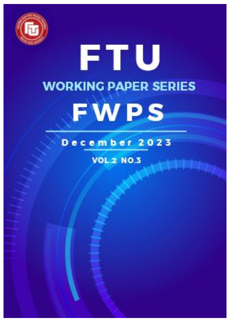

Working Paper 2023.2.3.3
- Vol 2, No 3

PHÂN TÍCH LOGISTICS NGƯỢC CỦA APPLE NHẰM THÚC ĐẨY CÁC HOẠT ĐỘNG BỀN VỮNG

Phan Thế Anh[1], Nguyễn Ngọc Hùng, Ngô Ngọc Chi, Hoàng Năng Đức, Lê Thảo Linh, Hoàng Phúc Nam

Sinh viên K60 CLC Kinh tế đối ngoại – Viện Kinh tế và Kinh doanh quốc tế

Trường Đại học Ngoại thương, Hà Nội, Việt Nam

Nguyễn Thị Yến

Giảng viên Viện Kinh tế & Kinh doanh quốc tế

Trường Đại học Ngoại thương, Hà Nội, Việt Nam

Tóm tắt

Logistics ngược (RL) là quá trình quản lý việc trả lại, tái sử dụng hoặc xử lý sản phẩm sau khi chúng được giao cho khách hàng. RL đặc biệt quan trọng trong ngành công nghệ, nơi các sản phẩm có vòng đời ngắn và tạo ra một lượng lớn rác thải điện tử. RL có thể giúp đạt được tính bền vững bằng cách giảm tác động đến môi trường, tiết kiệm chi phí và nâng cao sự hài lòng của khách hàng. Bài viết này nhằm mục đích khám phá hệ thống RL của Apple, một trong những công ty công nghệ hàng đầu thế giới và cách hệ thống này góp phần vào sự bền vững ở ba khía cạnh: kinh tế, môi trường và xã hội. Bài viết phân tích dữ liệu thứ cấp từ nhiều nguồn khác nhau, bao gồm nghiên cứu khoa học, đánh giá tài liệu và báo cáo chính thức từ Apple. Bài viết nhận thấy rằng hệ thống RL nói chung và các phương án tái chế trong giai đoạn xử lý nói riêng có tác động tích cực đến tính bền vững ở cả ba khía cạnh. Tuy nhiên, bài viết cũng chỉ ra một số hạn chế, rào cản trong việc triển khai hoạt động RL và đề xuất một số giải pháp để Apple khắc phục những trở ngại này, nâng cao hiệu quả hoạt động RL.

Từ khóa: Apple, xử lý, logistics ngược, sự bền vững

JEL: Q56

[1] Tác giả liên hệ, Email: k60.2111110020@ftu.edu.vn

APPLE INCORPORATED'S REVERSE LOGISTICS STRATEGY FOR ADVANCING SUSTAINABLE PRACTICES

Abstract

Reverse logistics (RL) is the process of managing the return, reuse, or disposal of products after they have been delivered to customers. RL is especially important in the technology industry, where products have a short life cycle and generate a large amount of electronic waste. RL can help achieve sustainability by reducing environmental impacts, saving costs, and enhancing customer satisfaction. This paper aims to explore the RL system of Apple, one of the leading technology companies in the world, and how it contributes to sustainability in three aspects: economic, environmental, and social. The paper analyzes secondary data from various sources, including scientific studies, literature reviews, and official reports from Apple. The paper finds that RL systems in general and recycling options in the disposition stage in particular have positive effects on sustainability in all three dimensions. However, the paper also identifies some limitations and barriers in the implementation of RL activities and suggests some solutions for Apple to overcome these obstacles and improve its RL performance.

Keywords: Apple, disposition, reverse logistics, sustainability

JEL: Q56

---

1. Introduction

Reverse logistics (RL) is concerned with the backward movement of goods from suppliers to consumers (Hazen, 2011). Product disposition, a key process of RL, involves activities associated with making a decision about what to do with used or returned products (Prahinski & Kocabasoglu, 2006). Reverse logistics offers environmental and economic benefits, and can enhance a company's reputation and customer satisfaction by providing efficient and effective return and repair services (Waqas et al., 2018). Apple Incorporated (Inc.), a multinational technology company, is efficiently implementing reverse logistics to reduce waste, save costs, and increase customer satisfaction, with multiple means such as the Apple GiveBack program or Battery Replacement services.

Sustainability in logistics refers to the practice of applying environmentally friendly and socially responsible processes and practices throughout the logistics supply chain. This includes reducing carbon emissions, using environmentally friendly transportation methods, and applying sustainable packaging and materials (Banguera Arroyo et al., 2023). Apple has performed several initiatives to achieve this goal, such as using only renewable energy sources for its operations and supply chain, cutting down its emissions by 40 percent since 2015 and aiming to be carbon neutral by 2030, utilizing more recycled or renewable materials in its products and packaging, and improving its transportation efficiency by using more rail and sea freight, better packaging, and lower-carbon vehicles and fuels (Apple, 2022b). These initiatives help Apple reduce waste, save costs, and increase customer satisfaction.

Our contributions are threefold. Firstly, it examines Apple Inc.'s RL processes, offering insights into its strategies for handling product returns and end-of-life devices. Secondly, it analyzes the impact of these RL processes on sustainability across economic, environmental, and social dimensions. Lastly, it identifies the positive outcomes and barriers that Apple encounters in its pursuit of sustainability goals while implementing RL and provides recommendations.

The study collects data from several sources, including journal articles, Apple's official reports, and publicly available records. An approach using qualitative case study methods is employed to analyze the research questions. This study seeks to address the following questions:

- How does Apple Inc. implement and manage its RL processes, and what are the key strategies and practices involved?
- To what extent do Apple's RL processes contribute to sustainability in terms of economic, environmental, and social dimensions, and what are specific outcomes within each dimension?
- What are the positive results achieved and the barriers encountered by Apple in its pursuit of sustainability objectives through the integration of RL practices, and what are certain remedies that can be applied?

The paper is structured into three main sections. The first section establishes the theoretical framework by exploring RL, sustainability, and their interconnectedness. The second section presents a detailed case study of Apple's RL practices in the context of sustainability, covering Apple's RL processes and their effectiveness. The third section engages in a focused discussion, addressing the barriers faced during RL implementation and providing specific recommendations for Apple's sustainable supply chain management.

2. Theoretical framework

2.1. Reverse logistics

The first known definition of reverse logistics was published by the Council of Logistics Management (CLM) in the early nineties (Stock & Management (U.S.), 1992), covering all logistics activities such as recycling, waste disposal, source reduction, product returns, reuse ,substitution of materials, and repair. However, this definition is quite broad, covering a list of activities that are conducted in reverse logistics.

Since then, a number of definitions have been proposed and research publications on reverse logistics in both a broad and a detailed view of many different sectors have emerged increasingly. Rogers & Tibben-Lembke (1999) illustrated reverse logistics and its objectives sufficiently as the process of planning, implementing, and controlling the efficient, cost-effective flow of raw materials, in-process inventory, finished goods, from the point of consumption to the point of origin with an aim of recapturing value or proper disposal. Basically, reverse logistics, as opposed to forward logistics, is the transfer of goods or materials from the point of consumption to the point of origin with the emphasis on value restoring and appropriate disposal of products. Similarly, the goal of reverse logistics, stated by Banguera Arroyo et al. (2023), is to minimize waste and maximize the value of goods and resources by effective planning and management, which includes duties such as product returns, repair and refurbishment, and end-of-life product disposal.

As shown in **Figure 1**, according to Stoyanov (2012), the key processes of reverse logistics include five steps: (1) Gate-keeping; (2) Collection; (3) Inspection/Selection/Sorting; (4) Disposition; (5) Redistribution.

Figure 1: Main process of reverse logistics

Source*: Stoyanov (2012)*

Gate-keeping process is the classification procedure to determine which products can be added in the return stream with the purpose of recovery or proper disposal. In some cases, the acquisition of used products and components is carried out from not only the end customers or users but also the markets (Abdelshafie et al., 2021).

Collection is an important process usually conducted by the service third-party and intermediaries with the purpose of gathering return products to the recovery point.

Inspection process is to disassemble, test, sort and evaluate the discarded products at the recovery place, allowing for identifying the product characteristics and level of quality. Based on this information, the appropriate treatment will be selected.

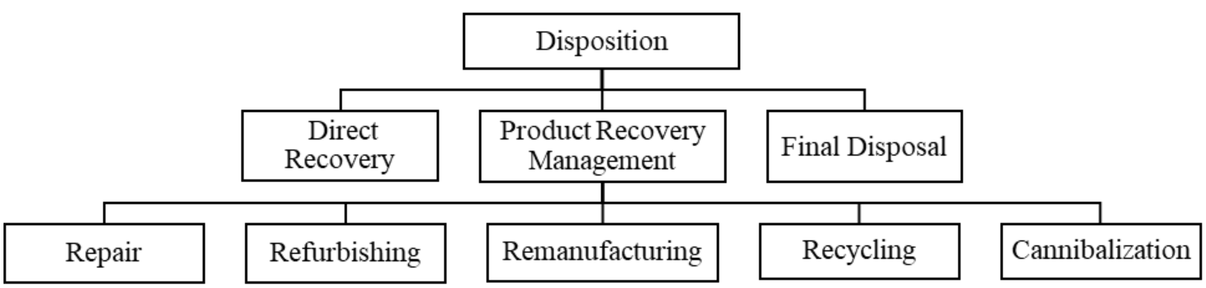

Figure 2: Disposition options of reverse logistics

Source*: Thierry et al. (1995)*

The disposition processes (**Figure 2**) according to the degree of disassembly are classified into direct recovery, product recovery management and final disposal group (Thierry et al., 1995). If the goods are deemed to be "as-good-as-new" or the state of the returns is satisfactory enough, the companies will operate the reuse or the direct recovery. In a different scenario, the returned products that fail to perform their function will be transferred to product recovery management.

The five primary activities that constitute product recovery are repair, refurbishing, remanufacturing, recycling and cannibalization. All these activities are described clearly in **Table 1** shown below.

Table 1: Product recovery management of disposition

	Definition
Repair	The fixing and/or replacement of broken parts while other parts are basically not affected.
Refurbishing	The process to bring used products up to specified quality standards that are less rigorous than that for new products.
Remanufacturing	The process to bring used products up to specified quality standards that are as rigorous as that for new products.
Recycling	The process to reuse materials from used products and components to produce new parts.
Cannibalization	The process to recover a limited set of reusable parts from used products or components for repair, refurbishing or remanufacturing of other products or components.

***Source**: Thierry et al. (1995)*

Following either product recovery management or direct recovery, the products will proceed to the following phase, which is redistribution. Disposal is the last disposition option, applied when recovering the value of the discarded goods is impossible. The final disposal can be implemented by either incineration or landfill.

Redistribution, the final step in reverse logistics, involves pushing the reconditioned products, materials, and components back into forward logistics by distributing the goods to the marketplaces in an effort to draw in new clients.

2.2. Sustainability in the logistics

Sustainability, also known as sustainable development, is defined as the process of development based on three pillars to meet “the needs of the present without compromising the ability of future generations to meet their own needs” (United Nations Brundtland Commision, 1987). The three pillars of sustainability, including the advancements in environmental, social and economic domains, are also referred to as the triple bottom line (TPL) or the three dimensions of performance.

Specifically, Banguera Arroyo et al. (2023) stated that sustainable logistics refers to the implementation of socially and environmentally responsible practices throughout the logistics process. Some activities to achieve sustainability in logistics are to reduce carbon emissions, utilize sustainable packaging and materials, ensure fair treatment of workers, promote ethical business practices and use eco-friendly transportation. Furthermore, thanks to the advanced technology in the Industry 4.0 era, logistics sectors have been placed in favorable position to take advantage of opportunities for improving economic efficiency, environmental impact and social performance (Sun et al., 2021). Thus, along with the technology transformation, the capability to balance the trade-offs among the three dimensions of sustainability plays a major role in the optimization of the sustainable logistics system.

2.3. The relationship between reverse logistics and sustainability

Effective RL programs can enhance customer happiness, reduce expenses, and raise profits, all of which can contribute to sustainable development and provide businesses a competitive edge (Rogers & Tibben-Lembke, 1999). By offering rapid and economical return and repair services, RL can improve a business's reputation and increase customer happiness while also having positive environmental and financial effects (Waqas et al., 2018; Zhang et al., 2022).

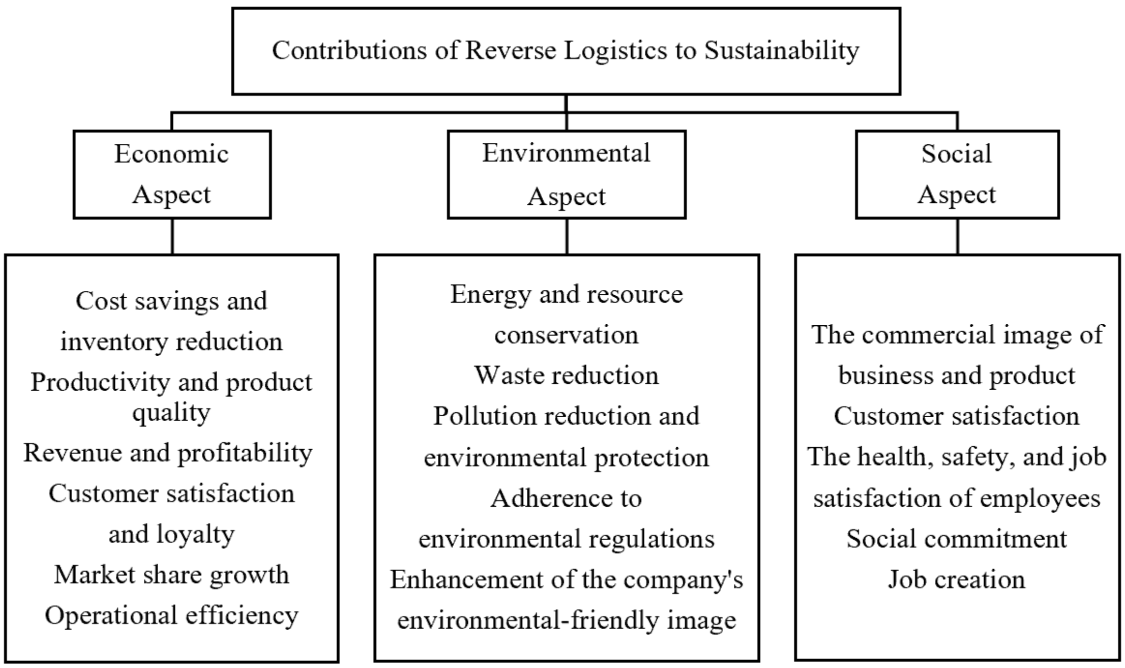

Figure 3: Reverse logistics impact on three pillars of sustainability

Source*: Hương et al. (2023)*

Regarding the pillar of economics, RL influences business's financial performance with a primary emphasis on six key areas: cost savings and inventory reduction, productivity and product quality, revenue and profitability, customer satisfaction and loyalty, market share growth, and operational efficiency (Hương *et al.*, 2023). Among these benefits, cost savings are the most frequently discussed in research (Pawar et al., 2021; Padmanabh & Jeevananda, 2019). Pawar et al. (2021) showed that RL can help reduce production costs by nearly 25% and increase business productivity by approximately 10%, while Grabara et al. (2014) demonstrated that businesses using recycled materials in their products can save up to 60% in estimated costs compared to new products. Govindan et al. (2015) studies show that RL improves productivity and enhances product quality. Furthermore, Geng et al. (2017), based on experimental research results in emerging Asian economies, confirmed the positive influence of RL on productivity and product quality improvement for businesses.

In the context of ecological sustainability, RL exerts direct and indirect effects on sustainable development through five primary dimensions: energy and resource conservation, waste reduction, pollution reduction and environmental protection, adherence to environmental regulations, and enhancement of the company's environmental-friendly image (Hương *et al.*, 2023). According to Yu (2018), environmental efficiency can be improved by up to 18.2% through the implementation of RL operations. Study by Geng et al. (2017) indicates that RL promotes the utilization of alternative resources. This not only results in cost-effectiveness but is also environmentally friendly by extending the product lifespan, thus conserving energy and resources. Furthermore, as suggested by Alnoor et al. (2019) and Ali et al. (2018), RL helps reduce waste generated during production and consumption, contributing to environmental pollution reduction. In addition, implementing RL activities aids companies in complying with government environmental regulations, thus reducing environmental incidents (Shaik & Abdul-Kader, 2018; Diabat et al., 2013). The adoption of RL practices also helps companies enhance their environmentally-friendly image (Diabat et al., 2013; Keh et al., 2012).

Concerning social impact, five main aspects of RL are considered: the commercial image of business and product, customer satisfaction, the health, safety, and job satisfaction of employees, social commitment, and job creation. The findings from Alnoor et al. (2019) demonstrate that RL creates employment opportunities, increasing people's income, and thereby improving the health and safety of both employees within the business and the general population. These findings are consistent with the research conducted by Keh et al. (2012), which is a notable example of the success of RL at IBM Montpellier, where worker employment creation was acknowledged. This job creation effect is also acknowledged by the U.S. Environmental Protection Agency (EPA). The EPA estimates that every 10,000 tons of raw materials lead to one job in the incineration stage, six jobs in the landfill stage, 36 jobs in the recycling stage, and generate jobs for approximately 28 to 296 individuals in the recycling business (Kaihan & Chin, 2021). Agrawal et al. (2016) underscore the substantial role of recycling and reusing in fostering job prospects and societal progress. Additionally, this research emphasizes that businesses exhibit social responsibility through the implementation of RL. As a result, the commercial image of the business and the image of its products are enhanced (Shaik & Abdul-Kader, 2018; Younis et al., 2016), leading to increased consumer satisfaction (Simoes et al., 2017).

Therefore, this paper aims to comprehensively assess the impact of Apple's reverse logistics system through five steps: (1) Gate-keeping; (2) Collection; (3) Inspection/Selection/Sorting; (4) Disposition; (5) Redistribution on ecological, environmental, and social sustainability indicators.

3. A look at Apple's reverse logistics

3.1. Overview of Apple

Apple Inc. is a globally operating technology corporation headquartered in Cupertino, California. Apple is known for its excellence in creating, producing, and delivering consumer devices, software, and online services.

According to Statista, Apple generated $394.3 billion revenue in 2022, making it the most valuable technology company in the world (Macrotrends, 2023). The company's product portfolio includes a range of technologically advanced devices, such as the iPhone, iPad, Mac desktops, Apple Watch, and Apple TV, among other offerings. These products are composed of different materials, such as aluminum, glass, plastic, steel, and rare earth elements.

Apple has received praise for its dedication to sustainability in terms of economic efficiency, environmental protection and social responsibility. As specified in Apple's 2022 Environmental Progress Report, the company aims to minimize its environmental impact by lowering greenhouse gas emissions, conserving resources, and using renewable energy sources (Apple, 2023a). Apple has also implemented recycling programs and activities to encourage the proper disposal and reuse of its goods. The company has over 500 Apple Stores and more than 5,000 Apple Authorized Service Providers around the world, where customers can purchase, repair, or recycle their devices (Apple, 2019b; Niall McCarthy, 2021). Through its reverse logistics practices, Apple tries to maximize the recovery and recycling of materials from its products, prolonging their lifespan and reducing waste. Apple's goal is to make a significant contribution to the sustainability of the technology industry by integrating sustainable practices into its supply chain and operational processes.

3.2. The implementation of reverse logistics of Apple and sustainability assessment

Apple Inc. has been a pioneer in implementing reverse logistics, recognizing it as a valuable component of their supply chain management. The company understands that effective reverse logistics can lead to direct benefits such as cost savings, improved customer satisfaction, and enhanced sustainability. The following four sections delve deeper into the specific processes and strategies that Apple employs in their reverse logistics operations.

3.2.1. Apple's classification of eligible goods for return & restoration

Apple sees returns management as a competitive advantage that helps optimize value recovery for returned items, in contrast to many other firms that may see returns as a cost center. It has introduced a thorough return policy for items called the Apple GiveBack program, which allows customers to trade in their old devices for discounts on new products. It is stated that you may only return things to Apple if you bought them directly from Apple, online or at one of their retail locations. Apple items bought from other shops need to be returned in line with that stores' specific refund and return policies (Apple, 2023b). With its stringent quality control, Apple does not accept products that are severely damaged or abused, and customers must provide details about their device, including its model, specifications, and condition. Apple will then evaluate the condition of the returned product and decide whether it is eligible for return and potential recovery. The accepted returned goods only then proceed to the collection stage and are shipped back to the factory where they are disassembled and recycled to create new parts that are utilized to make new gadgets (Team, S. 2022). By developing this program, Apple not only provides customers with an incentive to upgrade their devices and a convenient way to dispose of their old ones but also reduces the environmental impact of its products and saves on raw materials and manufacturing costs.

3.2.2. Collection & inspection

Apple collects outdated models and returns them to their manufacturers using tracking techniques like shipping and packaging labels to guarantee proper and prompt handling (Aaron Smith, 2017). In order to collect the items, it also collaborates with other service providers and middlemen like electronic merchants, e-waste recycling businesses, or manufacturer take-back initiatives. In 2019, Apple made a major expansion of its recycling programs by which customers could return their iPhone to Best Buy stores throughout the US and KPN retailers in the Netherlands. During that year, a new manufacturer take-back initiative called Material Recovery Lab was also established in the US to help Apple discover innovative solutions involving machine learning & robotics for traditional methods like collection, sorting and shredding (Apple, 2019a).

Once the old models are collected, they are sent back to factories. This is where the inspection process begins. To ascertain the device's trade-in worth or recycling eligibility, Apple assesses the physical components, general operation, and attractiveness. The returned products are thoroughly examined, and this action involves high costs as it requires Apple Inc. to go through some progress of cleaning, repairing, disassembling, and testing (Panha, 2018). Apple also offers instructions and tools to assist users in appropriately backing up their data and ensuring a seamless transfer.

3.2.3. Disposition options

Apple’s reverse logistics system employs two main disposition strategy groups: repair & refurbish, and recycling & cannibalization. The repair & refurbish strategy involves mending and restoring returned products to a near-new condition, extending the product lifecycle and providing cost-effective options for customers. The recycling & cannibalization strategy involves extracting valuable components from returned products for use in new devices, contributing to waste reduction and efficient resource use. Remanufacturing is not commonly employed in Apple’s system due to the rapid technological advancement rendering older models obsolete and the high costs and complexity associated with remanufacturing, making it a less viable option for Apple.

a. Repair & refurbish

After each device is thoroughly examined to ensure it meets Apple’s high-quality standards in the inspection stage, if a device is found to be defective or missing parts, it is repaired or refurbished using newly produced parts or recycled parts from other returned devices (Muthukumar & Purkayastha, 2011). Extending the lifespan of products is an effective utilization of the resources invested in their creation. The reconditioning and reuse of products play a pivotal role in mitigating the environmental impact of each device, particularly in terms of carbon intensity over its operational lifetime. Apple is committed to prolonging the longevity of its products by designing them to be used by multiple owners and facilitating customer device exchanges for upgrades. Multiple initiatives, such as Apple Trade In, the iPhone Upgrade Program, AppleCare, and the corporate Hardware Reuse Program, have been implemented to collect devices for refurbishment and reuse.

Besides improving its repair and refurbishment strategies, Apple has also applied strategies to expand product lifetime by designing more durable products, offering customers more repair options and making repairs more accessible and affordable at the same time. For example, the iPhone 14 and iPhone 14 Plus boast an increased number of repairable components compared to their predecessors. These models have undergone an internal redesign that enhances the repairability of the back glass and simplifies access to internal components, making repairs more convenient. This new design separates the aluminum housing from the back glass, eliminating the need to replace the entire housing when repairing the back glass. They also come with enhanced durability features and improved water resistance. Additionally, starting from 2018 with the product 13-inch MacBook Air with a Retina display and newer models, battery replacement has been made easier with stretch-release adhesive, allowing for easier access to components (Apple, 2023a). Furthermore, Apple has expanded the availability of repair parts in various countries worldwide to support vintage products for up to seven years. For instance, a program for Mac notebooks allows battery repairs to be performed up to 10 years after the product's last distribution.

b. Recycling & cannibalization

Once the devices are collected and inspected, they are sent back to Apple’s factories. Here, each device undergoes a process known as cannibalization. Cannibalization is the selective dismantling of pre-owned products to examine and salvage usable components. The recovered components must adhere to strict quality criteria, which vary according to their intended use. Particularly, the taken apart products are inspected and tested by Apple’s technicians, who identify the functional parts or components, such as screens, cameras, speakers, microphones, or logic boards. The functional parts or components are then reused in other products or services, such as refurbished or repaired devices, replacement parts, or donations to charity (Hays, 2023).

The recycling process allows Apple to reuse parts from previous models in their newer products. The collected products are then sent to Apple’s recycling facilities, where they are disassembled by Apple’s recycling robots, such as Daisy and Dave. These robots use advanced technology to separate and sort the materials from the products, such as aluminum, glass, plastic, steel, rare earth elements, tungsten, cobalt, and gold. The separated and sorted materials are then processed and refined by Apple’s recycling partners, with strict standards for smelters and refiners. The processed and refined materials are then used to make new products or components, such as new iPhone devices, Taptic Engines, or solder for logic boards (Apple, n.d.; Baterna, 2021).

Apple's recycling efforts are a vital component of their commitment to sustainability. Apple has actively engaged in product take-back and recycling collection initiatives in nearly all the countries where they market their products. Moreover, Apple continually seeks out top-tier recyclers who hold regional certifications like Weeelabex, e-Stewards®, or R2, while also expanding its collaborations with recyclers globally (Apple, 2023a). Apple conducts regular evaluations of these recyclers to ensure they comply with labor and human rights, security, and environmental, health, and safety (EHS) standards, regulations, and best practices, conducting 61 recycler assessments in 2022 (Apple, 2022c). They increasingly target specialized providers capable of handling specific material streams, aiming to enhance both the quantity and quality of materials recycled.

To increase product recovery rates, Apple has been conducting multiple training and education courses for its partnering recyclers. Recyclers will receive useful information to enhance their productivity, quality, and capacity. Apple also helps these partners develop the capacity to dismantle their devices in order to optimize material recovery and minimize waste. For example, Apple has recently included the new Studio Display and some iPhone models to the Apple Recycler Guides in 2022 (Apple Inc., 2022). The technical team has created these recommendations to help recyclers optimize their recovery operations and make sure they can be implemented with tools and methods that are available to a wide range of experienced recyclers. These manuals give insightful analyses of the recycling procedure and suggestions for sending dismantled components to the best downstream facilities for resource recovery. By putting in place a lean manufacturing instructional program, the business also supports initiatives to improve recycling capacity, quality, and efficiency in partnership with U.S.–based recycling providers through the Apple Education Hub. Adopting lean techniques and management systems may improve economic viability, solve safety issues, and increase employee engagement.

The company has also unveiled Daisy, a recycling robot that can quickly and easily disassemble iPhones and other products in 2018 (Rossignol, 2018). It is an improved version of Apple's previous deconstruction robot, Liam, which was created in 2016. Daisy does a preliminary scan of the device to identify its model and accurately count the number of parts before starting the disassembly process. Additionally, it dismantles the gadget piece by piece using a range of attachments and suction cups, retrieving a plethora of priceless components that may be utilized in other items. This robot can distinguish between at least nine distinct smartphone models, disassemble up to 200 of them in an hour, and collect 1.2 million phones annually, all while effectively sorting the materials that are retrieved.

3.2.4. Apple’s redistribution

Apple has different ways of redistributing the products that are returned by customers or discarded by Apple. Apple sells the returned or discarded products through various channels, such as its online store, retail stores, or third-party resellers. The products that are sold are either new, refurbished, or repaired, and have lower prices than the original products. Apple ensures that the products that are sold meet its quality standards and provides warranty and support services for them. The resold products also come with a one-year warranty and 90 days of complementary technical support (Owen, 2021). Apple also gives the returned or discarded products to various organizations, such as schools, nonprofits, or communities. These donated products are used for educational, social, or environmental purposes. Apple collaborates with organizations that share its values and vision, and provides training and support for the recipients of the given products (Ross, 2020). The company also uses the returned or discarded products for its own purposes, such as testing, research, or development to improve products, services, or processes.

Apple’s approach to redistribution in reverse logistics is multifaceted and highly efficient. The Trade-in Program is one of the solutions that not only encourages customers to return their old devices but also allows Apple to effectively redistribute reconditioned products back into the market. Additionally, the diversification of the supply chain also helps with the redistribution of reconditioned products by ensuring that production and distribution are not concentrated in a single location. Following Covid lockdowns that interrupted production, Apple has taken action to diversify its supply chains, moving away from China and toward Vietnam and India. It was set to shift 5% of global iPhone 14 production to India by late 2022 and is expecting to produce 25% of all iPhones in India by 2025 (Reuters, 2022). Apple has also implemented a ship-from-store strategy by serving customers living within 100 miles of an Apple store (Solomon, 2020). The shift means faster deliveries for customers who live closer to stores than to distribution centers. This strategy can boost the redistribution of reconditioned products by ensuring that they reach customers quickly and efficiently.

3.3. Assessment of Apple’s reverse logistics strategy

3.3.1. Economic - Social - Environmental analysis

a. Economic

From an economic standpoint, Apple has achieved remarkable success. By the end of 2018, the best-selling iPhones were experiencing a decline in sales. This was primarily attributed to the fact that iPhones had become more expensive than ever before, causing even dedicated Apple fans to consider skipping annual upgrades (Barkho, 2019). To address this challenge, Apple introduced trade-in and financing options such as the GiveBack program, which had a positive impact on the company's revenue by the end of 2018. As a result, in 2022, over 12.1 million devices and accessories found new owners for reuse, each refurbished and reused item contributing to a reduction in the overall environmental footprint (Apple, 2022a). These reclaimed components can either replace existing parts or find new applications in creative ways. Apple is continuously broadening the range of components that can be salvaged and refurbished to meet their high-quality and performance standards, and repurposed as replacements. This approach minimizes the necessity to manufacture spare parts for device repairs.

According to Laricchia (2023), global Apple sales experienced a slight dip in 2019 but rebounded in the subsequent three years, ultimately reaching $394.23 billion in revenue by 2022. During this period, Apple's strategies, including trade-in and financing options, has also helped the company not only boost its sales but also increase its market share. By 2022, the iPhone has captured nearly 18% of the global smartphone market as illustrated in **Figure 4**, solidifying Apple's position as a major player in the industry.

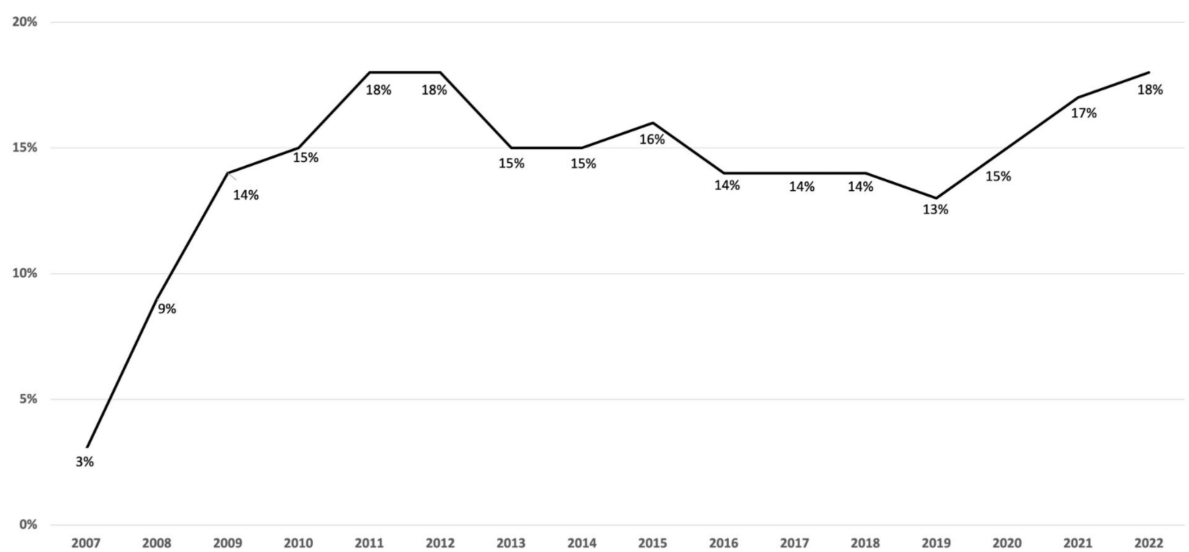

Figure 4: Apple iPhone annual market share from 2007 to 2022

***Source**: Counterpoint (2023)*

By reusing parts from old models in newer products, Apple can reduce production costs and manage inventory more effectively. Recycling also contributes to revenue growth and profitability, as it allows Apple to offer discounts on new products, thereby attracting more customers, enhancing customer satisfaction and potentially increasing market share. Apple's recycling initiative, epitomized by its disassembly robot Daisy, facilitates the recovery of valuable materials such as rare earth elements and precious metals, thereby reducing the necessity for new material procurement and consequently lowering material costs. The program's waste and pollution reduction strategies further decrease costs associated with waste management (McGrenary, 2020). Moreover, the recycling program, despite requiring substantial initial investments, can offset these costs through the upcycling and reintroduction of collected products into the supply chain (Adzo, 2022). Lastly, the enhanced brand image resulting from Apple's commitment to environmental sustainability may indirectly contribute to overall profitability by potentially increasing sales and customer loyalty. From 2019 to 2022, Apple experienced significant growth in total net sales from $265.174 million to $394.328 million, representing nearly 48.7% growth. However, the fact that the total cost of sales increased from $161.872 million to $223.546 million (an increase of 38.1% only) indicated a greater profit margin (**Figure 5**).

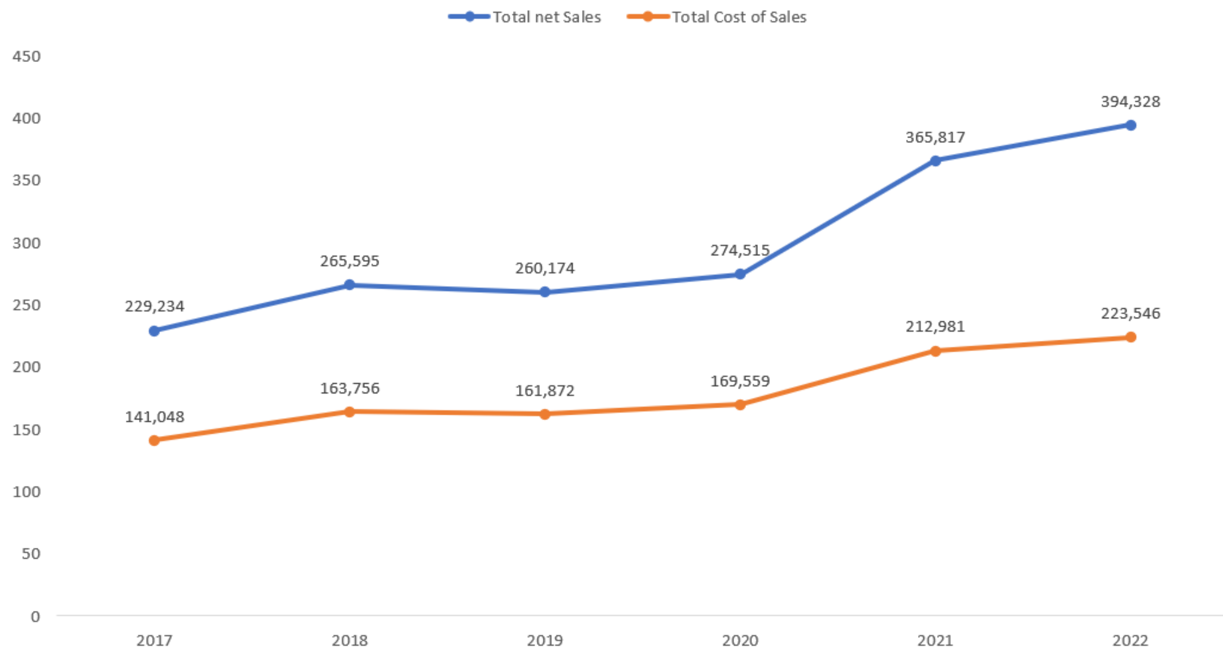

Figure 5: Total net sales and total cost of sales of Apple from 2017 to 2022

***Source**: Author's summarization from Macrotrends (2022)*

b. Environmental

Apple's recycling process in its reverse logistics system has also demonstrated the company's commitment to environmental sustainability. The collection process, which involves the return of old devices from customers, showcases Apple's dedication to reducing electronic waste. This initiative, coupled with collaborations with service providers and recycling businesses, underscores Apple's social commitment and adherence to environmental regulations. It also helps in waste reduction and pollution reduction, thereby contributing to environmental protection. According to the Environmental Progress Report, Apple successfully recycled more than 40,000 metric tons of electronic waste worldwide in 2022 and it also saw a remarkable 70% growth in volumes handled by suppliers producing materials using low-carbon energy and recycled content, with aluminum playing a pivotal role (Apple, 2023c). A range of products containing 100% recycled aluminum enclosures were released, including various models of iPad, Mac, and Apple Watch. Furthermore, Apple increased the usage of certified recycled gold and started delivering items made of certified recycled steel in 2022. Both commodities normally have high carbon footprints. The use of certified recycled gold in its products increased from 1% in 2021 to approximately 4% across all product lines in 2022 (Apple, 2022b). Apple stated that it used 99% recycled tungsten, 98% recycled rare earth elements, and 45% certified recycled gold in its products in 2020 (Apple, 2020). In addition, the company more than doubled the use of recycled tungsten, rare earth elements, and cobalt in 2021 as 30% of certified recycled tin, and 13% of certified recycled cobalt were utilized. 59% of all the aluminum Apple used in its products came from recycled sources, with many products featuring 100% recycled aluminum in their enclosures

(Hardy, 2022). In summary, Apple's dedication to recycle materials is evident in their products, with approximately 20 percent of the materials used in manufacturing now being sourced from recycled content. This represents a substantial milestone and is recognized as the highest-ever utilization of recycled materials in the production of Apple products.

In addition, the total waste of Apple has decreased in general with the implementation of multiple recycling programs. As can be seen from **Figure 6**, the total waste generated by Apple in 2021 Apple was 52,490 tonnes, 10.1% lower than that of 2019 (58,406 tonnes). Apple even recorded a 5-year low in 2020, with only 45,714 tonnes of waste produced.

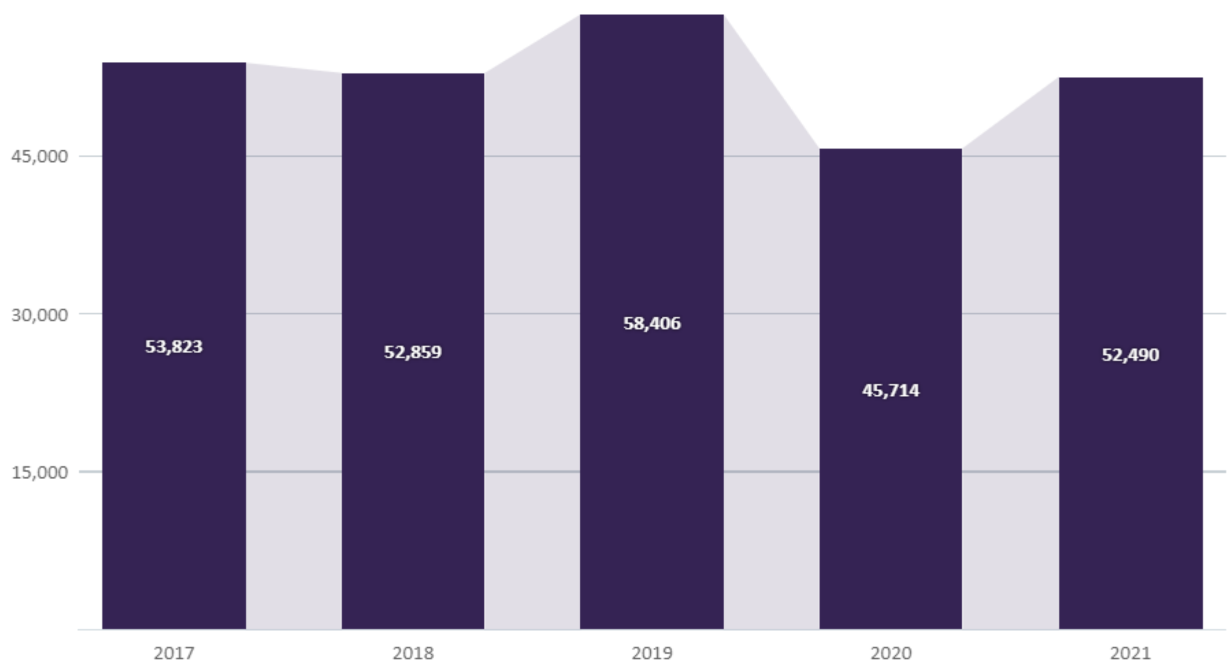

Figure 6: Generation of waste by Apple

***Source**: GlobalData (2022)*

With an estimated 52,490 tonnes of waste in 2021, 33,334 tonnes were recycled (Apple Inc, 2021). Apple's landfill diversion rate of consistently approximately 70% over the years (**Figure 7)** significantly bolsters its sustainability efforts. This high diversion rate conserves natural resources by reducing the demand for new materials and minimizes environmental impact by decreasing waste disposal in landfills (Kamczyc, 2022). Additionally, the conversion of diverted waste into energy enhances energy efficiency and diminishes reliance on fossil fuels. The reduction in landfill waste also mitigates methane emissions, a potent greenhouse gas predominantly produced by landfills.

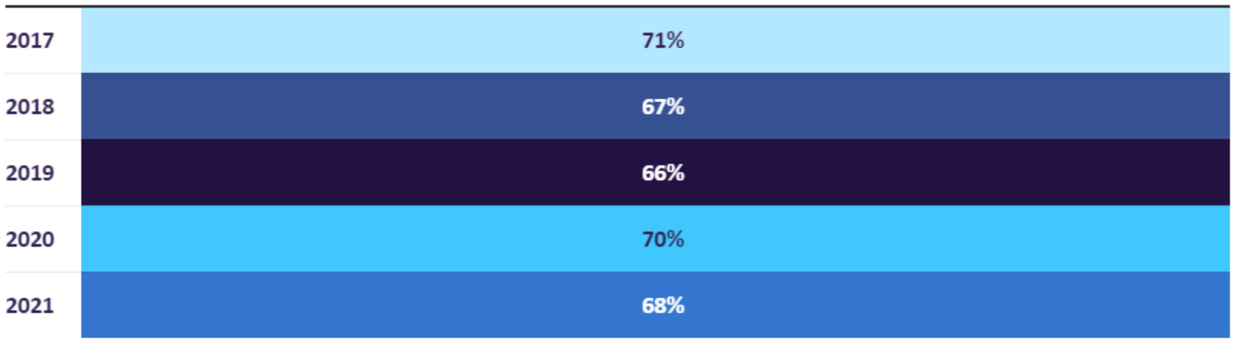

Figure 7: Landfill diversion rate of Apple (2017 - 2021, %)

***Source**: GlobalData (2022)*

Apple's RL processes in their reverse logistics system are a testament to the company's commitment to sustainability through energy and resource conservation, waste reduction, pollution reduction, and environmental protection.

c. Social

From a commercial and social perspective, the GiveBack program enhances Apple's corporate image by demonstrating its commitment to environmental sustainability. It positions Apple as a responsible business that not only cares about its bottom line but also the health of the planet. This can strengthen customer loyalty and attract environmentally conscious consumers, thereby potentially boosting sales. In terms of customer satisfaction, the GiveBack program provides tangible benefits to customers. By offering incentives and thorough instruction for returning old devices and ensuring that returned products are handled properly, Apple makes customers feel valued and appreciated. This can lead to increased customer retention and loyalty. Finally, the GiveBack program underscores Apple's social commitment. Apple's active promotion of recycling and minimizing electronic waste contributes significantly to addressing a critical environmental concern.. This not only benefits the environment but also contributes to the broader societal goal of sustainable development. Additionally, Apple is working with several businesses from the Impact Accelerator's first class as part of the company's supply chain network in order to boost the job creation process. It is a prime example of how businesses can achieve commercial success while also contributing to societal well-being and sustainability.

3.3.2. Limitations

a. Health and safety concerns

Health and safety contribute to a very significant part in the social aspect, and certain activities and processes within the field of reverse logistics can have distinct implications for them. To illustrate, activities like shredding, which result in air emissions or the release of hazardous chemicals, may pose greater risks to workers compared to tasks such as sorting and disassembly. According to Smith (2010), even seemingly harmless products can contain dangerous chemicals in their production process, and Apple's iPhones are no exception, with chemicals like "phthalates", which is prohibited in young children's toys in EU. Mishandling or improper dismantling of these phones can potentially lead to significant safety concerns and long-term health issues. Another instance of concern raised by Greenpeace pertains to the risks associated with battery recycling, where the potential hazards must be carefully considered (Sarkis *et al.*, 2010).

b. Intricacies in handling returned products

Dealing with returned commercial products due to defects or customer dissatisfaction is a common challenge for companies like Apple. The challenges involved in managing returned products are manifold. In terms of cost, processing returns can be expensive for companies, as they have to incur costs for shipping, handling, inspecting, repairing, repackaging, reselling, or disposing of the returned products. The average retailer's reverse logistics costs for consumer goods are equal to 8.1 percent of total sales (Frei *et al.*, 2020). Regarding quality, Apple has to ensure that the products are in good condition, functional, and safe before they are resold, donated, or reused. The company also has to deal with fraudulent returns, such as counterfeit products, damaged products, or products with missing parts. Lastly, managing returns can have negative environmental impacts for Apple, as they have to deal with waste, emissions, and resource consumption. With an increasing number of returned products each year, it is necessary for the company to constantly develop its reverse logistics system, as an inefficient one will cause supply chain bottlenecks and severely damage the company's revenue and image.

c. Streamlining return order flows

Streamlining return order flows in the supply chain is crucial, as it involves complex coordination with multiple partners and decision-making processes. When items are returned for processing, several steps are involved, including inspection, verification, and testing, and decisions need to be made regarding the most cost-effective approach for handling returned products, such as recycling versus refurbishing defective items (Avron, 2022). Additionally, the decision-making process regarding whether to refurbish or recycle returned products may be constrained by the condition of the items and their potential market value. One notable challenge is the complexity of managing returns for a wide range of electronic devices and components. The complex coordination of multiple partners, including suppliers, service providers, and recycling facilities, can also pose logistical challenges.

4. Discussion

4.1. Apple's future development orientation

Apple has demonstrated a noteworthy dedication to sustainability as the business aims to attain a net zero carbon footprint *(carbon neutral)* by 2030 and reduce emissions by 90% by 2050. The company's efforts also extend beyond its internal activities by engaging more than 300 suppliers globally in the Supplier Clean Energy Program.

Apple is also increasing its use of recycled materials in its products. The company has committed to using more recycled materials in its products to reduce its environmental impact (Apple, 2023a). Apple is working to reduce waste and environmental impact in its packaging. The company is using more sustainable materials, reducing packaging size, and eliminating unnecessary packaging components. In 2022, Apple announced that it would no longer include a charging adapter or wired headphones in the box with its iPhones. This decision is part of the company's efforts to make its products more environmentally friendly by reducing waste and unnecessary packaging. By not including these items in the box, Apple's boxes will be substantially smaller, allowing the company to fit 70% more iPhones onto a shipping pallet.

Apple's decision to eliminate the charger and headphones from the iPhone box is a step towards reducing unnecessary EEE (electrical and electronic equipment products) that duplicate those that customers already have. By not including these items, Apple can reduce waste and minimize the environmental impact associated with the extraction of primary raw materials, manufacturing, and distribution of products.

4.2. Challenges in modern days

Apple is facing numerous challenges in its pursuit of sustainability. Some sustainability initiatives may be costly, and Apple may need to balance these costs with the benefits of improved brand reputation and customer loyalty.

- Insufficient collection sites for electronic devices pose a major challenge in waste management. Apple's existing recycling program addresses part of the e-waste issue, yet the scale remains significant. If Apple ceased hardware sales today, an estimated 80% of its products would become obsolete in 8 years, requiring collection, processing, and recycling amounting to 200,000 metric tons (Kingsley-Hughes, 2021). Inadequate collection sites risk improper disposal, increasing environmental pollution.
- Apple's supply chain is intricate and spans the globe, posing challenges in ensuring all suppliers' compliance with the company's sustainability criteria. Apple has demonstrated advancements in this issue, yet it continues to encounter obstacles in guaranteeing its suppliers' adoption of ethical and environmentally sustainable methods.
- Apple has been criticized for its slow adoption of Right to Repair initiatives, limiting consumers' ability to repair their devices and contributing to electronic waste. Apple products are designed to be durable and long-lasting, but they can also be difficult to repair once they break. This phenomenon renders the repairing process more challenging and exacerbates the issue of waste accumulation.

4.3. Recommendations for Apple in achieving future sustainability orientation

4.3.1. The application of technology in achieving sustainability

By implementing technological tools, organizations can track and manage returned products more efficiently, identify trends in returns, and predict future product demand, ultimately enhancing their reverse logistics operations. One advanced method that Apple could potentially explore or enhance in their reverse logistics system is Blockchain. Up until now, Apple has solely used blockchain technology in transactions, processing close to 285 million transactions every day while reverse logistics processes have not been concerned (Solansky, 2023). Blockchain is a distributed digital record-keeping system that facilitates secure and transparent transactions. Its unique characteristics such as immutability, transparency, and traceability make it well-suited for improving supply chain processes, including reverse logistics. By implementing blockchain technology in their reverse logistics system, Apple could benefit in several ways:

- Firstly, blockchain can provide a tamper-proof record of important information related to returned products, such as the reason for return, repair history, and refurbishment status. This ensures the integrity and transparency of the process, reducing the possibility of fraud or counterfeit products entering the supply chain.
- Secondly, blockchain can facilitate the traceability of products, enabling Apple to track the entire lifecycle of a device, from manufacturing to recycling or disposal. This traceability can enhance authenticity verification, ensure compliance with sustainability standards, and accurately assess the environmental impact of their products.
- Thirdly, blockchain can streamline and automate certain aspects of reverse logistics, such as the processing of returned products or the management of warranties and refunds. Smart contracts, which are self-executing contracts with predefined conditions embedded in the blockchain, can automate and enforce the execution of agreements between Apple and customers, improving efficiency and reducing administrative overhead. Furthermore, blockchain technology can create new opportunities for collaborative initiatives and partnerships in reverse logistics. By securely sharing data and maintaining transparency, Apple could collaborate with suppliers, recyclers, or third-party repair centers to optimize their end-to-end reverse logistics processes.

Another alternative is cloud-powered platforms. Real-time data processing capabilities of cloud platforms can help Apple gain valuable insights into the status and whereabouts of returned products. This enables dynamic rerouting of goods for refurbishment, recycling, or resale, optimizing the resource utilization and reducing waste. The cloud-based reverse logistics solutions also offer the flexibility to seamlessly integrate with Apple's existing logistics systems, promoting enhanced collaboration within its logistical networks. By harnessing the power of the cloud, Apple can not only improve its sustainability efforts but also streamline the handling of returned products, ultimately delivering a more efficient and eco-friendly reverse logistic.

4.3.2. Mitigating environmental & working risk for employees

To address risks associated with recycling activities, such as air emissions and hazardous chemical release, Apple shall ensure well-ventilated facilities, conduct regular maintenance and monitoring, and provide workers with appropriate protective gear. Exploring advanced recycling technologies with effective containment and filtration mechanisms is essential to reduce risks to both workers and the environment. For battery recycling, Apple should consider using advanced sorting technology like automation and robotics to minimize accidents and exposure to hazardous materials. Proper storage and transportation in designated containers following safety regulations is also crucial. Apple's investment in AI-powered robots like "Daisy" for iPhone recycling should continue, with more resources allocated to developing more advanced versions to increase recycling capacity.

4.3.3. Smoother returns and faster assessments

In order to address the issues of streamlining the return process, Apple should give instructions and streamlined documentation for customers by establishing effective communication channels with suppliers, service providers, and recycling facilities to ensure smooth coordination and timely processing of returned products, making it easier for customers to return items. Apple also needs to enhance the inspection and verification process for returned items to accurately assess their condition and determine the appropriate course of action. As discussed above, the utilization of advanced technologies such as machine learning algorithms or automated systems to improve the accuracy and speed of inspection can help to reduce the time and effort required for decision-making.

4.4. The necessary conditions for applying the aforementioned recommendations

Because of the complexity and the difficulty of applying new procedures in Apple's operation practice, there must be several conditions needed to successfully integrate the technology, risk mitigation and the optimized assessment framework. The application of advanced technologies like blockchain and cloud-based platforms requires significant technological capacity. Apple would need the necessary technology infrastructure, for example, upgrading the computer system to increase the speed of processing data, and allocating resources to implement and maintain these systems. For the risk mitigation program, the company must put employee's benefit beyond the profit goals. The successful execution of strategies like the Trade-In program or improved return process will also require active participation from customers. As such, it would be crucial for Apple to effectively communicate the advantages of these initiatives to its customer base, encouraging them to partake in these sustainable practices.

Lastly, and most importantly, all these recommendations would require strong commitment from Apple's management. The company must be ready to invest time, effort, and resources into improving its reverse logistics, acknowledging the long-term benefits of these initiatives for their sustainable growth.

Conclusion

This research has undertaken a comprehensive analysis of secondary data sources, encompassing scientific studies, literature reviews, articles, and official reports from Apple, to clarify the relationship between Apple's reverse logistics (RL) and sustainability. The findings of this study illustrates the impact of various processes within Apple's RL system, which includes Gate-keeping, Collection & Inspection, Disposition, and Redistribution, on the three pivotal dimensions of sustainability: economic, environmental, and social. It is evident from the research that these RL processes have varying degrees of positive influence on all three sustainability pillars.

Particularly, the study reveals that certain options within the RL system, most notably recycling, exert a substantial influence on economic, environmental, and social aspects of sustainability objectives. Economically, recycling holds the potential to generate significant cost savings for Apple, particularly by reducing the need to procure new resources for product manufacturing, thereby leading to a reduction in production costs. Environmentally, recycling is instrumental in reducing environmental waste, minimizing pollution, and making substantial contributions to energy and resource conservation. Socially, Apple can garner favorable public perceptions and support when effectively executing recycling initiatives. This provokes greater trust and loyalty from customers, ultimately contributing to sustained profitability.

However, this study also underscores certain challenges and limitations encountered during the implementation of RL activities. These encompass concerns regarding health and safety when handling waste materials, the intricacies involved in processing returned products, and the complexities inherent in decision-making processes. In light of these challenges, the study proposes viable solutions, such as the application of blockchain technology and cloud-powered platforms to enhance transparency and efficiency, ensuring workplace safety through stringent protocols, and disseminating comprehensive user guidelines.

Reference

Aaron S. (2017), “Reverse Logistics 101”, *All Things Supply Chain*, Available at: https://www.allthingssupplychain.com/reverse-logistics-101/.

Abdelshafie, A., Fatouh, T. & Rashid, M. (2021), “Trends and Practices of Reverse Logistics in Electronic Industry: A Case Study of Samsung Company”, *Global Business and Management Research: An International Journal*, Vol. 13 No. 3.

Adzo, K. (2022), “Apple Recycling Program: the Good and the Bad”, *Apple Gazette*, Available at: https://www.applegazette.com/news/apple-recycling-program-the-good-and-the-bad/.

Agrawal, S., Singh, R.K. & Murtaza, Q. (2016), “Triple bottom line performance evaluation of reverse logistics”, *Competitiveness Review*, Vol. 26 No. 3, pp. 289–310.

Aitken, J. & Harrison, A. (2013), “Supply governance structures for reverse logistics systems”, *International Journal of Operations & Production Management*, Vol. 33 No. 6, pp. 745–764.

Ali, A., Zalavadia, S., Barakat, M. & Eid, A. (2018), "The Role of Sustainability in Reverse Logistics for Returns and Recycling", *Archives of Business Research*, Vol. 6 No. 7, pp. 12–33.

Alnoor, A., Eneizan, B., Makhamreh, H.Z. & Rahoma, I.A. (2019), "The Effect of Reverse Logistics on Sustainable Manufacturing", *International Journal of Academic Research in Accounting, Finance and Management Sciences,* Vol. 9 No. 1, pp. 71-79.

Apple Inc. (2021), "Apple Reports Fourth Quarter Results", *Apple Newsroom*, Available at: https://www.apple.com/newsroom/2021/10/apple-reports-fourth-quarter-results/.

Apple Inc. (2022). "Recycler Guides", *Apple*, Available at: https://www.apple.com/recycling/recycler-guides/.

Apple. (2019a), "Apple expands global recycling programs", *Apple* , Available at: https://www.apple.com/newsroom/2019/04/apple-expands-global-recycling-programs/.

Apple. (2019b), "Apple Store - Find a Store - Apple", *Apple*, Available at: https://www.apple.com/retail/.

Apple. (2020), **"**Product Environmental Report IPhone 12 Date Introduced Made with Better Materials Tackling Climate Change", *Apple.*

Apple. (2022a), "Apple Calls on Global Supply Chain to Decarbonize by 2030", *Apple Newsroom*, Available at: https://www.apple.com/newsroom/2022/10/apple-calls-on-global-supply-chain-to-decarbonize-by-2030/.

Apple. (2022b), "Apple Expands the Use of Recycled Materials across Its Products", *Apple Newsroom,* Available at: https://www.apple.com/newsroom/2022/04/apple-expands-the-use-of-recycled-materials-across-its-products/.

Apple. (2022c), "Apple Supplier Code of Conduct", *Apple.*

Apple. (2023a), "Environmental Progress Report", *Apple.*

Apple. (2023b), "Apple Trade In", *Apple*, Available at: https://www.apple.com/shop/trade-in.

Apple. (2023c), "Apple Unveils Its First Carbon Neutral Products", *Apple Newsroom (Liechtenstein)*, Available at: https://www.apple.com/li/newsroom/2023/09/apple-unveils-its-first-carbon-neutral-products/.

Apple. (n.d.), "Recycling", *Apple (Montenegro),* Available at: https://www.apple.com/me/recycling/.

Avron, S. (2022), "Six Challenges Associated with Reverse Logistics… and How to Overcome Them | flevy.com/blog", *FlevyBlog*, Available at: https://flevy.com/blog/six-challenges-associated-with-reverse-logistics-and-how-to-overcome-them/.

Banguera Arroyo, L.Á., De Los Santos Barreto, C.A., Santos Vasquez, O.B. & Vera Nicola, R.J. (2023), "The importance of Reverse Logistics and Green Logistics for Sustainability in Supply Chains", *Journal of Business and Entrepreneurial Studie*, Vol. 7 No. 4, pp. 46–72.

Barkho, G. (2019), “Apple Bets on iPhone Trade-In Program to Boost Slowing Sales”, *Observer*, Available at: https://observer.com/2019/05/apple-iphone-sales-trade-in-program/.

Baterna, Q. (2021), “How Does Apple’s Recycling Process Work?”, *MUO*, Available at: https://www.makeuseof.com/apple-recycling-process-explained/.

Counterpoint, T. (2023), “Apple iPhone Market Share: 2007 to 2023”, *Counterpoint*, Available at: https://www.counterpointresearch.com/insights/apple-iphone-market-share-quarter/.

Diabat, A., Khodaverdi, R. & Olfat, L. (2013), “An Exploration of Green Supply Chain Practices and Performances in an Automotive Industry”, *The International Journal of Advanced Manufacturing Technology*, Vol. 68 No. 1, pp. 949–961.

Frei, R., Jack, L. & Brown, S. (2020), “Product returns: a growing problem for business, society and environment”, *International Journal of Operations & Production Management*, Vol. 40 No. 10, pp. 1613–1621.

Geng, R., Mansouri, S.A. & Aktas, E. (2017), “The relationship between green supply chain management and performance: A meta-analysis of empirical evidences in Asian emerging economies”, *International Journal of Production Economics*, Vol. 183, pp. 245–258.

GlobalData. (2022), “Apple: Waste Generation in 2021”, *Global Data*, Available at: https://www.globaldata.com/data-insights/technology-media-and-telecom/apple-waste-generation-2095979/#:~:text=The%20company%20directed%20more%20than.

Govindan, K., Khodaverdi, R. & Vafadarnikjoo, A. (2015), “Intuitionistic fuzzy based DEMATEL method for developing green practices and performances in a green supply chain”, *Expert Systems with Applications*, Vol. 42 No. 20, pp. 7207–7220.

Grabara, J., Man, M. & Kolcun, M. (2014), “The Benefits of Reverse Logistics”, *International Letters of Social and Humanistic Sciences*, Vol. 26, pp. 138–147.

Hardy, E. (2022), “There’s Recycled Gold in Them There iPhones”, *Cult of Mac*, Available at: https://www.cultofmac.com/773489/theres-recycled-gold-in-them-there-iphones/.

Hays, L. (2023), “The Apple Recycling Program: It’s Easy Being Green (2023)”, *IPhoneLife*, Available at: https://www.iphonelife.com/content/apple-recycling-program-its-easy-being-green.

Hazen, B.T. (2011), “Strategic reverse logistics disposition decisions: from theory to practice”, *International Journal of Logistics Systems and Management*, Vol. 10 No. 3, pp. 275.

Hương H.H., Thuy N.T. & Nga N.T.D. (2023), “Tổng quan nghiên cứu về ảnh hưởng của logistics thu hồi tới phát triển bền vững”, *Tạp chí Khoa học Nông nghiệp Việt Nam 2023*, Vol. 21 No. 6, pp. 706–717.

Kaihan, Y. & Chin, T.A. (2021), “Revisit the Effect of Reverse Logistics Practices on Sustainability Performance”, *International Journal of Academic Research in Business and Social Sciences*, Vol. 11 No. 11.

Keh, P., Rodhain, F., Meissonier, R. & Llorca, V. (2012), "Financial Performance, Environmental Compliance, and Social Outcomes: The three Challenges of Reverse Logistics. Case Study of IBM Montpellier", *Supply Chain Forum: An International Journal*, Vol. 13 No. 3, pp. 26–38.

Kingsley-Hughes, A. (2021), "Apple's Colossal e-waste Timebomb", *ZDNET*, Available at: https://www.zdnet.com/article/apples-colossal-e-waste-timebomb/&sa=D&source=docs&ust=1700996947539095&usg=AOvVaw3q1A71gi2ytgGeT0zwNdMW.

Laricchia, F. (2023), "Global Revenue of Apple from 2004 to 2023", *Statista*, Available at: https://www.google.com/url?q=https://www.statista.com/statistics/265125/total-net-sales-of-apple-since 2004/&sa=D&source=docs&ust=1699318591168733&usg=AOvVaw0yNhPGwwBtfIZuKpJMbstK.

Macrotrends. (2022), "Apple Financial Statements 2005-2019 | AAPL", *Macrotrends*, Available at: https://www.macrotrends.net/stocks/charts/AAPL/apple/financial-statements.

Macrotrends. (2023), "Apple Revenue 2006-2022 | AAPL", *Macrotrends.net*, Available at: https://www.macrotrends.net/stocks/charts/AAPL/apple/revenue.

McGrenary, S. (2020), "In My Opinion: Apple's Policies Have wide-reaching Impact", *E-Scrap News*, Available at: https://resource-recycling.com/e-scrap/2020/09/03/in-my-opinion-apples-policies-have-wide-reaching-impact/.

Muthukumar, R. & Purkayastha, D. (2011), "*Apple Inc's Returns Management Practices"*, *The Case Center*, IBS Center for Management Research.

Niall McCarthy. (2021), "Infographic: the Apple Store Empire", *Statista Infographics*, Available at: https://www.statista.com/chart/24857/total-number-of-apple-stores-worldwide/.

Owen, M. (2021), "How to Check Your Warranty on iPhone, iPad, or Mac", *Apple Insider*, Available at: https://appleinsider.com/articles/21/01/19/how-to-check-your-warranty-on-iphone-ipad-or-mac.

Padmanabh, B. & Jeevananda, S. (2019), "Inquiry into reverse logistics and a decision model", *International Journal of Logistics Systems and Management*, Vol. 33 No. 3, pp. 353.

Panha, P. (2018), "How Apple Applies Reverse Logistics Efficiently in Their Business", *The University of Sydney*.

Pawar, A., Kolte, A., Sangvikar, B.V. & Jain, S. (2021), "Analysis of Reverse Logistics Functions of Small and Medium Enterprises: The Evaluation of Strategic Business Operations", *Global Business Review*, p. 097215092199601.

Prahinski, C. & Kocabasoglu, C. (2006), "Empirical research opportunities in reverse supply chains", *Omega*, Vol. 34 No. 6, pp. 519–532.

Reuters. (2022), “Apple may move a quarter of iPhone production to India by 2025 -JPM”, *Reuters*.

Ross, L. (2020), “How the Apple Supply Chain Stays Top Ranked in the World”, *Thomas Net*, Thomas Publishing Company, Available at: https://www.thomasnet.com/insights/apple-supply-chain/.

Rossignol, J. (2018), “Apple Debuts New iPhone Recycling Robot Daisy and GiveBack Trade-In Program”, *MacRumors*, Available at: https://www.macrumors.com/2018/04/19/apple-new-daisy-robot/.

Sarkis, J., Helms, M.M. & Hervani, A.A. (2010), “Reverse logistics and social sustainability”, *Corporate Social Responsibility and Environmental Management*, Vol. 17 No. 6, pp. 337–354.

Shaik, M.N. & Abdul-Kader, W. (2018), “A hybrid multiple criteria decision making approach for measuring comprehensive performance of reverse logistics enterprises”, *Computers & Industrial Engineering*, Vol. 123, pp. 9–25.

Simões, R., Carvalho, C., Félix, R. & Arantes, A. (2017), “Survey of Reverse Logistics Practices - the Case of Portugal”, *Proceedings of the 6th International Conference on Operations Research and Enterprise Systems*.

Smith, S. (2010), “Hazardous Materials Found in Apple’s iPhone”, *Greenpeace USA*, Available at: https://www.greenpeace.org/usa/news/hazardous-materials-found-in-a/.

Solansky, G. (2023), “Apple’s ‘Blockchain’ Processing 285M Transactions per Day?”, *The Crypto Times*, Available at: https://www.cryptotimes.io/apples-blockchain-processing-285m-transactions-per-day/.

Solomon, M. (2020), “Apple ship-from-store strategy ends total reliance on centralized distribution”, *FreightWaves*, Available at: https://www.freightwaves.com/news/apple-ship-from-store-strategy-ends-total-reliance-on-centralized-distribution.

Stock, J.R. & Management (U.S.), C. of L. (1992), “*Reverse Logistics: White Paper”*, Council of Logistics Management.

Stoyanov, S. (2012), “*A Theoretical Model of Reverse Logistics Network for End-of-Life Vehicles Treatment in Bulgaria”*, Doctoral dissertation, Master thesis, Aarhus School of Business, University of Aarhus, Denmark.

Sun, X., Yu, H., Solvang, W.D., Wang, Y. & Wang, K. (2022), “The application of Industry 4.0 technologies in sustainable logistics: a systematic literature review (2012–2020) to explore future research opportunities”, *Environmental Science and Pollution Research*, Vol. 29 No. 7, pp. 9560–9591.

Team, S. (2022), “15 Things You Need to Know about Reverse Logistics ”, *Sifted*, Available at: https://sifted.com/resources/15-things-you-need-to-know-about-reverse-logistics/.

Tibben-Lembke, R.S. & Rogers, D.S. (2002), “Differences between forward and reverse logistics in a retail environment”, *Supply Chain Management: An International Journal*, Vol. 7 No. 5, pp. 271–282.

Thierry, M., Salomon, M., Van Nunen, J. & Van Wassenhove, L. (1995), “Strategic Issues in Product Recovery Management”, *California Management Review*, Vol. 37 No. 2, pp. 114–136.

United Nations Brundtland Commission . (1987), *Report of the World Commission on Environment and Development: Our Common Future*, p. 16.

Waqas, M., Dong, Q., Ahmad, N., Zhu, Y. & Nadeem, M. (2018), “Critical Barriers to Implementation of Reverse Logistics in the Manufacturing Industry: A Case Study of a Developing Country”, *Sustainability*, Vol. 10 No. 11, p. 420.

Younis, H., Sundarakani, B. & Vel, P. (2016), “The impact of implementing green supply chain management practices on corporate performance”, *Competitiveness Review*, Vol. 26 No. 3, pp. 216–245.

Yu, Z. (2018), “The Impact of Reverse Logistics on Operational Performance”, *American Journal of Mechanical and Industrial Engineering*, Vol. 3 No. 5, p. 99.

Zhang, X., Zou, B., Feng, Z., Wang, Y. & Yan, W. (2021), “A Review on Remanufacturing Reverse Logistics Network Design and Model Optimization”, *Processes*, Vol. 10 No. 1, p. 84.