# Reverse Logistics of Information and Communication Technology Equipment: A Comparative Assessment of Laws and Programs

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# REVERSE LOGISTICS OF INFORMATION AND COMMUNICATION TECHNOLOGY EQUIPMENT: A COMPARATIVE ASSESSMENT OF LAWS AND PROGRAMS

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**Abstract:** Considering the environmental issues related to e-waste caused by excessive consumption and early disposal of ICT equipment, this paper aims to analyze policies, programs, regulations and legislation in Brazil and in selected geographies with a higher incidence of e-waste (Europe, USA, China and Japan). A comparison matrix is presented and, within this context, it is clear that the Brazilian law (12.305) relative to international laws is both limited and subjective in regards to producer responsibilities because it is limited to the requirement to structure and implement reverse logistics and defines them as issuer pays. As a contrasting example, the European EPR (Extended Producer Responsibility) system is more efficient in controlling and managing e-waste, since it extends to the end-life of products. As such, it serves as a basis for regulations in many other countries. This paper is theoretical and based on the results of literature reviews.

**Keywords**: E-waste, ICT Legislation, Reverse Logistics.

## 1 Introduction

Over the last ten years, Brazil has experienced significant growth, mainly driven by household consumption. According to the IBGE [1], all major regions showed an increase in real average monthly income: North (7.7%), Northeast (10.7%), Southeast (7.9%), South (4.0%) and Midwest (10.6%). Considering also that issues related to globalization have increased competition, the shortening of product life cycles and emergence of new products make the new middle class eager for new products, especially related to Information and Communication Technologies (ICT), increasing consumption and thereby creating higher waste production.

Also according to the IBGE, between 2009 and 2011, the durable goods that showed higher growth were personal computers with internet access (39.8%), followed by personal computers (29.7%) and mobile telephones (26.6%). More recent data from the IDC [2] [3] confirm growth: in 2012 smartphones and tablets grew by 78% and 171% respectively compared to 2011.

In recent years, economic forces, such as the increasing deregulation of the business world, the proliferation of free trade agreements, increased foreign competition, increased industrial globalization and improved logistics performance were essential to position logistics at a high level. Thus, companies started to think about products and services flowing unhindered from the source of raw materials to end-consumers as well as including the reverse movement of the supply channel [4]. The main drivers of the growth in reverse logistics are general economic growth, increasing purchasing power of lower income consumers and nascent concerns of environmental sustainability.

Among the various factors that drive reverse logistics activity, the legal aspect stands out [5]. The reasons for this importance are related to laws and incentive programs created by global government authorities, whose purpose is to promote and encourage the implementation of reverse logistics processes in organizations, so as to ensure a sustainable return to the production cycle. This way, it is possible to reverse distribution channels or proper disposal, minimizing any environmental impacts and increase the efficiency and sustainability in organizations.

This paper aims to analyze policies, programs, regulations and legislation in Brazil and in countries with a higher incidence of electronic waste production: Europe, USA, China and Japan, for a comparative analysis of initiatives and practices in the countries studied.

This research is theoretical and exploratory, conducted from a literature review of policies, programs, regulations and applicable laws, as well as related work in reverse logistics, particularly related to the disposal of ICT products nationwide and internationally.

# 2 Literature Review

## Information and Communication Technologies - ICT

The electronics equipment industry is one of the fastest growing in the industrialized world. Waste discarded from the electronics equipment industry is known as Waste Electrical and Electronic Equipment - (WEEE). [6]

The accumulated amount of electronic waste worldwide is approximately 40 million tons, 80% of which ends up in developing or emerging countries like Brazil, which in turn discards about 0.5 kg per capita / year from PCs, more than that discarded by China, which has a per capita volume of only 0.23 kg / year. [7].

Recent data from 2013 show that Brazil produces about one million tons of electronic waste per year [8]. China experienced a significant increase in sales of electrical equipment (computers, air conditioners, refrigerators, washing machines and mobile phones) between 1995 and 2011, which resulted in the disposal of 3.6 million tons of electronic waste in 2011 [9]. The U.S. produced 3.4 million tons of electronic waste in 2011 [10]. The production of electronic waste in Japan is around 4 million tons per year and the annual average in Europe is 9 million tons per year [7] [11].

The volume of ICT equipment sold in the market will result in the generation of large volumes of e-waste as well as human health risks that are inherent in them. Issues related to the production and disposal of electronic waste have been the subject of study by several authors, as well as agencies and organizations like UNEP, StEP [7], EPA [10], who periodically disclose country reports in these respects.

## Reverse Logistics

Direct Logistics is defined as the process of planning, efficiently implementing and controlling at an effective cost, the flow of raw materials, work in process, finished product and related information from point of origin to the end-consumer in order to meet customer needs. [12].The difference between direct logistics as defined by the CSCMP and Reverse Logistics is only the direction in which the process occurs and its objectives. Therefore, Reverse Logistics is defined, however, as the flow going from the consumption point to the point of origin, this time in order to recover the product value or to properly dispose of [5]. This way, Reverse Logistics process adds value of various types: legal, economic, ecological among others.

Among the reasons for performing the reverse logistics process those that stand out are: Competitiveness (65.2%), channel cleaning (33.4%) and legal issues (28.9%) [5].The increasing relevance of legal aspects has led to the emergence of incentive programs and laws that regulate such activity in Brazil and worldwide.

In Reverse Logistics, economic aspects and strategic advantages can be taken into account, and it is not an optional activity for companies that want to be successful, on the contrary, it is mandatory. Three tools can be observed in the reverse logistics process: Innovation, Coordination and Integration. There is a high degree of innovation in terms of creating systems and procedures to find solutions to deal with returns, as the diversity of products and materials requires a high degree of coordination in the management of reverse logistics, thus requiring the participation of several integrated companies in the treatment and final disposal of products and hazardous materials [13] [14]. Business dynamism created in the pursuit of maximum efficiency and waste elimination to cover costs, associate with economic globalization during the last decades, tends to shorten product life cycles, increasing the return rate of unsold items.

## ICT Reverse Logistics

The concern with reverse logistics of electronics waste is driven by a combination of unique features found in this waste stream, a fact that has led governments around the world to develop a system for collecting and processing electronic waste known as the “take-back system” or the “return system” [15]. These factors are:

- The shelf life of the equipment
- Toxic materials found in electronic waste that harm both the environment and human health

- Valuable materials found in e-waste that help reduce mining of virgin materials
- The high cost of the recycling process that often exceeds the value of the recovered material.

The main difficulties in ICT reverse logistics are in the collection and costs of collection involved in this process, which can often derail the process. Industry associations and electronics recycling companies do not have actual data on the quantities of returned materials making it difficult to analyze the percentage of reuse of these materials, their efficiency and their cost. However, there is a business concern with new reverse flow legislation. ICT waste reverse logistics, like that of other products, meets barriers mainly related to the high degree of uncertainty in aspects such as quality, time and especially the place of origin of the goods to be collected, where a fragmented market makes their consolidation difficult [16]. In regulations under the Extended Producer Responsibility (EPR) regime, reverse logistics plays an important role because producers can take back their products for appropriate treatment and disposal [6].

## 3 Comparison Matrix

Table I presents a comparative analysis of Brazilian law 12.305/2010 National Policy on Solid Waste - (PNRS) regulated by Decree No. 7404, December 2010 [17]. In the face of the main laws and international programs, a matrix was created for comparison of countries with the highest incidence of electronic waste production (Europe, USA, China and Japan) to analyze the results generated in their respective countries.

***TABLE I - Key Laws, Regulations and Programs worldwide in the treatment of waste derived from ICT.***

| COUNTRY | CONSUMPTION VOLUME/ELECTRONIC WASTE | LAWS/REGULATIONS/PROGRAMS/ POLICIES/ | RESULTS |
|---|---|---|---|
| Brazil | Generates close to 1 million tons/year. Waste 0.5 kg/per capita/year 8. [7] | 12.305/2010 – Established PNRS (National Policy for Solid Waste) regulated by decree 7.404/2010. State resolution SMA 38 of 08/2011 defines reverse logistics for electronics and others. [17] | One of the primary destinations of electronic waste produced in developed countries. [7] |
| Europe | Generates approx. 8.3 to 9.1 million tons/year. [7] | WEEE Directive 002/96/EC + RoHS directive - (Restriction of Hazardous Substances) 2002/95 02/2003, into effect 07/2006. EPR Regime 2021. [7] | The EPR regime was inspired by various other developing and developed countries.[21] |
| USA | Generated 3.4 million tons of electronic waste in 2011. [10] | ESAP, a sustainability self-assessment program.[23] Federal law H.R. 2284- not approved.[22] | No defined responsibility and has different systems. Recycles ~25% of generated electronic waste.[10] |
| China | Disposed of 3.6 million tons of electronic waste in 2011. [9] | Law nº 36 of 2000 – prohibition of waste imports \| Law nº 115 of 2006 – 3R principle (reutilization, recycling and recuperation) \| Ordinance 39 of 2007 – ICT and hazardous material pollution control\| Law 40 of 2008 – Adm. measures – prev. EEE waste pollution \| Council of State nº 551 – of 2011. Recycling mgmt. and EEE waste disposal and extended producer responsibility– EPR. [9] | Receives ~70% of electronic waste from developed countries such as the USA. [24].<br><br>35% of EEE imports in 2011. [8] |
| Japan | Generates 4 million tons/year. [11] | 2001 DHARL 8, 2004 3R System per G8 summit. [11] | One of the most efficient systems for managing and controlling EEE waste. [9] High incidence of REEE recycling. [25] |

Source: the authors

## 4 Analysis and Discussion

It is necessary to perform an analysis of the laws, regulations and programs in the countries studied to better discuss the results.

**Brazil**: Law 12305 [17] in which "polluter pays" is one of the tenets, defines shared responsibility for the product life cycle, individually and linked, covering all participants in the supply chain. Article 33 speaks of the requirement of manufacturers, importers, distributors and dealers to structure and implement reverse logistics systems, upon return of the product after use by consumers. In this sense, for Leite [17], although the decree does not set goals of any kind, and allows companies to present studies and projects for reverse logistics, the law is pragmatic in placing confidence in supply chain participants for the implementation of reverse logistics. Such a measure may connote subjectivity, as the lack of clear goals will hamper the identification of the obtained results. On the other hand, Ferreira and Vicente [19] believe that the law requires review and a redirection of practices by companies as well as societal awareness, which in turn requires technical knowledge for a proper evaluation of the solid waste destinations. The authors also believe that the law presents complex solutions by engaging political, social, cultural and economic dimensions. Even in a negative aspect, Leite [17] considers the law a bit cautious regarding consumer penalties for breach of product disposal.

Being fairly recent, the Brazilian law establishing the PNRS is still controversial in some aspects, with divergence in the opinions of some researchers. The fact is that possibly due to lack of sufficient time, the PNRS has not generated positive results or sufficient controls to change, for example, the scenario in which Brazil presents itself as one of the main destinations of electronic waste produced in developed countries [7].

Positively speaking, the law provides incentives of various kinds such as financial, accounting and tax, but it will take some time to achieve concrete results for a more effective analysis. In general, the PNRS of 2010 brings hope for an evolution in reverse logistics activities in Brazil, besides the relevant environmental aspects concerning the return process in a sustainable manner, since before PNRS, UNEP studies in Brazil in 2008 pointed to a country that did not have a comprehensive federal waste management law, which could be seen as an obstacle to the development of specific electronic waste regulation in the country. Given this, the study published by UNEP in 2009, concluded that in Brazil electronic waste did not seem to be a priority for the federal associations representing the electronics industry. Currently EEE are covered in Article 33, paragraph IV of PNRS.

**European Union** - EU: The EU follows the WEEE directive 2002/96/EC [20], the primary objective being the prevention of waste from electric and electronic equipment and also the reuse, recycling and other forms of waste recovery in order to reduce disposal and contribute to the protection of human health, while also improving the environmental performance of economic operators involved in the life cycle of electrical and electronic equipment and its management. The ROHS, beyond the restriction of hazardous substances, establishes the collection, recycling and recovery of electrical goods which is part of a legislative initiative to solve the problem of large amounts of toxic e-waste. The EU designs its regulations under the EPR system, which means that EEE producers have responsibilities beyond the manufacture of their products, including environmentally sound management at the end of their useful life. The WEEE Directive has clear goals to achieve a minimum rate of 45% return by 2016 and 65% by 2019 of the volume of EEE sold in the market in the three preceding years in the member state or alternatively 85% of the EEE waste generated in the territory of the member state. Member states must establish dissuasive and effective penalties for violation of the rules [25].

As a result, in 2010 the majority of European countries achieved a reuse and recycling rate of over 80%, five member states of the EU were between 70% and 80%. In the same year, the return rate was between 30-45% in nine countries and over 45% in four countries [25]. For efficiency the UN recommends that developing countries adopt restrictions found in the EPR system, upon which Europe designed its regulations [21].

**USA**: In 2011, the U.S. Congress introduced federal law HR 2284 pertaining to the responsible recycling of electronics, but the bill was not approved. The law would have made it illegal to send toxic e-waste to developing countries. Twenty-five American States passed legislation requiring recycling of electronic waste in the U.S., which represents 65%, of the domestic population being covered by a state law for recycling this type of waste [22]. The ESAP is an environmental self-assessment that has the objective of assessing the progress of companies to meet the letter of intent for sustainable development, developed by the Global Environmental Management Initiative - GEMI, together with Deloitte and Touche in the 90s [23]. In the U.S., the lack of a clear definition of responsibilities in the process of returning ICT-derived waste may explain the low rate of recycling in the country, less than 25%, of the total generated [22]. It is also noted that the self-assessment program by itself, does not produce effective results.

**China**: Over the past decade, China has proven to be concerned about environmental issues by creating important laws and regulations that manage and control the inappropriate disposal of EEE waste [9]. Although this set of laws covers both the EPR system adopted by the member states of the European Union, and the Japanese 3R efficiency principle, (reuse, recycle and recover) it does not connote effectiveness in controlling electronic waste imports, since even with the specific law China is the destination of 70% of e-waste from developed countries such as the USA.[24]. On the other hand, when compared with Brazil, and even with four times the production of electronic waste, China has less than half (0.23 kg) the waste per capita / year than Brazil (0, 5 kg), which shows greater efficiency in some aspects of its laws. Superficially analyzing the laws and their objectives in Table I, apparently law No. 115 of 2006, which has as a principle the 3R system and EC No. 551 of 2011, which manages the EEE recycling and disposal process and establishes extended producer responsibility (EPR), are responsible for the results, by encouraging reuse, recycling and recovery before disposal.

**Japan:** One of the most significant laws in Japan is DHARL – the Designated Household Appliance Recycling Law, created in 2001 that regulates the treatment of EEE waste and defines the obligations of the parties involved in collection, transportation and recycling. The country has good EEE waste recycling rates, for example, TVs and air conditioners with a minimum 50% and 70% respectively in 2010, totaling about 26 million recycled units [8]. Japan stands out among developed countries, with the 3R system being the best functioning systems of electronic waste management in terms of scope levels and compliance, despite European countries having developed such practices since the beginning of the 21st century. [9]

# 5 Conclusions

Brazilian law is relatively new for a conclusive analysis, but compared to the Japanese 3R system and to the European EPR it is possible to perform a preliminary analysis that the polluter-pays and shared responsibility model adopted in Brazil will struggle to deliver effective results, because of its subjectivity and lack of clear goals.

One can see that the volume of produced or disposed ICT waste does not determine the creation of laws or programs to better manage the return of such waste, depending on the awareness of each country in prioritizing this activity for economic, social or environmental reasons. The results show that it is not necessarily the quantity, but rather the efficiency of laws, programs or schemes regarding this question, that determine better rates of return, recycling and reuse of EEE waste.

Continuing the present study, we propose a comparative analysis of the application of the same laws and programs presented in this article, between developed and developing countries

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