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Closed loop supply chains in apparel: Current state and future directions

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Abstract

The apparel and textile industry (AT) is considered one of the most polluting industries in the world due to the complexity of the supply chain and the high volume of natural resources and toxic chemicals used during manufacturing. Closed loop supply chains (CLSC) for apparel and textile are unique and therefore the circular economy solutions that exist for other industries, especially the electronics industry where these solutions are used extensively, may not be successful. This study aims to evaluate the practices of fashion brands that currently employ a CLSC to better understand the existing strategies and prevalent issues in comparison to the electronics industry. We developed a framework based on factors that identify the delineating aspects of a CLSC and performed a content analysis of the publicly available sustainability reports of companies. The results show the need for different solutions between the industries and indicate a need for research that is informed by the AT specific contextual factors since one-fits-all solutions will not work well across industries.

KEYWORDS

apparel and textile, closed loop supply chains, electronics, remanufacturing, waste

Highlights

- The best closed loop supply chain (CLSC) solutions will be context dependent, industry characteristics will dictate the type and mode of CLSC solutions that will work; what works in one industry might not work in another.
- Key decision makers should assess their industry's circular maturity, the less mature an industry the more fluid its CLSC practices may be giving executives greater flexibility on type and mode of CLSC practices to implement.
- Key decision makers in the apparel or similar industries should note that industry level differences in End-of-Use product acquisition, component reprocessing, and material recycling have implications for CLSC design and coordination.

1 | INTRODUCTION

A circular economy (CE) involves creating an ever-rejuvenating economic system that decouples economic growth from natural resource depletion and environmental degradation (Hvass & Pedersen, 2019). It can be a means of "value creation, cost reduction, revenue generation, and increased resiliency and legitimacy for companies" (Unal et al., 2019, p. 562). For manufacturing companies, an important component of CE is an effective closed loop supply chain (CLSC) structure and management system. To establish a CLSC, forward and reverse supply chain logistics must be integrated to allow for the seamless collection of end-of-use (EOU) products, disassembly, reassembly, and remarketing (Van Wassenhove, 2019). Within a CLSC, value creation is based on utilizing the economic value retained in EOU products to produce new offerings (Hvass & Pedersen, 2019). A primary way to utilize products′ retained value is through remanufacturing, the process of restoring a previously used product to like-new quality specifications (Abbey & Guide, 2018). Remanufacturing has been studied in the automotive and electronic goods industries (Van Wassenhove, 2019). However, less is known about it in other business-to-consumer markets, such as the AT industry (Sandvik & Stubbs, 2019).

AT is one of the largest manufacturing industries behind automotive and technology (Jia et al., 2020). It is considered one of the most polluting industries in the world (Patwa & Seetharaman, 2019). The polluting nature of the AT industry coupled with rampant consumerism (120 million tons of apparel projected to be purchased by 2030) has led practitioners and researchers to seek viable environmental and business solutions to solve or at least lessen the harmful impacts of the AT industry (Pal et al., 2019).

In the last 5 years, circular business models within the AT industry have increased, with the circular market forecasted to be worth $700 billion by 2030 (Business of Fashion, 2022). While more AT companies are implementing CE practices, most are unprofitable and only account for a small percentage of a firm′s annual sales (Kent, 2022b). The AT industry′s specific remanufacturing issues, detailed below, help to explain the lack of CE practices.

Remanufacturing in the AT industry is contextually different from remanufacturing in the electronics or automotive industries. The standard practices in those industries do not necessarily apply to the AT industry (Abbey & Guide, 2018; Abbey, Meloy, et al., 2015). Implementing remanufacturing in the AT industry requires a different approach—no "one fits all" process exists. One key difference is found in the salvage value of the EOU products. The 40%–65% cost savings (Wang et al., 2014) from remanufacturing possible in electronic and automotive industries due to component recovery (Wang et al., 2018) are not seen in the AT industry due to the low marginal value of EOU garments (Cai et al., 2022; Morana & Seuring, 2007). Remanufacturing often costs more than the retained value of the EOU clothing (Dissanayake & Sinha, 2015; Morana & Seuring, 2007). Another key difference can be observed in the networks for acquiring EOU garments, which are less robust than the collection networks for electronics. There are challenges accruing EOU garments with the necessary fiber blends (e.g., cotton, silk, lycra) to enable effective remanufacturing (Deeley, 2021b). Due to the wide diversity of materials in EOU garments, reverse supply chain sorting may occur at numerous sites and via different stakeholders (Lewis et al., 2016). Such differences leading to AT-specific circularity challenges require better understanding and insights. The AT industry is beginning to implement CE practices, and more context-dependent (Van Wassenhove, 2019) knowledge and solutions should lead to more effective CLSCs.

The purpose of this paper is to highlight that CLSC strategies used in other industries may not apply within the AT industry. Despite its size and impact on global economics (Jia et al., 2020), little operations management literature focuses on the AT industry, presenting academics with complex and interesting research opportunities. To showcase this, we set a foundational understanding of the current CLSC practices within the AT industry, key players within the system, opportunities, and barriers. We then provide a comparison of remanufacturing practices employed by AT firms and consumer electronic firms. Finally, we discuss the salient CLSC issues in the AT industry compared with other industries and highlight different aspects that necessitate further investigation.

2 | REMANUFACTURING IN THE APPAREL INDUSTRY: OVERVIEW

Abbey and Guide (2018) suggest three primary disassembly levels in remanufacturing: product reprocessing, component reprocessing, and material reprocessing. Although these levels are represented in the AT industry, there are distinctions to recognize. Table 1. identifies the differences and below we describe the AT specific levels of disassembly and then remanufacturing.

2.1 | Reverse flows for an apparel company

2.1.1 | Resale

Resale in the AT industry is similar to Abbey, Meloy, et al. (2015) product reprocessing level. In resale, the original brand collects used garments, sorts, cleans, performs minor

TABLE 1 EOU product disposition activities in electronics versus apparel.

CONSUMER ELECTRONICS	APPAREL AND TEXTILES
Product reprocessing for resale - Requires partial disassembly	Product reprocessing for resale
Component Reprocessing for Resale	Component Reprocessing for Repurpose - Upcycle - Downcycle
Materials Reprocessing- Recycle and discard	Recycling - Recycle and discard - Recycle and remanufacture

repairs, and re-sells them in their secondary market at a discounted price. This type of remanufacturing has been widely employed in the AT industry over the last 3 years with over 100 brands launching a resale channel in 2021 (Business of Fashion, 2022). While the resale market is expected to grow substantially, few programs have yet to be profitable due to scalability issues (Kent, 2022b), with many firms using resale as a tool for new customer acquisition (Chen, 2023).

2.1.2 | Repurpose

Repurposing is akin to the component reprocessing level (Abbey & Guide, 2018) in the level of disassembly—but that is where the similarities end. Unlike consumer electronics, remanufacturing the same product using components from EOU products does not exist in AT. In this level of remanufacturing, the EOU garments are either downcycled into lesser-value items, such as insulation or filler for bedding or upcycled into items of the same or higher retail value. When brands downcycle, the EOU garment is used for another product outside the scope of the retail brand. At that point, it is no longer a part of their CLSC, and no more oversight is needed by the brand.

In upcycling, the company will use parts and pieces of EOU garments to create new items. Upcycling within the AT industry has several challenges that limits the process to niche markets (Dissanayake & Sinha, 2015). The current remanufacturing approach is to develop one-of-a-kind products through a time and labor-intensive process using in-house seamstresses and designers hired specifically to perform the upcycling process (Dissanayake & Sinha, 2015). The types of products that can be made from EOU garments depend on collection, making planning for upcycled production difficult. The upcycled garments are sold in niche markets at higher price points. The upcycling process is unique to AT and not seen in other industries.

2.1.3 | Recycle at the material level

The material processing level or recycling is where the EOU garment is disassembled to the material (i.e., fiber) level and then used to create new material for forward manufacturing. Material recycling depends on the materials used in the original products (Blum, 2021). There are two main material recycling processes: mechanical and chemical (Blum, 2021). Mechanical recycling can only be used for natural fibers such as cotton and wool (Cao et al., 2022). The small handful of US firms operating an apparel remanufacturing program utilize mechanical recycling due to environmental concerns (Amy Hall, *pers. commun.*, September, 2022). However, firms like EILEEN FISHER who use mechanical recycling struggle to collect sufficient quantities of EOU garments in the required natural fibers to have a consistent flow for remanufacturing. Chemical recycling is used for synthetic fibers such as polyester and nylon (Cao et al., 2022). The use of chemical recycling is less dependent on the material blends of the original garments (Cao, 2021). This process can permit a variety of garments to be recycled down to the material level allowing for higher levels of EOU supply and remanufacturing. With more EOU garments being used for remanufacturing, scalability may become more viable.

While material-level reprocessing seems to be the most viable option for the industry, not many firms are currently engaged in this level of remanufacturing. The development of new recycling technologies may help overcome the material quality and scalability problems that hinder firms' actions.

2.2 | CLSC process flows in AT

To further delineate the different levels of remanufacturing in the AT industry we showcase the reverse flows and the prominent supply chain members. Figure 1 shows the forward and reverse product flows of a representative CLSC in the AT industry. The major actors in the AT industry are the manufacturers, remanufacturers, EOU product collectors, and the recyclers. The reverse product flows include *Resale*, *Repurpose*, and *Recycle at material level*. Below we discuss the different reverse flows individually.

In an AT CLSC, the consumer is vital and initiates the reverse flow of goods at each level of remanufacturing. EOU garments flow from the consumer to the retail outlet or a third-party collector/material handler. What is collected at the retail outlet will also be sent to the third-party collector/material handler for the initial sorting and grading. This initial flow is common for all levels of remanufacturing. At the resale level, resaleable garments flow to the distribution center and start a forward flow to a secondary market owned by the fashion retailer. The items deemed unsaleable in their original form travel to a third-party downcycler, a third-party material recycler (depending on the material makeup of the garment), or to the fashion
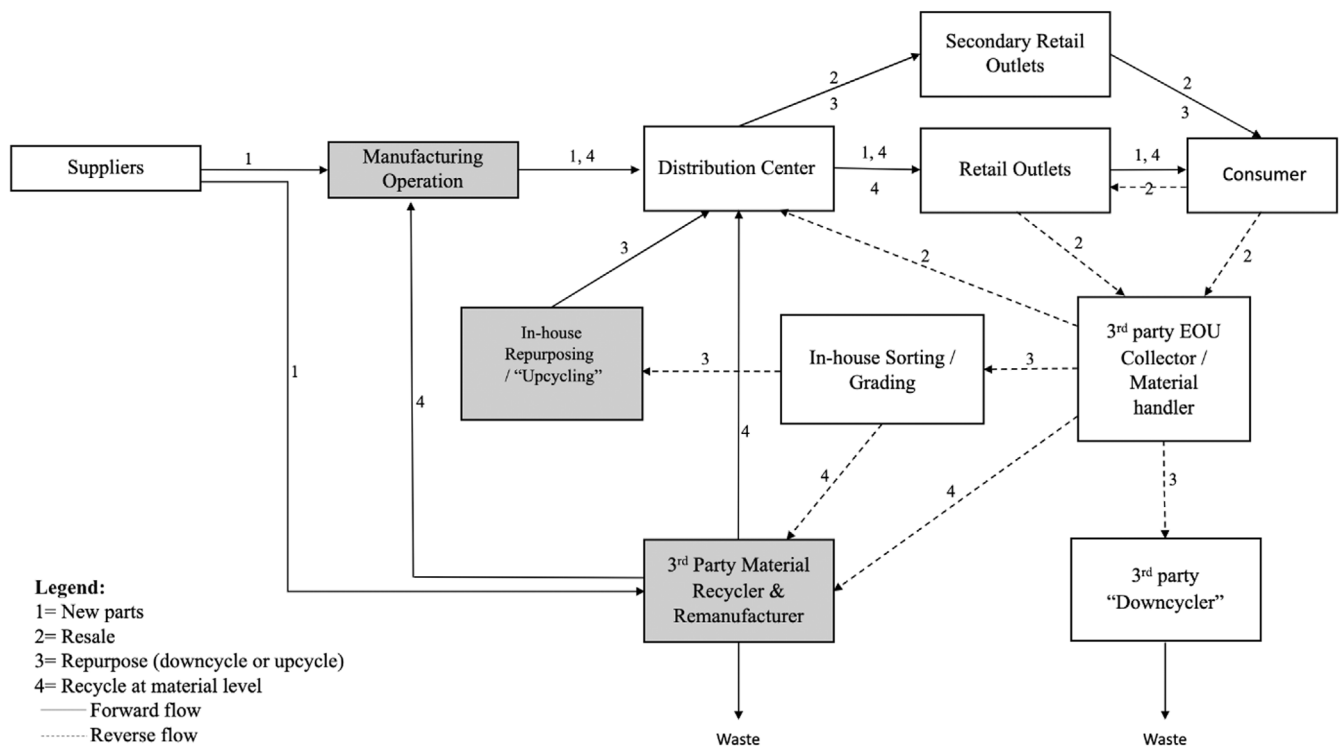
FIGURE 1 Flow of goods at three levels of remanufacturing: resale, repurpose, and recycle at material level.

retailer to be used in the upcycling process. If EOU garments flow to the third-party downcycler, they move out of the fashion brand's CLSC- no more oversight needed. EOU garments flowing from the third-party collector/material handler to the fashion retailer for upcycling go through another round of grading/sorting by the fashion brand. Here, the EOU garments can flow to the retail brand for in-house upcycling remanufacturing or to the third-party material recycler. For recycling at the material level, EOU garments can flow into (i) the third-party material recycler from the third-party collector/material handler; (ii) the retail brand's in-house sorting; and (iii) the in-house upcycling facilities. Once at the third-party material recycler, the EOU garments are taken down to the fiber level and made into material yardage for forward manufacturing. The third-party material recycler can also act as the remanufacturer. For example, Renewcell, a material recycler, also acts as a remanufacturer. Shown in the reverse flows are the unique factors of the AT CLSC for remanufacturing at the upcycling and material levels.

3 | COMPARING THE APPAREL AND TEXTILE INDUSTRY TO CONSUMER ELECTRONICS

To showcase the need for industry-specific solutions, we compare the CLSC practices in the AT and consumer electronic industries through content analysis. We created a framework for content analysis (Weber, 1990) performed on publicly available documents from apparel and consumer electronic companies. The companies analyzed were selected based on brand recognition and reputation as having some form of CLSC practices. Sixteen apparel companies and 14 consumer electronic companies were chosen for the comparison. We did not single out a specific consumer electronic product (e.g., mobile phone) but considered the CLSC practices of the consumer electronic brand as a whole.

Before document collection, we determined factors for the framework that could lead to different CLSC practices. The factors were created based on a review of the remanufacturing literature and the researchers' content expertise in electronic remanufacturing and the AT industry. The factors selected are *Market Position, Mode of EOU Product Acquisition, Boundary of EOU Product Acquisition*, and *Mode of Circularity*. The key differences between the consumer electronics and AT industries exist primarily within the *Mode of Circularity*. The differences are due to the different approaches to remanufacturing in those industries (see Appendix A for the content analysis coding guide).

Document collection was conducted by gathering descriptive data from the identified company's websites and their sustainability reports (Stemler, 2000, 2015). When available, a parent company's sustainability report

was collected to give further insight into the CLSC practices. Additionally, if the CLSC partners such as material recyclers or third-party acquirers were mentioned in the documents, the researchers cross-referenced the documents with those of their CLSC partners.

Prior to document analysis a coding guide was created (see Tables A1 and A2 in Appendix A). Two companies in each industry (selected arbitrarily) were used as a pilot test and coder training prior to researchers coding independently (Craighead & Meredith, 2008). The collected documents were analyzed to determine the current CLSC practices for each selected company based on the pre-determined factors. Two researchers and two research assistants carried out the analysis and coding of the collected materials. Any differences in coding the material were discussed during the coding process until full consensus was reached (see Tables B1 and B2 in Appendix B for examples of coded text).

3.1 | Apparel and textile industry

Table 2 shows the findings from the content analysis performed on the documents from the AT industry. As mentioned, CLSC practices have not yet reached maturity in the AT industry. At this developmental stage, companies have been trying various strategies. These different remanufacturing strategies appear to be based on market position indicating that certain CLSC practices make more sense based on brand positioning in the market.

We can observe from Table 2 that self and third-party collection strategies are used equally, with Luxury brands preferring self-collection of their own products. In contrast, Budget brands tend to collect EOU garments from any brand using a third-party collector. Resale is a common mode of circularity for brands in the Luxury and Bridge markets, but not for brands in the Moderate and Budget markets. This is consistent with the product attributes of high quality and durability ubiquitous in the high price point markets. Repurpose in both forms (upcycle and downcycle) is not a common strategy, most likely because of scalability problems.

While many brands claim the use some form of recycled materials, the amount of recycled material in their products varies a great deal and is not regulated. Recycled material can be post-use (EOU items) or pre-use (reuse of scraps from manufacturing) waste. CLSCs with remanufacturing using a brand's own products recycled at the material level and then used in manufacturing new products is observed in only a limited number of brands and for a limited number of their products. However, the products created using this CLSC practice are fully circular. For example, Patagonia offers only one product, the Tee-Cycle T-shirt, that is fully circular, using their own EOU garments recycled at the fiber level to remanufacture into the t-shirt (Ram, 2021).

3.2 | Consumer electronics

Table 3 shows the findings for the consumer electronics industry. Generally, this industry is more homogeneous in its CLSC practices than AT and there appears to be no differences with respect to market position. This may be due to the e-waste legislations or the maturity of CE practices within the industry.

The primary mode of EOU product acquisition is third-party, with only a few companies using self-acquisition. These companies (e.g., Amazon) have robust networks allowing EOU acquisition to be feasible. The preferred boundary of EOU acquisition is brand only, with only a few firms taking any EOU brand consumer electronics. In the limited cases when a firm takes back another brand's electronics, the product will not be refurbished but sent to a recycler.

Most companies provide product repairs to extend the life of the electronics. To our knowledge, in the past, extending products' useful life by enabling repairability had not been a typical practice in the electronics industry. However, firms are beginning to design for remanufacturing (DfR) to enable easy disassembly allowing consumers to perform the required repairs. In DfR, the company would provide repair kits with the necessary tools and parts. For example, the Fairphone 4 has been designed to disassemble using a standard screwdriver. All companies that perform refurbishment at the product or component level do so on their own devices. This practice allows the brands to control the secondary market for their products and gain the associated economic benefits. The exception is Fairphone, which refurbishes any brand's device using a third-party. Since consumer electronics are primarily sold through a retailer, the retailer can collect the EOU electronics and refurbish them using a third-party certified through the consumer electronics brand. This is a way for the consumer electronics brand to ensure the quality of the refurbished products and control brand image and reputation.

All consumer electronic brands use third-party recyclers to recycle EOU products that are unfit for refurbishment. Apple is the exception, with some recycling performed in Apple, Inc. facilities using robots programed to disassemble select portions of the iPhone and extract raw materials for use in new products. All brands use recycled materials in new offerings, and there appears to be no concern for utilizing recycled materials specifically from the brands' products. This may be due to the material

TABLE 2 Classification of CLSC practices in the apparel industry.

Fashion brand	Market position				Mode of EOU product acquisition		Boundary of EOU product acquisition		Mode of circularity							
										Repurpose (downcycle)		Repurpose (upcycle)		Recycling	Remanufacturing use of recycled material	
	Luxury	Bridge	Moderate	Budget	Self	Third-party	Brand only	Any brand	Resale Yes	Self	Third-party	Self	Third-party	Third-party	Brand only	Any brand
Ganni	X				X		X		X					X		X
Ralph Lauren Luxury	X				X		X		X		X					X
Ugg	X															X
Dior	X													X		
Elieen Fisher		X			X		X		X			X		X	X	
PHV Tommy Hilfiger		X			X		X		X			X		X		X
Reformation		X				X		X	X			X		X		X
Guess?		X			X			X					X	X		X
Patagonia			X		X		X		X					X	X	X
Wrangler			X									X		X		X
Zara (Inditex)			X		X			X			X			X		X
Columbia Sportswear			X		X			X			X			X		
Fruit of the Loom				X							X			X		X
Old Navy				X		X		X						X		X
H & M				X	X			X	X		X			X		X
Hanes				X		X		X						X		X

Note: See Tables A1 and A2 in Appendix A for descriptions of factors and subfactors.

TABLE 3 Classification of CLSC practices in the consumer electronic industry.

Consumer electronic brand	Market positioning			Mode of EOU/L acquisition		Boundary of EOU/L acquisition			Product repair	Product/component reprocessing				Recycling		Use of recycled material	
	High end (premium)	Mid-range	Low end	Self	Third-party	Brand only	Select brands	Any brand	Yes	brand only	Any brand	Self	Third-party	Self	Third-party	Brand only	Any brand
Samsung	X	X			X			X	X	X		X			X		X
Apple	X			X		X			X	X		X		X	X		X
HP		X	X	X	X	X			X	X		X			X		X
Fairphone	X				X			X	X		X		X		X		X
Microsoft		X	X	X	X		X		X	X		X			X		X
Lenovo	X	X	X		X	X			X	X		X			X		X
Dell		X	X		X			X	X	X		X			X		X
Sony	X	X			X	X			X						X		X
Acer			X		X	X			X	X		X			X		X
Panasonic		X	X		X	X			X						X		X
Nokia			X		X	X			X	X		X			X		X
ASUS		X	X		X	X									X		X
Google		X	X		X			X		X		X			X		X
Amazon		X	X	X			X			X		X			X		X
LG	X	X	X		X	X			X	X		X			X		X

Note: See Tables A1 and A2 in Appendix A for descriptions of factors and subfactors.

components (e.g., aluminum, cobalt) used in the electronics being transferable regardless of original use.

3.3 | Industry level differences

The AT and consumer electronic brands reviewed reveal industry-level differences in their CLSC practices. Our review reveals three primary differences: *EOU Collection, Component Modularity*, and *Material Recycling*.

3.3.1 | EOU product acquisition

The first salient difference between the two industries is the mode and boundary of EOU product acquisition. Consumer electronics brands, for the most part, outsource the collection of EOU products to third parties but maintain oversight in the collection of their products. EOU product collection is much more fluid in the AT industry, with brands split between EOU garment collection using a third-party and performing self-collection (along with collecting other brands' garments).

3.3.2 | Component reprocessing

Another major difference between the industries is remanufacturing at the component level. Electronics are a combination of transferable modular parts and components that can be taken from one EOU product and placed in another. This transferability is not readily seen in the AT industry. The components of one EOU garment cannot easily be transferred to another; therefore, component-level remanufacturing as repurposing is not widely seen in the AT industry.

3.3.3 | Material recycling

The final significant difference at an industry level is the use of recycled material. Consumer electronic brands utilize recycled materials from any brand. The main concern is that the recycled materials, such as aluminum or plastic, have the required properties necessary for the new electronic. These products are not fully circular as they pull recycled materials from other CLSCs. Note that we use the term "fully circular" to indicate that the brand has circularity within its own CLSC. In contrast, a few AT brands have created a fully circular CLSC for a limited number of products. These fully circular products made from the brands own material waste is unique and has a number of implications for CLSC design and coordination.

4 | AT: CONTEXT-DRIVEN RESEARCH OPPORTUNITIES

Based on the three salient differences seen at an industry level (EOU collection, component modularity, and material recycling) and the context-specific attributes of remanufacturing in the AT industry, we provide further discussion and propose future research questions.

4.1 | End-of-use collection

The variation in mode and boundary of EOU product acquisition between consumer electronics in AT can be attributed to the differences in legislation between the two industries (e.g., extended producer responsibility; Atasu & Van Wassenhove, 2012) and the retail mode used. The primary EOU garment takeback system used in the AT industry is an individual producer-operated system, where the company controls the collection, sorting, and recycling of its products (Atasu & Van Wassenhove, 2012). In many cases, the AT brands that utilize self-EOU garment collection have a network of branded brick-and-mortar stores allowing consumers to discard EOU garments in-store. This is not the case in electronics, with most products sold through a third-party retailer such as Best Buy. Early research suggests that AT brands that only collect their own EOU garments cannot set up viable remanufacturing programs due to the lack of material supply (Morana & Seuring, 2011). However, brands that only collect their own EOU garments have better foresight and planning abilities (Savaskan et al., 2004). Furthermore, due to quality concerns, most high-end brands want to reclaim their own raw material (fiber and fiber blends). Research in electronics suggests that the individual producer-operated system can create better coordination within reverse flows and incentives for DfR, but it has so far not been cost-effective due to the lack of scale economies (Atasu & Van Wassenhove, 2012). A collective take-back system where AT brands collaborate to acquire EOU garments can be more cost-effective for brands, but it can be challenging to determine the appropriate cost-sharing approach and requirements for material quality. *Future research should address the different collection schemes of AT brands and how they impact remanufacturing in the coordination of reverse flows, planning, DfR, material quality, and cost.*

4.2 | Takeback legislation

As mentioned, the differences in EOU acquisition between the two industries can partly be attributed to

extended producer responsibility and takeback legislation. While there is no current AT takeback legislation (Kirby & Holger, 2022), the EU is pushing to establish legislation to encourage recycling so that by 2025 all EU municipalities will have a standardized collection system for EOU textiles (Deeley, 2021a). France has state-run collective systems requiring brands to pay for collecting, sorting, and recycling EOU garments (Deeley, 2021a). If the proposed standard EOU collection legislation is passed in the EU, it could have significant implications on the economic efficiencies associated with the collection of EOU garments as well as unintended consequences on product design, as observed in the electronic industry as a result of the Waste Electrical and Electronic Equipment (WEEE) legislation (Atasu & Van Wassenhove, 2012). Due to the recent regulatory push to monitor AT waste (Kent, 2022a), *future research in policy design for takeback legislation should address how design for remanufacturability/recyclability can be encouraged if collective takeback mechanisms are used.*

4.3 | Secondhand markets

In AT, different from the secondary markets owned by the brands themselves, independent secondhand stores or other similar outlets sell EOU garments of different brands in a random manner. Secondhand sales do not seem to cause a threat to the original fashion brands, except for brands in the luxury market who may be worried about brand dilution. This is unlike the independent remanufacturers in the electronics sector who can refurbish and sell the same product in the secondhand market and are considered a threat to the original brand (Abbey, Blackburn, & Guide, 2015). The main reason seems to be the relative uniqueness of the textile products. A certain model for a smartphone will be standard with similar product attributes and can be collected in reasonably high volumes. In contrast, a specific fashion brand product will show high variability among attributes such as size and color. This makes acquisition of EOU garments for a specific style in high volumes much less viable. Even a common garment like jeans will have many attributes, and chances of all possible assortments of the same jean ending up in the same secondary outlet are very low. Therefore, unlike the electronics industry, there is no market expansion or cannibalization effect. Traditionally, there is a high fragmentation of collection systems like thrift shops and consignment stores, and many EOU garments find their way into these outlets. This seems to present an opportunity for third-party collectors to exploit but will still be limited to more standardized products. Independent third-party collectors may not

threaten lower price point brands since they do not seem interested in resale. Although, this practice is outside the brand's CLSC, it helps reduce waste and its environmental impacts. *Further research is needed to explore the viability of an independent third-party collection for secondary resale and whether or not it threatens the original brand.*

4.4 | Design for Remanufacturing

Based on the sample of electronic firms in the content analysis, many firms design products for durability, to be easily disassembled for simple repair, refurbishment, and recycling by using modular components as noted in their firm's sustainability reports. It appears that DfR within consumer electronics is similar across all levels of remanufacturing. Within the AT industry, DfR varies depending on the level of remanufacturing or the mode of circularity employed. For example, if a firm employs resale, their design approach should be for durability—to extend the product's useful life. In AT design for durability is in direct conflict with design for disassembly (H&M Group, n.d.). Durable garments are more labor-intensive to disassemble, making upcycling costly (Ashby, 2018). Additionally, design decisions regarding the material make of garments have implications on recyclability (Blum, 2021) and scalability. Material selection for effective recyclability is a crucial design decision as will be discussed in more detail in the next section. The segmentation of design decisions with respect to the mode of circularity practices can explain why many AT brands do not utilize all modes of circularity practices. Doing so would lead to conflicting product design approaches. The different design approaches based on the mode of circularity would seem to directly affect CLSC integration and economic benefits to the firm. Additionally, if AT firms only utilize one mode of circularity, say extending the life of products through resale, environmental concerns such as carbon emissions and textile waste may not be properly addressed. *Future research should address the firms' choice of circularity practices considering the design trade-off in product quality, durability, and recyclability along with the associated costs and environmental impact.*

4.5 | Material recycling

The most significant problem in AT industry from a sustainability perspective is reducing the amount of textile waste sent to landfills. The bulk of textile waste are EOU garments that have not been collected (i.e., discarded by end consumers) or cannot be put to better use. Unlike

the electronics, automotive, and appliance industries, the EOU garment or other textile products do not include valuable material to be extracted or components to be reused. This means all the material may be recycled at the lowest bill of material (BOM) level and used to produce entirely new products, leading to significant savings in virgin material use.

Textile recyclers in AT CLSCs receive EOU products from collectors and brands, recycle them at the lowest BOM level, and send the material produced back to the brands for use in forward manufacturing. This mirrors the collection and recycling of aluminum cans to be used in the making of new aluminum cans for beverage manufacturers. However, fashion brands who create fully circular garments are significantly more stringent about their input material. Therefore, when they use recycled material, they want to ensure that the recycled material is from their own products. This makes coordination between the fashion brand and the recycler imperative. *Future research should investigate if and when to implement vertical integration between brands and textile recyclers as well as optimal contract design between them.*

A significant barrier for textile recyclers in AT is the materials used in manufacturing. The materials used in the original garment, whether a mono-fiber or a blend, have implications on recyclability and use in new product offerings. There are mainly three types of material used in products: cellulose material (e.g., cotton, wool, silk), synthetic material (e.g., petroleum derivative nylon, acrylic), and mixed materials (e.g., cotton polyester blend). From a recyclability perspective, mixed materials are the most problematic. For example, spandex fiber (e.g., Lycra) is commonly mixed with cotton and cannot be separated when recycled. Technology development for better materials to substitute for today's synthetics to make recycling viable are relatively new and not at scale. This limits the use of recycled fiber materials (Pentatonic, 2022). From an environmental standpoint, the best approach would be designing the end product for remanufacturability both in terms of material content and variability in attributes. It is, however, up to the fashion brand to implement a policy for DfR. Unlike other industries, textile recyclers may have more impact on the brands since they are the suppliers of the recycled materials. A recycler may ask for specifications for the EOU garments to be recycled and motivate the brand to DfR. *In connection with takeback legislation, whether or not a recycler may have a voice in the material used by the fashion brand presents an interesting research question.*

The industry level differences between AT and consumer electronics shed light on the need to develop remanufacturing insights that are industry specific. We have put forth six future research questions for CLSC practices in the AT industry. Given the forecasted growth of the AT circular market (Business of Fashion, 2022) and

the possibility of extended producer responsibility legislation (Deeley, 2021b; Kent, 2022a) the time is right for the development of context specific AT remanufacturing knowledge and solutions.

5 | CONCLUSION

This study has laid the initial framework for the current CLSC practices within the AT industry and highlighted industry specific challenges for circularity. Through content analysis of company sustainability reports we showcased the industry level differences between the AT and consumer electronics CLSC practices. The most salient differences being at the mode and boundary of EOU acquisition, component level reprocessing, and material level recycling. The results of the content analysis indicate the fluid state of the AT industry in terms of best strategies and practices for CLSCs. The CLSC and remanufacturing practices within the AT industry offer unique challenges focused on DfR, demand and supply flows of EOU garments, future extended producer responsibility legislation, the role of and possible vertical integration of the third-party collector and the material recycler with the fashion brand. Based on the differences, industry specific practices are appropriate given the unique factors present in each industry. As demonstrated in this paper, there is no "one fits all" approach for remanufacturing. It is important that CLSC research address the context specific differences and challenges individual industries present. Due to the infancy of remanufacturing within the AT industry and the expected market growth, research focused on AT remanufacturing is fertile research grounds that has the ability to shape practice in profound ways.

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APPENDIX A

TABLE A1 Apparel and textile content analysis coding guide.

Factor	Subfactors		Description
	First level	*Second level*	
Market position	Luxury		Brand is characterised by a high level of quality, exclusiviity and high price points ($1,000+).
	Bridge		Brand mimics that of luxury but has lower levels of quality, exclusivity, and price point($300-$1,000) (*can be a secondary line for a designer*)
	Moderate		Brand creates similar looking garments to luxury or bridge but are low quality, lack exclusivity, and have price points between $100-$300.
	Budget		Brand has wide appearl and focuses on affordability. Typical price point for less than $100.
Mode of EOU Acquisition	Self		Fashion brand has a clothing take-back program that they manage themselves. Customers can drop off clothing instore or mail back to the company.
	3rd party		Fashion brand has a clothing take-back program that is managed by a 3rd party acquirer. Customers can mail clothing to 3rd party. 3rd party may also acquire clothing from the brand (e.g., unsold merchandise from past seasons).
Boundary of EOU Acquisition	Brand only		The brand has a take-back scheme that is either managed by the brand or a 3rd party and will only accept the brand's EOU clothing.
	Any brand		The brand has a take-back scheme that is either managed by the brand or a 3rd party and will accept any brand's EOU clothing.
Mode of circular economy practices	Resale		EOU clothing acquired by take-back scheme is resold by the brand in their secondary market at a discount. The brand controls sale of resale items.
	Repurpose *(downcycle)*	Self	EOU garments that are not reselable are downcycled by the brand to be used in items that are of lesser value than the original garment (e.g., insulaton).
		3rd party	Brand sends EOU garments not resale-able to a downcycler. Downcycler shreds the material & is then used for products of lesser value than original garment (e.g., insullation).
	Repurpose *(upcycle)*	Self	Brand uses in-house designers and seamstresses to dissasemble EOU garments to the material and trim level to be used to produce new products that are of equal or greater value than the original garment.
		3rd party	Brand sends EOU garments to 3rd party to be dissasembeled and the material or tirms used to produce new products that are of equal or greater value than the original garment.
	Recycling	3rd party	Brand sends clothing that is not resale-able to textile recycler. The textile recycler breaks down the material and recyles it into new material (e.g.,fabric yardage).
	Use of recycled material	Brand only	Brand uses recycled material that was recycled from ONLY their own EOU garments.
		Any brand	Brand uses recycled material regardless of the original EOU garment brand.

TABLE A2 Consumer electronics content analysis coding guide.

Factor	Subfactors		Description
	First-level	*Second-level*	
Market position	High end		Brand is characterized by a high level of quality, exclusivity and high price points.
	Mid-range		Brand targets mass-market and is characterized by value-blend of features and prices.
	Low end		Brand is characterized by a low level of quality, and low price points.
Mode of EOU acquisition	Self		Electronics brand has a take-back program that they manage themselves. Customers can mail back to the company.
	Third-party		Electronic brand has a take-back program that is managed by a third-party acquirer. Customers can mail electronics to third-party or drop off at a retail location (e.g., Best Buy).
Boundary of EOU acquisition	Brand only		The brand has a take-back scheme managed by the brand, will only accept their own electronics.
	Select brands		The brand has a take-back scheme managed by the brand, will accept their own electronics & a few select brands.
	Any brand		The brand has a take-back scheme managed by the brand, will accept any brand of electronics.
Mode of circular economy practices	Product repair		EOU electronics are repaired by the company (not third-party or customer) to new/almost new quality and the original user continues to use the electronic.
	Product/component level reprocessing	Brand only	Brand receives EOU branded electronics that are then disassembled; worn or defective parts replaced, clean, tested, and reput together by to be sold in a secondary market.
		Any brand	Brand receives EOU electronics of any brand that are then disassembled; worn or defective parts replaced, clean, tested, and reput together by to be sold in a secondary market.
		Self	Product or component level reprocessing is performed by the company/ within facilities owned by the company. Refurbished items will be sold in a secondary market controlled by the company.
		Third-party	Product or component level reprocessing is performed by a third-party. Refurbished items will be sold in a secondary market controlled by the company.
	Recycling	Self	The brand collects e-waste and recycles products in own facilities.
		Third-party	The brand sends EOU electronics that are not resale-able to certified e-waste recycler. The recycler breaks down the material and recycles it.
	Use of recycled material	Brand only	Brand uses recycled material for the creation of new products regardless of the original use.
		Any brand	Brand used their branded recycled material for the creation of new products.

APPENDIX B

TABLE B1 Apparel and textile content analysis text examples.

Company name	Factors	Subfactors	Content analysis text examples	Data source
Ganni	Market position		In 2020, affordable Danish luxury brand Ganni announced its Responsibility Game Plan	https://the-ethos.co/fabrics-of-the-future-ganni/
	Mode of EOL product acquisition		"…we would like to pilot a second-hand concept in our Postmodern store in Copenhagen…"	Ganni Responsibility Report 2021
	Boundary of EOU product acquisition		"…customers can trade in their pre-loved GANNI products."	Ganni Responsibility Report 2021
	Mode of circularity	Resale	Buy and Sell Ganni Pre-loved Fashion on Ganni Repeat	https://www.ganni.com/en-gb/ganni-repeat.html
		Repurpose: Downcycle	No information available.	
		Repurpose: Upcycle	No information available.	Ganni Responsibility Report 2021
		Recycling	Not a current practice.	Ganni Responsibility Report 2021
	Use of recycled material		"In 2020, we managed to switch almost half of the wool used in our collections to recycled wool made of pre and post-consumer recycled content. Recycled wool and cashmere now account for 45.5% of the total wool used in our 2020 collections."	
Ralph Lauren	Market position		"Ralph Lauren has built the business into…an iconic global luxury brand operating in more than 50 countries around the world."	https://corporate.ralphlauren.com/on/demandware.store/Sites-RalphLauren_Corporate-Site/default/Default-Start?_ga=2.1739443.340788872.1685724161-656354.1685724161
	Mode of EOL product acquisition		"We will establish both physical and digital platforms that connect consumers to services that help extend the life of their Ralph Lauren products. These include opportunities to sell and buy preloved items, rent iconic pieces and locate resources for recycling maintenance and repair."	Ralph Lauren Global CSR Report 2022
	Boundary of EOU product acquisition		"We will offer more circular services for consumers as we continue to enable the recirculation of Ralph Lauren product through our various digital and brick and mortar distribution channels."	Ralph Lauren Global CSR Report 2022
	Mode of circularity	Resale	"These include opportunities to sell and buy preloved items."	Ralph Lauren Global CSR Report 2022

TABLE B1 (Continued)

Company name	Factors	Subfactors	Content analysis text examples	Data source
		Repurpose: Downcycle	"In addition to introducing rental programs to consumers, we are donating products that are no longer in circulation to Delivering Good, a nonprofit that gives manufacturers and retailers an efficient way to share excess inventory across their network of nonprofits to help those stricken by poverty, or to provide disaster relief to communities in need across the United States."	Ralph Lauren Global CSR Report 2022
		Repurpose: Upcycle	No information available.	Ralph Lauren Global CSR Report 2022
		Recycling	"In 2020, Ralph Lauren invested in Natural Fiber Welding, a leading sustainable material science startup that is scaling a new industry standard for natural fiber recycling."	Ralph Lauren Global CSR Report 2022
	Use of recycled material		"In 2020, Ralph Lauren invested in Natural Fiber Welding, a leading sustainable material science startup that is scaling a new industry standard for natural fiber recycling…increase the availability of high-quality inputs and significantly reduce dependence on the extraction of virgin materials."	Ralph Lauren Global CSR Report 2022
Ugg	Market position		"We were first embraced as a functional, post-surf brand and then a global symbol of provocation and laidback luxury."	https://www.ugg.com/our-story/
	Mode of EOL product acquisition		No information available.	
	Boundary of EOU product acquisition		No information available.	
	Mode of circularity	Resale	No information available.	
		Repurpose: Downcycle	No information available.	
		Repurpose: Upcycle	No information available.	
		Recycling	No information available.	
	Use of recycled material		"We repurpose once discarded fabrics and materials into new formats that would otherwise go to waste or be destroyed."	https://www.ugg.com/responsible-materials/

TABLE B1 (Continued)

Company name	Factors	Subfactors	Content analysis text examples	Data source
Dior	Market position		"Christian Dior Couture obtained Positive Luxury's Butterfly Mark certification."	https://www.dior.com/en_us/fashion/news-fashion-shows/folder-news-and-events/dior-sustainability
	Mode of EOL product acquisition		No information available	
	Boundary of EOU product acquisition		No information available	
	Mode of circularity	Resale	No information available.	
		Repurpose: Downcycle	No information available.	
		Repurpose: Upcycle	No information available.	
		Recycling	"…but also through creative circularity and innovations in high quality textile recycling."	https://www.dior.com/en_us/fashion/news-fashion-shows/folder-news-and-events/dior-sustainability
	Use of recycled material		No information available.	
EILEEN FISHER	Market position		"…it unveiled a higher-priced 'bridge' line—the name given in the industry for goods priced just below designer level…"	https://www.referenceforbusiness.com/history2/49/Eileen-Fisher-Inc.html
	Mode of EOL product acquisition		"Bring your EILEEN FISHER clothes back to any US EILEEN FISHER or Renew store…"	https://www.eileenfisherrenew.com/learn-more
	Boundary of EOU product acquisition		"Bring your EILEEN FISHER clothes back to any US EILEEN FISHER or Renew store… no matter what condition it's in."	https://www.eileenfisherrenew.com/learn-more
	Mode of circularity	Resale	"We created EILEEN FISHER Renew so we could extend the lifecycle of the clothes we love. Our philosophy is simple: Buy quality pieces, wear them as long as possible—and when you are done with them, pass them on to someone else."	https://www.eileenfisherrenew.com/learn-more
		Repurpose: Downcycle	No information available.	
		Repurpose: Upcycle	"In 2018, clothing designer Eileen Fisher debuted Waste No More, a design studio dedicated to making artisanal textiles from post-consumer clothing."	https://www.wastenomore.com/about
		Recycling	"Only garments that are in great condition are resold—the rest are recycled or transformed into one-of-a-kind works of art using our custom felting technique."	https://www.eileenfisherrenew.com/learn-more

TABLE B1 (Continued)

Company name	Factors	Subfactors	Content analysis text examples	Data source
	Use of recycled material		"We're increasing our use of recycled materials to reduce our dependence on finite sources."	https://www.eileenfisher.com/first-life.html?loc=default
Tommy Hilfiger	Market position		"Tommy Hilfiger brand is targeting the upper-middle-class people."	https://www.marketing91.com/marketing-strategy-of-tommy-hilfiger/#~:text=Tommy%20Hilfiger%20brand%20is%20targeting,'classic%20American%20cool%20style'.
	Mode of EOL product acquisition		"You trade in the Tommy pieces you no longer need... We'll renew your pre-loved items or reuse them to create a remixed one- then find them a new home."	https://uk.tommy.com/tommy-for-life
	Boundary of EOU product acquisition		"Tommy for Life is a new circular business model that will take pre-owned or damaged Tommy Hilfiger and Tommy Jeans garments..."	https://fashionunited.uk/news/fashion/tommy-hilfiger-launches-circular-initiative-tommy-for-life/2020100851289
	Mode of circularity	Resale	"Reloved: Previously owned products traded-in by consumers. Refreshed: Restored items from store and e-commerce returns."	https://fashionunited.uk/news/fashion/tommy-hilfiger-launches-circular-initiative-tommy-for-life/2020100851289
		Repurpose: Downcycle	No information available.	
		Repurpose: Upcycle	"you trade in the Tommy pieces you no longer need... We'll renew your pre-loved items or reuse them to create a remixed one- then find them a new home."	https://uk.tommy.com/tommy-for-life
		Recycling	"When pieces are made from a single material, they are turned into new fibers and fabrics."	https://www.the-spin-off.com/news/stories/Brands-Tommy-Hilfigers-circular-initiative-Tommy-for-Life-15629
	Use of recycled material		"Obtaining 40% of our nylon from recycled sources."	https://responsibility.pvh.com/tommy/materials-and-innovation/
Reformation	Market position		"Reformation is a semi-luxury brand."	https://beautymag.com/stores-like-reformation/
	Mode of EOL product acquisition		"Together with thredUP we just made it a whole lot easier for you to give those questionable purchases a second life."	https://www.thereformation.com/sustainability/ref-recycling.html
	Boundary of EOU product acquisition		"So we're paying you to send us Ref shoes, bags, denim, sweaters, tees, outerwear, and activewear you don't want anymore."	https://www.thereformation.com/sustainability/ref-recycling.html
	Mode of circularity	Resale	"For stuff you don't want, but someone else might. Get a kit and get rid of it with thredUP... Resell."	https://www.thereformation.com/sustainability/ref-recycling.html

TABLE B1 (Continued)

Company name	Factors	Subfactors	Content analysis text examples	Data source
		Repurpose: Downcycle	No information available.	https://www.thereformation.com/sustainability/ref-recycling.html
		Repurpose: Upcycle	"We've been reusing and recycling clothes since 2015, but this is the first time we're making new Ref out of old Ref."	https://www.thereformation.com/sustainability/ref-recycling.html
		Recycling	"Whether you loved it to death or it was just a fling, RefRecycling helps you recycle anything you can't rewear or resell with help from our friends at SuperCircle."	https://www.thereformation.com/sustainability/ref-recycling.html
	Use of recycled material		"Our goal is to have 100% of our fabrics be from recycled, regenerative or renewable materials by 2025."	https://www.thereformation.com/sustainability/ref-recycling.html
Guess?	Market position		"The company targets a middle- to high-end customer base."	https://amplifyxl.com/guess-target-market/
	Mode of EOL product acquisition		"Bring in their unwanted clothing and shoes—from any brand—to any GUESS store in the U.S... Your items will be sent to Homeboy Recycling for upcycling, refurbishing, and recycling."	https://sustainability.guess.com/ensuring-product-responsibility
	Boundary of EOU product acquisition		"We encourage customers to bring in their unwanted clothing and shoes—from any brand—to any GUESS store in the U.S. for recycling."	https://sustainability.guess.com/ensuring-product-responsibility
	Mode of circularity	Resale	No information available.	
		Repurpose: Downcycle	No information available.	
		Repurpose: Upcycle	"Your items will be sent to Homeboy Recycling for upcycling, refurbishing, and recycling."	https://sustainability.guess.com/ensuring-product-responsibility
		Recycling	"We encourage customers to bring in their unwanted clothing and shoes—from any brand—to any GUESS store in the U.S. for recycling."	VISION: Guess- Sustainability Report FY2020-2021
	Use of recycled material		"GUESS Eco non-denim products contain 20%–100% environmentally preferred materials that are recycled, organic and innovative."	Guess Eco Materials guide: 3rd Edition
Patagonia	Market position		"a lot of labels straddle this category... The bulk of sportswear falls into this category"	https://fashion-incubator.com/apparel-price-point-categories/

(Continues)

TABLE B1 (Continued)

Company name	Factors	Subfactors	Content analysis text examples	Data source
	Mode of EOL product acquisition		"Trade in your gear by mail…or at any of our stores"	https://wornwear.patagonia.com/trade-it-in
	Boundary of EOU product acquisition		"Trade in Patagonia items you no longer want."	https://wornwear.patagonia.com/trade-it-in
	Mode of circularity	Resale	"Worn Wear is our program to trade in and buy used Patagonia® gear."	https://wornwear.patagonia.com/
		Repurpose: Downcycle	No information available.	
		Repurpose: Upcycle	No information available.	
		Recycling	"We'll send them to Infinited Fiber, our Finland-based supply-chain partner that recycles the material from the used tees into Infinna™ Fiber."	https://www.patagonia.com/our-footprint/take-back-program.html
	Use of recycled material		"Our recycled cotton is made from cotton scraps gathered from factory floors."	https://www.patagonia.com/our-footprint/recycled-cotton.html
0Wrangler	Market position		"It is well known for its long heritage in the production of quality jeans for toughness and durability."	https://www.marketing91.com/marketing-mix-wrangler/
	Mode of EOL product acquisition		No information available.	
	Boundary of EOU product acquisition		No information available.	
	Mode of circularity	Resale	No information available.	
		Repurpose: Downcycle	No information available.	
		Repurpose: Upcycle	"Our tough, durable denim can be repurposed, and re-loved, to allow our customers to buy better."	https://www.wrangler.com/shop/we-care
		Recycling	"We're tackling the fashion industry's waste problem head on by investing in new ways to use recycled cotton, polyester and other fibers in clothes while retaining the iconic look and feel of our denim."	https://eu.wrangler.com/ie-en/sustainability-product.html
	Use of recycled material		"…investing in new ways to use recycled cotton, polyester and other fibers in clothes while retaining the iconic look and feel of our denim."	https://www.wrangler.com/sustainability/Product.html

TABLE B1 (Continued)

Company name	Factors	Subfactors	Content analysis text examples	Data source
Zara	Market position		"Cutting edge fashion at affordable Prices."	https://www.harbott.com/analysing-zaras-business-model/
	Mode of EOL product acquisition		"Closing the loop programme... is fully implemented in our offices and logistics centres, as well as in 598 Zara stores in 14 markets worldwide... Also, thanks to a collaboration with Cáritas, and with the aim of extending this programme beyond our stores, 1856 containers were installed on Spanish streets between 2016 and 2017."	https://static.inditex.com/annual_report_2017/assets/pdf/c61_en.pdf
	Boundary of EOL product acquisition		"You can donate any kind of clothing or fabrics you wish to recycle."	https://www.zara.com/us/en/help-center/ClothesCollectionProgram#JoinLifeZaraClothes
	Mode of circularity	Resale	No information available.	
		Repurpose: Downcycle	"These programs allow customers to donate unwanted items to a number of NGOs such as the Red Cross, Caritas or Oxfam who benefit from their resale and reuse"	https://static.inditex.com/annual_report_2017/assets/pdf/c61_en.pdf
		Repurpose: Upcycle	No information available.	
		Recycling	"We collaborate... with companies that specialize in recycling and with specialists in different technologies to prevent used garments from ending up in landfill."	https://static.inditex.com/annual_report_2017/assets/pdf/c61_en.pdf
	Use of recycled material		"As a result, we have launched a number of collections with various startups like Nextevo and Renewcell in a process of continuous collaboration. We have, as a result, signed our first forward purchase commitment with Infinited Fiber."	Inditex Group Annual Report 2022
Columbia Sportswear	Market position		"a lot of labels straddle this category... The bulk of sportswear falls into this category"	https://fashion-incubator.com/apparel-price-point-categories/
	Mode of EOL product acquisition		"Columbia's Rethreads program encourages consumers to bring in their used clothing and shoes in clean, dry condition, to Columbia retail stores to be given a new life."	https://www.columbia.com/ReThreads.html
	Boundary of EOL product acquisition		"Columbia's Rethreads program encourages consumers to bring in their used clothing and shoes in clean, dry condition, to Columbia retail stores to be given a new life."	https://www.columbia.com/ReThreads.html

(Continues)

TABLE B1 (Continued)

Company name	Factors	Subfactors	Content analysis text examples	Data source
	Mode of circularity	Resale	No information available.	
		Repurpose: Downcycle	"…fibers for new products such as insulation, carpet padding, stuffing for toys…"	https://www.columbia.com/ReThreads.html
		Repurpose: Upcycle	No information available.	
		Recycling	"Garments and footwear that are dropped in ReThreads bins in each Columbia store, will be sent to a textiles processing facility through I:CO, a textile recycling solutions provider."	https://www.columbia.com/ReThreads.html
	Use of recycled material		"Material highlights: 100% cotton is organic or recycled; 80% polyester is recycled 32% bluesign® certified materials; 32% wool is recycled."	2021 Environmental, Social, & Governance Report
Fruit of the Loom	Market position		"Our colorful T-shirts and underwear are known by consumers in all corners of the globe and our name is synonymous with providing quality, value and style."	https://www.fruit.com/fruit-story-static.html
	Mode of EOL product acquisition		No information available.	
	Boundary of EOU product acquisition		No information available.	
	Mode of circularity	Resale	No information available.	
		Repurpose: Downcycle	"For example, our textile waste goes to a partner who recycles textiles or repurposes them into insulation for mattresses or car seats."	Fruit of the Loom Inc. 2021 Sustainability Report
		Repurpose: Upcycle	No information available.	
		Recycling	"For example, our textile waste goes to a partner who recycles textiles or repurposes them into insulation for mattresses or car seats."	Fruit of the Loom Inc. 2021 Sustainability Report
	Use of recycled material		"Each sustainably designed t-shirt is made with 20% Recover™ best-in-class recycled cotton fiber and is available in eight colors."	https://recoverfiber.com/newsroom/fruit-of-the-loom-and-recover-launch-affordable-and-sustainable-t-shirt-collection
Old Navy	Market position		"Old Navy targets customer from lower-middle to middle-class income groups."	https://www.mbaskool.com/marketing-mix/products/17483-old-navy.html
	Mode of EOL product acquisition		"Through our partnerships with thredUP®, Give Back Box, and How2Recycle, we engage customers in	Gap Inc. 2021 ESG Report

TABLE B1 (Continued)

Company name	Factors	Subfactors	Content analysis text examples	Data source
	Boundary of EOU product acquisition		reselling old clothes and donating clothes to people in need."	Gap Inc. 2021 ESG Report
			"Through our partnerships with thredUP®, Give Back Box, and How2Recycle, we engage customers in reselling old clothes and donating clothes to people in need."	
	Mode of circularity	Resale	No information available	
		Repurpose: Downcycle	No information available.	
		Repurpose: Upcycle	No information available.	
		Recycling	"We're also working with Accelerating Circularity to develop knowledge on textile-to-textile recycling, anticipating the transition to advanced chemical recycling techniques."	Gap Inc. 2021 ESG Report
	Use of recycled material		"…committed to an increased use of recycled cotton in its denim assortment…"	Gap Inc. 2021 ESG Report
H&M	Market position		"H&M differentiates its brand by virtue of proposing low prices for high quality and design products…this is due to their focus on cost minimization."	https://thesocialgrabber.com/positioning-zara-hm/
	Mode of EOL product acquisition		"Bring any unwanted clothes or textiles, by any brand and in any condition, to one of our stores."	https://www2.hm.com/en_us/sustainability-at-hm/our-work/close-the-loop.html
	Boundary of EOU product acquisition		"Bring any unwanted clothes or textiles, by any brand and in any condition, to one of our stores."	https://www2.hm.com/en_us/sustainability-at-hm/our-work/close-the-loop.html
	Mode of circularity	Resale	"Extend the life cycle of your H&M clothing through Rewear: a space to buy and sell previously owned (and loved) styles."	https://www2.hm.com/en_ca/sustainability-at-hm/secondhand/re-wear.html
		Repurpose: Downcycle	"If the clothes or textiles are not suitable for rewear, they're turned into other products, such as cleaning cloths."	https://www2.hm.com/en_us/sustainability-at-hm/our-work/close-the-loop.html
		Repurpose: Upcycle	No information available.	
		Recycling	"All other clothes and textiles are shredded into textile fibers and used to make, for example, insulation materials."	https://www2.hm.com/en_us/sustainability-at-hm/our-work/close-the-loop.html

(Continues)

TABLE B1 (Continued)

Company name	Factors	Subfactors	Content analysis text examples	Data source
	Use of recycled material		"Renewcell uses post-consumer textiles from several sources to make new material, including our garment collecting programme. In 2021, we used Circulose® in several styles across our brands and collections."	https://hmgroup.com/sustainability/circularity-and-climate/recycling/
Hanes	Market position		"...make t-shirts from high-quality fabrics, their products are reasonably priced... suitable for all budgets."	https://threadlogic.com/blogs/logo-embroidery/hanes-vs-gildan-two-fan-favorites-go-head-to-head#:~:text=Affordable%3A%20Even%20though%20Hanes%20and,brands%20suitable%20for%20all%20budgets.
	Mode of EOL product acquisition		"Hanes... announced that it is partnering with Give Back Box® to encourage consumers to reduc[e] waste, giving their old clothes new life... Give Back Box is an online service that coordinates the shipping of gently used outerwear."	https://ir.hanesbrands.com/news-releases/news-release-details/hanes-partners-give-back-box-give-old-clothes-new-life-earth-day
	Boundary of EOU product acquisition		"Hanes... announced that it is partnering with Give Back Box® to encourage consumers to reduc[e] waste, giving their old clothes new life... Give Back Box is an online service that coordinates the shipping of gently used outerwear."	https://ir.hanesbrands.com/news-releases/news-release-details/hanes-partners-give-back-box-give-old-clothes-new-life-earth-day
	Mode of circularity	Resale	No information available.	
		Repurpose: Downcycle	No information available.	
		Repurpose: Upcycle	No information available.	
		Recycling	"We kickstarted the use of circular economy practices years ago by partnering with yarn mills to manufacture reclaimed and recycled cotton."	https://hbisustains.com/circularity/
	Use of recycled material		"We are working closely now with a number of recycled yarn manufacturers who now have technology to spin recycled cotton into yarn for fleece and t-shirts."	https://hbisustains.com/circularity/

TABLE B2 Consumer electronics content analysis text examples.

Company name	Factors	Subfactors	Content analysis text examples	Data source
Samsung	Market position		"The company's marketing strategies focus on reinforcing premium branding while targeting multiple market segments through different price points for its consumer electronics."	https://panmore.com/samsung-marketing-mix-4p-analysis
	Mode of EOL product acquisition		"Consumers directly dispose e-wastes at some 781 locations (since 2020) in partnership with uBreakiFix...partners are certified to provide national coverage supporting Samsung's commitment for responsible recycling in all 50 states."	https://www.samsung.com/global/sustainability/planet/circular-economy/#AYUppVv6BHwAlx_C
	Boundary of EOU product acquisition		"Any electronic waste is collected regardless of brand."	https://www.samsung.com/uk/sustainability/environment/resource-efficiency/#rrp
	Mode of circularity	Product repair	"We design our products in a manner that allows users to easily disassemble and repair them to prolong their use and make it easy to recycle discarded parts."	Samsung Electronics Sustainability Report 2022
		Product/component reprocessing	"They are refurbished by Samsung, in a Samsung facility where many new smartphones are also built. So, parts are replaced with 100% Samsung genuine parts quickly and easily."	https://www.samsung.com/us/smartphones/certified-re-newed-phones/#faq
		Recycling	"Collected electronic goods are sorted, pre-processed, and pressed to be reused as materials for new product manufacturing."	Samsung Electronics Sustainability Report 2022
	Use of recycled material		"We strive to increase the use of sustainable materials in smartphones and tablets. To that end, we have developed innovative technologies to recycle waste fishing nets to reduce ocean plastic pollution...we used 5587 tonnes of plastic materials recycled from discarded products in the manufacturing of new products."	Samsung Electronics Sustainability Report 2022
Apple	Market position		"The premium pricing strategy involves offering Apple products at a premium."	https://panmore.com/apple-inc-marketing-mix-4ps
	Mode of EOL product acquisition		"Trade in your way—online or at an Apple Store."	https://www.apple.com/shop/trade-in
	Boundary of EOU product acquisition		"With Apple Trade In, you can get a great value for your current device and apply it toward a new one."	https://www.apple.com/shop/trade-in
	Mode of circularity	Product repair	"Repair options include Apple Store locations, Apple Authorized Service Providers, participating Independent Repair Providers, mail-in repair centers, onsite service, and Self Service Repair."	Environmental Progress Report

(Continues)

TABLE B2 (Continued)

Company name	Factors	Subfactors	Content analysis text examples	Data source
		Product/component reprocessing	"You will receive a refurbished device with genuine Apple replacement parts (as needed) that has been thoroughly cleaned and inspected. Refurbished IOS devices will come with new battery and outer shell. Every device will come with all accessories, cables and operating systems. Footnote 1 All Apple Certified Refurbished products are packaged in a brand new white box and will be sent to you with free shipping and returns."	https://www.apple.com/shop/refurbished/about
		Recycling	"Apple products contain materials that can be used to build new ones. And research from our Material Recovery Lab in Texas helps us reclaim more of these building blocks with innovative tools and technologies. Our team of disassembly robots, Daisy, Dave, and Taz, is leading the way in recovering crucial materials like gold, cobalt, tungsten, and rare earth elements from recycled devices."	https://www.apple.com/environment/
		Use of recycled material	"100% recycled gold in the wire of all cameras and in the plating of multiple printed circuit boards...in 2022, 20 percent of the material we shipped in products came from recycled or renewable sources."	Environmental Progress Report
HP	Market position		"The products are known to be reliable and hence the brand has a good customer base..." "an affordable tower server..." "policy of Hewlett Packard is fair pricing as well as competitive pricing."	https://iide.co/case-studies/marketing-mix-of-hp/#:~:text=2.,HP%20Price%20Strategy,on%20a%20suitable%20selling%20price
	Mode of EOL product acquisition		"Once you're done with your HP device, you can safely and sustainably return it to us using our HP Device Recovery Service."	https://www.hp.com/us-en/hp-information/sustainable-impact/planet-product-recycling.html
	Boundary of EOU product acquisition		"Once you are done with your HP device, you can safely and sustainably return it to us using our HP Device Recovery Service."	https://www.hp.com/us-en/hp-information/sustainable-impact/planet-product-recycling.html
	Mode of circularity	Product repair	"When they reach the end of their service, our robust product repair, reuse, and recycling programs help to ensure that products and materials are repurposed, which keeps them at their highest value state for as long as possible."	https://h20195.www2.hp.com/v2/getpdf.aspx/c06971467.pdf
		Product/component reprocessing	"Our remanufacturing programs help to extend hardware lifespan, reducing environmental impacts from replacing products that still have useful life. We provide customers guidance about how to repair their own HP product."	https://h20195.www2.hp.com/v2/getpdf.aspx/c06971467.pdf
		Recycling	"HP recycles hardware (both HP and non-HP) that cannot be economically repaired or reused."	https://h20195.www2.hp.com/v2/getpdf.aspx/c06000309.pdf

TABLE B2 (Continued)

Company name	Factors	Subfactors	Content analysis text examples	Data source
	Use of recycled material		"EvoCycle cartridges include 76% reused and recycled components."	2021 HP Sustainability impact report.
Fairphone	Market position		"the Fairphone 4 costs a premium... It's also getting a much more limited Europe-only release."	https://www.theverge.com/22716194/fairphone-4-review
	Mode of EOL product acquisition		"Get a quote, on our partner's website, for your old phone to see how much it is still worth. After knowing your old phone's value you can decide if you want to return your phone or not."	https://shop.fairphone.com/en/recycle
	Boundary of EOU product acquisition		"Brand options: Fairphone, Apple, Samsung, Huawei, Crosscall."	https://fairphone.cadaoz.com/en/device
	Mode of circularity	Product repair	"You don't need to be an expert to swap out the battery or display. No part of Fairphone 4 is glued shut, so you can choose to easily repair it yourself with a standard screwdriver."	https://shop.fairphone.com/en/?ref=header
		Product/component reprocessing	"The refurbished phones are sold through a trusted partner so someone else can enjoy them."	https://shop.fairphone.com/en/recycle
		Recycling	"Phones that are no longer functional and cannot be repaired go to a European recycling facility where they're processed to recover the valuable resources inside."	https://shop.fairphone.com/en/recycle
	Use of recycled material		"Designed to last, with fair and recycled materials...the phone's body is machined from aluminium from ASI certified vendors*, with a 100% recycled plastic back cover."	https://shop.fairphone.com/en/?ref=header
Microsoft	Market position		"In the market-oriented pricing strategy, Microsoft sets the prices of many of its products, based on market factors, such as competitors' pricing and consumer demand."	https://panmore.com/microsoft-corporation-marketing-mix-4ps-analysis#:~:text=In%20the%20market%2Doriented%20pricing,competitors%20pricing%20and%20consumer%20demand
	Mode of EOL product acquisition		"Send in [mail in] an eligible device."	https://www.microsoft.com/en-us/store/b/microsoft-trade-in?rtc=1&activetab=pivot:forpersonaltab
	Boundary of EOU product acquisition		"Microsoft offers recycling programs for any individual who wants to recycle a Microsoft-branded consumer product....In certain jurisdictions in the United States (*), Microsoft accepts devices from other brands for recycling purposes."	https://www.microsoft.com/en-us/legal/compliance/recycling

(Continues)

TABLE B2 (Continued)

Company name	Factors	Subfactors	Content analysis text examples	Data source
	Mode of circularity	Product repair	"To get service for a personal Surface device (not a business device), you can send it in to get quality service performed by trusted experts using certified parts. You'll be back up and creating your best work on your Surface."	https://support.microsoft.com/en-us/surface/how-to-get-service-for-surface-b06da716-0763-65b3-e2f2-116d9e30f877
		Product/component reprocessing	"The Microsoft Authorized Refurbisher program offers you access to a diverse and trusted group of partners offering options for used devices. Microsoft experts are the ones who certify the refurbished devices."	https://devicepartner.microsoft.com/en-us/communications/comm-resource-center-microsoft-authorized-refurbisher#tab-content-3.
		Recycling	"Microsoft offers recycling programs for any individual who wants to recycle a Microsoft-branded consumer product, its battery and/or its packaging."	https://www.microsoft.com/en-us/legal/compliance/recycling.
	Use of recycled material		"We introduced two new accessories that are made in part from recycled waste materials: several new Xbox Wireless Controllers, built using over 30 percent post-consumer recycled (PCR) materials; and the Ocean Plastic Mouse, which has a plastic shell made with 20 percent recycled ocean plastic."	2021 Environmental Sustainability Report
Lenovo	Market position		"Lenovo offers products belonging to different price ranges so that it can cater to customers belonging to various segments."	https://www.mbaskool.com/marketing-mix/products/17419-lenovo.html
	Mode of EOL product acquisition		"Customers simply prepare the product for shipment and follow the steps on the RLGA webpage which includes detailed instructions regarding how to request a free prepaid label."	https://www.lenovo.com/us/en/social_responsibility/sustainability/ptb_us/
	Boundary of EOU product acquisition		"Nationally, Lenovo offers free recycling for Lenovo-, Medion-, and select IBM-branded PCs; Iomega and LenovoEMC network-attached storage devices, and Medion TVs for Lenovo's home and home-office customers."	https://www.lenovo.com/us/en/social_responsibility/sustainability/ptb_us/
	Mode of circularity	Product repair	"We will share a Fed Ex label for you to send your device to us. Then we will repair your device and send it back."	https://en-us.support.motorola.com/app/repair-faqs/category/what-my-service-options
		Product/component reprocessing	"Lenovo locations or suppliers who refurbish end-of-life product, parts, or components for the purpose of returning the products, parts or components to original condition for reselling to end users."	https://www.lenovo.com/us/en/social_responsibility/sustainability/ptb_us/
		Recycling	"Lenovo's consumer offering provides a free recycling solution (shipping included) for all Lenovo-, Medion-, Iomega-, and LenovoEMC-branded products and select IBM-branded products, including system units, monitors, keyboards, mice, network-attached storage devices, and Medion-branded televisions. The program offers convenient options for recycling Lenovo products, including free shipping."	https://www.lenovo.com/us/en/sustainability-product-recycling/

TABLE B2 (Continued)

Company name	Factors	Subfactors	Content analysis text examples	Data source
	Use of recycled material		"New sustainable and recyclable materials are being researched and introduced into products... This fiscal year, the Company more than doubled the number of products containing CL PCR to 248 products. Also, the Company expanded the types of components that contain PCC plastics. The Company introduced recycled aluminum and magnesium as well as ocean bound plastic for the first time to select components in FY 2021/22."	FY2022 Lenovo Sustainability Report
Dell	Market position		"The main goal of Dell is to provide a low price and profitable PC for the customers."	https://iide.co/case-studies/business-model-of-dell/#:~:text=Price%20Mix%20of%20Dell,-Pricing%20strategies%20usually&text=The%20main%20goal%20of%20Dell,affordability%20of%20the%20local%20consumers
	Mode of EOL product acquisition		"Drop off any brand of old electronics at a participating Goodwill® and Dell will recycle it for free... Drop off at a local mailing center or call (800) Go-FedEx (800–463-3339) to schedule a pick up through Dell's Package Return Program."	https://www.dell.com/en-us/dt/corporate/social-impact/advancing-sustainability/how-to-recycle.htm#/cdt/home/computer-accessories
	Boundary of EOU product acquisition		"We accept any brand of used computers and electronics in any condition."	https://www.dell.com/en-us/dt/corporate/social-impact/advancing-sustainability/electronics-recycling/index.htm
	Mode of circularity	Product Repair	"At Dell Technologies, we have long supported customers' choice to repair their own device or seek out another convenient repair option."	FY22 Enviornmental, Social, and Goverance Report: Dell Technologies
		Product/component reprocessing	As Dell Corporate Customers return leased computers to Dell Financial Services LLC (DFS), we select the highest quality systems for refurbishment and make them available for sale through this website, formally known as DFS Direct Sales. Our products are visually and diagnostically inspected and tested to ensure the highest quality standards and reliability.	https://www.dellrefurbished.com/cms/about/about-dfs/1.html
		Recycling	"That's why we provide convenient trade in and recycling solutions that help us reuse precious materials to make new Dell products."	https://www.dell.com/en-us/dt/corporate/social-impact/advancing-sustainability/how-to-recycle.htm?hve=recycle%20now#/
	Use of recycled material		"In the last year alone we introduced closed-loop aluminum from out of use hard drives, bioplastics made from tree waste in the paper making process and scaled our use of reclaimed carbon fiber to over 1.2 million pounds."	https://www.dell.com/en-us/blog/pushing-the-boundaries-of-sustainable-pc-design-concept-luna/
Sony	Market position		"Sony has two different types of pricing strategies: premium pricing strategy and competitive pricing strategy."	https://startuptalky.com/sony-marketing-strategy/#:~:text=Sony%20has%20two%20different%20types,goods%20than%20its%20rivals%20do

(Continues)

TABLE B2 (Continued)

Company name	Factors	Subfactors	Content analysis text examples	Data source
	Mode of EOL product acquisition		"Sony has partnered with ERI to offer their Take Back and Recycling Program nationwide."	https://eridirect.com/sony/
	Boundary of EOU product acquisition		"If you can't find an option, look for an upcoming recycling event or mail your Sony branded product to us for responsible recycling at no cost."	https://eridirect.com/sony/
	Mode of circularity	Product repair	Product Repair depends on the consumer electronic	https://us.esupport.sony.com/support/s/service?language=en_US&cpint=spt-d2c_footer_repair
		Product/ component reprocessing	The Sony Certified Refurbished Store is now closed. You can find graded and refurbished cameras and accessories from Sony Pencoed here or other Sony products through our dealers.	https://pro.sony/en_GB/certified-refurbished-products
		Recycling	Sony has partnered with ERI to offer their Take Back and Recycling Program nationwide.	https://eridirect.com/sony/
	Use of recycled material		To promote recycling, we work with recyclers and reuse materials from used products around the world.	https://www.sony.com/en/SonyInfo/csr/eco/RoadToZero/gm_en.html
Acer	Market position		"Acer has enhanced its operation and supply chain system thereby is able to offer its products at reasonable prices to its consumers… the major strategy adopted by Acer is value based pricing"	https://www.mbaskool.com/marketing-mix/products/17323-acer.html#:~:text=Acer%20Price%2FPricing%20Strategy%3A&text=The%20major%20strategy%20adopted%20by,based%20on%20the%20value%20proposition.
	Mode of EOL product acquisition		"Acer offers a recycling program through its partner, Reverse Logistics Group Americas, Inc. (RLGA)."	https://www.acer.com/us-en/about/recycling/recycling-pc
	Boundary of EOU product acquisition		"Acer's customers to return certain Acer branded products for recycling free of charge."	https://www.acer.com/us-en/about/recycling/recycling-pc
	Mode of circularity	Product repair	"Acer offers to customers of all EPEAT-registered products, product repair and replacement services for at least 3 years from the date of sale… available hardware features may only be offered as part of an upgrade, repair, or replacement service offered by Acer or its authorized repair service providers."	https://www.acer.com/us-en/about/csr/epeat-program
		Product/ component reprocessing	"These items are usually customer returns that have been fully refurbished directly by Acer to their factory standards."	https://acerrecertified.com/Content/FAQ
		Recycling	"Acer offers a recycling program through its partner, Reverse Logistics Group Americas, Inc. (RLGA)."	https://www.acer.com/us-en/about/recycling/recycling-pc.

TABLE B2 (Continued)

Company name	Factors	Subfactors	Content analysis text examples	Data source
	Use of recycled material		By 2025, 20%–30% of core products will use post-consumer recycled plastics, including notebooks, desktops, and monitors.	2021 Acer Sustainability Report
Panasonic	Market position		"The company ensures the availability of products to each and every section of the society through its affordable and reasonable pricing policy."	https://www.mbaskool.com/marketing-mix/products/16874-panasonic.html#:~:text=Panasonic%20Price%2FPricing%20Strategy%3A&text=Thus%2C%20fair%20Price%20Policy%20and,creates%20a%20new%20consumer%20base
	Mode of EOL product acquisition		"To obtain a shipping label for free recycling of your TOUGHBOOK product, please visit the MRM home page here and click on 'Mail back your product' under 'Recycle now'. Or call MRM at 888769-0149."	https://na.panasonic.com/us/computers-tablets-handhelds/toughbook-services/replacement-recycle-services
	Boundary of EOU product acquisition		"To obtain a shipping label for free recycling of your TOUGHBOOK product."	https://na.panasonic.com/us/computers-tablets-handhelds/toughbook-services/replacement-recycle-services
	Mode of circularity	Product repair	Panasonic Connect North America, referred to hereinafter as "Panasonic," will repair or replace, at Panasonic's sole discretion, the Panasonic Mobile Computer products listed below ("Product(s)") with new or rebuilt parts, free of charge, in a Panasonic Authorized Service Center."	https://na.panasonic.com/us/support/computers-tablets-handhelds-warranties
		Product/component reprocessing	No information	
		Recycling	"In 2007, Panasonic joined with Sharp and Toshiba to form an e-waste collection and recycling management company called Electronics Manufacturers Recycling Management Company (MRM), with the purpose of bringing manufacturers together into a collective effort to recycle electronic products."	https://na.panasonic.com/us/environment/sustainability-initiatives
	Use of recycled material		"By 2024 we will double our use of recycled resin."	https://www.na.panasonic.com/greenimpact
Nokia	Market position		"Nokia believes in producing budget-friendly products... Nokia uses a pricing technique that focused on low prices and superior quality in terms of durability and reliability."	https://iide.co/case-studies/marketing-mix-of-nokia/#:~:text=NOKIA%20PRICING%20STRATEGY,-Nokia%20believes%20in&text=Nokia%20uses%20a%20price%20skimming,terms%20of%20durability%20and%20reliability
	Mode of EOL product acquisition		"Nokia Solutions and Networks India Private Limited (Nokia Networks) has joined the following entities to fulfil its Extended Producer Responsibility (EPR) compliance..."	https://www.nokia.com/about-us/company/worldwide-presence/india/responsible-recycling-at-nokia/

(Continues)

TABLE B2 (Continued)

Company name	Factors	Subfactors	Content analysis text examples	Data source
	Boundary of EOU product acquisition		"At Nokia Networks, we are committed to responsibly recycling of our end-of-life products."	https://www.nokia.com/about-us/company/worldwide-presence/india/responsible-recycling-at-nokia/
	Mode of circularity	Product repair	"We take back or acquire excess and obsolete products from customers and markets and then repair…"	https://www.nokia.com/about-us/sustainability/environment/#circular-practices-and-solutions
		Product/ component reprocessing	"We take back or acquire excess and obsolete products from customers and markets… refurbish these units for inclusion in the product supply chain for customer purchase or our own internal use."	https://www.nokia.com/about-us/sustainability/environment/#circular-practices-and-solutions
		Recycling	"Products that cannot be reused are sent to recycling to Nokia authorized facilities, to generate raw material for another application or industry."	https://www.nokia.com/about-us/sustainability/environment/#circular-practices-and-solutions
	Use of recycled material		"We estimate that 45% of over 10,000 tons of cast aluminum parts used in Nokia products in 2022 have recycled content in them… The recycled material is from inter-industry manufacturing waste, as there are still challenges related to material purity when adding postconsumer material into our components."	Nokia People and Planet 2022 Sustainability Report
ASUS	Market position		"…Customers receive the highest quality solutions cost-effectively."	https://www.asus.com/in/About_ASUS/Winning_formula/
	Mode of EOL product acquisition		"Recovery and Recycling: Provide global and diverse take back services based on the sales service model of each country… ASUS's recycling partner, ERI."	ASUS Detailed 2021 Report
	Boundary of EOU product acquisition		"If you would like to dispose your old ASUS products, we welcome you to recycle them through our free recycling service."	https://csr.asus.com/english/article.aspx?id=112
	Mode of circularity	Product repair	"Through the easy disassembly for recycling, the consumer can update spare parts to accommodate with the usage when the product needs to upgrade for improving the computing performance, thus there is no need to replace the entire product."	ASUS Detailed 2021 Report
		Product/ component reprocessing	No information	ASUS Detailed 2021 Report
		Recycling	"ASUS provided recycling services in 30 countries in 2021, which covered 75% of the sales market. We provided diverse recycling services based on the sales model in each country, including setting up drop off, mail back, trade-in, and pick up services."	ASUS Detailed 2021 Report

TABLE B2 (Continued)

Company name	Factors	Subfactors	Content analysis text examples	Data source
	Use of recycled material		"Among ASUS products, mainstream products contain more than 30% plastic of total weight, which accounts for the largest amount of materials used. Therefore, we cooperate with the suppliers to explore the opportunities that increase the use of post-consumer recycled (PCR) plastic as much as possible without compromising quality, function, and durability."	ASUS Detailed 2021 Report
Google	Market position		"Google's marketing mix involves pricing strategies that satisfy the different kinds of products available from the company... The market-oriented pricing strategy... Google's marketing mix uses this strategy for pricing products like Pixel devices that compete at the diverse price points of competitors like Samsung."	https://panmore.com/google-marketing-mix-4ps
	Mode of EOL product acquisition		"You can only trade in your old phone through Google Store in Canada, Germany, Japan, the United Kingdom, and the United States."	https://support.google.com/store/answer/9882124?hl=en&co=GENIE.CountryCode%3DUS
	Boundary of EOU product acquisition		"In 2021, we offered our take-back program in all countries where we ship Google consumer hardware products, allowing customers to responsibly recycle old and unused devices for free—whether made by Google or not."	Google Environmental Report 2022
	Mode of circularity	Product repair	"Offer repair services that consumers can do."	https://store.google.com/us/magazine/repaircenter?hl=en-US
		Product/component reprocessing	"We strive to keep our products usable for the long haul. These like-new products undergo our rigorous quality control process to ensure each device lives up to Google standards. We clean and restore to like new condition."	https://store.google.com/us/magazine/refurbished_devices?hl=en-US#
		Recycling	"You can request shipping at no additional charge. Our third-party recycling partner will send a postage-paid shipping label to your inbox."	https://support.google.com/store/answer/3036017?hl=EN#zippy=
	Use of recycled material		"All Nest and Pixel devices launched since 2020 include recycled materials...Pixel 6 and Pixel 6 Pro are designed with recycled aluminum."	Google Environmental Report 2022
Amazon	Market position		"Amazon.com Inc. uses low prices... Amazon uses market-oriented pricing as its primary pricing strategy. For example, the company evaluates competitors' prices as basis for pricing AmazonBasics products. The advantage of this pricing strategy is that it makes selling prices more competitive, affordable and attractive to target consumers."	https://panmore.com/amazon-com-inc-marketing-mix-4ps-analysis

TABLE B2 (Continued)

Company name	Factors	Subfactors	Content analysis text examples	Data source
	Mode of EOL product acquisition		"Send us your Trade-in: You may ship your item(s) via UPS for free, or drop-off at an approved Trade-in location within 45 days."	https://panmore.com/amazon-com-inc-marketing-mix-4ps-analysis
	Boundary of EOU product acquisition		"Trade-in Amazon Devices…Trade-in non-Amazon devices from other manufacturers."	https://www.amazon.com/b/ref=ti_surl_tradein?ie=UTF8&node=9187220011&ref=recpromod
	Mode of circularity	Product Repair	No information.	
		Product/component reprocessing	"Products sold on Amazon Renewed are professionally inspected and tested to meet quality standards by an Amazon qualified and performance-managed supplier.…Amazon performs a rigorous multi-step process on each Pre-Owned Amazon Device, including a full diagnostic test, thorough cleaning and inspection, updating to the most recent software version available for the device, secure data wipe, and, where applicable, replacement of defective parts identified in testing."	https://www.amazon.com/gp/help/customer/display.html?ref=s9_acss_bw_cg_arb310_1a1_w?nodeId=202089470&pf_rd_m=ATVPDKIKX0DER&pf_rd_s=merchandised-search-10&pf_rd_r=EE6C98MS214MZ2TK2M1P&pf_rd_t=101&pf_rd_p=55317a6d-1ae8-4249-b4ea-16027f3aaaa6&pf_rd_i=1265393011
		Recycling	"Recycle small consumer electronics for free… Visit our recycling page and receive a free shipping label to mail in your small electronics to our Amazon-approved recycling partner."	https://www.amazon.com/gp/help/customer/display.html?ref_=help_search_1-6&nodeId=G200197550&qid=16857178861887&sr=1-6
	Use of recycled material		"In 2021, we launched several Echo, Fire TV, Fire Tablet, Kindle, and Smart Home devices and accessories that include up to 60% recycled molded plastic, up to 100% recycled fabrics, up to 100% recycled aluminum, and up to 70% recycled magnesium, depending on the product."	https://sustainability.aboutamazon.com/environment/sustainable-products
LG	Market position		"The products by LG are priced from low to high ends."	https://www.mbaskool.com/marketing-mix/products/16883-lg.html
	Mode of EOL product acquisition		"LG wants to make recycling a simple and easy process at no cost for general consumers, so we have partnered with Electronic Recyclers International to bring you our Mail-back Recycling Program."	https://lgrecyclingprogram.com
	Boundary of EOU product acquisition		"Provide general consumers a convenient way of recycling their used, unwanted or obsolete LG consumer electronic products."	https://www.lg.com/global/take-back-recycling-global-network-north-america
	Mode of circularity	Product repair	"Need to setup repair for your appliance or other electronic device? Washers and Dryers, Refrigerators, TVs, etc."	https://www.lg.com/us/support/repair-service/schedule-repair
		Product/Component Reprocessing	"Each refurbished product delivers the same requirements as every new LG product, providing a quality product at a reduced price. All products go through a comprehensive process, including repairs,"	https://www.lg.com/global/take-back-recycling-policy

TABLE B2 (Continued)

Company name	Factors	Subfactors	Content analysis text examples	Data source
		Recycling	replacements with genuine LG parts, and quality testing, to ensure you receive a product that performs like new."	https://www.lg.com/us/refurbished-products
			"LG Electronics offers a customized e-waste take-back & recycling service that meets local needs and requirements in the countries where e-waste regulations are in place, and also provides product take-back & recycling service voluntarily in some regions... Recycling partners of LG Electronics in US are signatories of the Basel Action Network 'e-Stewards certified', and maintain environmental quality systems accredited to the requirements of 'ISO 14001'".	
	Use of recycled material		"We also contributed to resource reduction by increasing the use of recycled materials by 6% for ten types of plastic."	https://www.lg.com/global/greener-products-application