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Assessing the side-effects of ICT development: E-waste production and management
A case study about cell phone end-of-life in Manado, Indonesia

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ABSTRACT

The rapid evolution of ICT devices, together with an increasingly wide spread of the Internet and features such as social networks, results in a tremendous increase in the number of discarded cell phones. While the number of cell phone users is increasing very fast in Indonesia, the fate of phones once they are not used anymore is largely unclear. This study aimed at obtaining an overview of E-waste management in Indonesia using a critical case study approach, assessing the cell phone life cycle. The study was carried out in Manado, a medium-sized provincial capital in Indonesia, which has received government awards for its waste management. Yet, the study found indications that E-waste is ending up in landfills, and that dedicated legislation and monitoring systems for E-waste were lacking. As a result, there was little take-back action by producers, consequently leading to a lack of user awareness regarding E-waste disposal. The problems the Indonesian government is facing are twofold: first, E-waste is smuggled into the country in the form of used devices; second, a large number of second-hand devices with unknown sources are circulating within the country uncontrolled. From the current number of subscribers, it is estimated that more than 9.500 tons of waste are produced annually in Indonesia from cell phones alone, and the amount is steadily increasing. While the current study focused on the life cycle of cell phones, the situation for other electronic devices is likely to be very similar. Sustainable management of E-waste generated from the use of cell phones as well as other ICT devices is required not only to provide economic benefits from recycling of the valuable substances they contain, but most importantly for environmental protection. The results of this study indicate that an incentive system should play a key role in any take-back system for cell phones.

1. Introduction

In recent years, concurrent with the worldwide increase of ICT usage, society has become dependent on the availability of electronic devices. ICT devices have spread to both developed and developing countries, bringing advantages in many aspects of life such as education, communication, banking, entertainment, or navigation, through the widely increasing availability of internet access. This has

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consequences for the abundance of retired devices known as electronic waste (E-waste). According to the OECD (Organization for Economic Cooperation and Development), electronic waste or E-waste is defined as any household appliance consuming electricity and reaching its end of life [1,22].

Due to the high cost of recycling in an environmentally sound way in industrialized countries, much of the E-waste is sent to poorer countries, even though this practice is banned by the Basel Convention and the European directive on Waste for Electrical and Electronic Equipment (WEEE) [2,3]. The global E-waste generated per year amounts to approximately 20–25 million tons, most of which is being produced in rich nations like the U.S. or European countries. Based on the number of discarded ICT devices collected in Europe, computers, cell phones, fixed-line telephones, televisions and radios are the major electronic products, and together they amounted to 11.7 million tons in 2007 [3]. In the United States alone, 130,000 computers and more than 300,000 cell phones are disposed each day, and an estimated 80 percent of the generated E-waste is sent to less-developed countries [4]. China is among the biggest receivers of E-waste sent by wealthier countries, along with countries such as Peru, Ghana, Nigeria, India and Pakistan [5–7]. Singapore is one of the known destination countries of E-waste in Southeast Asia, while neighboring countries such Malaysia, Vietnam, Philippines and Indonesia are suspected to receive a large share of this waste through illegal imports [4].

E-waste frequently contains valuable as well as potentially toxic materials. These materials require a special treatment when the devices reach their end of life in order to avoid environmental contamination and accumulation of hazardous substances in the human body [7]. Hazardous materials contained in cell phones include brominated flame retardants, arsenic, antimony, beryllium, cadmium, copper, lead, mercury, nickel, and zinc. In the Resource Conservation and Recovery Act (RCRA) of the U.S., these materials are categorized as persistent bio-accumulative toxins. They have a long life-span and they can accumulate in animal tissues, increasing their amount in the body over time and thus leading to contamination through the food chain. In humans, they can lead to cancer as well as reproductive, neurological and development disorders [7–9]. In addition, special treatment of E-waste should be considered to prevent wasting valuable and rare elements. Materials such as gold and palladium can be mined more effectively from E-waste compared to mining from ore [10]. Among ICT devices, cell phones and computers contain the highest amount of precious materials. Because cell phones have a small size, as well as the shortest life-span among ICT devices, they are easily being thrown in the garbage or end up in landfills undetected. Therefore, it is important to avoid obsolete cell phones from being kept at home, as it is usually just a matter of time for them to end up in landfills [10,11]. While the amount of cell phones in industrialized countries has begun to level off at around 115 per 100 inhabitants, ownership in developing countries is still increasing rapidly and currently lies at about 70 per 100 inhabitants [12]. If ownership there reaches 100%, the vast majority of cell phones will be located in developing countries, where recycling is still far from adequate [12,13]. The problem faced by developing countries stems not only from the trans-boundary movement of E-waste but also from domestically-generated waste as result of local use.

In the following section, the concept of a take-back system as the underlying approach of E-waste management in developed countries is described, followed by the research questions on potential E-waste in Indonesia resulting from the use of cell phone.

2. E-waste management approach

In most industrialized countries such as the OECD member countries, including all of the European Union, E-waste management is implemented quite effectively on the basis of Extended Producer Responsibility (EPR), to cope with the pollution and waste generated [14]. EPR is defined as "an environmental policy approach in which a producers' responsibility for a product is extended to the post-consumer stage of a products' life cycle including its final disposal" [15]. In other words, EPR refers to the responsibility of any producer for his products when they become obsolete or are discarded by the users. This includes both financial as well as physical responsibility for collection and recycling. In this context, 'producer' means any manufacturer or brand including the importer or exporter, as well as persons distributing under the brand's name [8,15]. Take-back programs, where the producers are collecting their devices for their final treatment, are often said to be the purest kind of EPR. Most of the OECD member countries have implemented take-back policies either as mandatory or as voluntary programs. In mandatory take-back programs, governments usually set their own recycling target for a producer to achieve. For example, a government sets a goal of a 75 percent recycling rate for a producer, based on the quantity of electronic devices from this producer entering the market [16]. Voluntary take-back programs are usually initiated by the producers without regulation by the government. The producers agree to take back their obsolete electronic products independently and to manage them in an environmentally sound way. However, experiences from Europe indicate that the lack of a mandatory take-back system leads to a poor performance by the producers, underlining the important role of regulation in Europe. A Producer Responsibility Organization (PRO) is usually formed to manage the E-waste recycling in order to meet the EPR recycling target [14,15].

In Germany, the volume of the devices which enter the German market (in kg) is reported to the EAR (Elektro-Altgeraete Register), a PRO, by the producers every month. The EAR then calculates the total market volume share and notifies each of the producers to retrieve their E-waste from collection sites managed by the municipalities. Nokia, for example, collaborates with recyclers for the actual recycling process. Reports of total recycled E-waste are sent to Nokia and the EAR [17]. In Korea, the EPR regulation for electronic devices has been implemented in 2003, covering television sets, personal computers, refrigerators, washing