

Save the *Galaxy*: E-waste Recycling at Samsung and Sustainability in Korea*

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I. Introduction

In February 2017, Samsung Electronics invited hundreds of media and tech influencers to a press conference to announce their new tablets and VR technology at the Mobile World Congress, the world's largest exhibition for the mobile industry. As soon as Samsung Electronics Europe's CMO, David Lowes, began his opening remarks, Greenpeace protestors interrupted the speech by walking up on stage in front of the press and unfurling a large yellow banner bearing a recycle logo with the *#GalaxyNote7* hashtag (Figure 1).

Greenpeace's public protest was a call out to Samsung's recall of more than 3 million Galaxy Note7 smartphones the previous year due to defective batteries. Initially, Samsung had announced that it would dispose of the recalled smartphones due to

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〈Figure 1(a) Samsung's Galaxy Note7 〈Figure 1(b)〉 Greenpeace activists at MWC

safety risks. However, Greenpeace and other environmental organizations had been forcing Samsung to introduce a sustainable recycling plan instead of adding to the existing 45 million tons of global electronic waste. Greenpeace's bold interruption at the Mobile World Congress was widely covered by media and tech influencers, and brought worldwide attention to electronics manufacturers like Samsung on issues of electronic waste and its sustainable operations practices.

In broad terms, sustainability helps create conditions for humans and nature to co-exist in productive harmony. For electronics manufacturers like Samsung, sustainability means finding the right balance between selling products that people need and limiting the environmental damage caused by the disposal of those products. Firms must actively seek sustainable business practices in areas including supply chain management, environmental health and safety, energy management, carbon management, and product stewardship. In light of growing awareness about sustainability, shareholders and investors today also conscientiously review businesses' ESG (environmental, social, and governance) performance reports. ESG performance is now perceived as one of the most vital parts of a firm's sustainability competency to the market, primarily driven by the millennial investors who make up 40% of all investors. More than 86% of S&P 500 companies currently report on their ESG performance through sustainability reports using GRI Standards.

Two years after Samsung's press conference, Mark Newton, head of corporate sustainability at Samsung Electronics America, spoke publicly about the company's goal to collect 3.8 million tons of electronic waste by 2020. Newton also shared

Samsung's plan to enhance sustainability by maximizing its product's life spans, reducing raw material consumption, and increasing the use of recycled materials across each stage of the product life cycle. Despite these efforts by Samsung and other manufacturers, global electronic waste continued to increase at a rate of 4 to 5% per year.

II. Electronic Waste

2.1 Electronic Waste and Green Supply Chain Management

Electronic waste, or e-waste, is created when an electronic product is discarded after the end of its useful life without intent to reuse. Electronic products include temperature exchange equipment (e.g., refrigerators), large equipment (e.g., washing machines), IT and telecommunication equipment (e.g., televisions, laptops, and mobile phones), and small equipment (e.g., toasters, lamps). These products are made up of raw materials such as gold, silver, copper, platinum, as well as hazardous substances and toxic additives such as lead, mercury, and cadmium, which make electronic products difficult to recycle without causing environmental damage.

According to the 2020 Global E-waste Monitor published by the UN and the International Telecommunication Union (ITU), the world produced 53.6 million tons of e-waste in 2019, up from 44.4 million tons in 2014. This number is expected to grow to more than 74 million by 2030. While the total amount of recycled e-waste has increased by 1.8 million tons since 2014, the percentage of recycled e-waste has increased only by 0.4% during this period; that is, the total amount of e-waste is still growing at a dreadful pace.

This rapid increase in e-waste is mainly due to the increasing consumption of electric and electronic equipment, decreasing product life cycles, limited options for repair, and lack of regulations or funding to support recycling for manufacturers and consumers. In particular, mobile phones made record sales of 1.4 billion devices in the past five years. However, e-waste from small IT and telecommunication equipment only increased by 2% since 2014, compared to a 7% increase for temperature exchange

equipment. This is due to collective efforts by governments, environmental organizations, and manufacturers to reuse and recycle mobile phones. According to the U.S. Environmental Protection Agency, 35 thousand pounds of copper, 772 pounds of silver, 75 pounds of gold and 33 pounds of palladium can be recovered from every million mobile phones recycled.

To increase the amount of recycled e-waste, manufacturers are implementing green supply chain management practices--integrating environmental thinking throughout the entire product life cycle from product design, to sourcing and manufacturing, to end-of-life management. Such green practices allows firms to increase their energy efficiency while reducing the e-waste that can potentially lead to reduced operational costs.

2.2 E-waste Recycling: the United States and Europe

In the United States, recycling initiatives are primarily led by non-profit organizations such as the National Center for Electronics Recycling (NCER) and e-Stewards instead of being mandated by federal laws. In addition, 25 states have issued legislation regarding e-waste collection and recycling targets. Most of these electronics recycling laws impose recycling fees on **consumers**, such as California's Electronic Waste Recycling Act that requires retailers to collect electronic waste recycling fees from consumers. As a result, 9.4% of e-waste was recycled in the United States in 2019.

Contrary to the consumer-based recycling effort in the U.S., the European Union takes the opposite approach by enforcing **manufacturers** to be accountable for electronic waste. The EU's legislation on e-waste recycling, Restriction of Hazardous Substances (RoHS) Directive, requires all electronics manufacturers to pay for recycling costs. In addition, the Waste Electrical and Electronic Equipment (WEEE) Directive provides consumers with free recycling services and conveniently located collection centers that can be found on government websites. With such government-led initiatives, 42.5% of e-waste generated in Europe was recycled in 2019.

2.3 E-waste Recycling: South Korea

The Korean recycling model follows the government-driven European model, which places responsibility on manufacturers. In particular, the recycling process in Korea is overseen by the Eco-Assurance System of Electrical and Electronic Equipment and Vehicles (EcoAS) under the Ministry of Environment. Following the EU's list of available e-waste collection centers in each country, the Korean government's recycling laws allow consumers to turn in electronic products for recycling at any school, train station, and electronics retail store, free of charge. In addition, the Korean government operates free pick-ups of larger electronic products like TVs and air conditioners. The government also operates more than five public electronics recycling centers supported by funding from major manufacturers like Samsung and LG. These centers combined process nearly all of the electronic products collected for recycling, with the main center in the metropolitan area collecting up to 360,000 products per year. In 2019, Korea generated 15.8kg of e-waste per capita, which is higher than the global average of 7.2kg per capita. The same year, an estimated 35.6% of the total e-waste generated was collected and recycled in Korea.

III. Samsung's E-waste Recycling Process and Circular Economy

3.1 The Aftermath of the Greenpeace Incident

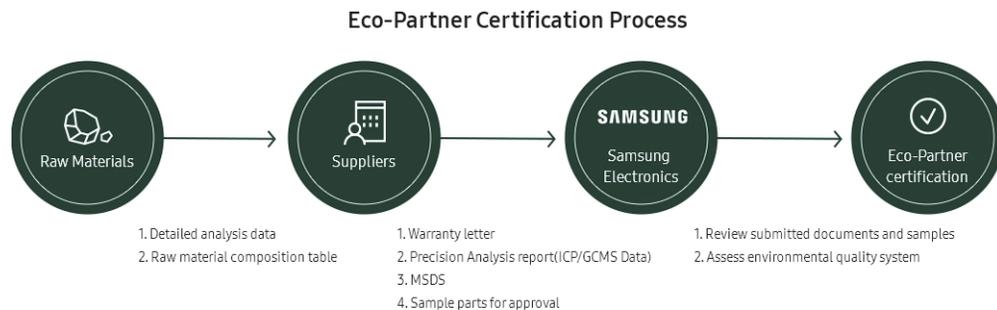
Two months after the Greenpeace incident, Samsung publicly announced that it would refurbish some of the recalled Galaxy Note7 smartphones for sale and extract raw materials and components for reuse in other products. This move represents Samsung's **circular economy** policy that focuses on maximizing the product lifespan and reusing post-industrial materials as much as possible at the manufacturing stage.

As part of the circular economy initiative, Samsung expanded the Galaxy Note7's product lifespan by turning more than 400,000 recalled devices into a refurbished, limited-edition Galaxy Note Fan Edition. The company used unopened Galaxy Note7 smartphones combined with new smaller batteries to produce the next edition instead of dismantling all of the recalled smartphones. The Galaxy Note Fan Edition was first

sold in Korea and became available in other select countries. For the rest of the recalled Galaxy Note7 smartphones, Samsung worked with third-party certified recycling companies as well as its internal recycling centers to recycle reusable components like semiconductors and camera modules for use in test sample production for future smartphone models. The company also extracted 157 tons of gold, silver, cobalt and copper for reuse and sale.

3.2 Samsung's Global SCM and Sustainability

Samsung conducts environmentally-sustainable operations across its global supply chain to comply with e-waste legislation in more than 70 countries. The company works with more than 2,200 global suppliers that provide raw materials and equipment for its various electronic products. Samsung stipulates that these suppliers must be certified every two years by its in-house environmental management certification program, called the Eco-Partner scheme. This review includes product environmental policy training and eco-friendly production and management practices. The Eco-Partner certification process is illustrated in Figure 2.



〈Figure 2〉 Samsung's Eco-Partner Certification Process

In 2019, Samsung made up 19.2% of the global mobile phone market, selling over 296 million devices in one year. However, Samsung collected only 4.03 million tons of e-waste between 2009 and 2019. To improve its e-waste recycling capacity, Samsung's sustainability initiative aims to cover all areas of the smartphone product life cycle from production to recycling. Following its circular economy strategy, 30,000 tons of

recycled plastics, including those recycled from e-waste, were used in its latest phones and chargers produced in 2019. As short product lifespans also contribute to e-waste, Samsung invests in extensive quality testing to maximize product lifespans. The company also promotes minimal use of resources in other areas, such as sustainable display kits in retail stores that can be re-used for newer models.

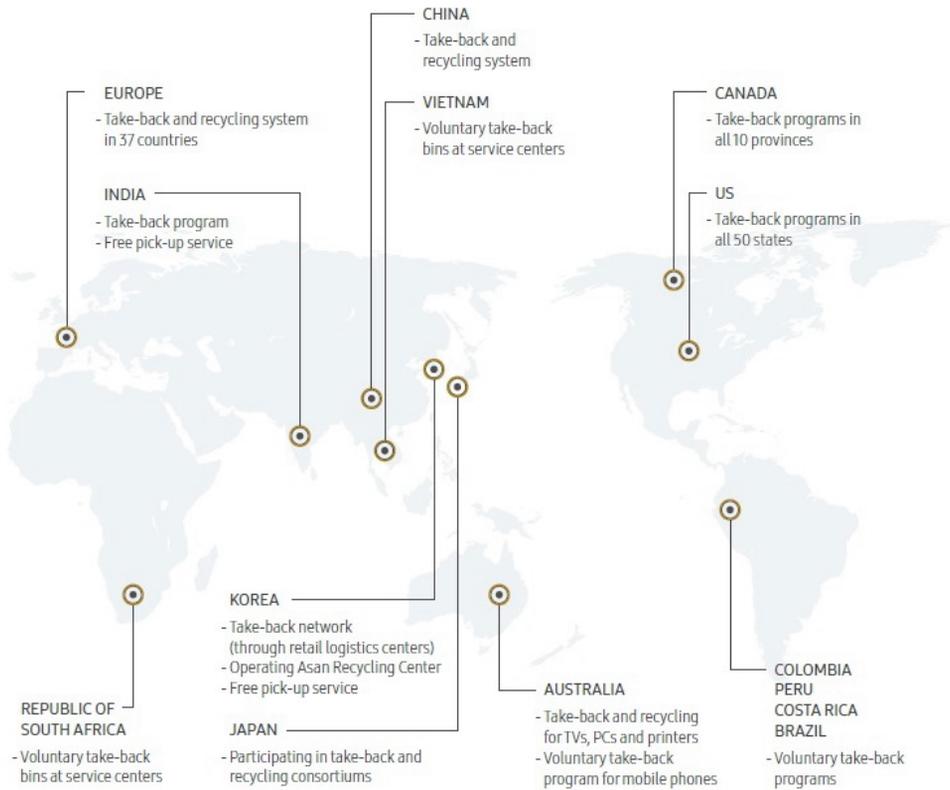
3.3 Samsung's Re+ Program

Samsung's global sustainability initiative traces back to more than a decade ago. Since 2009, Samsung has operated a free recycling service called the Re+ Program in 54 countries, collecting a total of 4.03 million tons of e-waste to date. Through the Re+ Program, consumers can drop off smartphones and other electronic products at various Samsung stores and service centers for free.

While the primary goal of the Re+ Program is to reduce e-waste, its operational process varies according to each country's e-waste regulations. Figure 3 illustrates Samsung's global recycling partnership as part of its Re+ Program. For example, Samsung India runs a Care for India program through direct contracts with government-authorized recycling companies who have committed to no incineration, landfilling, or exporting of hazardous waste to developing countries. This partnership provides a phone number that all Samsung customers can call to request free e-waste pick-ups. In the U.S., Samsung operates 500 independent collection centers across the country, accepting any brand of electronic products for free, and collaborates with recycling partners like Call2Recycle to collect mobile devices and batteries. In Africa, where e-waste recycling infrastructure is scarce, Samsung partnered with a Netherlands-based social enterprise called Closing the Loop to buy and recycle scrap phones.

Once a smartphone is collected through the Re+ Program, a preconditioning phase reviews the value of the product/components before it is pulverized to extract resources like steel, copper, aluminum, and plastic. The battery is removed separately and sent through four processing stages, including salting, perforation, drying, and fragmentation. During the process, other resources are sorted automatically and transferred to third-party smelting firms to be transformed into raw materials for use in other products.

Samsung does not provide incentives or discounts for consumers to turn in used electronic products but instead provides all recycling services for free. The company's e-waste treatment process is shown in Figure 4.



〈Figure 3〉 Samsung's Global Recycling Programs



〈Figure 4〉 Samsung's Waste Treatment Process

3.4 Samsung's Asan Recycling Center

Asan Recycling Center is another sustainability initiative Samsung started in 1998. Through its Asan Recycling Center, Samsung separates major metals and plastic are separated for reuse in other Samsung products. The center processes up to 370,000 electronic products each year and separates up to 25,000 tons of plastic and major metals like steel, copper, and aluminum, on an annual basis. Once consumers return e-waste products to Samsung retail stores and service centers, they are sent to the recycling center to be sorted by resources. The individually sorted resources items are then further processed to reclaim useful raw materials like cobalt, which is used to manufacture mobile phone batteries. A sample recycling process at Asan Recycling Center is illustrated in Figure 5.

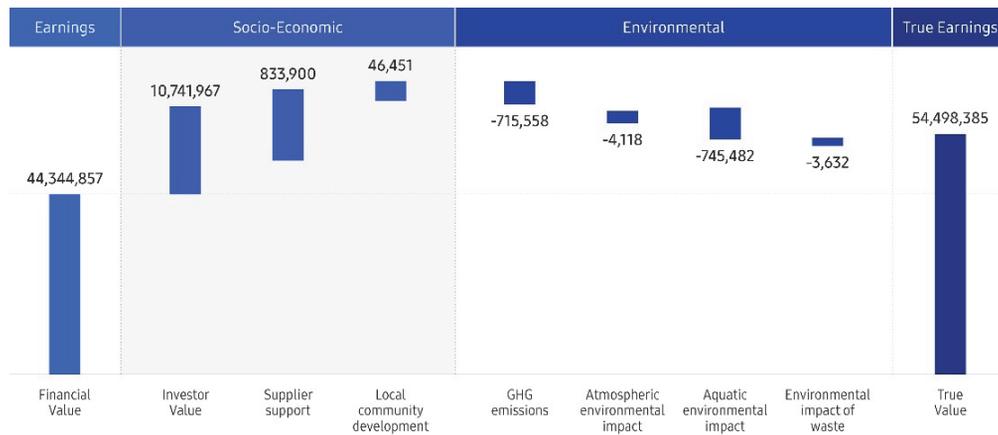


〈Figure 5〉 Samsung's Closed-Loop Recycling Process at Asan Recycling Center

3.5 Samsung's Future Sustainability Goals

Since 2016, Samsung has used the KPMG True Value methodology to evaluate the impact of its sustainable management activities. Environmental value is calculated by measuring the social cost related to GHG emissions, air pollutants, water usage, waste landfill, and recycling. As electronic products inevitably create environmental

damage, it is understandable to see negative earnings from the environmental aspect, as shown in Figure 6. Nonetheless, it is interesting to observe that the socio-economic benefit offsets the environmental harm caused by the company's products.



〈Figure 6〉 Samsung's 2019 Sustainability Management Value

To further increase the gap between the financial value and the true value earnings, Samsung must increase environmental value (i.e., decrease environmental harm) across its global supply chain. According to Samsung's 2020 Sustainability Report, Samsung aims to use sustainably-sourced paper in packaging, increase recycled plastic usage by 0.5 million tons, and take back a cumulative total of 7.5 million tons of e-waste by 2030. However, there are more than 50 million tons of global e-waste generated in 2019 alone. To enforce real change in e-waste recycling, environmental organizations like Greenpeace will need to monitor Samsung closely to ensure that the company expands on its current plans for sustainability.

IV. Global Trends in E-Waste Recycling and Sustainability

4.1 Global Trends in Sustainability Regulations

As of October 2019, only 78 out of 193 countries are covered by national e-waste policy, legislation, or regulations. This number has increased from 67 countries in

2017, showing that more countries understand the need for regulations to increase the amount of recycled e-waste. Today, many OECD countries are adopting Extended Producer Responsibility (EPR) legislation. This adds environmental costs throughout the product life cycle to the market price of the product, thereby placing financial and legal responsibility of e-waste management on manufacturers.

Most EPR legislation provides tax benefits, infrastructure, and other forms of support to help offset the cost of e-waste recycling for manufacturers. However, in the long run, EPR legislation seeks to shift recycling trends from the pure waste management model that creates financial burdens for manufacturers to the circular economy model that focuses on economic benefits for manufacturers. Within this circular economy model, manufacturers will be able to reduce production costs overall by increasing the amount of recycled raw materials for production. The Global E-waste Monitor estimates that 39 million tons of raw materials were used to produce new electronics in 2019. If all global e-waste were recycled appropriately, this would have created up to 25 million tons of raw materials in saved costs for manufacturers.

4.2 Global Trends in Green Supply Chain Management

While EPR legislation is being introduced in more countries, the lack of infrastructure to support e-waste recycling means that actual implementation will be slow. In the meantime, global electronics manufacturers must adapt to local legislation to collect end-of-life products and invest in internal recycling processes.

These policies differ by company depending on their location, product lineup and resources. For example, Apple operates an online trade-in service where old products can be exchanged for credit towards a future purchase. Consumers can answer a set of questions to see how much their device is worth. Apple collects up to 1 million end-of-life devices per year. These products are then refurbished and sold to consumers. Currently, the company refurbishes up to 7.8 million Apple devices per year.

Similar to Samsung's e-waste recycling process, Apple also reuses raw materials extracted from end-of-life products in future Apple products. Apple operates an in-

house Material Recovery Lab in Texas with the help of Daisy, a robot that disassembles 1.2 million devices for sustainable raw materials each year. Batteries recovered from this lab are sent upstream in the supply chain, combined with scrap from select manufacturing sites, and used to make new batteries. Apple also uses recycled tin and aluminum in their electronic products, which reduces their carbon footprint.

This trend in recycling is expanding from mobile phones to other electronics products. Since 2014, Dell partners with Goodwill to collect and recycle old computers for free through its Dell Reconnect program. Dell uses recycled plastics in more than 70 products and estimates savings of \$1.3 million annually compared to the cost of new raw plastics. Microsoft also recycles data servers and hardware through its recently launched Microsoft Circular Centers. Recycled server and network components are both reused internally and sold back to suppliers.

V. Future Initiatives for Sustainability

As more of the world's population gain access to electronic devices, the rapid increase in e-waste will not slow down. To offset the growing environmental damage caused by e-waste, manufacturers, consumers, governments, and environmental organizations must actively work together to increase e-waste recycling numbers by enacting and enforcing relevant legislation and infrastructure. As electronics manufacturers like Samsung are the producers of e-waste, it will be up to them to take a leading role in reducing e-waste. Moving forward, manufacturers should also expand sustainability efforts to other supplemental areas, including sustainable packaging and recyclable accessories.

5.1 Sustainable Packaging

With an increase in electronic waste comes an increase in other forms of supplemental waste, such as plastic waste from the product packaging. Sustainable packaging has been an issue for the past decade, as electronics manufacturers sought to keep their packaging looking premium while reducing glossy covers and plastic protective coverings.

Samsung's packaging has included recycled materials since 2003. The packaging of the latest Galaxy S20 smartphone is comprised only of FSC-certified paper boxes that are 100% recyclable. The plastic covers on in-box accessories like chargers and earphones have also been replaced with recyclable paper covers.

5.2 Recyclable Accessories

Samsung also sells cases that protect expensive electronic products from falls or bumps. While these are usually made from plastic and rubber, Samsung has recently collaborated with Kvadrat, a Danish textile brand that creates environmentally friendly designs, to create cases from recycled materials that are fully compostable.

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