Extended Abstract
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Second-hand smartphones in Finland: Key actors, barriers and enablers

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Introduction

The sustainability challenges associated with smartphones include significant social and ecosystem impacts (Zufall *et al*. 2020). Smartphones contain valuable metals, such as gold, silver, copper and palladium (Bookhagen *et al.* 2020). In addition, plastics, which constitute a large share of the device, are challenging in terms of recyclability and contaminants (Eerola *et al.* 2021). Favouring repair and refurbishing of phones would significantly diminish their environmental impacts, which mostly originate from the production of new devices (Pamminger *et al.* 2021; Rizos *et al.,* 2019).

Smartphones tend to be replaced before the end of their technical life (Zufall *et al.* 2020; Wieser & Tröger, 2018) and the lifetimes can be even shorter than 2 years (Cordella *et al.* 2021). Thus, there is potential to extend the lifetime of phones by reusing them either directly or after repair (Kivikytö-Reponen *et al.* 2023; Messmann *et al.* 2019), which is seen in the steady growth of the second-hand phone market size (IMARC, 2025).

However, several challenges, including repairability, updatability, low collection rates and difficulty of disassembly of phones, would need to be solved (Eerola *et al.*, 2021). In addition, consumer concerns, behaviour and attitudes play a role (Mugge *et al.* 2017; Cordova-Pizzarro *et al.* 2020; Wieser and Tröger, 2018; Ruismäki *et al.* 2024).

Significant business potential exists in the global market of used smartphones and the market in Finland is yet underdeveloped, too (Ruismäki *et al.* 2024). Thus, this research addresses the following questions:

- Which actors play a key role in the value chain of used smartphones?
- What factors enable the reuse of smartphones?

This paper adds to the knowledge regarding development needs and identifies topics for further research.

Materials and methods

We carried out a total of nine 30-minute semi-structured interviews (Gillham, 2005), where the focus was on the flows of second-hand smartphones and key barriers and enablers of their refurbishment and reuse. The first interviewees were selected based on the insights gained from the literature review, and additional interviewees were included based on suggestions of the interviewees (Table 1).

Interview questions were prepared by a group of researchers and were specifically targeted for each interviewee. Interview notes were thematically analysed regarding actors, activity types, partners, stakeholders, value chain geographies, enablers, barriers and development needs using Atlas.ti online.

Table 1: Interviewees

Actor type	Description
EPR[1] organization	WEEE management
	WEEE management
	Battery end-of-life management
Telecommunications company	Smartphone sales
	Second-hand phone sales
Leasing company	ICT leasing to organisations
Recycling company	Collection of WEEE, electronics refurbishing
Public sector	WEEE statistics
	Regional council

Results

Value network of refurbished smartphones

Value networks and flows for smartphones are diverse and dispersed (Figure 1).

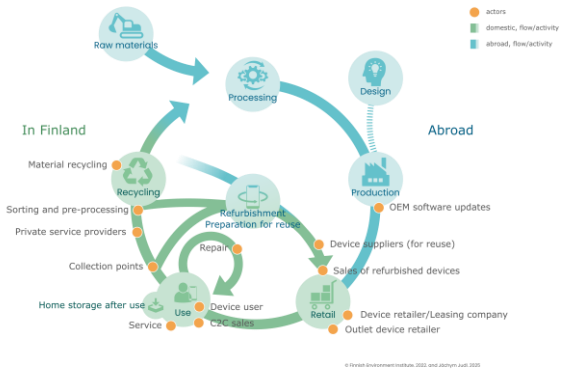

Figure 1 System overview: smartphone value chain and actors

Used devices can be handled locally from consumer to consumer (INT#2) or by actors such as the *Recycling Centre* in Finland and sold back to consumers (INT#1). Typically, used phones are collected at specific WEEE collection sites, electronics retailers, mobile telecommunications companies and private service providers and are then further processed for reuse (INT#1; INT#2; INT#3). Many usable devices are discarded during refurbishment due to being locked (INT#9), which the end user can prevent (INT#5; INT#8). After preparing for reuse (erasing data, functionality check, and repairing eventually broken parts), private service providers may sell them onwards domestically or abroad (INT#1; INT#3;INT#8).

Some activities to prepare for reuse also occur abroad, creating partnerships and value chains that cross borders, even continents. Used smartphones from other markets enter the local market in Finland. They are traded by international wholesalers and then sold by second-hand retailers in the domestic market. (Figure 2).

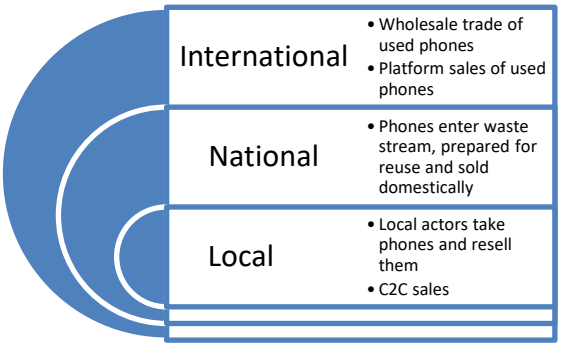

Figure 2: Different geographic scales for used smartphone value chains

Importantly, large amounts of used smartphones are kept by households either as reserve phones, used by family members, or stored for data security concerns (INT#2;INT#3; INT#5; INT#6). A significant opportunity for value creation from used smartphones is therefore lost.

Enablers for a more circular smartphone value chain

Several technical and organizational factors already enable the reuse of smartphones. Technical characteristics of the device, such as high-quality phones (INT#1; INT #3; INT#4; INT#8), as well as long-lasting batteries (INT#5), are crucial enablers. Availability of devices in good condition is improved by add-on solutions, such as protective screens and

[1] Extended Producer Responsibility

protective covers (INT#5; INT#8). When large quantities of devices in good condition are available, it becomes feasible to assess and prepare similar phones for reuse (INT#2), enabling standardized operations and economies of scale. Pivotal partners provide secure erasing software or services (INT#1; INT#9).

The main technical barriers are, most importantly, the limited timeframe during which software updates (operating system) are available (INT#5), data encryption applications that prevent reuse of phones (INT#5; INT#9) and limitations in the logistics and storage capacity for the used phones (INT#4). Further expertise and processes for recognising devices fit for reuse are needed (INT#2, INT#4).

Most importantly, consumer behaviour and attitudes are a significant hindrance (INT#6). For example, consumers hoard their used phones due to a lack of trust (INT#1; INT#4) and fears of spreading their data (INT#1; INT#4; INT#5). Yet, there would be significant potential for circularity from the hoarded phones (#1; #5; #6; #7). The smartphones that are brought to collection points are generally very old models (INT#1) from which the value can no longer be captured.

Discussion and conclusions

The study showed that a value network for improving the reuse and refurbishment of smartphones exists, and capacities are being increased to better capture the potential. A significant barrier, however, is consumer hoarding (also e.g. Wieser & Tröger,2018; Ylä-Mella et al., 2015), which limits an effective value chain of used smartphones. Moreover, as attitudes towards repair vary from country to country (Wieser & Tröger, 2018), studying the local attitudes would be beneficial.

In order to achieve economies of scale, large number of transactions of similar phones is needed. Thus, where domestic market is small, as is the case of Finland, wholesale traders operating in the Nordic, European markets or globally, have a key role in the value network. However,this topic is academically understudied, and therefore, little can be said beyond the information gathered in the interviews. Future studies should focus on differences in environmental impacts between fully domestic value chains and those that involve international brokers, as well as local wholesale business opportunities.

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