retail chains undergo tremendous pressure[3] in terms of Climate change, carbon footprint, waste management, regulatory and compliance[4] pertaining to sustainability[5][6] because of little actions as their ambitions does not turn to reality[1]. When these chains go global its directly impacting their business and the onus cannot be passed on only to the consumers who are visiting to the Retail chain. We are seeing a positive trend in terms of awareness for sustainability globally at the corporate level. [7], [8]

Retail chains have responsibility to establish environmental stewardship when they globally expand in terms of operations, supply chain and offerings[9], [10]. By prioritizing the initiatives retail chains can reduce impacts on environment, resource waster and mitigate risks related to that with the help of concepts like IoT. Lack of such initiatives might have impact to the brand image. The sustainability initiatives could also potentially benefit in terms of Cost and efficiency[11], managing regulatory compliance and increase supply chain resilience[12].

The Internet of Things (IoT) refers to a network of physical objects, devices, and sensors embedded with connectivity capabilities, enabling them to collect and exchange data over the internet. In the context of retail chains, IoT offers various potential applications including store monitoring, energy management, predictive maintenance, shelf, product analytics, inventory management etc.,

1.1. Research Significance

Retail industry is significantly contributing to the environment footprint in terms of GHG (Greenhouse gas emission), resource depletion, water generation and pollution. It is essential for the industry especially the retail chains to reduce their environmental impact for mitigating the climate change issues and preserve the natural resources. In one of the survey[13] conducted by BCG with 37 global retailers, across five retailer types, with annual revenues ranging from $1 billion to ~$500 billion. This survey report indicates that retailers one of the largest contributors of plastic packaging at whopping 40% of global plastic usage and are also responsible for more than 25% of global emissions – through scope 3[14]. The below given image (Figure 1: Sustainability Maturity in retail chains) provides the reference to the maturity level outlined in the report on different type of retail chains. To be clear Scope 3 emissions are the result of activities from assets not owned or controlled by the reporting organization, but that the organization indirectly affects in its value chain. Also, it's important to understand that Every year, 1.3 billion tons of food that could have been eaten are wasted. This food is lost or wasted at every stage of the food supply chain, from production to consumption[15]. Similarly, the research on sustainability retain industry has an impact in the context of Regulatory, Compliance, Consumer Demand, Brand Reputation, Cost Efficiency etc.,

Figure 1: Sustainability Maturity in retail chains (Source: BCG Global Survey, March 2022)

The paper aims to examine the importance of prioritizing sustainability initiatives in retail chains within the context of the Internet of Things (IoT). The paper aims to explore the challenges that retail chains face in integrating sustainability practices in an IoT framework and identify the opportunities that arise from leveraging IoT technologies for sustainable operations. By addressing these aspects, the paper aims to provide insights into the potential benefits, considerations, and strategies for retail chains to prioritize sustainability in the context of IoT.

2. Literature Review

The existing literature primarily focuses on sustainability in the retail sector, including the drivers, strategies, performance measurement, and implementation of sustainable development principles outlined Table 1: Table of existing literature references. However, there is a need for further research that specifically examines different types of retail chains and their specific sustainability practices.

Table 1: Table of existing literature references

Sno#	Title	Year	Inference
1	Corporate environmental sustainability in the retail sector: Drivers, strategies, and performance measurement[16]	2018	The literature review investigates the primary motivators behind the implementation of corporate environmental sustainability (CES) strategies within the retail sector, along with prevalent strategies and methods used to gauge their effectiveness
2	Sustainable development concept and	2019	Identify where the principles of sustainable

	creation of innovative business models by retail chains[17]		development (SD) are integrated into the operational model of retail chains, specifically in relation to the creation of customer value
3	Key Aspects of Sustainability in Fashion Retail[18]	2016	Findings demonstrate the rising importance of sustainability in fashion retail
4	Measuring the Economic, Environmental, and Social Sustainability of Short Food Supply Chains[19]	2019	The results suggested that, among the 486 supply chains assessed, involving 208 food producers across 7 countries, longer supply channels were associated with reduced environmental impacts per unit of production, as measured by factors such as food miles and carbon footprint.
5	Towards A Sustainable and Ethical Supply Chain Management: The Potential of IoT Solutions[20]	2023	Explores the capacity of IoT technology to enhance supply chain management procedures, emphasizing the significance of cross-industry collaboration in achieving enhanced efficiency and effectiveness in supply chain management across Agriculture, Pharma, and Manufacturing-Retail Chains
6	The impact of unmanned stores' business models on sustainability[21]	2021	Analysed the sustainability impact of unmanned stores with sustainability and economic impact focus expansion through Dynamic pricing. It recommended need for strong digital infrastructure for effective data analysis for potential implementation along with social sustainability.
7	IoT, Environmental Sustainability, Agricultural Supply Chains[22]	2022	Recommends that reducing resource wastage and reducing pollution at the food production stage, IoT and sensor networks have the potential to play a significant role in reducing food wastage at all stages of the food supply chain.

8	Prioritizing Enabling Factors of IoT Adoption for Sustainability in Supply Chain Management[23]	2021	Study aimed at enabling factors of IoT Adoption through comprehensive literature review and prioritize them using Multi Criteria Decision Making. It also ranked those factors based on quantitative and qualitative methods.

2.1 Research Gap

Limited attention has been given to investigating the sustainability initiatives and challenges specific to different types of retail chains. While some studies discuss sustainability in the fashion retail sector, there is a lack of comprehensive research considering other types such as quick-service restaurants, pharmacy and drug store chains, convenience stores, supermarket/grocery stores, electronic and mobile wear chains, and jewellery retail chains. Understanding the unique characteristics, sustainability challenges, and strategies of these different retail chain types is essential to develop tailored sustainability approaches and identify best practices.

Furthermore, there is a gap in the literature regarding the integration of sustainability practices in retail chains through the analysis of business case studies. While several investigations aspects encompassing the economic, ecological, and societal dimensions of short food supply chains, there exists a requirement for additional case studies focusing on the effective execution of sustainability initiatives across various retail chain environments. These case studies can provide valuable insights into the practical aspects, outcomes, and lessons learned from sustainability integration in retail chains.

Therefore, the research paper aims to address the research gap by conducting a comprehensive analysis of diverse types of retail chains and examining business case studies to identify the challenges, opportunities, and best practices in integrating sustainability initiatives within these contexts. This approach will contribute to a deeper understanding of sustainability in the retail industry and provide practical insights for retail chains to enhance their sustainability performance.

2.2 Objectives

Analyse the significance of sustainability initiatives in the retail industry and the growing role of IoT technologies in driving sustainable practices. To identify and examine the specific challenges faced by retail chains in implementing sustainability initiatives within an IoT context, including technological, organizational, and stakeholder-related challenges. To explore the opportunities that arise from leveraging IoT technologies for sustainability in retail chains, such as improved energy efficiency, waste reduction, supply chain optimization, and data-driven decision-making. To showcase best practices and real-world case studies of retail chains successfully integrating sustainability initiatives within an IoT framework. To provide recommendations and insights for retail chains to overcome challenges and maximize the opportunities presented by IoT in their sustainability journey there by contributing to the existing body of knowledge on sustainability practices in the retail industry, specifically within the context of IoT, and stimulate further research and innovation in this area.

3 Materials and Methods

3.1 Research Design

The research will primarily adopt a qualitative research approach, focusing on in-depth case studies and analysis of industry reports and literature. The research would focus on the case studies and industrial reports. With respect to case studies a sample case studies of different type of retail chains have been selected which have implemented IoT-driven sustainability initiatives. Collect qualitative data through document analysis to gain insights into the implementation process, outcomes, and challenges faced by each case study.

The research also includes review of existing industry reports, sustainability reports published by the organizations, engineering case studies available on the organizations portals, academic literature, and other relevant sources to gather insights, trends, and theoretical frameworks related to IoT-driven sustainability initiatives in retail chains.

Research methods would involve Descriptive analysis to present an overview of the IoT-driven sustainability initiatives, their focus areas, and their impact on environmental and business performance. Will perform competitive analysis based on key metrics to identify leaders in sustainability practices and highlight areas for improvement. Case study analysis will be performed with notable IoT-driven sustainability initiatives will be examined through case studies to provide detailed insights into their strategies, implementation, and outcomes.

Sample Selection: The sample for this study will comprise a diverse range of retail chains from different sectors, including supermarkets, fashion retail, quick-service restaurants, and e-commerce. The selection will be based on the availability of data and information related to their use of IoT for sustainability.

Limitations: The study may have certain limitations, such as the availability of data and information for all retail chains, as well as the reliance on publicly available sources. The findings will be based on the data collected up to 2018-

2021 timeframe and some may not reflect the most recent developments in the retail industry.

Table 2: Retail chains and Sustainability Goals

Sno #	Org	Retail Chain	Net Zero Target	Benefit Statements
1	Sainsbury's[24]	Mass/Hypermarket Retail Chain	2035	13% reduction in our operational food waste tonnage from our 2019/20 baseline
2	Coca Cola[25]	Retain chain for Beverages	2040	Approximately 14% of total beverage volume was served in reusable packaging in 2022
3	Nordstrom [26]	Department Store Chain	NA	Starting from 2014, achieved a 17.1% reduction in energy consumption per square foot, resulting in energy savings equivalent to the annual power consumption of 9,391 homes
4	Walmart[27]	Mass/Hypermarket Retail Chain	2040	
5	7-Eleven[28]	Convenience Store	2050	SEI reduced CO2e emissions by 27% from FY2013 to FY2021.
6	Alibaba[29]	E-commerce	NA	In FY2022, Intime traded 87 million kWh in green electricity, a year-over-year increase of more than 190%, corresponding to around 62,000 tons of emissions reduction.
7	IKEA[30], [31]	Furniture Retail	NA	
8	Amazon[32]	E-commerce	2040	-
9	Target[33]	Super Market Chain	2040	Achieved a 32% absolute reduction in operational emissions, well on our way to achieving our goal of a 50% reduction by 2030.
10	McDonald's[34]	Quick Service Restaurant	2050	We have achieved a 2.9% reduction in the absolute greenhouse gas (GHG) emissions of our restaurants and offices compared to 2015 figures
11	Starbucks[35], [36]	Quick Service Restaurant	2050	-
12	Dominos [37], [38]	Quick Service Restaurant		
13	KFC[39]–[41]	Quick Service Restaurant	2040	
14	H&M[42]	Fashion Retail	2040	
15	Carrefour [43]	Super Market Chain	2040	Normalized for floor area, CO2 emissions associated with energy usage have shown an 8% reduction, declining from 0.169 tCO2/m2 in 2014 to 0.155 tCO2/m2 in 2016

4.2 Role of IoT in Retail Sustainability

Based on the Deloitte CXO Sustainability report 71% have increased the efficiency of energy usage, 57% reduced air travels, 56% started adopting climate friendly products and 71% start adopting sustainable materials. Organization has started outlining the ESG (Environmental, Social and Governance) commitment as part of their core strategy. According to that report, focus has been on emission reduction, waste reduction, circular economy.[44]

Role of Internet of Things (IoT) in Retail Business and Enabling Smart Retailing Experiences is to be properly understood for understanding the impact it can bring on to the sustainability aspects. Hossain mentions about the IoT Ecosystems which can change the customer experience in retail context. He also communicates that it can integrate with the Building Management System (BMS) of a retail store and IoT Platform contributing to increase in sales. [45]. Author further discusses the use case of Amazon Go, Watasale, Zippin to substantiate the same. The research further discusses the challenges in terms of labour cost, Omnichannel reach, rise in millennials some of the challenges at forefront for adoption.

In 2021, Javid Ghahremani Nahr discusses the green supply chain based on AIOT (Artificial Intelligence in IoT) and proposed a framework which can be adopted at supply chain level which can have greater impact in the retail chains as well. In this research advocates Realtime cargo tracking, Monitoring storage status of the product during shipment, predicting product movement upon arrival and determination of the destined warehouse, etc., [46] These initiatives can help sustainability which might call for additional validation and research.

In the recent NRF 2023 (National Retail Federation) conducted in U.S. Outlines the variety in sustainability neds of the customer, it's identified as a continuous process. It also called for sustainable suppliers in the supply chain and collaborating with them is crucial as well. For prioritizing such initiatives data is crucial. It identified that fragmented data protocols and systems might hamper sustainability initiatives.[47]

The following Table 3: Indicative IoT Use cases in retail chain types outlines the various indicative use case or adoption of IoT with respect to different retail chains:

Table 3: Indicative IoT Use cases in retail chain types

Retail Chain Type	IoT Use Cases
Supermarkets/Mass/Hypermarkets	1. Smart shelf management and inventory tracking
	2. Temperature and humidity monitoring for perishables
	3. Automated checkout and contactless payments
	4. Energy-efficient lighting and HVAC systems
Department/Grocery Stores	1. Interactive displays and personalized promotions
	2. Smart fitting rooms with virtual try-on capabilities
	3. Customer traffic analytics for store optimization
	4. Asset tracking for efficient inventory management
Apparel/Fashion Retailers	1. RFID tagging for real-time inventory tracking
	2. Smart mirrors and interactive displays
	3. Virtual assistants for personalized recommendations
	4. Smart hangers for inventory management
Home Goods/Electronics Retailers	1. Interactive product demos and virtual showrooms
	2. Smart shelves for real-time stock updates
	3. Beacon technology for personalized offers
	4. Smart home integration for connected devices
Convenience Stores/Food chains	1. Automated temperature monitoring for food safety
	2. Smart vending machines with remote monitoring
	3. Energy management systems for efficient operations
	4. Mobile apps for frictionless purchases
Online Retailers	1. IoT-enabled supply chain visibility and tracking
	2. Smart packaging for optimized logistics
	3. Personalized customer experiences through IoT data
	4. Warehouse automation and smart inventory systems

These use cases may be providing values in terms of improved customer experience, cost savings, operational improvements. This kind of implementations pave way for the IoT implementation from sustainability context.

4.3 Use cases and Case Studies of IoT in Sustainability Context

As discussed so far in today's rapidly evolving retail landscape, sustainability has become a critical focus for

retail chains across the globe. To address environmental and sustainability challenges, retail chains are increasingly turning to the transformative potential of Internet of Things (IoT) technologies. IoT offers opportunities to integrate sustainability initiatives into various aspects of retail operations. From energy management and waste reduction to sustainable supply chains and customer engagement, IoT enables retail chains to prioritize sustainability in innovative ways.

In this context, the following Table 4: Indicative IoT use case from Sustainability context presents a collection of use cases that illustrate how IoT can be applied to diverse types of retail chains, highlighting their potential contributions to sustainability. These use cases highlight the diverse applications of IoT in optimizing energy consumption, managing waste[48], promoting sustainable practices, and enhancing overall sustainability performance across the retail industry.

Table 4: Indicative IoT use case from Sustainability context

Retail Chain Type	IoT Use Cases for Sustainability
Supermarkets	1. Smart energy management to optimize lighting and HVAC systems
	2. Waste management with smart bins for efficient recycling
	3. Real-time monitoring of refrigeration systems for energy efficiency
	4. Smart irrigation systems for on-demand water usage
Department Stores	1. Smart lighting systems with occupancy sensors for energy savings
	2. Real-time monitoring of water usage for conservation
	3. Sustainable product labelling and tracking with IoT tags
	4. Digital signage for promoting eco-friendly products
Apparel Retailers	1. Sustainable supply chain tracking with IoT sensors
	2. Smart garment hangers for energy-efficient lighting
	3. Interactive displays with sustainability information
	4. Waste reduction through smart packaging and recycling bins
Electronics Retailers	1. Energy-efficient in-store displays and devices
	2. Reverse logistics management for e-waste recycling
	3. Smart power outlets to monitor and reduce standby power
	4. Smart product lifecycle management for repair and refurbishment
Convenience Stores/Food Chains	1. Energy management systems for optimizing lighting and HVAC
	2. IoT-enabled smart shelving for reduced food waste
	3. Real-time monitoring of energy consumption for efficiency
	4. Water leak detection systems for conservation
Online Retailers	1. Sustainable packaging solutions with IoT-enabled tracking
	2. Smart warehouses for optimized inventory and energy usage
	3. Last-mile delivery optimization for reduced emissions
	4. Real-time carbon footprint tracking and reporting

We will analyze and discuss the information presented in the table, drawing insights from the aggregated data, identifying common trends, and highlighting notable case studies. This analysis will shed light on the effectiveness of IoT-driven sustainability initiatives, their impact on environmental sustainability metrics, and their alignment with global sustainability goals.

4.4 Case Studies

Food Waste reduction: Sainsbury's, a UK-based supermarket chain, implemented IoT sensors in its stores to monitor food waste[49][50]. The sensors track temperature, humidity, and expiration dates, alerting store staff when products are at risk of spoilage. This real-time data helps Sainsbury's optimize inventory management, reduce f, and improve overall sustainability by minimizing unnecessary disposal. Sainsbury have introduced “smart fresh” label which can change in color over time as the food becomes inedible. Food waste Reduction by Dynamic Shelf Life Labelling is one of the key strategy for them and this would allow the seller to adjust the use by date and also the HVAC systems accordingly.[51]

Energy Efficient Smart Lighting: Nordstrom, a prominent department store chain, implemented IoT-connected smart lighting systems in its stores. They have reduced our energy consumption per square foot by 17.1%. The lighting systems use occupancy sensors and daylight harvesting capabilities to adjust light levels based on the presence of customers and natural lighting conditions with the help of Energy Management Systems Platform. Their systems gather approximately 300 energy data points and upload them to the cloud every 10 minutes. Platform enables to swiftly generate reports and make informed decisions. This IoT solution plays a pivotal role in reducing energy consumption significantly, ultimately enhancing sustainability and generating cost savings.[52]

Sustainability practice in Operations – Bring your own Bottle: Coca Cola trailing package fewer vending machines which would help to fill their own containers and provide reusable bottles and rinsing station. Coca cola has vending machines which have various capabilities for inventory monitoring, refilling etc., They have sustainability goal of collecting and recycling 100% of

their cans and bottles. This adopts cashless gateway, integrates TV commercials, etc., [53]

HVAC and Energy Management: 7-Eleven, a global convenience store chain, by deploying IoT-enabled technologies and advanced energy management solutions, 7-Eleven has successfully improved energy efficiency, reduced carbon emissions, and minimized environmental impact. Since 2008, more than 10800 high efficiency HVAC unit has been installed. More than 6900 stores have EMS installed which helps in monitoring, control and optimize performance of HVAC.[54]

Smart Warehouse in e-Commerce fulfilment: Alibaba has implemented Smart Warehouse[55] which would have lot of sustainability benefits eventually. By leveraging Internet of Things (IoT) technologies, artificial intelligence, and data analytics, Alibaba has implemented innovative solutions to enhance warehouse operations while minimizing environmental impact. Use of automated robots can minimize or optimize energy usage in terms of mobilizing the inventory. It can directly contribute to minimize vehicle idling, co2 emission through effective inventory mobilization and orchestration.

4.5 Prioritization Approach & Factors

Retail chains can prioritize IoT initiatives that align with their sustainability goals, have a significant impact on environmental performance, and are feasible and cost-effective to implement. This approach ensures that resources and efforts are focused on initiatives that offer the most value in driving sustainability within the retail chain. For retain chains to adopt and reap such benefits attempted to provide an approach and focus areas for taking sustainability initiatives in the context of IoT as given in the Figure 2: Goals and Approach for sustainability with IoT.

To establish sustainability goals for IoT initiatives in retail chains, key metrics to consider include: energy efficiency, waste reduction, water conservation, supply chain sustainability, customer engagement, operational efficiency, ROI, and environmental impact. These metrics help measure energy savings, waste diversion, water optimization, carbon emissions, customer involvement, productivity gains, financial performance, and environmental outcomes. By incorporating these metrics, retail chains can develop comprehensive sustainability goals for their IoT initiatives.

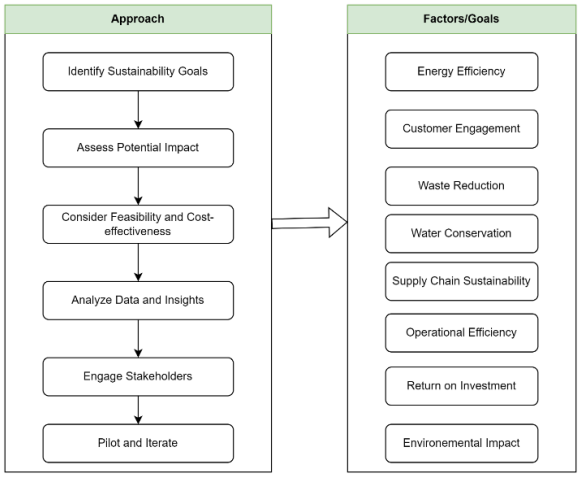

Figure 2: Goals and Approach for sustainability with IoT

4.6 Appropriate Prioritization frameworks

The prioritization of the IoT initiatives which one to take it up first could be a major challenge. Prioritization frameworks are crucial[56], [57] for effective decision-making by providing structure and transparency. They ensure consistent evaluation of initiatives, optimize resource allocation, and align with strategic goals. By utilizing specific frameworks, organizations can evaluate initiatives based on criteria such as impact, feasibility, risks, and stakeholder input. This promotes efficient resource allocation, minimizes biases, and fosters strategic alignment. Moreover, frameworks enable organizations to proactively manage risks, streamline decision-making processes, and focus on initiatives that contribute most significantly to sustainability objectives. By incorporating prioritization frameworks, organizations can make informed choices, maximize goal achievement, and drive positive outcomes in their sustainability efforts.

Some of the prioritization framework which can be leveraged in the Sustainability context are outlined in the table as recommendation:

Table 5: Prioritization Framework for sustainability context

Sno	Framework	Purpose
1	TBL – Triple Bottom Line[58]	The TBL framework evaluates initiatives based on their social, environmental, and economic impacts. It considers the sustainability outcomes across these three dimensions and prioritizes initiatives that demonstrate positive outcomes in all areas.
2	Life Cycle Sustainability	LCSA evaluates the environmental impacts of products or processes throughout their life cycle, from

	Assessment (LCSA)[59]	production to disposal. Applying LCA to IoT initiatives helps prioritize those that minimize environmental impacts and resource consumption across the entire life cycle.
3	Sustainability Framework [60]	It helps define vision and strategy, sustainability goals and objectives, their alignment with Sustainable Development Goals and your key performance indicators (KPIs).

The prioritization of sustainability initiatives (Table 5: Prioritization Framework for sustainability context) in retail organizations is influenced by several key factors. Firstly, the environmental impact plays a crucial role, with a focus on addressing challenges like carbon emissions, waste reduction, and resource conservation. Secondly, the business case is considered, including the potential financial benefits, cost savings, and improved brand reputation associated with sustainability initiatives. Stakeholder expectations also drive prioritization, as organizations strive to meet the demands of customers, employees, investors, and local communities. Furthermore, benchmarking against industry best practices and ensuring regulatory compliance are important factors. The growing consumer demand for sustainable products and responsible practices further motivates prioritization. Supply chain integration, technological feasibility, and the long-term impact of initiatives are additional considerations that organizations consider. By balancing these factors, retail organizations can effectively prioritize and allocate resources to achieve meaningful and impactful sustainability outcomes. The global SDG goals are seemed to be mapped and evident in the sustainability reports.

4.7 Findings and Discussions

The case studies discussed highlight the significant sustainability benefits achieved through the integration of IoT technologies in various retail chain types. Sainsbury's implementation of IoT sensors for food waste reduction showcases how real-time data monitoring can optimize inventory management and minimize unnecessary disposal. By tracking temperature, humidity, and expiration dates, Sainsbury's can prevent spoilage and improve overall sustainability. This approach is particularly valuable for grocery retail chains that deal with perishable products. Similarly, Coca-Cola's adoption of package-less vending machines and reusable bottles exemplifies the use of IoT-enabled solutions to promote sustainable practices. By integrating cashless payment systems, inventory monitoring, and refilling capabilities, Coca-Cola reduces waste and contributes to their goal of 100% collection and recycling of cans and bottles. This case study highlights the potential of IoT technologies in the beverage industry, allowing retailers to reduce single-use packaging and encourage more environmentally friendly practices. The sustainability impact in retail chains would greatly impact when the number of stores is high in the retail chains.

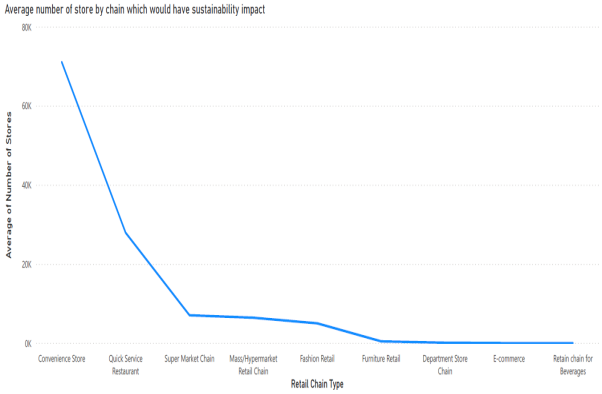

Figure 3: Sustainability impact in retail chains

Furthermore, the case studies demonstrate how IoT-driven sustainability initiatives can be implemented across different retail chain types. Nordstrom's smart lighting systems, powered by IoT technologies, significantly reduce energy consumption in their department stores. By utilizing occupancy sensors and daylight harvesting capabilities, Nordstrom optimizes light levels based on customer presence and natural lighting conditions, resulting in improved energy efficiency. This example showcases the application of IoT in large-scale retail chains, emphasizing the potential for energy savings and sustainability improvements. Additionally, 7-Eleven's deployment of IoT-enabled technologies and advanced energy management solutions highlights the impact on sustainability in convenience store chains. Through the installation of high-efficiency HVAC units and Energy Management Systems (EMS), 7-Eleven achieves enhanced energy efficiency, reduced carbon emissions, and minimized environmental impact. This case study illustrates how IoT technologies can be utilized to optimize energy consumption and address sustainability challenges specific to convenience store operations.

Table 6: Sustainability Initiatives summary

Retail Organization	Sustainability Initiatives
Sainsbury's	Food waste reduction through IoT sensors, Energy-efficient smart lighting systems
Coca Cola	Trailing package-less vending machines, Recycling 100% of cans and bottles
Nordstrom	Implementation of IoT-connected smart lighting systems, Energy management solutions
Walmart	Renewable energy adoption, Sustainable sourcing practices
7-Eleven	HVAC and energy management with IoT, Energy efficiency initiatives

Alibaba	Smart warehouse operations with IoT, Inventory mobilization optimization
IKEA	Renewable energy investment, Sustainable product design and sourcing
Amazon	Packaging waste reduction initiatives, Electric delivery vehicles
Target	Energy-efficient store design, Waste reduction and recycling programs
McDonald's	Sustainable sourcing of ingredients, Energy-efficient restaurant operations
Starbucks	Recycling and reusable cup initiatives, Sustainable coffee sourcing
Subway	Sustainable packaging and waste reduction, Energy-efficient restaurant operations
Dominos	Efficient delivery route planning, Packaging waste reduction initiatives
KFC	Sustainable chicken sourcing, Waste reduction and recycling programs
H&M	Sustainable materials and manufacturing, Garment recycling initiatives
Zara	Eco-efficient store design, Supply chain transparency initiatives
Carrefour	Renewable energy adoption, Waste reduction and recycling programs

The Table 6: Sustainability Initiatives given above broadly summarizes the various initiatives which are considered by the organization. The prioritization of these initiatives would be based on the various factors including the revenue of the organization. For example, organizations like Walmart having more than $550 billion dollar in revenue is directly focusing on the sustainability sourcing practices which might have in the downstream supply chains.

Overall, these case studies and studies made underscore the broad range of sustainability benefits that can be achieved through the implementation of IoT-driven initiatives in retail chains. The examples demonstrate the potential for waste reduction, energy efficiency improvements, and the promotion of reusable practices across different types of retail chains, including supermarkets, department stores, and convenience stores. The successful integration of IoT technologies in these contexts highlights the versatility and transformative power of IoT in driving sustainability in the retail industry.

5 Conclusion

In conclusion, the prioritization of IoT-driven sustainability initiatives in retail chains holds immense potential for driving positive environmental, social, and economic outcomes. By exploring case studies and gaining industry insights, this paper has shed light on the significance of prioritizing such initiatives and the challenges and opportunities associated with their implementation. The case studies highlighted the diverse applications of IoT in retail chains, ranging from food waste reduction and energy-efficient lighting to sustainable operations and smart warehousing. These examples showcased the tangible benefits that can be achieved through the integration of IoT technologies in retail chains. The trend seems to be more forwards towards sourcing, packaging as most of the retail chains are dependent on the suppliers and franchises for their operations. So different retail chain types are seeming to be similar strategies. For example, Fashion retail focus on sustainable sourcing and materials.

The discussion emphasized the need for a systematic approach to prioritize IoT initiatives, considering sustainability goals and objectives. Various frameworks, such as the Triple Bottom Line, Life cycle Sustainability assessment, Sustainability Framework helps to align with strategic objectives, optimize resources, and mitigate risks, thereby maximizing the positive impact on sustainability. Future research could contribute to the areas of specific metrics and its impact for prioritization in the context of Consumer behaviour or experience. Also, research can be made in validating the adoption of framework and its impact in the industry. In the future we there is scope to understand the volume and scale of the initiative and its impact to the SDG Goals and its policies.

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