

## Measuring the Impact of Smartphone Reuse Interventions on Consumer Choice and Product Lifetime – Preliminary Findings

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**Keywords:** circular consumption; consumer behavior; product reuse; effective interventions; environmental impacts.

### Introduction

The smartphone market is experiencing dual trends: while new models continue to flood the market, the reuse sector is also growing rapidly. However, the circular economy of smartphones faces significant challenges. Many devices end up in a state of 'hibernation' - unused but stored away - or are prematurely discarded, disrupting the potential for efficient supply and demand in the second-hand market. Consumer acceptance of used devices and recirculation at end-of-use are crucial to ensure adequate supply and demand in this evolving market.

Previous work has shown that the reuse of smartphones extends their lifetime compared to linear use (Cooper et al. 2015, Amatuni et al. 2023), leading to a decrease in demand for new products and avoiding environmental impacts associated with new production (Clemm et al. 2023). Consequently, stimulating consumer behavior leading to increased engagement with second-hand markets is in line with the goals of the circular economy and global emission reduction targets. However, the effectiveness of reuse-promoting interventions and policies has, thus far, hardly been measured and understood. Mugge et al. (2017) reported that product-related interventions were most effective in increasing consumers' intention to purchase refurbished smartphones, including improved battery life and guaranteed software updates, indicating a need for continued performance. Bieser et al. (2022) considered all consumer decisions that affect smartphone lifetime, including purchase and end-of-use behavior. They identified 26 interventions without quantifying their effectiveness. Koide et al. (2023) proposed a method integrating consumer choice with product circulation

modeling to assess the effectiveness of interventions for fostering the adoption of circular consumption, including reuse. Results were generated by adopting hypothetical scenarios and numerical examples only. Wilson et al. (2017) reported that mobile phones are hibernated for longer than they are actively used, emphasizing the need for interventions promoting circular consumption behavior.

This study aims to measure the potential of interventions aiming to promote product reuse. By evaluating the effects of interventions on consumer choice in markets, we strive to identify opportunities for extending smartphone lifespans and demonstrate their potential contributions to the circular economy.

### Methods

The screening of literature indicated that previous studies did not account for actual consumer behavior as a baseline to measure the effectiveness of interventions. To address this gap, first, we collect consumer data on actual reported purchase and end-of-use (EoU) behavior as a baseline. Second, data on purchase and EoU intentions, assuming interventions for circularity, is collected. Third, we use this novel data as input into an existing market-level stock-and-flow model that describes the flow of new and second-hand (SH) products through a market and computes the required production of new devices to meet demand (Clemm et al., 2023). This allows us to evaluate the cumulative effects of specific product reuse-promoting interventions on consumer choice and the demand and supply of new and SH devices in a simulated market.

This study, therefore, approaches the question of which interventions are effective to induce desirable change in consumer behavior and production rates. Unlike studies focusing on individual consumption impacts, this study adopts a population-level perspective, accounting for diverse behaviors across the market.

For this preliminary analysis, two interventions were selected to assess their impacts and demonstrate the method: (1) an extended warranty on SH smartphones of three years, mitigating functionality concerns, and (2) a free data transfer and erasure service to facilitate the recirculation of devices at end-of-use (EoU), mitigating data privacy concerns. The interventions were selected to address barriers to both supply and demand of used smartphones. Surveys were conducted among the general population in the US.

The employed market model captures product flows from manufacturing to end-of-life, requiring empirical market data on product lifespans and consumer reuse propensity to simulate scenarios. Data on average use times of new and SH smartphones were sourced from Amatuni et al. (2023), while consumer preferences and behaviors were gathered via the online survey. The pilot survey collected 54 responses covering recent purchase and EoU decisions under current conditions (baseline scenario) and intended behaviors under the proposed interventions (hypothetical scenarios). The models' outputs for these scenarios were compared to estimate the interventions' potential impacts.

## Results & discussion

The results reveal that under current conditions, about 14% of the respondents purchase SH devices, and the market-average total use time is 2.8 years. Introducing an extended warranty for SH devices could increase SH purchases to

22%, extend the average use time to 3.1 years, and reduce new production by 10% (Figure 1). In contrast, the free data transfer and erasure service showed no significant effect on consumer reuse behavior.

Additionally, the maximum potential of reuse-promoting measures was explored under an idealized scenario. This scenario assumed a technical limit of 5 years for smartphone use and a universal preference for obtaining and recirculating SH devices. Although new production is still needed to replenish retiring stocks in this scenario, the total production rate drops by 44%, with 60% of users opting for SH devices.

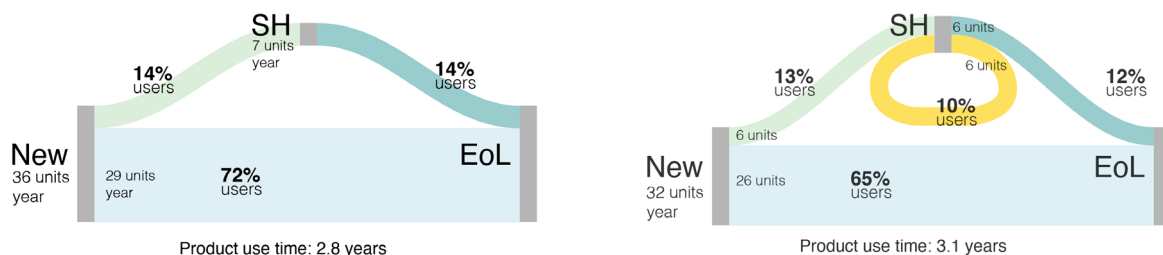
## Conclusions & outlook

Our approach enables us to quantify how interventions for reuse, such as extended warranties, can influence market dynamics for new and second-hand products.

Future research includes several key improvements and expansions. A larger, more representative survey will strengthen the reliability of the findings. The scope of assessed interventions will be broadened to include measures such as product upgrades and trade-in programs. Additionally, we aim to analyze different geographical regions to enable cross-regional and -cultural comparisons. Another focus will be exploring how distinct consumer segments, based on their attitudes and perceptions of second-hand goods, respond to various interventions. This targeted approach will help identify the most effective measures for encouraging reuse and maximizing their impact.

## Acknowledgments

This work was supported by the Japan Science and Technology Agency (JST) through the Belmont Forum (grant number JPMJBF2202), the Satomi Scholarship Foundation, the



**Figure 1. Sankey diagrams depicting the total demand for new smartphones and the flow between user types until products reach end-of-life (EoL) in a baseline scenario (left) and the scenario with extended product warranties (right) modeled for a market with a population of  $P = 100$ ; SH = second-hand.**

Environment Research and Technology Development Fund (JPMEERF20253M03) of the Environmental Restoration and Conservation Agency provided by the Ministry of Environment of Japan, and by National Institute of Advanced Industrial Science and Technology.

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