
Exploring Consumer Attitudes and Collection Strategies in Belgium's Smartphone Refurbishment Industry

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**EXPLORING CONSUMER ATTITUDES AND COLLECTION STRATEGIES
IN BELGIUM'S SMARTPHONE REFURBISHMENT INDUSTRY**

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5 Personal motivation

With the goal of ending my years of studies in the best way, I had in sight a work that was in line with my vision of the future. The starting point was the observation of the circular economy concept that has been brought to my eyes during my scholarship.

It started in a class given at HEC where I understood that without consuming behavior changes, companies would not change their business model based on linear economy. As important and as trending circular opinions and behavior are, the consuming model is in its transforming state paving the way for new systems. Therefore, economic and environmental opportunities arise and it is what motivated me to do some research on this topic.

The initial focus was on the digitalization of the electrical and electronic equipment industry and its connection to the circular economy, which is still at an innovative point. It evolved along with the meetings with my supervisor Mr. Pironet towards the refurbishment of mobile phones.

Refurbishment is compelling for several reasons. By extending the lifespan of devices and providing more affordable options for consumers, it offers consumers value and reliability. In a global world such as ours, where technology and specifically smartphones are practically required.

As an individual, I believe that the sustainability of our world is compassed by the promotion of the extension of the lifespan of any product. I firmly believe that addressing the challenges posed by electronics is crucial, particularly due to the hazardous nature of its processes and the excessive consumption of critical raw materials such as rare earth elements and precious metals. The unsustainable extraction of these resources not only depletes our planet's limited reserves but also poses significant environmental risks, including habitat destruction and pollution.

6 Introduction

6.1 Context

Overconsumption and modern technologies fuels the amount of discarded electrical and electronic equipment (EEE). These commodities when abandoned are referred to as electronic waste. “E-waste refers to EEEs and their parts, which have been discarded by their owners as waste, without the intent of reuse”. It includes every product or part that has reached its end-of-life (EOL) or is not considered up to date anymore or is no longer of use (Directive 2012/19/EU, 2012).

E-waste is a challenge that is currently mishandled by our modern society; it has an impact on the economy, the environment, and society. Economically, the value of the waste of EEE equipment is estimated to be 57\$ billion USD due to the presence of gold cobalt, copper, and phosphor (Forti et al., 2020). On top of that, together, the nations produced 53.6 million metric tons (Mt) of this kind of waste in 2019 (Forti et al., 2020) which is roughly equivalent to the weight of 147 Empire State Buildings.

WEEE constitution involves toxic components that if not handled properly has a negative impact on health. Frequently, these risks are brought on by the incorrect methods of disposal and recycling employed (Sati & Dasa, 2022).

Therefore, the current situation of consumption, production, and disposal of EEE is not sustainable, due to resource depletion, the release of hazardous materials, and the production of greenhouse gases during unofficial recycling processes. A strategy to fight this issue is to transition to a circular economy (CE) model, where materials and energy remain in a system, from a standard linear business model, which is defined by a take-make-use-dispose approach (Masi et al., 2017).

The circular economy in the electrical and electronic industry (EEE) has the power to retain a high value of resources over many product life cycles, as the industry is resource-demanding (Bressanelli et al., 2020). The concept of circular economy has imperative elements (reuse, repair and recycling) as other concepts such as refurbishing, redesign and repurpose (Reike et al., 2018).

According to Bressanelli et al. (2020), “CE in the WEEE industry mainly addressed the reduce and the recycle strategies, while limited attention has been paid to reuse and remanufacture.” At the same time, recent studies suggested that reuse and repair were more reliable than recycling for electrical and electronic equipment. For instance, mobile phones have the best environmental reduction from reuse, repair, and refurbishment, followed by desktops and monitors (Kouloumpis et al., 2023).

Hence, this research focuses specifically on the smartphone refurbishment industry in Belgium, exploring consumer attitudes toward refurbished smartphones and identifying effective strategies to improve collection rates of unused devices. Smartphones are particularly interesting to study within the context of e-waste and refurbishment for several reasons.

First, smartphones are one of the most rapidly replaced electronic devices due to the fast-paced innovation cycle and consumer demand for the latest technology. Research has shown that the average lifespan of a smartphone is decreasing, with many users upgrading their devices every two to three years (Mugge, Jockin, & Bocken, 2017). This frequent turnover results in a significant accumulation of unused devices, many of which still possess considerable functional and material value.

Furthermore, smartphones contain a complex mix of valuable materials, including rare earth elements, precious metals, and various minerals, making their recovery and reuse economically and environmentally beneficial (Forti et al., 2020). Given the high material value and the environmental impact of extracting and processing these materials, focusing on smartphones in the context of refurbishment and the circular economy offers substantial opportunities for reducing e-waste and conserving resources.

Additionally, smartphones are widely used across all demographics, making them an ideal subject for studying consumer behavior and preferences in the context of refurbished electronics (Nasiri & Shokouhyar, 2021). By understanding these behaviors, the study can provide insights into how to better promote the acceptance and adoption of refurbished smartphones, thereby contributing to more sustainable consumption patterns.

6.2 Research Significance

This thesis focuses on the repair, reuse, and refurbishment aspects of EEE, particularly examining how these strategies can be integrated more effectively into business models within the smartphone industry to enhance environmental outcomes and contribute to economic sustainability.

The urgency and relevance of this research are underscored by the substantial environmental footprint and economic value of EEE waste. Given the fact that recycling activities are not keeping pace with the global growth of e-waste, only 17.4% of the global e-waste generated in 2019 was officially documented as properly collected and recycled (Forti et al., 2020). For instance, the recycling rate of mobile phones in the European Union is estimated to be between 12% and 15% (European Commission, 2023).

This research aims to cover the repair, reuse, and refurbishment phases in the circular economy and discover if these techniques can empower a new business model in the refurbished smartphone industry while having a positive environmental impact and how it could be more effective.

6.3 Research questions

In exploring the role of refurbished smartphones as a solution to the growing e-waste problem, this research investigates several critical questions, including:

- What are the primary factors influencing consumer awareness and purchasing behavior towards refurbished smartphones?
- What is the potential impact of enhanced consumer education and improved recycling programs on the market for refurbished smartphones?
- How can refurbishers effectively utilize incentives and improve convenience to overcome obstacles and enhance their price offerings, thereby encouraging consumers to resell their used smartphones?
- How does the brand, age and condition of unused smartphones in households influence their potential for refurbishment and resale?

This set of questions explores consumer behavior and attitudes towards refurbished smartphones, aiming to understand the gap between high awareness and lower purchase rates. The questions investigate the barriers that prevent consumers from buying refurbished smartphones, the potential

impact of better information dissemination and accessible recycling programs, and the relationship between smartphone brands, conditions, and ages on refurbishment and resale viability.

Additionally, they examine the role of ecological benefits and sustainability in shaping consumer perceptions and willingness to purchase refurbished devices, seeking to identify the key drivers and obstacles that influence consumer decisions in this market.

6.4 Objectives

The primary objective of this research is to explore how refurbishment strategies can mitigate the growing issue of electronic waste while fostering new business models that yield positive environmental outcomes for smartphones. This study seeks to identify the key factors influencing consumer awareness and purchasing behavior towards refurbished smartphones. By identifying these factors, the research aims to design strategies that enhance consumer acceptance of refurbished devices. Additionally, the study will assess how these concerns affect consumer decisions and evaluate the potential influence of enhanced consumer education and recycling programs on the market for refurbished smartphones.

Another critical aspect of this research is to explore how refurbishers can effectively utilize incentives and improve the convenience of the resale process to encourage consumers to resell their unused smartphones. The research will also analyze how the brand, age, and condition of unused smartphones in households affect their potential for refurbishment and resale, identifying which devices are most viable for these processes.

7 Literature review

7.1 Circular economy

The circular economy is a trending topic now, mainly in Europe and China, which has an impact on companies and policymakers of these regions. A first definition of Circular Economy is stated by the conclusion of Geissdoerfer et al. (2017) as “a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling.”

CE is a concept that takes place in a sustainability movement. The definition of sustainability is stated as such by Geissdoerfer et al. (2017) “the balanced integration of economic performance, social inclusiveness, and environmental resilience, to the benefit of current and future generations.” To expand on this matter, Kirchherr et al. (2017) have conceptualized a circular economy definition based on the analysis of 114 definitions that confirms the previous statement on CE: “an economic system that replaces material recovery, recycling, and reduction in production, distribution, and consumption processes with the concept of “end-of-life.”

In other words, the concept of Circular Economy is to use different strategies to extend the product life cycle and minimize resource input, waste, and emission. The goal is to attain sustainable development by reducing emissions and utilizing minimal resource emissions by using materials and resources in multiple cycles for as long as possible (Potting et al., 2017).

It is important to understand the nature of the origin of sustainability and CE. Geissdoerfer et al. (2017) raised an important point differentiating sustainability and circular economy concepts. The latter is said to be more profitable from an economical and financial point of view for companies, whereas the former is more oriented to the alignment of stakeholder’s interest. The point is that a circular economy has primarily an economic incentive before social ones which can lead to imbalances in the goals with companies focusing on financial advantages e.g. greenwashing. The reason behind this is that the actors at the core are the economic actors that empower the economy and the environment, which in return affects society (Geissdoerfer et al., 2017).

7.2 Waste from electrical and electronic equipment (WEEE)

7.2.1 Definitions

To begin, it is essential to examine the definition of electrical and electronic equipment (EEE) in order to fully comprehend what constitutes WEEE. According to the European Union’s Directive 2012/19/EU, EEE is defined as:

“‘Electrical and electronic equipment’ or ‘EEE’ means equipment which is dependent on electric currents or electromagnetic fields in order to work properly and equipment for the generation, transfer and measurement of such currents and fields and designed for use with a voltage rating not exceeding 1 000 volts for alternating current and 1 500 volts for direct current.” (Directive 2012/19/EU, 2012).

Electrical and electronic items can be identified according to the way they behave and use electricity to carry out their functions. This is how they are characterized from one another, for electrical appliances, electricity is mostly transformed into various forms of energy, such as heat, light, sound,

or motion. Electronic devices do similar things, except they control energy to enable the equipment to carry out a certain function. In this paper, the focal point is on electronic devices as the subject is mobile phones.

EEE is usually designed to function for a certain period before reaching end-of-life or experiencing suboptimal performance (Shittu et al., 2021). EEE waste, also named WEEE, refers to EEE and its sub-components that their owner has disposed of or plans to dispose of without planning to reuse them (Manhart, 2010). Reusable appliances therefore fall in the WEEE group, as they are discarded and destined for a new life. Repairs, on the other hand, come under the EEE group, since the appliances remain with the same owner (Möbius Business Redesign SA, 2022).

7.3 9R principles

The 9R framework has been set up within the circular economy principles. The core principle of this framework is the expansion of nine concepts among others: reduce, reuse, recycle, and recover. The following stated below is a development of these strategies.

The list below seen in Figure 1 is a priority order of circularity. This means that the higher on the list a strategy is the higher its circularity impact rises. In general, recycling is the circularity approach that is employed the most commonly although high circularity approaches (R0 to R7), in terms of ambitious transition to a circular economy, are undoubtedly preferred (Potting et al., 2017). Changing the product manufacturing and use is definitely preferred over extending the lifetime of products for the simple reason that theoretically less natural resources are consumed which benefit the environment.

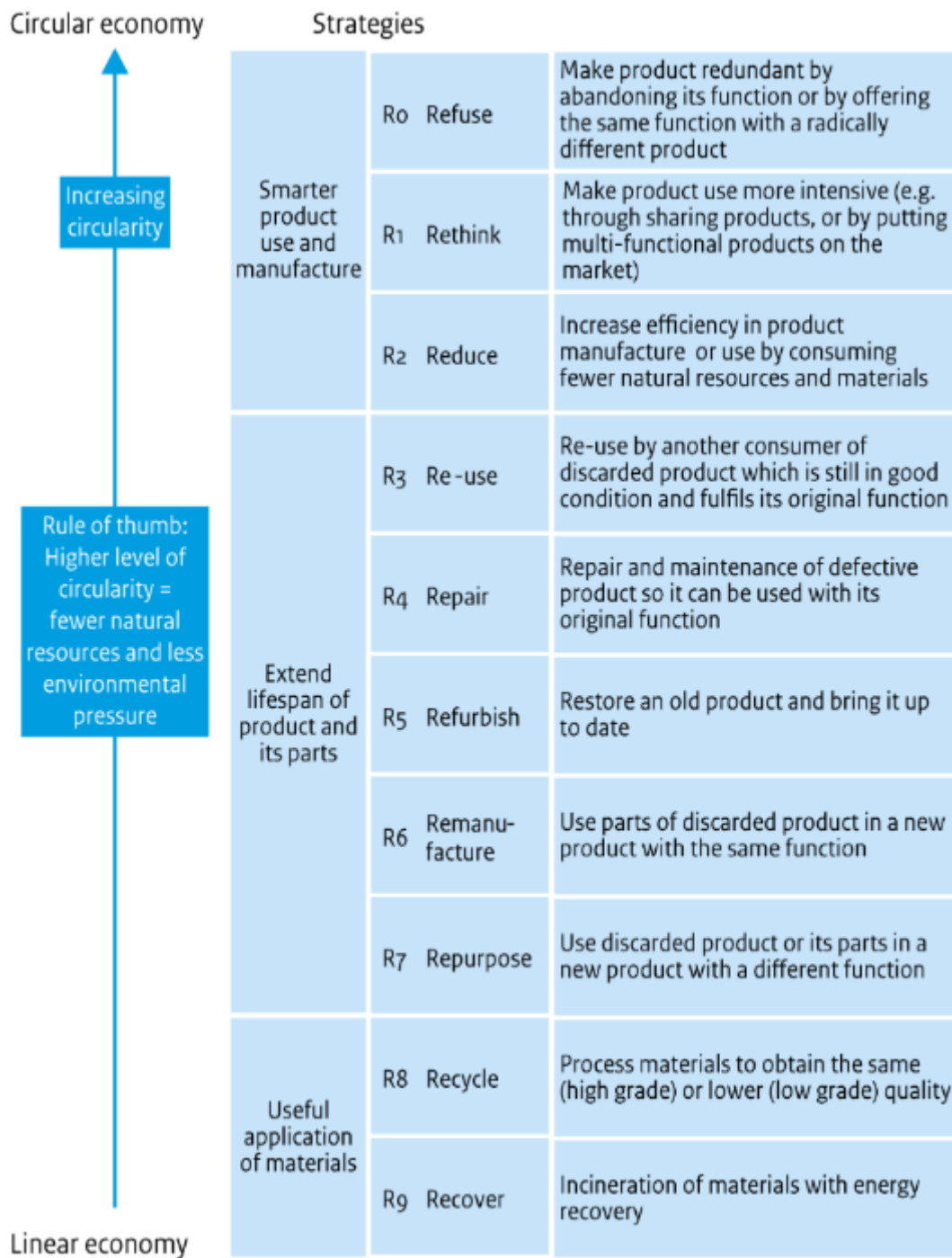


Figure 1 Rli (2015). Circular economy. From intention to implementation (in Dutch; Rli 2015/03, NUR740, ISBN 978-90-77323-00-7). Council for the Environment and Infrastructure (Rli), The Hague.

7.3.1 Smarter product use and manufacture

The strategies of refuse (R0), rethink (R1), and reduce (R2) are integral components of the circular economy framework, aimed at enhancing sustainability through smarter product use and manufacturing. The refuse strategy seeks to eliminate the need for certain products by either discontinuing their function or replacing them with radically different alternatives, such as encouraging the use of reusable bags instead of single-use plastic ones (Rli, 2015).

The rethink strategy promotes more intensive product use through sharing or multi-functional products, like car-sharing services or smartphones that double as tablets and computers, thus reducing the need for multiple devices (Rli, 2015).

Lastly, the reduce strategy focuses on increasing efficiency in product manufacture or use, minimizing resource consumption and waste generation by optimizing production processes and designing products that are more durable (Rli, 2015)

Implementing these strategies faces several barriers. For refuse, significant obstacles include consumer resistance to changing long-standing habits and market dynamics that favor disposable products, which can result in financial losses for businesses and require substantial restructuring (Joubert et al., 2022). Additionally, inadequate regulatory and policy support can hinder the promotion of refusing unnecessary products.

For rethink, the challenges include the need for robust infrastructure to support shared product systems, significant upfront investment without immediate benefits, and cultural norms that prioritize ownership over access. For example, car-sharing services often struggle with logistical problems, such as ensuring vehicle availability during peak times.

For reduce, technological challenges arise from the need for advanced, costly technologies to develop more efficient production processes, coupled with the complexity of aligning entire supply chains with reduction goals and the high initial costs involved.

Overcoming these barriers requires a concerted effort from various stakeholders. Policymakers must create supportive regulatory frameworks, businesses need to innovate and invest in sustainable practices, and consumers should be educated and incentivized to adopt more sustainable behaviors.

General barriers such as a lack of awareness and education, inadequate economic incentives, and resistance to change must also be addressed. Collaborative approaches, including economic incentives, technological advancements, and harmonized regulations, are essential to advance these strategies and achieve a more circular economy, ultimately fostering a sustainable and resilient economic system.

7.3.2 Useful applications of material

Recycle(R8) and recovery(R9) strategies are bounded; they refer to solid waste that are processed to obtain materials of high or low quality or that would serve as heat recovery by being burned. Apart from these solutions, solid waste would either be burned or placed for landfill.

The focus of current circular policies emphasize these strategies (Ghisellini et al., 2016; Lee et al., 2017). However, it involves quite a few inconveniences, for example: yield rates are usually small, if not nonexistent due to the treatment costs and in addition, products' integrity being destroyed results in a waste of material (Clark et al., 2016).

Although smartphones are composed of critical raw materials and over 50 different metals, their material value is approximately 1.11 EUR, which makes them economically unappealing for recyclers (Bundesanstalt für Geowissenschaften und Rohstoffe, 2020).

Nevertheless, the significant impact of recycling is still outstanding nonetheless, specifically for high-grade material, i.e. gold, which refers to a process that preserves the initial characteristics of the recycled material (Potting et al., 2017).

It is important to note that most emissions occur during the production process. For example, around 80% of a smartphone's total greenhouse gas emissions are generated during the production of its

integration circuits (Ercan et al., 2016). In contrast, recycling occurs at the end of the product's life cycle. This fact raises questions about the emphasis on recycling and highlights the value of circular strategies that extend the lifespan of products.

7.3.3 Life span extension

The group of strategies R3 to R7 (Reuse/repair/refurbish/remanufacture/Repurpose) are the primary solutions to extend the lifespan of products and their parts on the market while maintaining its functionality. One aspect that appears to still require development is European manufacturers' and customers' knowledge and awareness. It is of great importance, especially for extending the lifespan of products and their parts. In other words, reuse, repair, refurbish and to a lesser extent repurpose are strategies that are affected by consumer and producer responsibilities (Ghisellini et al., 2016).

Accordingly, Potting et al. (2017) explain that the primary objective is to extend at the same time the lifespan and the design of manufacturing as a primary option before recycling which remains a linear solution. The problem with this conception is that it necessitates a change of paradigm at the company level, which is the key to a circular economy (Morseletto, 2020). Nevertheless, not only, R3 to R7 strategies necessitate responsiveness to the market, efficient reverse logistics, revenue generation for all stakeholders, and implementation through a range of business models.

Prolonging the lifespan of certain items, has multiple impacts amongst others things, cannibalism, less innovation, and obstruction of the creation of novel or improved, environmentally friendly products (Bressanelli et al., 2018). In other words, the goal of sustainability can be hampered by the need to synchronize the interests of all stakeholders.

7.4 Reuse, repair and refurbish.

As seen in the chart below in Figure 2, reuse, repair, and refurbishment are three methods to extend the lifespan of products. After acquiring products from the distribution chain, they may either be disposed of or sent to landfills. Alternatively, these products can be reintegrated into the supply chain through various processes such as refurbishment, reuse within the second-hand market, or undergoing repairs through a repairer. The products move from consumers to repairers, then to retailers for refurbishment, and finally to the second-hand market for reuse before being discarded or going back to consumers.

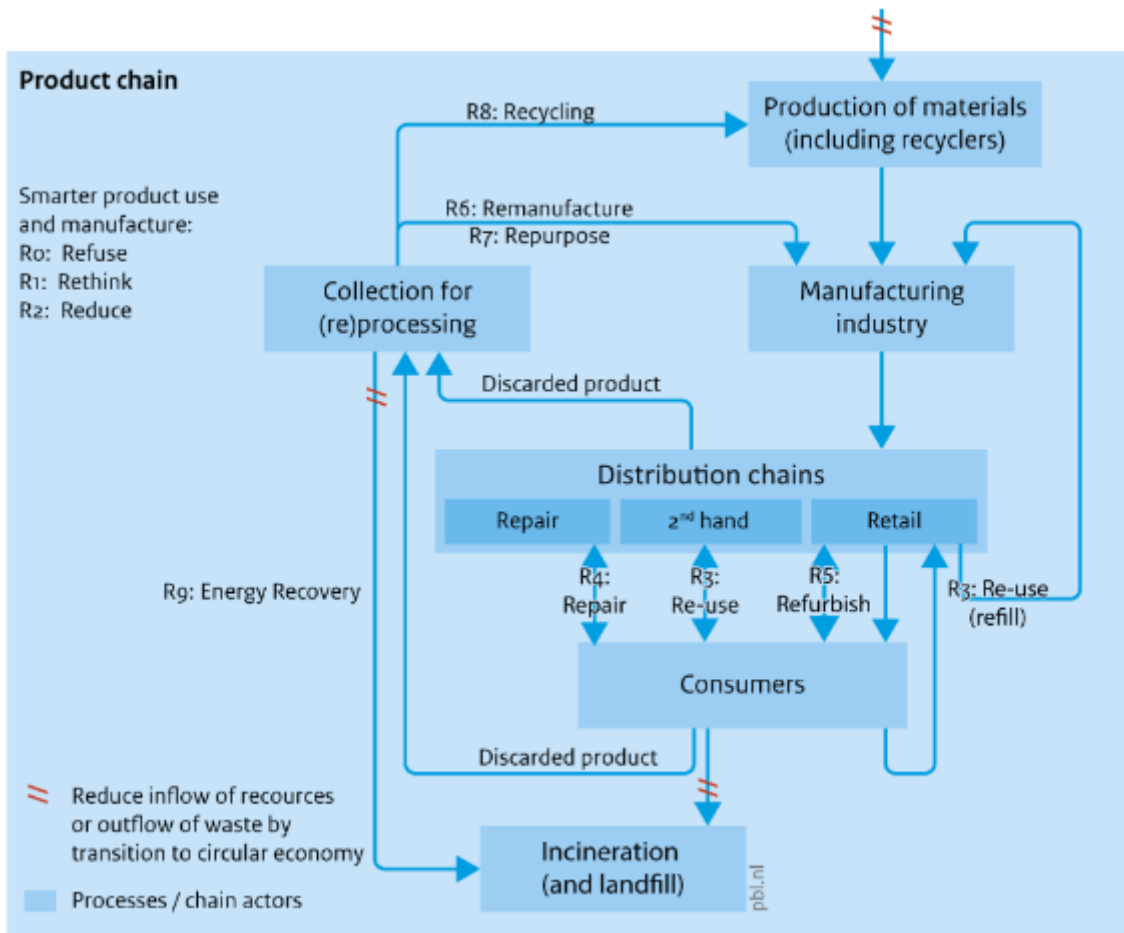


Figure 2 Rli (2015). Circular economy. From intention to implementation (in Dutch; Rli 2015/03, NUR740, ISBN 978-90-77323-00-7). Council for the Environment and Infrastructure (Rli), The Hague.

7.4.1 Reuse

The "reuse" strategy within the circular economy framework emphasizes extending the lifespan of products by allowing them to be used by new consumers after the original owner no longer needs them. This approach aims to maximize the utility of products, thereby reducing the need for new manufacturing and minimizing waste.

Reuse can occur through direct transfers between consumers or via organized channels such as second-hand markets, donation programs, and re-commerce platforms. For example, selling a functional used smartphone or donating wearable clothing allows these items to continue serving their purpose, decreasing the demand for new products and conserving the resources required to produce them.

By keeping products in use for longer, the reuse strategy significantly contributes to sustainability and resource efficiency.

Barriers to reuse

Several significant barriers can impede the implementation of the reuse strategy. Firstly, consumer perception often favors new products over used ones due to concerns about quality, status, and hygiene. (Jaeger & Upadhyay, 2020) Changing these perceptions requires efforts to assure consumers of the reliability and value of used products.

Secondly, market infrastructure needs to be well-developed to facilitate the collection, assessment, and redistribution of used items, including having accessible second-hand markets and efficient logistics. (Jaeger & Upadhyay, 2020)

Thirdly, regulatory support is essential; policies should encourage the reuse of products by providing incentives and minimizing bureaucratic obstacles. (Galvão et al., 2018)

Lastly, many products are not designed with reuse in mind, often having short lifespans, being difficult to repair, or lacking modularity, which makes them less suitable for second-hand use. (Jaeger & Upadhyay, 2020)

Addressing these barriers requires coordinated efforts from businesses, policymakers, and consumers to create a supportive environment for reuse.

7.4.2 Repair

In the reverse supply chain, the first scenario is usually repair. According to the European Commission, repair refers to a set of steps that fix specific defects or faults and/or replace defective components (that made a device inoperable) to return it to a fully functioning state, allowing it to be utilized for its intended purpose. (European Commission, 2017). In other words, repair makes a product or component available for reuse therefore extending its lifecycle.

However, according to Von Gries et Bringezu (2022) demonstration, they quantified the resource relevance of 5 types of appliances; E.g. flat screen monitors. In fact, just a few distinct components account for 90% of resource consumption. Therefore, using new spare parts to repair devices is not always a way of utilizing resources effectively to handle WEEE.

Barriers in repair

Main barriers to repair include the absence of replacement parts and, additionally, the inexperience or unavailability of information that limits reparations. On top of that, customers have difficulty evaluating the repair quality. It is likely that the perceived quality after reparation is low. Another significant barrier is the contrast between the repair cost and the cost of acquisition of a new product (Rudolf et al., 2022).

The reasons for this are multiple; the current state of our consumption model makes it difficult to be able to possess knowledge on every product given the amount of new products that are conceived in the day-to-day life. In fact, repairers must specialize themselves to be able to stay in the race and keep up to date with the new technologies, models and materials.

Another reason for this is the uncollected unused devices, which results in the impossibility of repairing devices because of the out of date spare parts (Rizos & Bryhn, 2022).

In addition, manufacturers lack cooperation in giving proper repair information on their products, an explanation for this is the cannibalism of sales; i.e., a sales loss due to the market introduction of products with a similar customer base. In fact, companies have no financial incentives to make their products easily repairable. Although, as of April 24, 2024, a European text was adopted to promote the repair of goods in Europe. This new action plan is detailed below.

Right to repair.

The "right-to-repair" movement seeks for government legislation that calls for manufacturers to give repair information, tools, and parts so that customers may independently fix their goods by themselves or in retail shops (European Commission, 2024).

Proponents of repair legislation claim it would dismantle manufacturers' repair market monopoly and favor consumers. However, the Right to Repair directive might prompt a pricing reaction in the market as manufacturers adjust to offset lost profits. According to this study made by Chen et al. (2023) on pricing, welfare, and environmental outcomes, lowering the costs of independent repairs could lead manufacturers to initially decrease, and then increase, the price of new products.

According to the same study, the new legislation might result in a triple loss scenario where manufacturer profits, consumer surplus, and environmental benefits are all compromised, even though repairs become easier and cheaper. One of the reasons is that manufacturers might be less incentivized to innovate for more durable or eco-friendly products if the repair market becomes more significant. This could slow the adoption of environmentally friendly technologies (Chen et al., 2023). However, the study emphasized the use impact and minimized the impact of production.

Problems identified with repair:

Within the legal guarantee period: When consumer goods become defective during the warranty period, consumers often opt for replacement rather than repair. This preference results in replaced goods being discarded, contributing to waste (European Commission, 2024).

Outside the legal guarantee period, defects arising from wear, tear, or mishandling present a significant obstacle to repair for several reasons. Consumers often hesitate to pursue repairs due to the lack of convenient repair services, uncertainty about the quality and reliability of the repair process, and concerns about the potential costs involved.

Objectives of the Proposal:

The proposal aims to address these issues by promoting repair over replacement through a legislative framework that encourages and facilitates consumer access to repair services. This includes making repair services more transparent, accessible, and economically feasible, and enhancing the market for refurbished and second-hand goods, thereby extending the useful life of products and reducing waste.

The proposal outlines several key elements aimed at promoting and facilitating the repair and reuse of goods (European Commission, 2024):

- **Legal guarantee amendment:** The goal is to prioritize repair over replacement when repair costs are lower or equal, increasing repair rates while protecting consumer rights.
- **Mandatory repair obligation:** Requires producers to repair certain goods beyond the legal guarantee, with plans to include more products like smartphones.
- **Online repair platform:** Connects consumers with repair services and sellers of refurbished goods, allowing price comparisons and service options.
- **European repair information form:** Standardizes information on repair terms and costs for transparency.
- **Voluntary quality standard:** Establishes a quality standard to help consumers identify trustworthy repair services.

These initiatives offer several benefits for refurbishers. Prioritizing repair over replacement can increase demand for their services, as consumers will be more likely to choose repair when it is more cost-effective. Additionally, the expansion of mandatory repair obligations to include products like smartphones opens up new market opportunities for reconditioners to grow in different segments.

The creation of an online repair platform will enhance visibility for refurbishers and provide access to a broader market by directly connecting consumers with their services. Moreover, standardizing information on repair costs and conditions through a dedicated form will strengthen transparency and consumer trust. Finally, the establishment of a voluntary European quality standard allows reconditioners to distinguish themselves by adhering to high standards, thereby increasing their credibility and attractiveness in the market.

Moreover, the directive's emphasis on setting reasonable prices for repair services and spare parts, which presents both opportunities and challenges for smartphone refurbishers (European Commission, 2024). By ensuring that repair costs are not prohibitive, reasonable repair costs can make refurbished smartphones more attractive, potentially expanding the market for these devices.

However, refurbishers may encounter challenges in managing costs, especially if manufacturers set high prices for spare parts. The directive does not impose a cap on costs, merely stating that they should be "reasonable." This is particularly concerning as original spare parts are often very expensive due to manufacturers holding a monopoly, which is the current situation in many cases.

Strategically, reconditioners should focus on building strong relationships with manufacturers to negotiate better prices for spare parts. Diversifying their sources for spare parts can also help avoid dependency on a single manufacturer and seek out more competitive pricing.

In conclusion, the proposed initiatives offer significant opportunities for refurbishers by increasing demand for repair services, expanding market opportunities, and enhancing consumer trust through standardized practices and quality standards. However, challenges remain, particularly in managing costs related to expensive spare parts due to manufacturer dominance. To navigate these challenges, reconditioners should focus on building strong relationships with manufacturers and diversifying their sources for spare parts to ensure competitive pricing and maintain profitability in a growing market.

7.4.3 Refurbishment

Refurbishment or reconditioning refers to operations that fully restore the main function, before placing the product back in the market through re-sale or donation. Intrinsicly, reconditioning may involve repair, nonetheless the process is usually longer (DigitalEurope, 2017).

It is important to dissociate refurbishing and repairing, as the latest does not always mean that a gadget is being resold or reintroduced into the market. As a result, its original owner can use it again. A refurbished or remanufactured item, on the other hand, is a product that has been re-sold after being placed back on the market, meaning both a change in ownership and a new product guarantee (Romagnoli et al., 2022).

As explained in Figure 3, refurbishment process starts at the collection of used phones, which are subsequently transported to a recycling site or directly to a refurbisher and are sorted by "refurbishable" phones that go through testing (Pamminger et al., 2021).

The next steps of testing are composed of the examination of the phone's condition, charging, and replacement of any necessary components in case of repair, data erasure, and factory reset. These are the steps in the refurbishing process that are taken into consideration. Ultimately, the reconditioned phones are sold to new customers to begin their second lives (Pamminger et al., 2021).

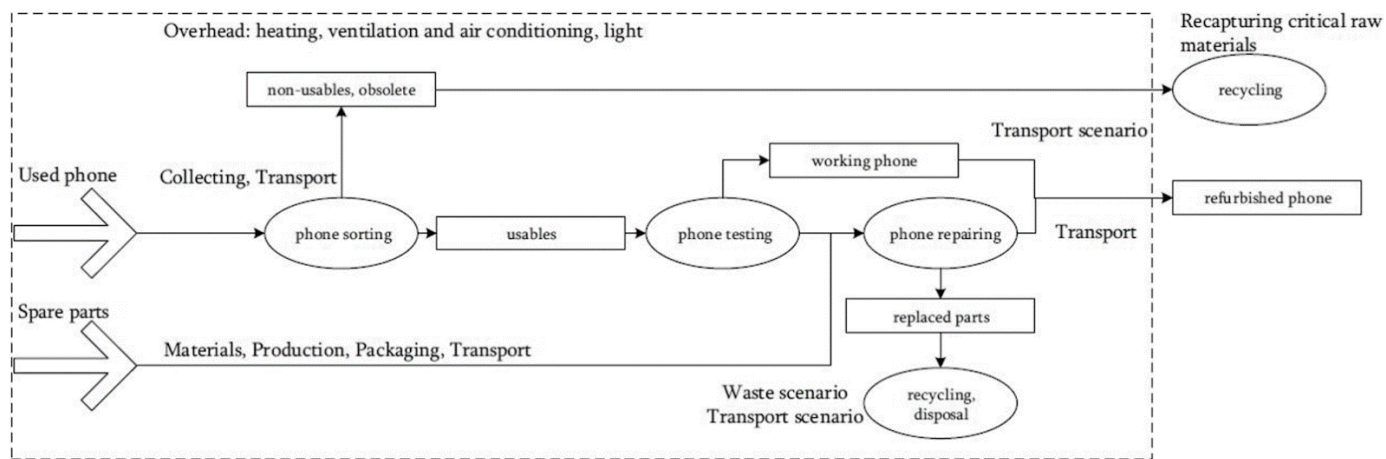


Figure 3 Pamminger, R., Glaser, S., & Wimmer, W. (2021). Modelling of different circular end-of-use scenarios for smartphones. *The International Journal Of Life Cycle Assessment*, 26(3), 470-482.

Types of Refurbishment

Refurbishment processes can vary significantly, ranging from simple cleaning to the comprehensive replacement of all worn parts. In some cases, refurbishment may involve merely cleaning the device and ensuring it is in good working order. In other instances, it might require adding new parts to replace those that are missing or damaged (Pamminger et al., 2021).

The replacement of parts during refurbishment can be either systematic or unsystematic. Systematic replacement involves a thorough overhaul where all components are checked and replaced if necessary, whereas unsystematic replacement might only address the parts that are visibly or functionally defective. In some refurbishing processes, second-hand parts are used to maintain the device, striking a balance between cost-effectiveness and functionality (Hazelwood & Pecht, 2021).

To provide a more comprehensive explanation, this section details the refurbishment process for electronic devices, from their initial receipt through to their entry into the refurbished marketplace.

Initially, the device is received and subjected to a thorough cleaning and physical inspection to identify any visible damages. Following this, the device undergoes functionality testing to pinpoint any failed components (Hazelwood & Pecht, 2021).

If the device is deemed repairable, the faulty components are replaced, and the device is reset and wiped of all data. The latest software updates are then installed. The device is tested again to ensure it is working correctly. Non-functional devices at this stage are sent for recycling (Hazelwood & Pecht, 2021).

For devices that pass the functionality test, final quality checks are conducted to verify their readiness for resale. Once deemed ready, the devices are repackaged and, in some cases, labeled as refurbished, provided they comply with the RecQ quality refurbishment label, which is endorsed by RCUBE. It is the first European label specifically focused on second-hand products, ensuring their quality (RCUBE.org, n.d.).

Finally, the refurbished device enters the marketplace for resale. This structured approach ensures that refurbished devices meet quality standards and are properly prepared for their second life in the market (Hazelwood & Pecht, 2021).

Finally, the place of reconditioning plays a crucial role in determining the overall quality and standards of the refurbished product, as different locations may follow varying guidelines and procedures.

The Ademe, which is a French governmental study, studied the environmental impact of buying refurbished electronic products. The conclusion of this research was heavily positive, with a yearly reduction of its environmental impact of 55% up to 91% for a newly bought refurbished mobile phone in a comparison with a new one (Fangeat et al., 2022).

Figge et al. (2022) questioned the results of this study, which insists on the risk that circular economy incentives might encourage less sustainable behavior. For example, buying more reconditioned products as they are cheaper or changing more often since the payback of recent phones is financially interesting.

Sources of unused smartphones

The supply sources for refurbished smartphones are diverse and include smartphones that are new, old, damaged or not working correctly. Refurbished products are processed through two primary channels: Original Equipment Manufacturers (OEMs) and third-party refurbishment firms.

For OEMs, several sources of returned products require refurbishment (Hazelwood & Pecht, 2021):

- New products returned within the legal return period. These items cannot be resold directly and must undergo a refurbishment process.
- Products returned through trade-in programs, such as when purchasing a new Apple smartphone, where the old device can be sold back at a favorable price.
- Products returned due to damage or poor performance during the warranty period.

As for third parties, they can purchase smartphones from customers by non-OEM companies through websites, kiosks, retail stores, nonprofit recycling and reuse initiatives, and different smartphone insurance plans (Hazelwood & Pecht, 2021).

Many third-party refurbishers acquire significant quantities of smartphones through transactions with brokers (Kurdhi et al., 2023).

The supply market for refurbished devices spans various regions, including France, Europe, Asia, and the United States, each with its standards and practices for refurbishment (Fangeat et al., 2022). According to L'ADEME, 48% of refurbished phones used in France are refurbished in France, followed by 26% in Asia and 26% for the rest of Europe (Fangeat et al., 2022).

The variation exists due in particular to different locations, costs, logistical scenarios and reconditioning methods. However, the benefits of refurbishing can be enhanced by localizing the origin and refurbishment of the product. It becomes clear that prioritizing locally discarded and refurbished products can reduce the environmental impact of refurbishing.

It is beneficial for consumers to check the origin of products, focusing primarily on the location of refurbishment. Local companies, sourcing domestically with second-hand parts and minimizing part replacements, are the most virtuous, and the difference is significant. This leads us to question the effectiveness and mission of the largest companies distributing refurbished products. Regardless of the refurbishment setup, the variation in impacts among refurbishment scenarios does not diminish the positive impact of refurbishment practices in comparison with purchasing new devices (Fangeat et al., 2022).

7.5 Refurbished mobile phones

7.5.1 The proposed reverse logistics framework

This work aims at developing and adds to the importance of extending the lifespan of products, therefore expanding on refurbishing strategies of electrical appliances with a focus on mobiles phones.

Remanufacturing, recycling, and selling are some examples of RL operations for mobile phones, depending on the device's state and interested parties. It is interesting to note that refurbished phones are different from used phones. The latest is usually sold as-is after having its personnel information removed. Whereas re-manufactured devices are close in terms of novelty as it meets the original production standards. However, refurbished phones by third parties might have slightly lower quality standards (Dasaklis et al., 2020).

To comprehend the context of the refurbishment industry, a Pest analysis of the reconditioning smartphone industry including every aspect of the supply chain: supply and distribution is paramount.

8 PEST analysis

To formulate more precise and targeted recommendations on the business model of smartphone reconditioning while answering the research questions. A PEST analysis was paramount to create a solid basis to understand the global context of the industry.

A PEST analysis was selected over a PESTEL analysis due to several specific considerations related to the focus of this research. The PEST framework centers on four key dimensions: political, economic, social, and technological factors. These elements are particularly pertinent for assessing the external environment of the smartphone refurbishment industry, where social and economic conditions significantly influence market dynamics. The additional dimensions of the PESTEL analysis—environmental and legal factors—while important, were not as directly relevant to the specific research objectives and already covered earlier in this paper. By concentrating on the dimensions provided by the PEST analysis, a more focused and in-depth evaluation of the critical factors affecting the industry was enabled, thereby enhancing the effectiveness and applicability of the strategic analysis.

The analysis will be divided into 2 parts supply and distribution, two segments of the value chain. It allows the examination in detail of how each factor affects the different stages of the phone reconditioning process as external effects affect each segment of the value chain.

8.1 Supply

8.1.1 Political

National and local regulations

National and local regulations play a crucial role in shaping the landscape for waste electrical and electronic equipment (WEEE) management. Laws and policies specific to WEEE management often include mandatory collection points. For instance, national policies may require retailers of electrical and electronic equipment (EEE) to offer collection points for WEEE. In the Walloon region of Belgium, retailers must accept the return of WEEE when consumers buy a new handset, thus facilitating the collection of old telephones (Walloon Government, 2010).

Local governments also contribute by setting up municipal collection centers where consumers can drop off their WEEE free of charge. This approach increases collection rates and ensures that used devices are recovered for reconditioning or recycling (Walloon Government, 2010).

Extended producer responsibility

Extended producer responsibility (EPR) programs further shape the collection landscape by placing the obligation of WEEE collection on producers. The EPR mechanism, first established by the 2002 EU WEEE directive, transfers the responsibility from municipal authorities to producers, requiring them to finance the collection and recycling of WEEE. This mechanism is not just for waste recycling; it also includes products designated for reuse (Kunz et al., 2018).

The EPR mechanism can be divided into two categories based on the method of cooperation between producers and treatment companies. Firstly, a producer can independently comply with the law by commissioning a company to recover its products. Secondly, producers can jointly comply with the law by joining a Producer Responsibility Organization (PRO), which takes charge of waste recovery on their behalf (Wang et al., 2017). Despite the implementation of EPR, WEEE collection rates in Europe have increased over the last twenty years, but collection rates for smartphones remain too low (Compagnoni, 2022).

EU regulations

Regulatory compliance with WEEE collection laws and regulations is crucial. In Europe, the 2012/19/EU directive, effective since 2014, aims to protect the environment and human health by reducing the harmful effects of electronic waste. It prioritizes the reduction of WEEE through improved reuse, recycling, and recovery resource efficiency. The directive emphasizes the importance of encouraging consumers to return WEEE and increasing the number of practical return facilities (European Parliament, 2012).

Reuse and preparation for reuse, such as repair and remanufacture, are vital components of the circular economy. Reuse must take precedence over recycling as it reduces greenhouse gas emissions, and resource consumption, and generates employment. However, an efficient return system is necessary at the national level to achieve these objectives. Currently, only 5% of mobile phones are collected in the European Member States, with many stored in homes awaiting reuse or recycling (European Commission, 2023).

Efforts concerning WEEE collection have garnered substantial attention due to their critical role in achieving the directive's underlying goals. Collection initiatives are pivotal in intercepting electronic products at the end of their lifecycle, thus averting potential adverse impacts if improperly disposed of. Consequently, member states have implemented diverse strategies tailored to their specific contexts to bolster WEEE collection rates.

A comprehensive study commissioned by the European Commission in 2022 aimed to foster take-back schemes to ensure higher rates of collection, reuse, repair, refurbishment, and recovery of such devices (European Commission, 2022). Several mechanisms have been employed to enhance collection efficiency, including the establishment of designated collection points, take-back schemes operated by manufacturers and retailers, and periodic collection events.

Public awareness campaigns have also been instrumental in promoting responsible disposal practices among consumers, fostering a culture of WEEE recycling and reuse. According to the European Directive 2012/19/UE, member states must ensure the implementation of a free collection system of WEEE for final consumers, for instance, in retail shops.

A 2022 European Commission study explored different return options for smartphones and other small electronic and electrical equipment. It concluded that the recovery system would be improved by measures such as financial incentives, regulatory measures, and user conveniences (European Commission, 2022).

In conclusion, effective management of waste electrical and electronic equipment (WEEE) requires a multi-faceted approach that involves national and local regulations, extended producer responsibility (EPR) programs, and public awareness campaigns.

Mandatory collection points, municipal collection centers, and EPR programs have contributed to increased WEEE collection rates in Europe. However, despite these efforts, collection rates for

smartphones remain low (European Commission, 2022), highlighting the need for further improvement.

To achieve a more circular economy, reuse and preparation for reuse must be prioritized over recycling, and efficient return systems must be established at the national level. The European Commission's studies and directives emphasize the importance of promoting responsible disposal practices among consumers, fostering a culture of WEEE recycling and reuse, and exploring measures such as financial incentives, regulatory measures, and user conveniences to improve the recovery system.

Ultimately, a comprehensive and coordinated approach is necessary to address the challenges of WEEE management and mitigate its environmental and health impacts.

8.1.2 Economical

Global economic trends and market demand in smartphone reconditioning

The global economy significantly influences the supply chain of smartphone reconditioning. During economic downturns, consumers tend to hold onto their devices longer, resulting in a reduced supply of used smartphones available for reconditioning.

Conversely, in a robust economy, higher consumer spending power leads to increased turnover of smartphones, enhancing the supply for reconditioning purposes (World Economic Forum, 2020). These economic cycles directly affect the availability of used smartphones, making the reconditioning market highly sensitive to broader economic conditions.

Market demand for reconditioned smartphones is driven by several economic variables, including price sensitivity and the growing awareness of sustainable practices. As the prices of new smartphones continue to rise, a larger portion of the population turns towards cost-effective reconditioned devices (IDC, 2022).

This shift in consumer preference not only supports the growth of the supply chain by creating a consistent market for used smartphones but also aligns with increasing consumer awareness and demand for sustainable products. The combination of these factors ensures a steady demand for reconditioned smartphones, which is crucial for the viability and expansion of the reconditioning industry.

In conclusion, global economic trends and market demand play pivotal roles in shaping the smartphone reconditioning sector. Economic cycles influence the supply of used smartphones, while rising prices of new devices and growing sustainability awareness drive demand for reconditioned products. Understanding these dynamics is essential for stakeholders in the reconditioning industry to navigate challenges and capitalize on opportunities for growth.

Financial incentives: Subsidies for collection systems, refunds for returned phones.

Studies highlight the crucial role of government policies and incentives in shaping the economic environment for smartphone reconditioning. Policies that support electronic waste management and provide subsidies for recycling initiatives can enhance the supply of used devices and encourage more businesses to enter the reconditioning market (Shevchenko et al., 2019).

These policies create a favorable landscape that promotes the recycling and refurbishment of electronic devices, thereby contributing to a more sustainable approach to electronic waste.

Furthermore, financial incentives such as discounts, vouchers, deposit systems, and financial rewards are proposed to motivate consumers to return their unused devices.

The amount of the financial reward varies depending on the condition of the product, specifically whether it can be reused or is at its end-of-life. Devices that are still in good condition and ready to be resold or donated possess a higher residual value, making them more attractive for return.

Emphasizing the potential value consumers could receive for returning their unused devices is likely to encourage higher participation rates. Reports indicate that such incentives are more effective when the offers are limited in time (European Commission, 2023).

To facilitate the return of smartphones, various programs across Europe have implemented monetary incentives. For example, Ecosystem, a French NGO, suggests that a minimum fee of €30-40 would incentivize consumers to bring back their used items (Donner une Seconde Vie À Mes Équipements Électriques | Ecosystem, 2024). Germany's ElektroG scheme mandates free returns of old electronics at designated points, providing vouchers worth €10 to €50 to incentivize returns (Bundesumweltministeriums, n.d.). Sweden's El-Kretsen program, supported by municipalities, offers small monetary rewards or reduced waste disposal fees, generally ranging from €5 to €20 for returned devices (El-Kretsen, n.d.). Similarly, the Netherlands' WeCycle initiative employs a points-based system where consumers earn points for each returned device, which can be translated into €10 to €30 discounts on new purchases or charitable donations (Wecycle, 2024).

These strategies successfully enhance e-waste collection rates by providing financial incentives and convenient return options.

Convenience

To increase effectively the collection rates of smartphones for reconditioning, it is essential to make the process as convenient as possible for consumers. Research has shown that the ease or difficulty perceived by individuals in performing proper e-waste recycling behaviors is significantly influenced by the consumer's transaction costs, which include personal resources such as effort, time, and money spent while returning e-waste (Bouvier & Wagner, 2011; Dixit & Vaish, 2020).

Bouvier & Wagner (2011) identified five major categories of convenience: knowledge requirements, proximity to collection sites, opportunities to drop off materials, the draw of the collection site, and the simplicity of the process. By addressing these factors and reducing time, information, planning, transportation, and psychological costs, the collection of smartphones can be significantly improved, making it easier and more attractive for consumers to participate.

A particularly effective solution to mitigate these inconveniences is the implementation of a pick-up service with pre-paid labels directly to refurbishers. This approach addresses all five categories identified by Wagner (Bouvier & Wagner, 2011).

Another significant issue at the collection stage for reprocessing is the lack of direct participation by manufacturers and retailers in improving collection systems. This results in restricted access to used electronic equipment (EE) products for reuse and refurbishment. One explanation for this behavior is sales cannibalism, where manufacturers and retailers fear that the sale of refurbished products might negatively affect the sales of new products (Lechner & Reimann, 2015). This reluctance to

engage in the collection and refurbishment process further complicates efforts to establish efficient and profitable recycling systems.

In other words, efforts to change consumer behavior must be accompanied by an effective collection infrastructure. If the infrastructure or processes are malfunctioning or overly complex, it may scatter the benefits. Additionally, valuable devices like recent laptops, tablets, or mobile phones cannot be easily collected using bins or similar solutions, even though bins have lower behavioral costs compared to drop-off systems (Best & Kneip, 2011). Therefore, developing a streamlined and user-friendly collection infrastructure is paramount to increasing participation rates and supporting the overall effectiveness of smartphone reconditioning initiatives.

Cost analysis

In terms of supply costs, refurbished phones need to be competitive with new handsets. For instance, refurbished phones are often purchased at around 35% of their resale value. This approach helps recover a significant portion of the product's value while still being attractive to consumers (Santana et al., 2021).

Presented below is a table listing various models from Samsung and iPhone, alongside the prices that Belmobil.be is willing to offer for these phones, considering only their condition—whether they are in good condition, have defects, or are non-functional—without regard to their age.

No conclusions are drawn from this table at this stage; however, it will later be used in comparison with data gathered from a survey to determine whether there is an overestimation of the smartphone's value from the perspective of either consumers or refurbishers.

Table 1

Smartphone take-back values

Make and model	Prurchase price(€)	Functional and in good condition (€)	Functional but with defects (€)	Non functional (€)
IPhone 11 64go	529	168	152	46
IPhone se 128 go (2022)	603	149	128	42
IPhone 11 Pro Max 64go	717	211	190	58
IPhone 12 64go	809	202	182	56
IPhone 13 256 go	909	306	278	84
Galaxy a 22 128 go	186	50	45	0
Galaxy a 52 128go	303	99	90	20
Galaxy s22 128go	489	249	224	30
Galaxy s23 128go	649	369	331	70
Galaxy s23 Ultra 256go	899	540	495	105

Note. Purchase prices were retrieved on July 15th, 2024, from Fnac.be, and take-back values were retrieved from belmobile.be.

According to research conducted on a refurbishing company in Brazil, the expenses incurred in purchasing cell phones back account for 66.85% of the total cost (Santana et al., 2021). This highlights the substantial financial outlay required to acquire smartphones for refurbishment. It should be noted that the only mobile phones restored in this project were those collected by the OEM through their reverse logistics and sold to participating refurbishing businesses, indicating that acquiring smartphones remains expensive.

In conclusion, the economic challenges associated with refurbishing phones are substantial. High acquisition costs, coupled with significant logistics expenses, make profitability difficult, especially for small independent businesses. Furthermore, the lack of direct involvement from manufacturers and retailers in the collection process hinders access to used products, exacerbating the problem. Addressing these issues requires a concerted effort to reduce supply costs, enhance collection systems, and foster greater collaboration between stakeholders to support the refurbishment industry.

8.1.3 Social

Perception of collection and willingness to participate in recycling programs.

Research into consumer attitudes reveals several intrinsic characteristics of small electronic devices that contribute to low collection rates. One significant factor is the perceived consumer value of these devices. Many consumers retain their old electronics for backup or data storage, under the belief that these items hold more value than their current market worth. This perception, combined with the devices' longer life spans due to advancements in product design and a growing second-hand market, leads to fewer devices being returned for recycling (European Commission, 2022).

The small size and lightweight nature of these electronics also make them easy to overlook or discard improperly. Additionally, the complex design of modern electronics increases the costs of recycling and complicates repair and refurbishment activities (European Commission, 2022).

Several major barriers further hinder effective recycling. The lack of public awareness about proper disposal methods, the presence of illegal collectors, and inefficient law enforcement are significant challenges. Emotional attachment to devices, data security concerns, and distrust in the recycling process also play crucial roles in low participation rates. Moreover, inadequate access to or awareness of appropriate collection systems exacerbates these challenges (European Commission, 2022).

In summary, there are several reasons behind the difficulty in recovering these electronic wastes; however, certain incentives can tip the balance, particularly the following points.

Effective collection methods must meet several criteria, as defined by Bliklen and Frick (2023). Firstly, collection initiatives need to go beyond legal standards. Secondly, these programs should target specific participant groups, such as households, corporations, or schools, offering incentives like rewards or convenience to boost collection rates. Lastly, active engagement with key stakeholders, including electronics producers, distributors, public authorities, and decision-makers, is essential to increase small WEEE collection rates.

Price incentives have shown to be particularly effective in influencing individuals to dispose of their end-of-life (EOL) mobile phones (Welfens et al., 2016). Despite this, only a small percentage of people currently dispose of their EOL phones, posing a threat to the functioning of the circular economy (N & Majhi, 2024).

Borthakur and Govind (2017) emphasize that increasing consumer awareness about the environmental impact of e-waste can significantly boost participation in recycling programs. Their study suggests that targeted awareness campaigns and educational initiatives can alter consumer behavior, leading to higher rates of smartphone collection for reconditioning. However, financial incentives remain a key driver in motivating consumers to part with their old devices (N & Majhi, 2024).

In conclusion, addressing the various factors influencing consumer attitudes and participation in recycling programs is vital for improving the collection rates of small electronic devices. Enhancing public awareness, offering financial incentives, and actively engaging stakeholders are key strategies that can drive the success of recycling initiatives and support the circular economy.

8.1.4 Technological

Innovations in collection systems.

To effectively increase the collection rates of smartphones for reconditioning, it is essential to make the process as convenient as possible for consumers. Research has shown that the ease or difficulty perceived by individuals in performing proper e-waste recycling behaviors is significantly influenced by the consumer's transaction costs, which include personal resources such as effort, time, and money spent while returning e-waste (Bouvier & Wagner, 2011; Dixit & Vaish, 2020).

Bouvier & Wagner (2011) identified five major categories of convenience: knowledge requirements, proximity to collection sites, opportunities to drop off materials, the draw of the collection site, and the simplicity of the process. By addressing these factors and reducing time, information, planning, transportation, and psychological costs, the collection of smartphones can be significantly improved, making it easier and more attractive for consumers to participate.

In other words, efforts to change consumer behavior must be accompanied by an effective collection infrastructure. If the infrastructure or processes are malfunctioning or overly complex, it may scatter the benefits.

Additionally, valuable devices like recent laptops, tablets, or mobile phones cannot be easily collected using bins or similar solutions, even though bins have lower behavioral costs compared to drop-off systems (Best & Kneip, 2011). Therefore, developing a streamlined and user-friendly collection infrastructure is paramount to increasing participation rates and supporting the overall effectiveness of smartphone reconditioning initiatives.

There are several ways to recover used smartphones that address all five categories identified by Wagner (Bouvier & Wagner, 2011); let us have a look at the new technologies and ideas being implemented.

In the United States, ecoATM operates kiosks that evaluate the value of your phone and provide immediate payment. The process involves obtaining an estimate, erasing personal information, and depositing the device into the machine. These kiosks are typically found in malls, grocery stores, and various other locations (ecoATM, n.d.).

Obyo is a trademark of the Belgian refurbishment company Asmartworld. It is an application designed to recover smartphones similarly to ecoATM. However, there are two key differences: users receive a shipping label, pack their smartphones, and drop them off at the nearest collection point and additionally, Obyo provides more than a buyback service for individuals; it also offers solutions for retail chains, telecom operators, and businesses (TakuyaWeb & ObyO, s. d.).

These examples illustrate innovations addressing collection challenges, emphasizing the need to promote and expand such solutions to increase collection rates. Currently, a significant issue is that the smartphones collected are at most five years old (TakuyaWeb & ObyO, s. d.) as older devices are deemed unprofitable. Additionally, the range of collected smartphones is limited due to the reconditioning center's capacity and the operators' training. Therefore, scaling up operations and enhancing workforce training is essential to broaden the range of collected devices.

8.2 Distribution

8.2.1 Political

Spare parts

Phone manufacturers often restrict access to spare parts, selling them only to authorized partners or keeping them exclusive to their service centers. This makes it difficult for independent reconditioning shops to obtain the parts they need for efficient, reliable repairs.

The "right-to-repair" movement described earlier seeks government legislation requiring manufacturers to provide repair information, tools, and parts, allowing consumers to independently fix their goods or have them repaired in retail shops (European Commission, 2024). These changes benefit refurbishers by making it easier and more affordable to access necessary parts and tools, thereby facilitating more efficient and cost-effective repairs. Additionally, it can dismantle the repair market monopoly held by manufacturers, leveling the playing field and enabling reconditioners to compete more effectively.

Proponents vouch for this legislation as it will promote consumer choice and reduce waste by extending the lifespan of devices through repairs. For refurbishers, it means greater access to repair parts and information, which can lead to higher-quality refurbishments and increased consumer trust.

8.2.2 Economical

Demand for refurbished smartphones

The Belgian market of the industry of refurbished smartphones is in expansion. In 2016, the Belgian telecommunications sector generated sales in excess of €13 billion (Statista, 2019). While, in their analysis, the International Data Corporation (IDC) forecasts that global shipments of used smartphones, encompassing both officially refurbished and pre-owned devices, will total 225.4 million units in 2020. This figure represents 1.5 billion units sold to end users in the same year. Furthermore, IDC anticipates significant growth in this sector, projecting that shipments of used smartphones will rise to 351.6 million units by 2024 (International Data Corporation, 2021).

New companies in the refurbished smartphone market, such as Back Market, Refurbed, and Rebuy, have attracted substantial investments, indicating strong market demand and growth potential. Notably, in May 2021, Back Market secured €276 million in funding, while Refurbed raised €15.6 million in 2020, demonstrating the burgeoning market for refurbished devices (Pavlova, 2020; RTE News, 2021).

The primary factors driving this growth include the expansion of trade-in programs by manufacturers, and increasing the number of returned smartphones. Moreover, the escalating average selling prices of new smartphones, despite the lack of substantial innovation, render older generations of smartphones relatively comparable in terms of performance (International Data Corporation, 2021).

The pricing dynamics of refurbished smartphones exhibit a significant disparity with their new counterparts, rendering them an attractive option for price-sensitive consumers. Research indicates that the price difference between new and refurbished devices can fluctuate between 10% to 50%, contingent upon the device model, condition, and warranty offered (Statista, 2023).

This substantial price differential underscores the competitive landscape of the refurbished smartphone market, where multiple players vie for market share by offering similar products at competitive prices, thereby intensifying price competition. Consequently, refurbished smartphone distributors must navigate this complex pricing environment to remain competitive, while also ensuring that their pricing strategies align with the perceived value of their products among consumers.

Addressing these defects requires a detailed and cost-effective refurbishment process, which directly influences the pricing and marketability of refurbished devices. Efficiently managing these refurbishing costs while ensuring high-quality repairs is crucial for maintaining competitive pricing in the market.

Repair cost

Obtaining data on the cost of restoration for reconditioned devices proved to be challenging. Consequently, the following data refers to the two most prevalent causes of unusable mobile phones and the associated repair costs for consumers. The information provided comes from a known retailer, Coolblue.

These data provide comprehensive insights into the costs and factors associated with smartphone repair parts, focusing on displays and batteries. The reported prices include both material and labor expenses.

Table 2

Battery and screen repair costs

Make and model	Retail price (€)	Battery repair cost (€)	Screen repair cost (€)
Samsung Galaxy A22 5G	244.53	69	129
Samsung A52 5G	466.83	69	159
Samsung S22 5G	899.73	79	209
Samsung S22 Ultra	1344.33	79	359
Apple iPhone SE 2022	466.83	89	179
Apple iPhone 12	735.93	105	359
Apple iPhone 13 Pro Max	1227.33	105	449

Note. Repair prices were retrieved on July 19th, 2024, from reparation.coolblue.be.

Firstly, the repair costs for batteries and screens difference is noteworthy. Apple devices tend to have higher screen repair costs than Samsung devices, while battery replacement costs are also higher for Apple. For instance, the average screen repair cost for an iPhone is €156.74, compared to €104.55 for a Samsung device. Conversely, battery replacement costs €100.55 for an iPhone, compared to €68.85 for a Samsung device.

For refurbishers, this data suggests that reselling Samsung models might be more advantageous in terms of lower repair costs, particularly for screen repairs. However, despite their higher repair costs, Apple devices often enjoy greater demand in the secondary market, which can justify higher resale prices for refurbished units.

Pricing strategies for refurbished phones.

Pricing strategies play a crucial role in maximizing sales and profit for refurbished smartphones. Research indicates that offering a maximum of 40% discount on a refurbished product compared to a new one is optimal. This approach maximizes the consumer's satisfaction of getting a good deal while minimizing doubts about the quality of the product. A discount beyond this threshold may generate mistrust or doubts among consumers, as they might perceive that a high-quality product cannot be sold at such a low price (Abbey et al., 2015).

The pricing strategy must also consider the perception of quality and market demand for refurbished products versus new handsets. Refurbished smartphones are frequently offered for sale at prices between 30% and 40% less than brand-new ones. This price range balances affordability and perceived value, making refurbished phones an attractive option for budget-conscious consumers (Nasiri & Shokouhyar, 2021). Additionally, Santana et al. (2021) emphasize the importance of aligning pricing strategies with market demand and consumer perceptions to ensure competitiveness and profitability in the refurbished smartphone market.

Research by Abbey et al. (2015) further supports the notion that consumers are highly sensitive to the pricing of refurbished products. A carefully calibrated discount can significantly influence their

purchasing decision, balancing between perceived value and quality assurance. This pricing approach is essential in fostering trust and encouraging consumers to choose refurbished over new products.

In conclusion, effective pricing strategies for refurbished smartphones should focus on providing significant discounts while maintaining consumer trust and perceived value. A discount of 30% to 40% is generally effective in achieving this balance. Additionally, these strategies must consider market demand, brand reputation, and technological relevance to optimize sales and profitability in the refurbished smartphone market. By addressing these factors, companies can enhance their competitive edge and attract a broader customer base, ensuring sustained growth in the refurbished electronics sector.

8.2.3 Social

Consumer trends

In France, 28% of people have already bought a refurbished smartphone, showing interest in this concept (Statista, 2023). In contrast, a survey in Belgium by a refurbishment company, Swappie, indicated that only 4% of the population possesses a refurbished smartphone, despite 76% being aware of the option (Swappie, 2021). This disparity could be explained by socio-cultural factors affecting the tendency of Belgians towards refurbished smartphones.

An effective circular economy's ability to implement a closed-loop supply chain strategy primarily relies on how keen consumers are to buy these kinds of products. According to a study on buying refurbished phones conducted in France in 2018, only 36% of the population intended to purchase a reconditioned phone (Statista, 2018).

The perceived incentives for consumers to purchase refurbished smartphones are varied; they include lower prices and the environmentally friendly image associated with these products as the primary motivations for purchasing those (Nasiri & Shokouhyar, 2021). However, studies show varying consumer perspectives on the environmental benefits of smartphone reconditioning. Experiments indicated minimal impact on purchases when reconditioning was associated with environmental friendliness (Abbey et al., 2015).

Another study supports this observation, revealing that brand equity significantly influences the sales of refurbished goods, with price setting being closely linked to it (De Vicente Bittar, 2018). Additionally, refurbishment sales are unaffected by consumer environmental concerns, highlighting the importance of the financial aspect in consumer purchase decisions. The perceived quality of refurbished devices, which often appear new and come with a 12-month warranty, further enhances their attractiveness to customers (Nasiri & Shokouhyar, 2021).

Multiple drivers of demand for reconditioned products depend on branding. Surprisingly, refurbished products offered by original equipment manufacturers (OEMs) can be less attractive compared to those offered by third-party reconditioners. For example, the total brand value decreases, and the selling price of new items drops when an OEM, like Apple, offers refurbished iPods (Abbey et al., 2015).

According to literature, important features for customers in smartphones, ranked from highest to lowest, include the camera, screen, battery, performance, innovative technologies, and internal storage (Sharifi & Shokouhyar, 2021). The degree of a product's technological obsolescence significantly influences how much a buyer is willing to spend on a refurbished cell phone. Customers

are more likely to buy reconditioned phones the less technologically obsolete they are (Sharifi & Shokouhyar, 2021).

Consumer behavior is influenced by multiple elements. Perceived inconvenience is a significant deterrent to purchasing refurbished goods. Uncertainty regarding the quality of refurbished products negatively influences consumer attitudes and demand (Kerber et al., 2021). Perceived quality relies mainly on brand image and the retailer's reputation. Reliable warranty services improve consumer trust, as providing a guarantee for remanufactured goods increases the volume of goods sold (Zhu & Yu, 2019; Tang et al., 2019).

Another critical factor limiting consumers' buying intentions is their level of knowledge about the product. Consumers' decision-making processes are heavily influenced by the experiences and recommendations of their peers. Positive peer experiences can enhance the perceived value and reliability of refurbished products, increasing demand. Conversely, negative feedback can deter potential buyers. Additionally, the availability and clarity of technical product information play a significant role in shaping consumer attitudes. Detailed and accessible information about the refurbished product's specifications, performance, and warranty can alleviate concerns about quality and functionality, encouraging purchases (Kerber et al., 2021; Sharifi & Shokouhyar, 2021).

In other words, the enhancement of buying intention is driven by perceived quality, brand name, and price. While environmental benefits are motivating factors, price remains the most crucial aspect influencing consumer behavior. Furthermore, marketing and branding efforts are essential in promoting refurbished phones. Consumers tend to prioritize impressing peers and maintaining their image over protecting the environment (Abbey et al., 2015).

Therefore, remanufacturing challenges not only involve educating customers on environmental benefits but also emphasizing quality and price. Early research revealed that refurbished items are generally not perceived as environmentally friendly. The most crucial aspect influencing consumers' opinions on reconditioned items is their perception of quality. Increasing public awareness of the remanufacturing process through marketing and education may be one of the best ways to spur interest in these products (Abbey et al., 2015).

However, the transition towards a circular economy, which includes practices such as reconditioning, is heavily influenced by societal attitudes towards sustainability. According to Geissdoerfer et al. (2017), societal support for sustainability initiatives is crucial. Positive societal attitudes can enhance the demand for reconditioned products and support the development of sustainable business models

8.2.4 Technological

Repairable smartphones

Based on multiple research, the main reasons for changing smartphones can be categorized into the defects observed in smartphones and the behavior of users when faced with a broken device. According to a study in Germany from 2019, the most common defects in smartphones are related to the display, which accounts for 67.4% of the issues, followed by the casing at 50%, the battery at 33.9%, connectors at 16.1%, and the camera at 7.9% (WERTGARANTIE Group, 2019). These defects significantly affect the functionality and usability of the devices, prompting users to consider replacements.

In fact, according to a recent Eurobarometer survey, the primary motivations for purchasing a new device are the breaking of the old device (37%), significant deterioration in performance (30%), and issues with certain applications or software (19%) (European Commission, 2020).

Part of the smartphones that are thrown away are so for a few reasons, first outdated products that do not work with modern technology (Santana et al., 2021), secondly, the cost of repairing and spare parts are higher than the profit estimated. Simply put, most defects are easily repairable; you just need to consider the viability of the repair cost.

Other factors make smartphones not repairable, from a technological point of view some devices are not worth refurbishing due to software problems. Smartphones and tablets rely on operating systems (OS) and firmware, which manage applications and hardware functions. Regular updates from producers are essential to fix problems and security issues, affecting device performance, including battery and CPU efficiency. Both updates and the lack of updates can render a device obsolete, highlighting their importance in extending device lifespan and reducing replacement rates. Security updates are crucial for maintaining functionality and data security, with their availability varying significantly by brand and operating system.

8.3 Conclusion

In conclusion, the PEST analysis conducted in this research offers critical insights into the external factors affecting the smartphone refurbishment industry. By focusing on political, economic, social, and technological dimensions, the analysis has provided a comprehensive understanding of the key drivers and challenges that shape the industry. This focused approach allowed for a deeper evaluation of the factors most pertinent to the refurbishment market, especially in the context of supply and distribution within the value chain.

The political analysis highlighted the significant role of regulations and extended producer responsibility (EPR) in shaping the landscape for smartphone collection and refurbishment (Kunz et al., 2018; European Commission, 2023). Despite efforts to increase waste electrical and electronic equipment (WEEE) collection rates, particularly for smartphones, the industry still faces challenges, including low collection rates and high costs associated with acquiring used devices for refurbishment (European Commission, 2022). Economic factors, such as global economic trends and financial incentives, further influence the supply and demand dynamics in the reconditioning market, emphasizing the need for competitive pricing and efficient cost management (Santana et al., 2021; Shevchenko et al., 2019).

The social and technological aspects of the PEST analysis underscored the importance of consumer perception, convenience, and technological innovations in driving the success of smartphone refurbishment initiatives. Consumers' attitudes toward refurbished smartphones are influenced by various factors, including perceived quality, brand reputation, and convenience in returning devices (Kerber et al., 2021; Sharifi & Shokouhyar, 2021; Bouvier & Wagner, 2011). Technological advancements, particularly in repairability and collection systems, are crucial in addressing these concerns and enhancing the overall efficiency of the refurbishment process (Best & Kneip, 2011). Moving forward, the insights gained from this analysis can guide industry stakeholders in formulating strategies to improve market penetration, increase smartphone recovery rates, and ultimately support the transition towards a more circular economy (Geissdoerfer et al., 2017).

9 Methodology

In the previous chapter, we established a theoretical foundation for this work. This chapter details the methodology applied in our research as well as the chosen methods. The steps from the creation of the studies to their execution will be described, and the choices made will be justified. The topic examined in this thesis is still in expansion therefore a deductive approach would be appropriate as the theme is still in development. The goal is to explore and give additional information on the refurbished industry. It was determined to conduct a quantitative study to gain additional understanding of our topic and the associated research objectives.

9.1 Research design

An online survey was selected as the method for conducting quantitative research. This method is not only quick and efficient but also allows for a broader reach, enabling the collection of a larger and more diverse sample. Additionally, online surveys offer convenience for respondents, who can complete the survey at their own pace and time, potentially increasing the response rate. The digital format also facilitates data analysis, as responses can be compiled with ease and analyzed using various software tools.

9.2 Identification and sampling of the participants

The target population for this study is the Belgian population. To achieve a confidence level of 95% with a margin of error of 5%, a sample size of 385 respondents was necessary. This sample size ensures that the results are statistically significant and representative of the broader population. By maintaining these parameters, the study can provide reliable insights and generalizable conclusions about the Belgian population's perspectives and behaviors. The confidence level of 95% indicates that if the study were repeated multiple times, the results would be consistent with the actual population 95% of the time. The 5% margin of error reflects the precision of the estimates, ensuring that the true values lie within this range of the survey results. This methodological rigor is crucial for validating the findings and making informed decisions based on the data collected.

The required sample size of 385 respondents was exceeded, with 464 respondents with an additional 30 incomplete responses. However, the sampling was not entirely random, as a significant number of responses came from close acquaintances.

This non-random sampling introduces potential biases, as respondents who are acquaintances may have similar views or experiences that are not reflective of the broader population. This limitation should be acknowledged, as it may affect the generalizability of the findings.

Despite this, the data collected still provides valuable insights, but the results should be interpreted with caution, considering the potential influence of the non-random sample on the study's outcomes. Future research should aim for a more random sampling approach to enhance the representativeness and validity of the results.

The questionnaire of the study can be found in the appendix 1. It was constructed to explore two parts of the value chain, distribution and collection. The first part of the questionnaire is dedicated to refurbished smartphones, focusing on consumer intentions and their perceptions. The second part

investigates the potential for smartphone resale by retrieving data on unused smartphones and perception for resale.

10 Results

10.1 Perception of refurbished smartphones

Questions 1, 2, and 3 respectively investigate the awareness, purchase history, and perception of refurbished smartphones. As shown in Q1, out of 464 respondents, 411 were aware of what a refurbished smartphone was before taking the survey. This indicates a high level of awareness (88.6%) among the respondents about refurbished smartphones.

Question 2 shows that 314 respondents (67.7%) have never purchased a refurbished smartphone, while 150 respondents (32.3%) have already purchased one.

Question 3 aimed at investigating the perception of refurbished smartphones as an ecological option. Respondents were asked to rate it on a scale of 1 to 5. Of the respondents, 30.1% gave a rating of 5 out of 5, 37.8% gave a rating of 4 out of 5, 19.9% gave a rating of 3 out of 5, 3.8% gave a rating of 2 out of 5, and 0.8% gave a rating of 1 out of 5. This shows a strong positive perception of refurbished smartphones as an eco-friendly option, with the majority of respondents rating it highly but the results still show the reservations that some people may have.

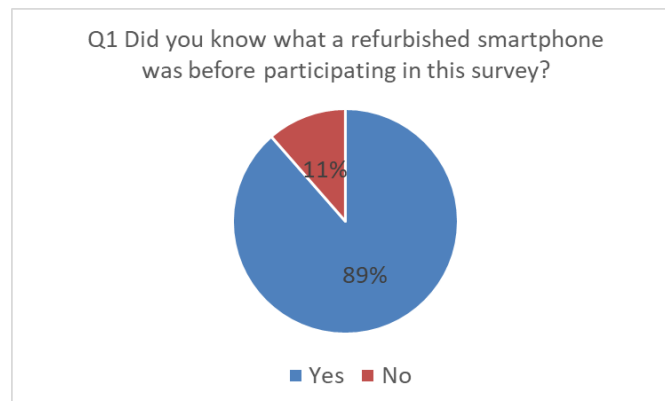


Figure 4 Awareness of refurbished smartphones (Yahia, 2024, Survey data)

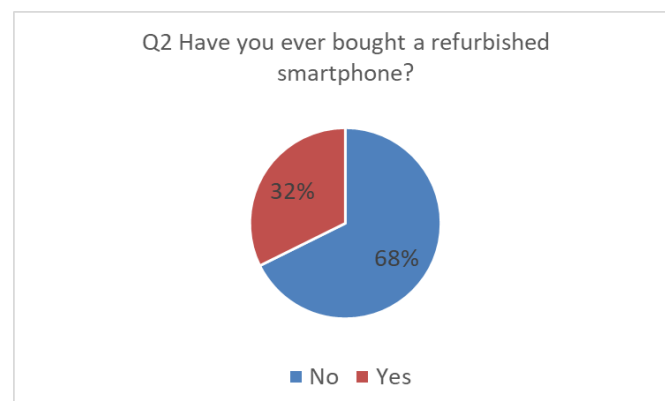


Figure 5 Prior purchase (Yahia, 2024, Survey data)

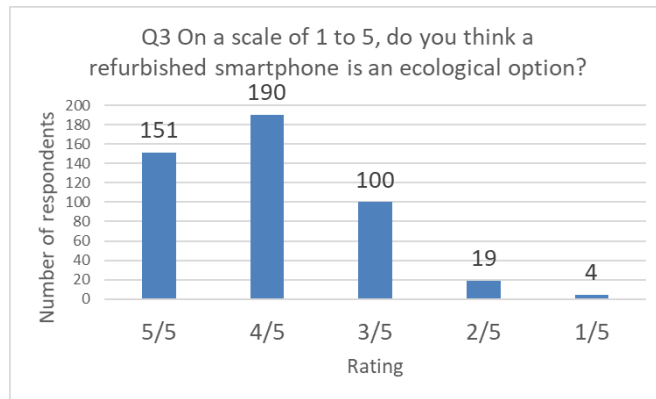


Figure 6 Ecological perception (Yahia, 2024, Survey data)

Q4 looked at the reasons for not purchasing refurbished smartphones among those who have never purchased a refurbished smartphone (314 respondents). Some participants (11.5%) were not aware of or had not considered this option before the survey. A significant portion of respondents (61%) expresses a lack of trust in the quality of refurbished smartphones, with common concerns about the quality of repairs and long-term reliability. Additionally, some participants (13.1%) find refurbished smartphones too expensive compared to their expectations. Various other reasons are mentioned, including a preference for new devices for a longer lifespan, the use of company-provided smartphones, no immediate need to replace their current phone and concerns about software updates potentially slowing down the phone. These comments reflect diverse perceptions and specific concerns, explaining why some consumers hesitate to choose refurbished smartphones.

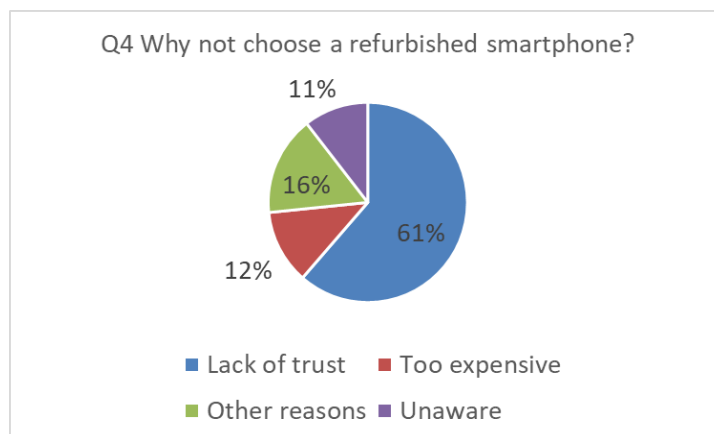


Figure 7 Reasons not to buy (Yahia, 2024, Survey data)

Q5 helped gather data on the most popular distribution platforms for acquiring refurbished smartphones. The most popular platform for purchasing refurbished smartphones was e-commerce sites such as Backmarket and Amazon. Second were retail distributors like Mediamarkt, Coolblue, and Vanden Borre. Third, specialized refurbishers such as Asmartworld and Swappie were also ranked highly. Finally, telecom operators were another common choice for acquiring refurbished smartphones.

Question 6 assessed user satisfaction with refurbished smartphones. The user experience with refurbished smartphones was predominantly positive, as evidenced by the survey responses. Specifically, 73 respondents indicated a good experience, while 59 respondents reported a very good experience. In contrast, negative feedback was minimal, with only 10 respondents reporting a bad experience and 8 respondents indicating a very bad experience.

Q7's purpose was to evaluate the importance of the refurbishment location for consumers. A significant proportion of respondents indicated the importance of the refurbishment location in their purchasing decisions for refurbished smartphones. Specifically, 283 respondents affirmed that they would consider the location of refurbishment, whereas 181 respondents stated that they would not consider it.

Questions 8, 9, 10, 11, and 12 respectively investigate the importance of price, quality, warranty, localization, and environmental impact when purchasing refurbished smartphones. Respondents rated the importance of various factors on a scale of 1 to 5. The results are as follows:

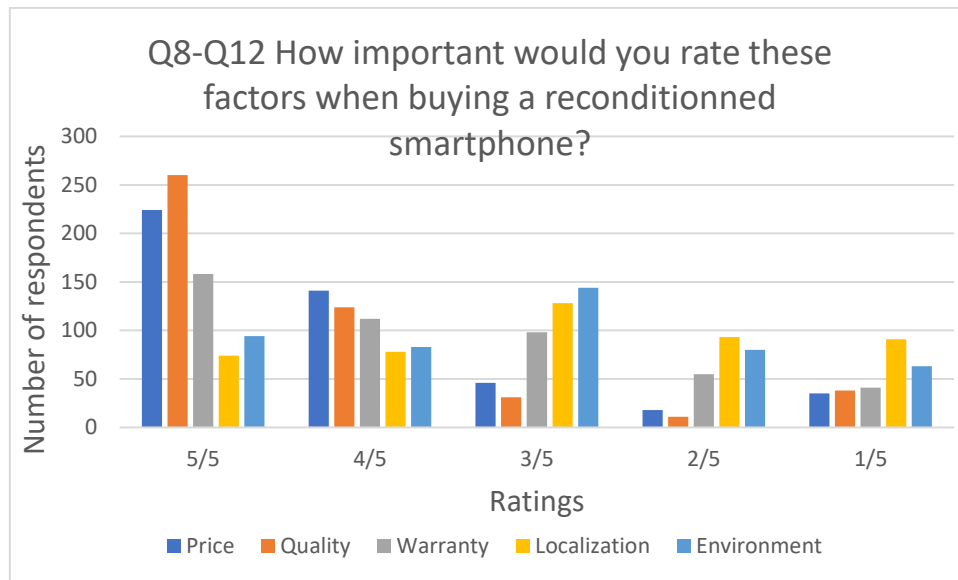


Figure 8 Importance of factors (Yahia, 2024, Survey data)

Most favored factors are:

- Quality (53.9% rated 5/5)
- Price (46.4% rated 5/5)
- Guarantee (32.7% rated 5/5)
- Environmental impact (19.5% rated 5/5)
- Localization of refurbishment (15.3% rated 5/5)

To have a clearer view, from the consumer's perspective when purchasing refurbished smartphones, the prioritization of these factors is as follows: foremost is quality, followed by price, warranty, environmental impact, and finally, the localization of refurbishment.

10.2 Smartphone resale

According to the results of Q13 presented in the pie chart, a significant majority of respondents, 73%, reported having unused and old smartphones at home, regardless of whether they are functional or not. In contrast, 26% of the respondents indicated that they do not have any such devices at home. Additionally, a small fraction, accounting for 1% of the respondents, did not provide any response to this question. This data suggests that the accumulation of unused smartphones is a common phenomenon among the surveyed population.

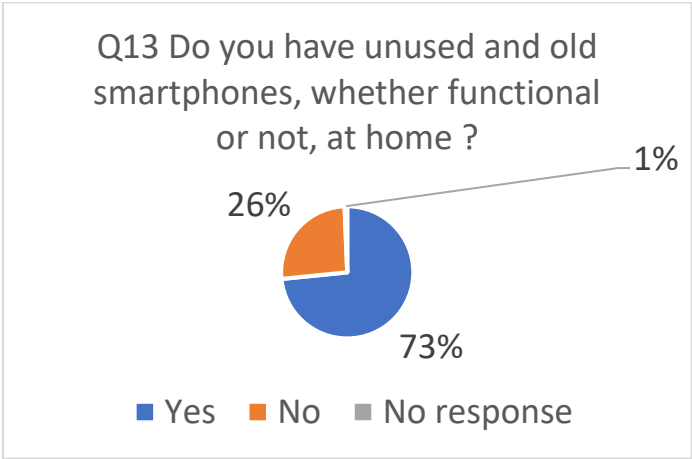


Figure 9 Unused smartphones (Yahia, 2024, Survey data)

The results of Q13 regarding the number of unused smartphones at home indicate that the largest groups of respondents have either one or two such devices, with 121 and 120 individuals respectively. A notable number, 64 respondents, have three unused smartphones, while smaller groups possess four (17 respondents), five (6 respondents), six (5 respondents), or seven or more (7 respondents) unused smartphones. The average number of smartphones at home, based on the data provided, is approximately 2.12 units.

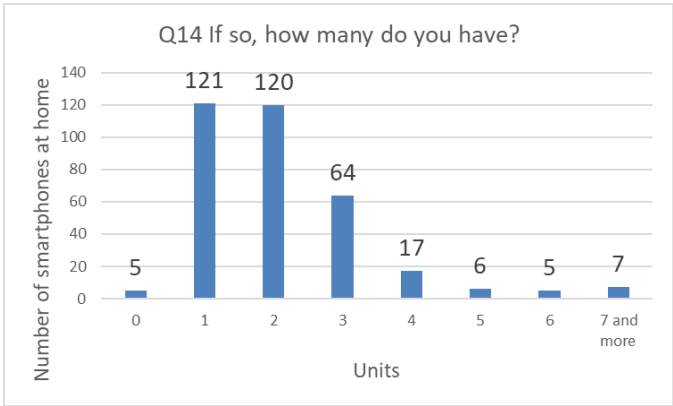


Figure 10 Distribution of unused smartphones (Yahia, 2024, Survey data)

Regarding the models of smartphones shown in Q14 no longer in use, the data reveals that 38% of respondents possess an unused iPhones, followed closely by 37% who no longer use Samsung

devices. Other brands mentioned include Huawei (11%), Xiaomi (4%), OnePlus (1%), Google Pixel (0%), and Nokia (5%), with a few respondents listing various other models (4%). This indicates that the average number of smartphones per respondent, based on the survey data, is 2.12. This means that, on average, each respondent possesses just over two unused smartphones. Moreover, the results show that the vast majority of brands represented are Apple and Samsung with over 75% of the total distribution of smartphones.

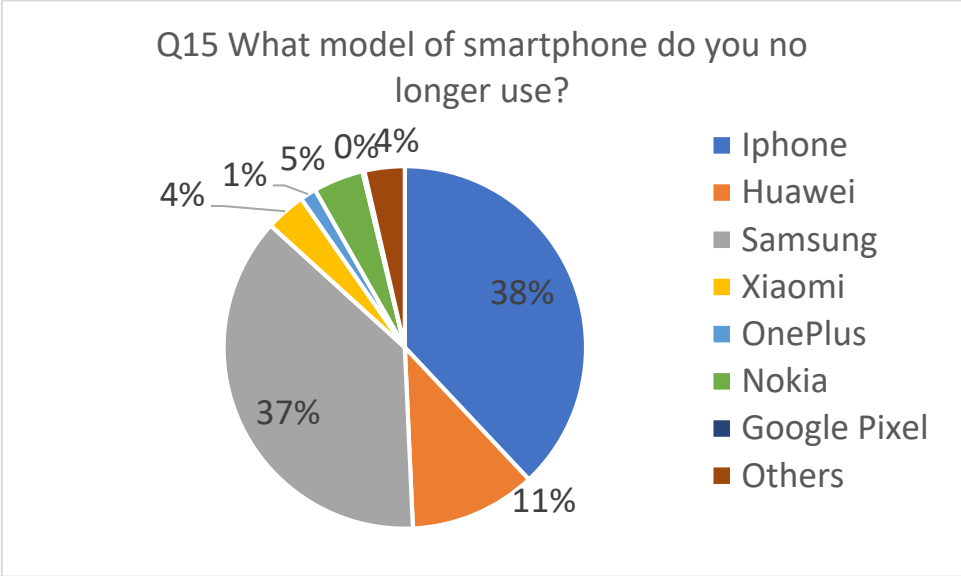


Figure 11 Brand distribution (Yahia, 2024, Survey data)

Q13 represents the condition of unused smartphones among respondents. Only smartphones that are five years old or less were considered in this analysis, as refurbishers typically do not recover older devices due to their diminished market value. The majority, 59%, reported that their unused smartphones are functional but have some defects. Meanwhile, 27% of respondents indicated that their unused smartphones are non-functional. A smaller portion, 14%, stated that their unused smartphones are still functional and in good condition. This distribution indicates that a considerable portion of the unused smartphones remain somewhat functional, despite having defects.

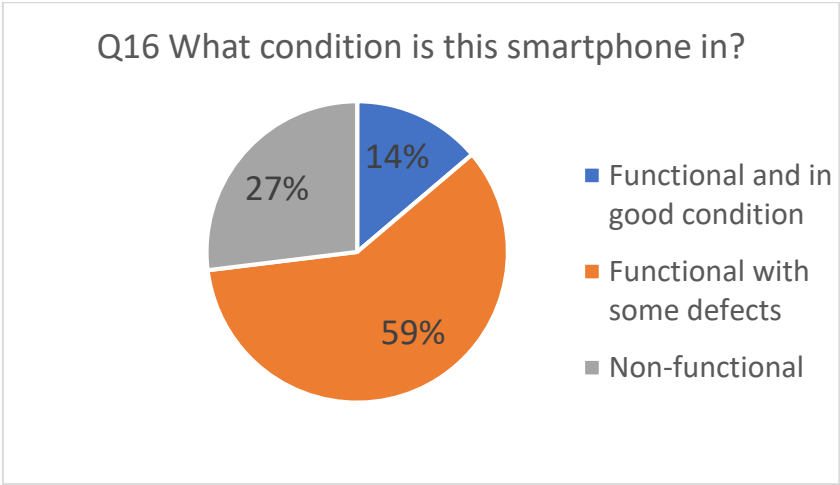


Figure 12 Condition distribution (Yahia, 2024, Survey data)

Q17 indicates the age distribution of unused smartphones among respondents. A substantial 46% of the smartphones are more than five years old. This is followed by 19% which are four years old, and both three-year-old and five-year-old smartphones each account for 13%. Smartphones that are two years old make up 6% of the total, while those that are less than two years old constitute the smallest group at 2%. The average age of the unused smartphones is approximately 4.75 years. These data shows that nearly half of the unused smartphones are quite old, having been in possession for more than five years.

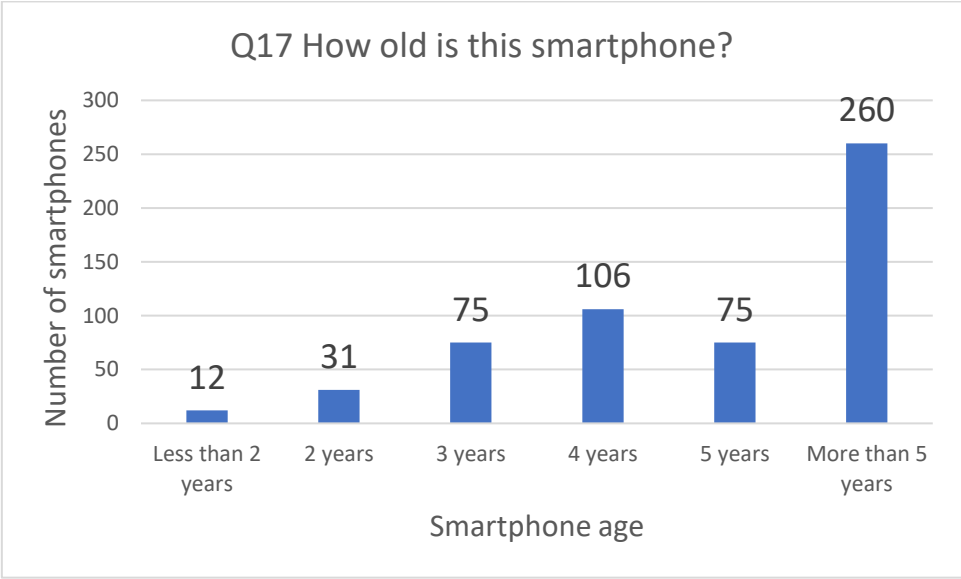


Figure 13 Age distribution (Yahia, 2024, Survey data)

Q18 helped to gather information on the original purchase price of the unused smartphones. Regarding the purchase price of unused smartphones, results show that 30% of respondents bought their devices for between 200 € and 400 €, making it the most common price range. This is followed by 18% who paid less than 200 €, and 15% who purchased their smartphones for between 400 € and 600 €. A smaller portion, 12%, reported buying their smartphones for between 600 € and 800 €, while 6% spent more than 800 € on their devices. This distribution reflects purchasing patterns where mid-range and budget phones are more common, probably due to affordability, good quality and market trends, while fewer respondents opt for premium models, which might be retained for longer use or have better resale opportunities.

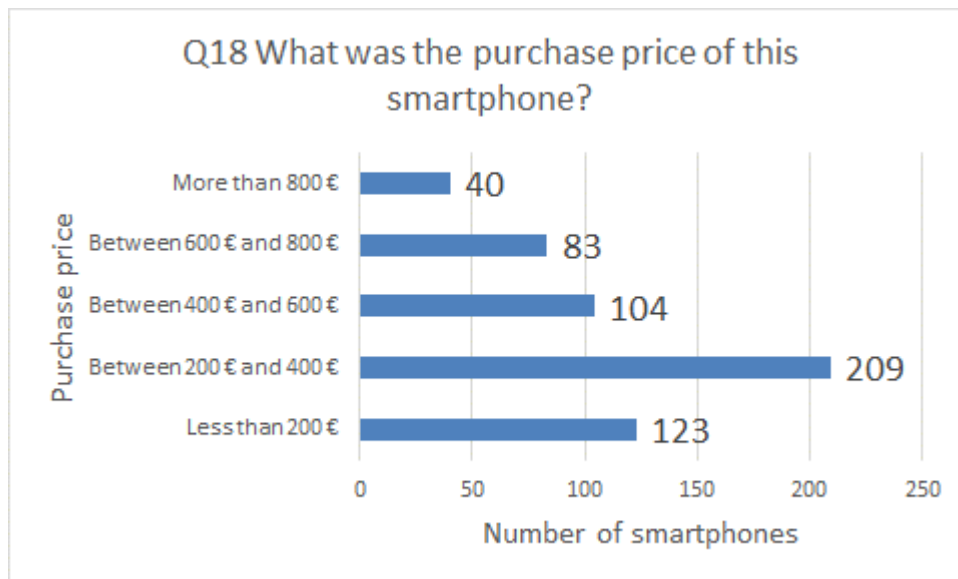


Figure 14 Purchase price (Yahia, 2024, Survey data)

Q19 goal is to understand the resale value respondents are willing to accept for their unused smartphones. When it comes to the amount respondents are willing to sell these smartphones for, the majority, 40%, indicated a willingness to sell for less than 50 €. Another 27% are willing to sell for between 50 € and 100 €, and 18% for between 100 € and 150 €. Smaller percentages of respondents are willing to sell their smartphones for between 150 € and 200 € (6%), and more than 200 € (10%). This data highlights a trend of respondents being willing to sell their unused smartphones at significantly lower prices than their original purchase costs. The data analysis must take into account for the fact that less than half of the smartphones studied are more than five years old, indicating that they hold less value—a fact of which consumers are aware.

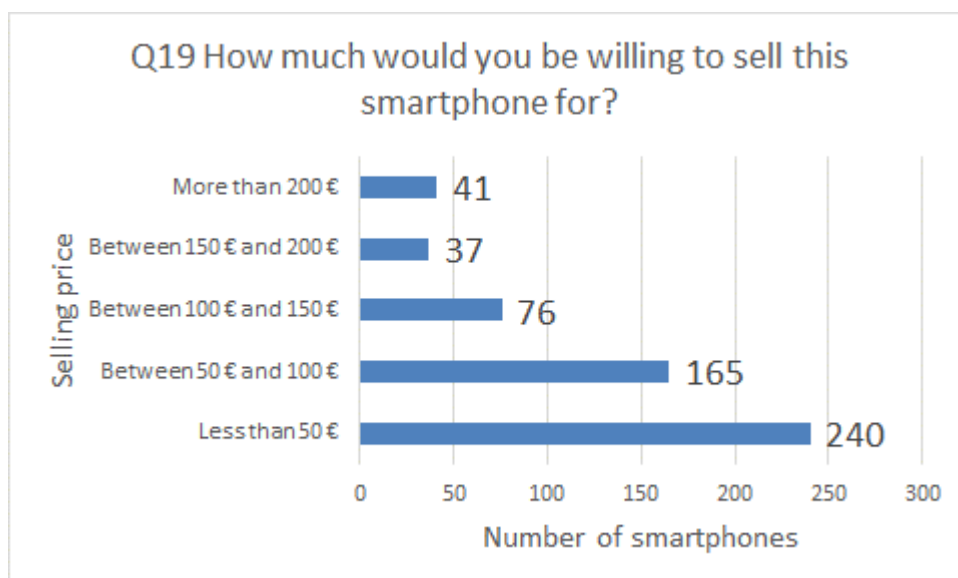


Figure 15 Resale price (Yahia, 2024, Survey data)

The survey results for Q20 reveal that a majority of respondents, 59%, are in favor of selling their smartphones directly to a reconditioning company via a prepaid order form. In contrast, 13% of respondents are not in favor of this method, while 28% are uncertain about their stance. This indicates a strong inclination towards the convenience of using a prepaid order form for selling smartphones, though a notable proportion remains unsure or opposed.

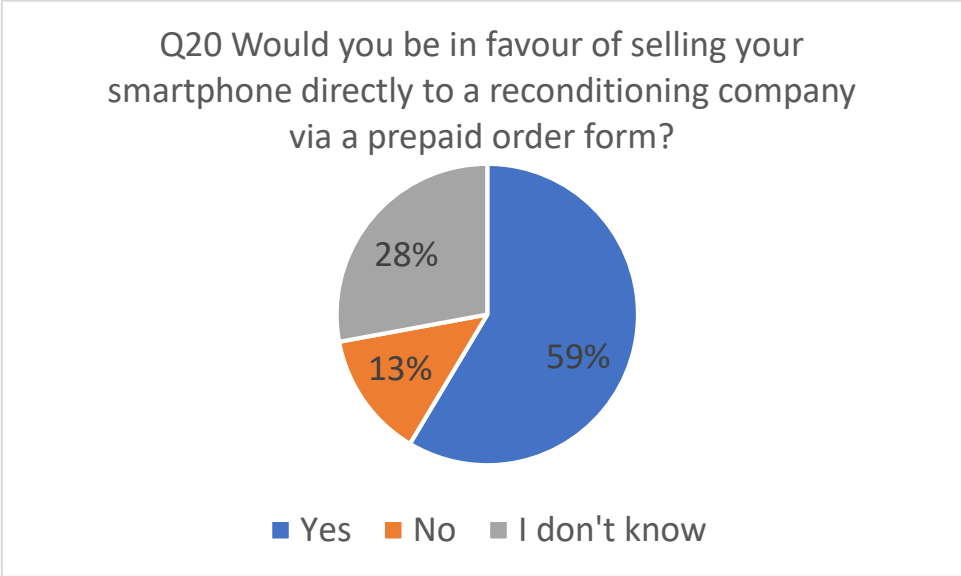


Figure 16 Direct sale to reconditioners (Yahia, 2024, Survey data)

The survey results for Q21 reveal the main reservations respondents have about selling their smartphones to a refurbisher. The leading concern, cited by twenty-one respondents, is a lack of confidence in the reconditioning process. Seventeen respondents believe the buyback price is too low. Another fifteen respondents indicated a lack of information about the reconditioning process as their main reservation. Additionally, ten respondents prefer to sell their smartphones to an individual, while sixteen chose 'Other' reasons, and seven respondents stated they do not know their main reservation.

The other reasons provided for not selling or giving away old smartphones encompass a range of personal and practical considerations. These include donating the devices to individuals in need, preserving them for sentimental value or nostalgia, and retaining them for future personal use in case their current devices fail. Additionally, some respondents cited the necessity to recover important data such as photos, contacts, and messages. While others refrain from selling completely non-functional phones due to worries about data retrieval. These findings highlight the significant apprehensions around trust and financial value in the reconditioning process. Furthermore, solutions and communication regarding data retrieval and data deletion should be addressed.

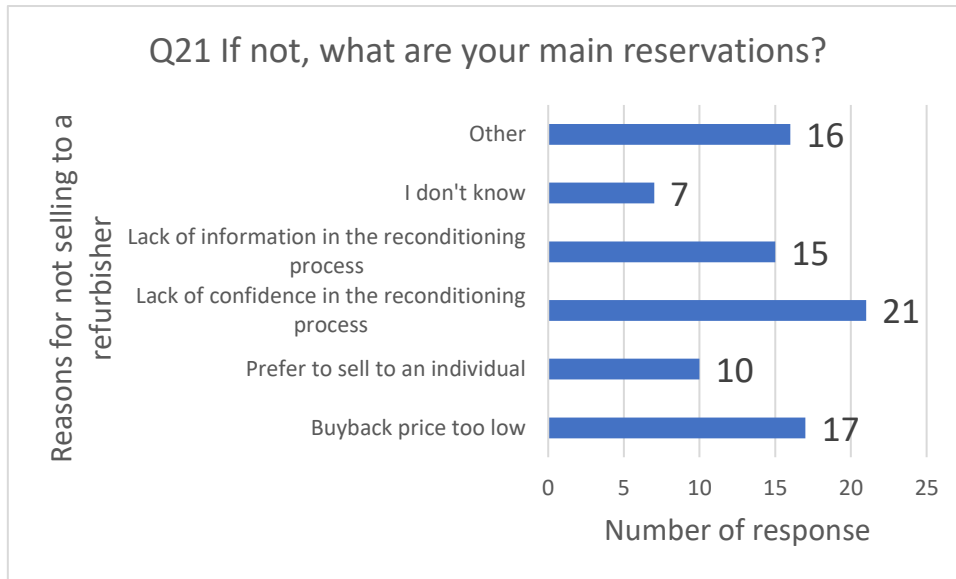


Figure 17 Reasons for not selling to refurbishers (Yahia, 2024, Survey data)

Q22 shows a nearly even split in awareness regarding the possibility of handing in used phones free of charge to distributors and retailers. 51% of respondents are aware of this option, while 49% are not. This indicates that one in two people are aware of this service, while a significant portion of the population remains uninformed. This highlights a potential area for increased communication and education efforts.

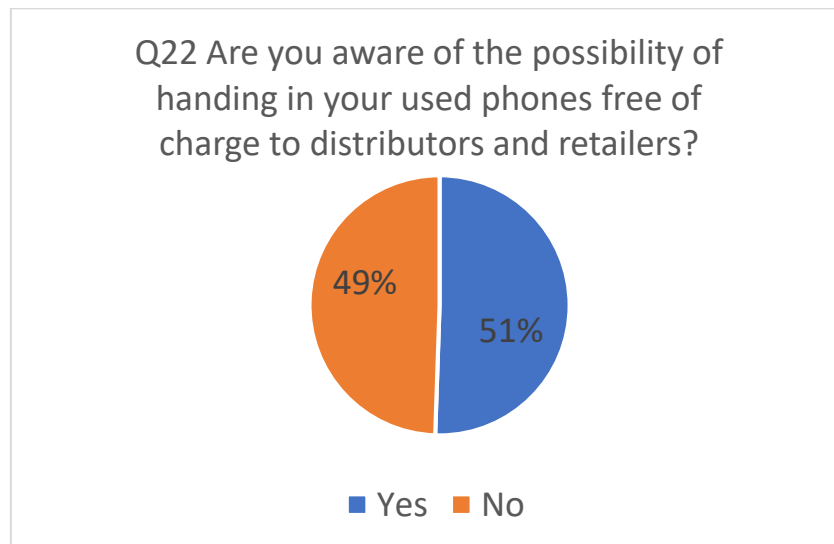


Figure 18 Awareness to hand in free smartphone (Yahia, 2024, Survey data)

Questions 12 to 15 were designed to assess the price at which consumers are willing to resell their smartphones, based on factors such as brand, purchase price, condition, and age. Tables 3 and 4 below provide a summary of these values for Samsung and iPhone, as these brands alone account for 75% of the data collected. The resale price and purchase price data were collected in the form of ranges, allowing participants to provide more accurate self-assessments without relying on memory.

Using ranges in data collection offers several advantages. First, it facilitates self-assessment by allowing participants to estimate their responses more easily without needing to recall exact figures, thereby reducing cognitive load and memory-related errors. Second, it decreases uncertainty by providing predefined options, which minimizes hesitation and the likelihood of approximate responses, ultimately enhancing the quality of the data collected. Lastly, data organized in ranges is easier to analyze, enabling the quick identification of general trends without the complexity of handling a wide array of specific values.

These data will serve as a basis for comparison with Table 1. It should be noted that smartphones over five years old were excluded from this analysis. According to TakuyaWeb and ObyO (n.d.), these older devices typically do not retain sufficient residual value and may be incompatible with the latest updates, significantly diminishing their resale value.

When comparing Table 1 with Table 3, some observations are made:

- For items classified as "**functional and in good condition**", the prices listed in Table 1 generally correspond to or exceed the willingness to sell range provided in Table 3 with several instances being positioned at the higher end of the range.
- For **items with defects**, the prices from Table 1 are largely consistent with the range specified in Table 3, although they frequently occupy the upper limit or slightly surpass the outlined ranges.
- Regarding **non-functional** items, the prices indicated in the first table generally align with the lower spectrum or are comparable to, the willingness to sell range presented in the second table.

In summary, the perceived value is generally lower for iPhones that are in good or fair condition.

Table 3

Average sell price range for iPhones.

Condition	Buying price(€)	Willingness to sell range(€)
Functional and in good condition		
	200-400	75.00-125.00
	400-600	100.00-150.00
	600-800	120.00-170.00
	800 and more	190.00-240.00
Functional but with some defects		
	200-400	70.59-120.59
	400-600	91.67-141.67
	600-800	125.00-175.00
	800 and more	150.00-200.00
Non-functional		
	200-400	20.00-70.00
	400-600	37.50-87.50
	600-800	61.11-111.11
	800 and more	100.00-150.00

Yahia, S. (2024). Survey on [Refurbished smartphone and resale of used smartphones] conducted in June 2024 [Unpublished raw data].

Key observations when comparing Table 1 with Table 4:

- **Good condition** devices: The prices in Table 1 generally exceed the willingness to sell range in Table 4, particularly for higher-end models.
- **With defects**: The prices from Table 1 are consistently higher than the corresponding range in Table 4, especially for more expensive models.
- **Non-functional**: The prices in Table 1 align well with Table 4’s range, though they tend to be at the higher end or slightly above for some models.

This comparison highlights that the prices listed in the first table are generally above the willingness-to-sell range provided in the second table, especially for devices in good condition or with some defects. However, non-functional prices tend to be more aligned with the expected ranges.

Table 4
Average sell price range for Samsung smartphones.

Condition	Buying price(€)	Willingness to sell range(€)
Functional and in good condition		
	200-400	37.50-87.50
	400-600	86.36-136.36
	600-800	133.33-183.33
	800 and more	200.00-250.00
Functional but with some defects		
	Less than 200	18.18-68.18
	200-400	32.76-82.76
	400-600	78.13-128.13
	600-800	104.17-154.17
	800 and more	162.50-212.50
Non-functional		
	Less than 200	5.56-55.56
	200-400	8.33-58.33
	400-600	25.00-75.00
	600-800	61.11-111.11
	800 and more	75.00-125.00

Yahia, S. (2024). Survey on [Refurbished smartphone and resale of used smartphones] conducted in June 2024 [Unpublished raw data].

11 Discussion

11.1 Consumer view on reconditioned smartphones

This study aimed to explore several research questions regarding consumer behavior and the market potential for refurbished smartphones. The study specifically examined the key factors influencing consumer awareness and purchasing behavior towards refurbished smartphones. It also explored the impact of concerns regarding quality, cost, and reliability on purchasing decisions, as well as the potential effects of enhanced consumer education and improved recycling programs on the market. Additionally, it assessed the role of environmental concerns and sustainability considerations in shaping consumer attitudes towards refurbished smartphones.

The first research question aimed to explore the factors that drive consumer awareness and the subsequent purchase of refurbished smartphones. The findings reveal a high level of awareness among respondents, with 88.6% indicating familiarity with refurbished smartphones before the survey. Despite this widespread awareness, a substantial proportion of respondents (67.7%) had never purchased a refurbished smartphone. This outcome contrasts with the findings of Swappie (2021), which reported that only 4% of the population owned a refurbished smartphone, suggesting either a significant increase in the purchase of such devices or a divergence in data trends.

Additionally, the same study in 2021 indicated an awareness level of 76% (Swappie, 2021), highlighting a marked improvement in consumer knowledge regarding refurbished smartphones. However, the data suggests that awareness alone is insufficient to drive purchasing behavior, indicating that other factors may play a crucial role in influencing consumer decisions.

According to Figure 7, the reasons for not purchasing refurbished smartphones are diverse, with the primary concern being a lack of trust in the product's quality. This finding aligns with existing literature, which identifies perceived quality as the most critical factor influencing consumer attitudes toward reconditioned items (Kerber et al., 2021).

Other respondents cited reasons such as the perceived high cost, a preference for new devices with a longer lifespan, reliance on company-provided smartphones, the absence of an immediate need to replace their current phone, and concerns about potential software updates slowing down the refurbished phone.

To boost consumer trust and increase sales of refurbished products, focus on enhancing brand image and retailer reputation. Providing reliable warranties is key, as guarantees significantly improve customer confidence and sales (Zhu & Yu, 2019; Tang et al., 2019).

Additionally, ensure that consumers have access to clear, detailed information about the product's specifications, performance, and warranty. To ensure consumers have a clear understanding of the performance and appearance of refurbished smartphones, it is advisable to establish and certify high-quality standards, possibly through third-party certification systems. This approach would help reassure consumers about the reliability and quality of the refurbished devices they are considering.

Positive peer experiences are also crucial, as they can significantly enhance perceived value and, consequently, drive demand (Kerber et al., 2021; Sharifi & Shokouhyar, 2021). Notably, Q6 indicates that user experience was evaluated as relatively positive, with 88% of respondents reporting a good or very good experience. This underscores the importance of leveraging positive user feedback to further boost consumer confidence and encourage the purchase of refurbished smartphones.

According to our findings, consumers prioritize several factors when purchasing refurbished smartphones, with quality being the most important, followed by price, warranty, environmental impact, and finally, the location of refurbishment.

While quality is paramount, the emphasis on price as the second motivator contrasts with Abbey et al. (2015), who argue that price is the primary factor. However, our results suggest that price is nearly as significant as quality in the decision-making process.

Regarding environmental impact, Nasiri and Shokouhyar (2021) consider it a major motivator, which is contested by Abbey et al. (2015), who found it to have minimal influence on purchasing decisions. Our results align more closely with the latter, indicating that environmental impact plays a relatively minor role in consumer decisions.

In addition, the perception of refurbished smartphones as an eco-friendly option is notably high, with only 4.6% rating it low. This reinforces the idea that, despite being well-regarded, environmental considerations are not a significant motivating factor in consumers' purchasing decisions.

Moreover, the results of Q7 indicated that 61% of consumers claimed they would consider the localization of refurbishment. However, in practice, this factor plays a minimal role in the buying decision process. While localization can be seen as contributing to both quality and environmental impact, consumers when making purchasing decisions do not significantly consider it.

Lastly, it is notable that the importance of a warranty is significant, primarily because it is closely associated with the perception of quality. As noted by Nasiri and Shokouhyar (2021), the perceived quality of refurbished devices, which often resemble new products and include a 12-month warranty, enhances their appeal to customers.

In conclusion, this study provides valuable insights into consumer behavior and the market potential for refurbished smartphones. While awareness of refurbished smartphones is high, with 88.6% of respondents familiar with the concept, this awareness does not necessarily translate into purchasing behavior, as a significant portion of consumers have yet to purchase a refurbished device. The primary factors driving consumer decisions are quality, price, and warranty, with quality emerging as the most critical concern. Although price is nearly as important, it does not surpass quality in influencing purchasing decisions.

Environmental impact, despite being perceived positively, plays a relatively minor role in consumer decisions, highlighting that eco-friendliness, while valued, is not a primary motivator. Similarly, the localization of refurbishment, although considered by some consumers, does not significantly affect purchasing decisions in practice.

The study underscores the importance of building consumer trust through reliable warranties, clear product information, and positive peer experiences. Enhancing brand image and retailer reputation, along with leveraging customer satisfaction, are key strategies to increase consumer confidence and drive demand for refurbished smartphones. These findings suggest that while awareness and positive perceptions are important, practical concerns such as quality assurance and trust remain pivotal in shaping consumer behavior in the refurbished smartphone market.

11.2 Smartphone resale

The research questions aim to explore how refurbishers can effectively utilize incentives and improve convenience to encourage consumers to resell their used smartphones, and how the brand, age, and condition of unused smartphones influence their potential for refurbishment and resale.

According to the results of Q13, 73% of respondents reported having unused and old smartphones at home. Moreover, the average number of smartphones per household is 2.12 units. This significant

majority indicates a substantial opportunity for reconditioners to tap into a large inventory of potential devices.

Refurbishers should consider creating programs or incentives for individuals who have multiple devices. For instance, offering bulk trade-in deals or additional discounts for multiple devices can encourage people to part with more than one smartphone at a time, increasing the reconditioners inventory.

The survey results indicate that over 75% of unused smartphones are either Apple or Samsung devices, suggesting that refurbishers should prioritize these brands due to their high demand and perceived reliability within the refurbished market. By specializing in these popular brands, reconditioners can streamline the refurbishment process, reduce costs, and attract a broader customer base.

According to Q16, the majority (59%) of unused smartphones are functional but have some defects, while 14% remain functional and in good condition. This trend is consistent across both Samsung and Apple devices. Reconditioners should focus on addressing these minor defects to prepare the devices for market. Additionally, emphasizing rigorous quality checks and offering warranties can further reassure potential buyers of the reliability of refurbished smartphones.

Q17 reveals that nearly half (46%) of the unused smartphones are more than five years old. These older devices may be less desirable in the current market. As discussed earlier in this paper, it would be prudent for refurbishers to concentrate on devices that are five years old or less to ensure they meet contemporary technological standards and consumer expectations.

The data from Q18 shows that most unused smartphones were originally purchased for between 200 € and 400 €, while the resale willingness data from Q19 indicates that most respondents are willing to sell their devices for less than 50 € to 100 €. Refurbishers should ensure that their buyback prices are attractive enough to encourage trade-ins while maintaining profitability. Competitive pricing strategies that reflect the device's condition and market demand can help balance this.

The survey results for Q20 reveal a majority preference for selling smartphones directly to a reconditioning company using a prepaid order form, with 59% of respondents favoring this method. In contrast, 13% of respondents are not in favor, and 28% are uncertain about their stance. This indicates a strong inclination towards the convenience and simplicity of using a prepaid order form for selling smartphones. However, the notable proportion of respondents who remain unsure or opposed suggests that there are underlying concerns or a lack of understanding about this method that need to be addressed by refurbishers. Enhancing communication regarding the process and benefits of utilizing prepaid order forms may effectively convert the uncertain and opposed groups into willing participants. However, a potential issue that could arise is the discrepancy between the consumer's self-assessment of the device's condition and the evaluation conducted by the refurbisher, which could result in a different final offer than initially anticipated.

The survey results for Q21 reveal that the main reservations respondents have about selling their smartphones to reconditioners include a lack of confidence in the reconditioning process, perceived low buyback prices, and insufficient information. Additionally, some prefer selling directly to individuals for better deals or quicker transactions, while others choose to donate, keep devices for sentimental reasons, or retain them for future use. Concerns about data security, especially with non-functional phones, are also noted.

These concerns are further supported by research showing that the ease or difficulty perceived by individuals in performing proper e-waste recycling behaviors is significantly influenced by transaction costs, which include personal resources such as effort, time, and money spent while returning e-waste (Bouvier & Wagner, 2011; Dixit & Vaish, 2020).

This connection underscores the importance of reducing perceived transaction costs, as well as improving transparency and trust in the reconditioning process, to encourage more consumers to engage in the resale and recycling of their unused smartphones.

Q22 reveals a nearly even split in awareness regarding the option to hand in used phones free of charge to distributors and retailers, with 51% of respondents aware of this service and 49% not. Half of the population is unaware of the option to hand in their used smartphones at retail stores, highlighting a significant gap in marketing efforts. This lack of awareness suggests that refurbishers and retailers need to enhance their communication strategies to inform consumers about this convenient and environmentally friendly option.

For strategic pricing, a comparative analysis of smartphone buyback prices has been conducted between Table 1, which presents the actual values offered by a refurbisher, and Tables 3 and 4, which reflect the price ranges respondents of the survey are willing to accept for selling their Samsung and iPhone devices. The analysis reveals that the perceived value is generally lower for iPhones in good or fair condition compared to the values offered by the refurbisher. Similarly, for Samsung devices, alignment between perceived value and actual buyback prices is primarily observed in non-functional phones.

This indicates a potentially valuable economic opportunity, given that 59% of unused smartphones are functional but have some defects, while 14% remain functional and in good condition.

However, it is crucial to acknowledge that this survey does not account for specific smartphone models, instead focusing on the purchase price, which may introduce biases in the findings. Additionally, the limited data available for certain price ranges suggests that notable discrepancies could exist, warranting a cautious interpretation of the results. This approach ensures refurbishers can still find value through cost-effective refurbishment while providing competitive buyback prices to consumers, irrespective of the phone's age or model.

In short, to overcome obstacles and enhance their price offerings, reconditioners can implement several key strategies. First, offering competitive buyback prices that accurately reflect the condition and market demand of the devices is crucial. This approach ensures that consumers feel they are receiving fair value for their smartphones, which can incentivize them to participate in the resale process.

Improving convenience is another vital strategy. Refurbishers can enhance the consumer experience by creating multi-device take-back programs, offering prepaid label forms, and launching awareness campaigns. These initiatives make the resale process more accessible and less time-consuming for consumers, encouraging greater participation.

Additionally, reconditioners should prioritize transparency in the reconditioning process by addressing data security concerns and highlighting the ease and security of prepaid label forms.

Moreover, targeting popular brands like Apple, Samsung, and Huawei, which have high demand and perceived reliability in the refurbished market, is also essential.

Lastly, focusing on devices that are less than five years old ensures that the refurbished smartphones meet current technological standards and consumer expectations.

12 Limitations and future research

The study has several limitations that should be taken into account when interpreting the findings. Firstly, a considerable number of survey respondents were from the same social circles and, in some cases, the same household, which may introduce bias into the results, specifically on the data of unused smartphones.

Additionally, the data collected regarding smartphone prices did not account for specific models, which could potentially influence the reported resale values. This lack of model-specific data may have affected the accuracy of the price estimates. To enhance the reliability of future price recommendations, a new survey could be conducted, targeting a specific category of smartphones and gathering more precise data on purchase prices and the condition of the devices, including a clear explanation of any issues they may have.

However, another limitation is that we assessed selling estimation rather than observing actual consumer behavior. Future research should aim to investigate these factors to help companies successfully collect unused smartphones.

Furthermore, regarding the proposal for prepaid labels, the lack of options provided to respondents could have influenced their responses. The absence of detailed explanations about negative externalities may also have impacted the participants' understanding and, consequently, their answers.

For future research, it is recommended to conduct a more targeted survey focusing on smartphones that are less than five years old and concentrating on a single brand. This approach would ensure the acquisition of a homogenous larger data set.

Additionally, obtaining more detailed information about the smartphone's condition and specific model would lead to a more accurate assessment of buyback prices. Future studies could also explore cost analysis, providing refurbishers with more precise recommendations on the viability of refurbishing certain devices.

13 Conclusion

The primary objective of this research was to explore how refurbishment strategies can mitigate the growing issue of electronic waste while fostering new business models that yield positive environmental outcomes for smartphones. The study aimed to identify the key factors influencing consumer awareness and purchasing behavior towards refurbished smartphones, to design strategies that enhance consumer acceptance of these devices. Additionally, it sought to assess how these factors impact consumer decisions and evaluate the potential influence of enhanced consumer education and recycling programs on the refurbished smartphone market.

Another critical aspect of this research was to explore how refurbishers can effectively utilize incentives and improve the convenience of the resale process, thereby encouraging consumers to resell their unused smartphones.

The research delves into the primary factors influencing consumer awareness and purchasing behavior towards refurbished smartphones, revealing that while awareness is high, it does not always lead to purchases. Quality, price, and warranty are the primary drivers of consumer decisions, as highlighted in the research questions. The study suggests that providing robust warranties and clear, accessible information about repairs and parts used is essential in overcoming these barriers.

Moreover, the research investigates the potential impact of enhanced consumer education and improved recycling programs on the market for refurbished smartphones. It finds that although environmental considerations are positively perceived, they currently play a minor role in influencing purchasing decisions. This insight aligns with the research's objective to identify key factors that could enhance consumer acceptance of refurbished devices. The study suggests focusing on enhancing the brand's image of quality rather than relying solely on ecological benefits to drive consumer behavior.

The study also sheds light on the significant opportunity within the smartphone resale market. It observes that the perceived buyback price for unused phones is often lower than the actual buyback price, representing an economic opportunity for refurbishers to become more competitive. By presenting a buyback price model for iPhones and Samsung devices, the study provides practical strategies for reconditioners to set prices that are more effective and achieve cost savings.

In conclusion, to maximize the impact of these initiatives and achieve the primary objectives of this research, refurbishers and policymakers need to work together to improve the quality and transparency of refurbished products. By doing so, they can enhance consumer trust and confidence, thereby increasing the attractiveness of refurbished devices.

Ultimately, this collaborative effort will drive greater participation in the refurbished smartphone market, contribute to reducing electronic waste, and foster more sustainable consumption practices. With the introduction of the right to repair and upcoming legislative initiatives promoting the circular economy, the market for refurbished smartphones may undergo significant transformations. Future research could explore how these regulations will not only influence refurbishment practices but also influence consumer perceptions and the adoption of refurbished devices in a context increasingly aware of environmental issues.

14 Appendix

14.1 Survey questions

1. **Were you aware of what a refurbished smartphone was before participating in this survey?**

• **Possible Answers:**

- Yes
- No
- Somewhat

2. **Have you ever purchased a refurbished smartphone?**

• **Possible Answers:**

- Yes
- No

3. **On a scale of 1 to 5, do you consider a refurbished smartphone to be an environmentally friendly option?**

• **Possible Answers:**

- 1 (Not at all)
- 2
- 3
- 4
- 5 (Very much so)

4. **What reasons might prevent you from opting for a refurbished smartphone? (Select all that apply)**

• **Possible Answers:**

- I don't know about them
- I don't trust the quality
- I find them too expensive
- Other (with space to specify)

5. **Through which platform did you purchase your refurbished smartphone? (Select all that apply)**

• **Possible Answers:**

- Mobile Operator
- Retailer (e.g., Mediamarkt, Coolblue)
- E-commerce site (e.g., Backmarket, Amazon)
- Specialized refurbisher (e.g., Asmartworld, Swappie)
- Other (with space to specify)

6. **What was your experience with the refurbished smartphone you purchased?**

• **Possible Answers:**

- Very bad
- Bad
- Good

- Very good

7. Would you consider the place of refurbishment when buying a refurbished smartphone?

• **Possible Answers:**

- Yes
- No

8. How important are the following factors when buying a refurbished smartphone? (Rank each on a scale of 1 to 5)

• **Factors:**

- Price
- Quality
- Warranty
- Location of refurbishment
- Environmental impact reduction

9. Do you have any unused, functional, or non-functional smartphones at home?

• **Possible Answers:**

- Yes
- No

10. If yes, how many do you have?

• **Possible Answers:**

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7 or more

11. What is the model of the smartphone you no longer use?

• **Possible Answers:**

- iPhone
- Huawei
- Samsung
- Xiaomi
- OnePlus
- Nokia
- Google Pixel
- Other (with space to specify)

12. What condition is this smartphone in?

• **Possible Answers:**

- Functional and in good condition

- Functional but with some defects (scratched screen, low battery, performance issues, etc.)
- Non-functional

13. How old is this smartphone?

- **Possible Answers:**
 - Less than 2 years
 - 2 years
 - 3 years
 - 4 years
 - 5 years
 - More than 5 years

14. What was the purchase price of this smartphone?

- **Possible Answers:**
 - Less than €200
 - Between €200 and €400
 - Between €400 and €600
 - Between €600 and €800
 - More than €800

15. For what amount would you be willing to sell this smartphone?

- **Possible Answers:**
 - Less than €50
 - Between €50 and €100
 - Between €100 and €150
 - Between €150 and €200
 - More than €200

16. After evaluating the price of your phone based on its condition and model via an application, would you be willing to sell it directly to a refurbishment company using a pre-paid shipping label?

- **Possible Answers:**
 - Yes
 - No
 - I don't know

17. If not, what are your main concerns? (Select all that apply)

- **Possible Answers:**
 - The buyback price is too low
 - Prefer to sell to an individual
 - Lack of trust in the refurbishment process
 - Lack of information about the refurbishment process
 - I don't know
 - Other (with space to specify)

18. Are you aware that you can return your old phones to retailers and sellers for free?

- **Possible Answers:**
 - Yes
 - No

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16 Executive Summary

This research investigates consumer attitudes and collection strategies within the smartphone refurbishment industry in Belgium, with a particular focus on understanding the factors that influence consumer behavior towards refurbished smartphones. The study also aims to identify effective strategies for refurbishers to improve collection rates of unused smartphones and enhance consumer acceptance of refurbished devices.

This study employs a quantitative research approach through an online survey, targeting the Belgian population. The survey was designed to explore consumer attitudes towards refurbished smartphones and the potential for smartphone resale, specifically examining the distribution and collection aspects of the value chain

The study reveals a high level of consumer awareness about refurbished smartphones, yet significant barriers persist that hinder actual purchase behavior. Quality, price, and warranty concerns are identified as the primary factors driving consumer decisions, with environmental considerations playing a relatively minor role. These findings suggest that while consumers are aware of and generally perceive refurbished smartphones positively, practical concerns related to the perceived reliability and value of these devices remain critical obstacles.

The research also highlights the significant opportunity present in the smartphone resale market. Many consumers are holding onto unused devices, which could be refurbished and resold, thereby contributing to a more sustainable consumption model. The study finds that perceived buyback prices for unused phones are often lower than the actual market value, suggesting that refurbishers could become more competitive by aligning their pricing strategies with consumer expectations.

To address the challenges identified, the research suggests that reconditioners should focus on enhancing transparency in the reconditioning process, providing clear and accessible information about repairs, and offering convenient resale options such as prepaid shipping labels.

Overall, this research contributes to a better understanding of the refurbished smartphone market in Belgium, offering practical insights for refurbishers aiming to strengthen their market position and enhance their smartphone buyback processes.