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Issue of Managing Waste Computer Equipment in Conakry City (Republic of Guinea)

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Abstract

The digitization of administrative activities is a technique that not only optimizes resources, but also professionalizes the working methods of public and private services. This dematerialization process involves technologies based on computer equipment, which, after use, becomes cumbersome waste. The aim targeted consisted of taking stock of the management of waste computer equipment imported into the Republic of Guinea, with a view of proposing a mode of environmentally sustainable management methods in a short time. To achieve this, the data was collected through investigation methods (observations, interviews, and questionnaires). This study reveals an excess of imports of electrical and electronic equipment in general, and computer equipment in particular, over the last ten years (2009-2019), With an import rate ranging from 4.03 to 54.45%. This study demonstrated the different ways in which computer and electronic equipment of all kinds are managed, with her failings. This study demonstrated the different ways in which computer and electronic equipment of all kinds are managed, as well as their failings. For this purpose, the different ways in which electronic waste is managed by different users were identified as storage, recycling, or rejection into nature or at waste storage points, often mixed with household waste. Companies specializing in the management of this type of waste and the presence of a certain number of regulatory texts almost do not exist. One company is only for the entire country but unknown to the majority of users.

Keywords

Waste Computers Equipment, Soil Pollution, Water Pollution,

Chemical Substances Management Methods

1. Introduction

Since the first three industrial revolutions (steam, electricity, and electronics), the evolution of the world of work today is marked by another fourth revolution called the "digital revolution", to which companies must adapt in order to offer themselves new opportunities to boost their performance and develop their services. This mutation seems complex with issues of demand for significant electronic equipment [1]-[4]. In 2019, the number of digital service users was four billion worldwide, and 34 billion digital devices were owned. This figure would be almost 200 billion by 2030 [5]. However, the African continent has become a place for the dumping of electronic waste of all kinds, according to UNCTAD (The United Nations Conference on Trade and Development), which is one of the factors of environmental deterioration in Africa [6]. A UN report also states that 85% of the waste of new or used electrical and electronic equipment produced in Africa is mainly due to domestic consumption. [7]. According to the Post and Telecommunications Regulatory Authority (ARPT) in the Republic of Guinea, the mobile penetration rate in 2020 was 89.6%, with 12 million active mobile subscribers and that of smartphones 15% or 2 million 'users [8]. However, these technologies rely on computer equipment that has an economic life cycle and is composed of toxic substances and precious metals that cannot be biodegraded, so they persist in the environment for long periods of time [3]. Waste from electronic devices consists of compounds of articles unused of which users tend to dispose of by throwing them into nature as waste, such as large and small devices (telephones, computers, batteries, worn cables, fluorescent bulbs, electronic devices). Most of these faulty electronic devices, such as computers, phones, batteries, old cables, fluorescent light bulbs appliances, are thrown away by users after being used or not sold for several years. They release dangerous toxic compounds that are generally included in their compositions as certain heavy metals: lead (a harmful neurotoxicant), mercury, cadmium, precious metals and critical minerals [2] [9] [10]. Hence, there is a need not to confuse them with other ordinary waste. Rigorous management of this type of waste is necessary for the protection of the environment and the exploitation of certain components that it contains. This is why, in February 2024, African leaders adopted a protocol for regulating digital trade on the continent [11]. These compounds, under the effect of rain and by infiltration or bioaccumulation, are found in the food chain because the annual pluviometry in the Conakry area (Capital of the Republic of Guinea) is very abundant and around 4000 mm in August/ year [12]. In Guinea, there is only one under-equipped sector for the management of electronic waste, because priority is given to household waste. Numerous studies on the problem of managing electrical and electronic waste in general have been reported [13]-[15]. In this present work, we will discuss

the state of locations of computer equipment waste management in the city of Conakry in order to provide basic information that could be used as tools for managers in the management of this specific waste.

2. Materials and Methods

2.1. Presentation of the Study Area

This study was carried out in the city of Conakry, capital of the Republic of Guinea (**Figure 1**).

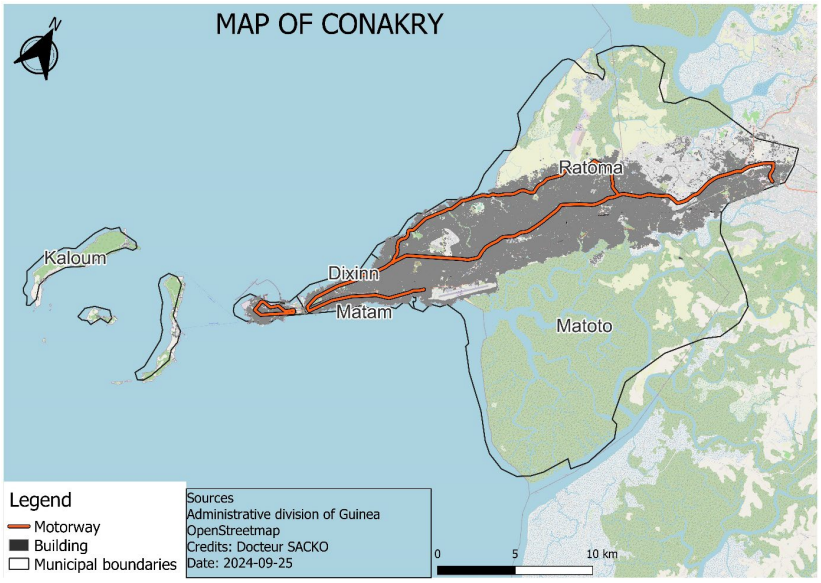


Figure 1. Showing a map of the city of Conakry with its communes.

The city of Conakry, capital of the Republic of Guinea, is located in the southwest of Guinea on the Atlantic Ocean, with a surface area of 450 km^2. The Conakry region has a dual status: political and economic capital of Guinea [16]. At present, its boundaries extend from the island of Tombo to the communes of Coyah and Dubréka. Conakry is located in a flat area at a 130 m altitude. It extends towards the south and north of the ridge, which gives uniform slopes averaging 4% - 5%, either directly to the sea or over marshy areas. This capital, which is the administrative center, is the study area of our research.

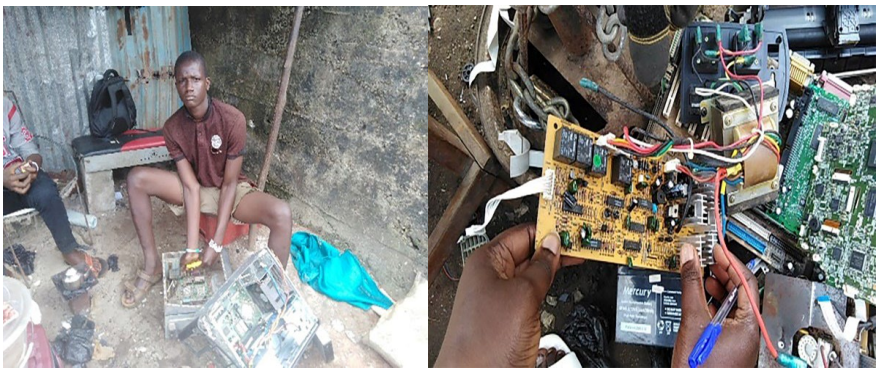
2.2. Study Framework

The Center for Environmental Studies and Research (CEER) of Gamal Abdel Nasser University of Conakry was used as the setting for this work.

2.3. Surveys and Observation in the Field

Documentary research and field observation enabled us to identify the people and organizations involved in the domain of computer equipment, but also in the waste management, which are importers, professional users, repairers/recyclers,

waste managers… The survey and field observation took place on the premises and departments of Institutions of Higher Education (IES), mobile phone operators, internet service providers, importers, and small and medium-sized enterprises (SMEs) in Conakry (Republic of Guinea). It consisted of a guided tour of the sites, during which we observed computer parks, repair workshops, sites for recovering materials from out-of-use equipment and household waste collection points. Figure 2 and Figure 3 show some of the points visited.



(a) (b)

Figure 2. Showing component disassembly activities in the computer equipment.

(c) (d)

Figure 3. Showing the deposit of computer waste in the street (c) and the store depot for out-of-service equipment (d).

In addition, a working visit was organized close to recyclers to define the become of used computer equipment (Figure 2).

Observation mechanisms

Direct observation enabled us to know the types of questionnaires to ask, namely, the questionnaires of closed types simply allowed significant statistical data. Closed-ended dichotomous questions were administered to respondents to gather their views and opinions on the fashion of management waste issues. For this purpose, certain state administration officials, cell phone companies and Internet service providers were questioned about the problem of managing waste computer equipment at the end of its life. The interviewers filled out the questionnaires.

2.4. Equipment Used

Centimeter of Measuring.

GPS device.

Notepad.

Image recorder (Smartphone, camera).

Audio recorder (Smartphone, dictaphone).

- Audiovisual recorder (Smartphone, camcorder).

Population/sample of study

The stratified sampling method was used for this study. The population of study is the whole of the people who have their daily activities related to the use of data-processing equipment and the management of waste. In view of the diversification of the stakeholders, due to the use they make of IT equipment, the study population was divided into four (4) categories, namely: those who use them to ensure their daily activities, known as users namely: (public/private higher education institutions); those who deal with their reuse (recyclers); those who sell them (importers) and those who receive them as waste (small and medium-sized waste collection companies (SMEs). After the identification of different actors, a mixed sampling was chosen and stratified because the categories of actors are different from each other due to their use of computer equipment. To have homogeneity within the population, we considered each category as a stratum. Stratified simple random sampling was used to select the sample within each stratum. Thus, in the lists obtained during the literature search of each actor, it was defined the proportion of (20%) as a sample in each stratum. So, a second level of stratification has been carried out in this category to choose the physical population represented by the people. Simple random sampling was carried out inside each stratum to draw the best conclusion regarding the population as a whole. A headcount of 220 people was affected by this study.

Statistical analysis of the data collected

Statistical analysis of the data collected has been statically according to the nature of the tools. For the questionnaires, the qualitative and quantitative analysis software Sphinx2 was used in three (3) stages: firstly, to draw up the various questionnaires; secondly, to collect the answers given and, finally, to process and analyze the results obtained in the form of tables or graphs depending on the relevance of the phenomenon to come out. The data recorded during the individual interviews was transcribed individually in Word. Each interview was listened to several times in order to accurately transcribe the information gathered. An analysis grid was designed with the significant themes and sub-themes for opinion restitution. The analysis was carried out in two stages: vertical and horizontal. Allowed cross-referencing the information on each theme and sub-theme from the various interviewees in order to produce an overall analysis of the subject, leading to an interpretation in line with the objectives of the study.

3. Results

3.1. Land, Sea and Air Import Data on Customs on the Equipment of Computers from 2009-2019

According to our investigations, the National Customs Department of the Republic of Guinea registers all computer equipment imported by sea, land and air grace its computer department. According to the Guinean Customs Code, this equipment is declared in two forms: personal effects of travelers in the provenance of Guinea, either 1.970.702 items of computer equipment declared personal effects with (31.30%), and effects goods declared by approved importers, either 438.318 imported (68.70%) between 2009 and 2019. Table 1 shows the quantities of computer equipment imported in the form of personal effects and goods from 2009 to 2019.

Table 1. Quantities of computer equipment imported in the form of personal effects and goods per year. (From 2009 to 2019)

Year	Declared equipment "Goods"	Declared equipment "Effects staff"	Total quantity of equipment imported
2009	5326	10286	15612
2010	2949	12025	14974
2011	5530	13081	18611
2012	11822	29034	40856
2013	6244	22813	29057
2014	7008	21730	28738
2015	24328	25386	49714
2016	46876	8484	55360
2017	70682	23708	94390
2018	75479	22872	98351
2019	182074	10283	192357
Total	**438 318**	**199 702**	**638 020**
Percent	**68.70 %**	**31.30 %**	**100 %**

The analysis of this table remarks that equipment declared as personal effects is superiors' equipment declared as goods from 2009 to 2014. The trends are linear, but they are growing for equipment declared as goods and decreased from 2015 to 2019. However, the equipment declared as goods is superior to the 2015-2019 equipment declared as personal. Figure 4 shows the growing and decreasing trend curves.

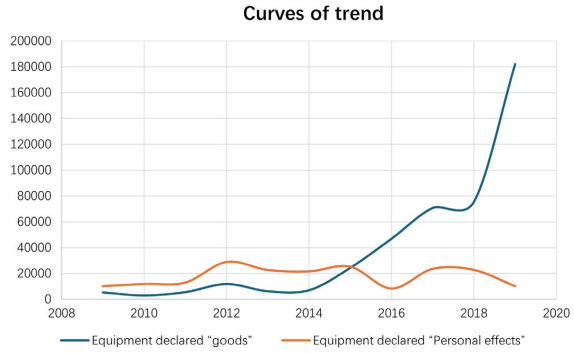


Figure 4. Curves of trend growing and decreasing.

3.2. The Annual Growth Rate of IT Equipment

Based on the change in the quantities of IT equipment imported, the rate of increase in IT equipment (TPA) was calculated, and the results of the calculations are shown in Figure 5. The figure shows a sawtooth increase in growth. Between 2011 and 2012, the rate increased the most, with TPA = 54.45%, while the following year (2012-2013), the rate fell by a value of −40.61%. It was from 2014-2015 onwards that an upward trend was observed with 42.19% in (2014-2015), 10.20% in (2015-2016), 41.35% in (2016-2017), 4.03% in (2017-2018) and 48.87% in (2018-2019). These results show that it was from 2015 onwards that the quantity of IT equipment grew rapidly in the Republic of Guinea, due to the interest that the population is showing in information and communication technologies.

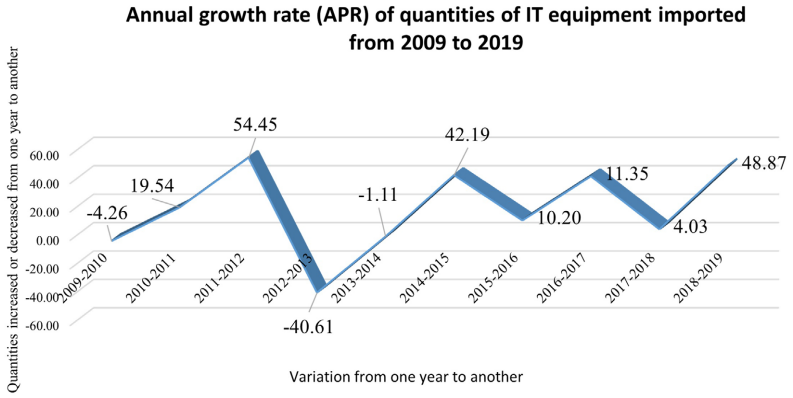


Figure 5. annual growth rate of imported IT equipment.

In this study, the annual increase in the imports of IT equipment into the Republic of Guinea enabled us to carry out a series of surveys on the management of the waste produced by these items. These surveys provided us with observations on IT equipment management methods: the state of operation and level of repair of equipment in workshops, the time taken to recover repaired IT equipment and components recovered/sold by collectors, the management methods used by recyclers for IEDs, and methods of use for IEDs found in collections. These results are shown in Figures 6-8 and Tables 2-4.

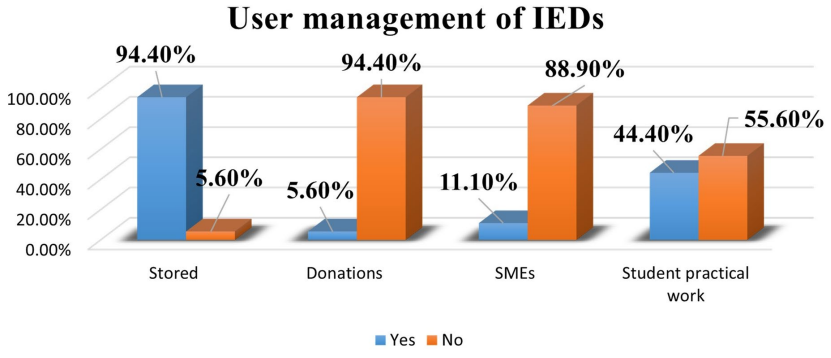


Figure 6. Fate of IT equipment outside services in institutions.

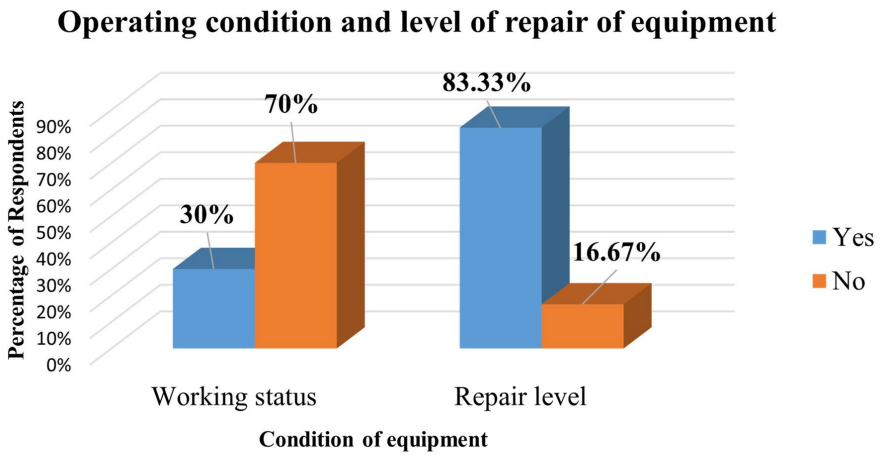


Figure 7. Operating status and level of equipment repair in workshops.

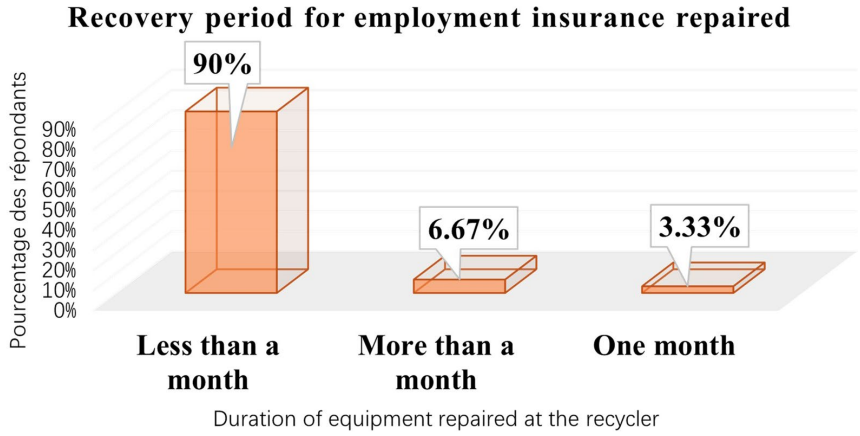


Figure 8. Recovery time for repaired IT equipment.

Table 2. Components recovered/sold by collectors.

Recycled components	Yes		No	
	Workforce	Percentage (%)	Workforce	Percentage (%)
Aluminium	25	41.67	35	58.33
SMD motherboard	24	40	36	60
Copper	25	41.67	35	58.33
Iron	28	46.67	32	53.33

Table 3. Management methods used by recyclers for IEDs.

How IEDs are managed	Yes		No	
	Work force	Percentage (%)	Work force	Percentage (%)
Recycling components	56	93.33	4	6.67
Repair and sell	13	21.67	47	78.33
Repair and sell	28	46.67	32	53.33
Store	10	16.67	50	83.33
Selling to other recyclers	30	50	30	50

Table 4. Methods of use of IEDs found in collections.

Use of IEDs	Yes		No	
	Workforce	Percentage (%)	Workforce	Percentage (%)
Dispose of household waste	17	28.33	44	73.33
Reuse	21	35	39	65
Sale of complete equipment	21	35	39	65
Sale of components	27	45	33	55

3.3. Ways in Which IT Equipment Waste Is Managed by Professionals

The management of IT waste is based on knowledge of the different ways in which it is treated by the various categories of players involved.

3.3.1. Storage Management Method Used by Professionals

The results of our surveys show that the storage of IT waste is considered by Guinean business users to be the preferred method of management (94.40% of respondents). This favors an increase in the quantity of IT equipment waste in institutions (Figure 6). With regard to the length of time IT equipment is kept in institutions, 83% of users said that their IT equipment has been stored in their institution for several years, while 17% keep it for at least a month. Only 5.56% of the users questioned acknowledged the presence of small and medium-sized enterprises (SMEs) specializing in the collection of WEEE and the contract with these specialist companies. However, the institutions prefer partnerships with household waste collection (SMEs), which sometimes help them to dispose of their WEEE in the form of a service or direct purchase of the WEEE as a means of collection (22.20 and 27.80%) respectively. Recovery conditions are described in the employment contract.

3.3.2. Management Methods Used by Recyclers for IEDs

Figure 7 shows the state of operation and level of equipment repair in the workshops. It reveals that repair workshops are filled with almost (70%) non-functional equipment compared with (30%) functional equipment. However, their capacity to repair equipment can reach (83.33%) and not be repaired (16.67%) (Figure 7). The survey showed that 93.33% of recyclers use either the barter system with certain customers or the recycling of certain components in good condition for the repair of other products, or recovering certain elements in a dismantling process from obtaining components with a market value and selling to other recyclers or collectors of electronics parts (Figure 2). The parts sought by recyclers are shown in the table (Table 2). Other methods of managing these parts would be to throw the rest in the rubbish bins, while others carry out DIY repairs and then resell them to needy customers. Only a small number of repairers, nearly 16%, use the storage method in their workshops. The management methods used by recyclers

for IEDs are shown in Table 3. According to the survey, (21.67%) of respondents said that staff did not have the necessary skills to repair equipment, while (78.33%) blamed the high cost of repairs in the workshops, preferring to buy new equipment. Others claim that customers do not come to the repair shops to collect their IT equipment after the recovery period. Figure 8 shows the time taken to recover repaired IT equipment from repairers. Some of the recyclers interviewed said that they lacked appropriate repair equipment. All these arguments are used to justify the reasons for the poor management of IT waste by the various social strata. It should be pointed out that the IEDs sold in full or in part by the collectors are made by nationals and foreigners, *i.e.*, 61.67% and 38.33% respectively. And the majority, 73.33% of customers, work in the informal sector.

3.3.3. How Importers Manage IEDs

IT equipment importers do not recover equipment after use, either from suppliers or consumers. They all stated that the idea of recovery was never mentioned when the equipment was bought or sold. (26.79%) of importers envisage recycling or recovery solutions for certain components with maintenance technicians recruited for this purpose. However, 5.36% feel that this task should be carried out by other sectors, such as recyclers. Meanwhile, 67.86% are not interested in managing end-of-life equipment. In terms of environmental certification, none of the importers surveyed had approved the ISO 14001 standard, and all of them said they did not have environmental certification. 25% thought that this was a role for suppliers or manufacturers of IT equipment, while 25% and 50% said they had no information on the existence of environmental standards (Table 4). To achieve this, the players in charge of the environment and the WEEE management partners included the payment of an eco-revenue tax on EEE that the respondents did not recognize or were unable to pay.

Table 4. Reasons for the absence of environmental certification.

No certification	Workforce	Percentage (%)
Suppliers play this role	15	25
The company does not meet international standards	15	25
No information on the standard	30	50

3.3.4. Waste Management Methods for IT Equipment in Institutions

(55%) of institutions opt to store out-of-use equipment in warehouses, (25%) opt to repair and refurbish it for use by staff, and (20%) use the components for students' practical work. All these methods are carried out informally, as indicated by those responsible for managing IT equipment or logistics at the institutions. The institutions do not consider these waste management activities to be a priority for environmental protection. However, only one considers the environmental concerns associated with WEEE throughout its life cycle. It has a contract with a (SME, (SMEs) (CEGEDI) specializing in the treatment and collection of WEEE.

However, this (SME, (SMEs) is unable to properly transfer and process the IT waste, as stipulated in the contract. This means that the waste is piled up or lying on the open ground under the heavy rainfall of the Conakry region **Figure 3(c)**.

3.3.5. Training, Information and Awareness-Raising Policies (Workshops, Seminars, Involvement of Other Sectors, Organized Groups, etc.)

80% of the institutions surveyed do not provide any training or raise staff awareness of the environmental and health hazards associated with equipment waste, while only 20% provide financial and material assistance to non-governmental organizations (NGOs) to organize awareness days on hygiene and environmental protection, with presentations on sustainable products and services, and methods of reducing the risks associated with the misuse of these products, from purchase to end-of-life disposal and treatment sites.

3.3.6. Indicators and Weaknesses for Measuring the Achievement of Significant Results in the Management of IEDs

Indicators such as certificates of destruction or recovery of waste (to measure their environmentally sound management), an effective institutional management policy does not exist in the majority of institutions, even those that have a service provider specializing in the management of this type of waste. For this reason, IEDs are always stored on the service provider's site or in warehouses. However, management is still hampered by transfers to foreign countries for treatment and recovery.

4. Discussion

This study showed the diversified activities from the import of IT tools, which amounts to 31.30% and 68.70% considered as personal effects and merchandise (**Table 1**), the use up to the final stage of electrical and electronic equipment and, globally, ordinary items contribute to the degradation of the environment in the Republic of Guinea. The annual rate of increase over the 10 years (2009-2019) has been up and down. The highest was between 2011-2012 (54.45%) and the medium-high between 2017-2018 (4.03%) (**Figure 7**), then rose again in 2018-2019 to 48.87%. This variation in figures can probably be linked to the health situation with the outbreak of the Ebola virus disease in West Africa, mainly in the Republic of Guinea, where the first case was detected in March 2014, which plunged the country into a severe economic crisis for several years, followed by another global health crisis on Covid. This increase in the production of waste of electrical, electronic and computer origin (WEEE) has been noted and confirmed by [2] which states that between 20 and 50 million tonnes of waste from electronic and electrical equipment (WEEE) are produced worldwide because this equipment, at the end of its life, becomes unusable or simply waste. According to [17], this figure is set to rise as a result of the high frequency of technological innovation and the use of IT tools. It should be pointed out that most of the water sources covering 70% of the planet's surface are now subject to strong anthropogenic pressure linked to

human activities such as industrial waste management, which results in changes to hydrological and geochemical conditions and surface run-off [18], especially given that rainfall in the Guinean capital is very high and most of this waste (IED) is exposed to this high rainfall. IT equipment imported into Guinea follows a linear arithmetic progression and this only increases the quantity of IED. The paradox in Guinea is that some stakeholders are unable to take the necessary legal and regulatory measures to manage IEDs in an environmentally sustainable manner. The various results in (**Figures 6-8**, and **Tables 2-4**) show how IT equipment is generally managed in the Republic of Guinea. However, the few African countries to have a policy regulating the management of electronic waste is the Republic of Rwanda, which is the second African country to have a serious facility for the disassembly and recycling of electronic waste, according to Olivier Mbera, Country Managing Director of Enviro Serve Rwanda, which is responsible for the said recycling facility, in order to set an example for other African countries [19]. In the Republic of Guinea, the survey revealed that 55% of institutions opt to manage IT waste by storing out-of-use equipment in warehouses (**Figure 3(d)**), 25% opt to repair and refurbish equipment for staff, and 20% opt to use components for practical work with students. The only institution that has a contract with the (SME, (SMEs)) (CEGEDI) specializing in the processing and collection of IEDs does not have the capacity to ensure proper management of this computer waste, which means that it is found piled up or scattered on the ground in the open air (**Figure 3(c)**). And (66.67%) of users use storage as the most effective means of disposing of it one day in unsuitable places. In terms of training, information and awareness-raising through workshops, seminars and the like, it was noted that 80% of the institutions surveyed have no framework for training or raising staff awareness of the management and environmental and health risks of IT or electrical waste, compared with only 20% who are involved through financial and material assistance made available to certain non-governmental organizations (NGOs), in order to organize these awareness-raising days on hygiene and environmental protection. Indicators such as: A study was carried out in Benin based on the search for solutions to the problems associated with the adoption of regulations and raising public awareness of WEEE issues [20].

5. Conclusion

Waste management is governed by legal texts such as laws, decrees and orders, the application of which is lacking in most African countries, particularly in the Republic of Guinea. This survey enabled us to assess the import rate, which has risen by almost 50%, the use of IT equipment up to the final stage, the different ways in which waste was managed between 2009 and 2019, and the lack of regulations governing this sector. According to our findings, various methods of managing IT waste have been identified, including storage, repair or recycling, donations, collection by SMEs, practical work by students, and so on. This study shows the environmental aggressiveness of the city of Conakry (Republic of Guinea)

through various methods of managing these types of waste by users. Unfortunately, the Republic of Guinea only has general regulations that apply to all categories of waste. However, the specific nature of the collection and management of electronic waste in general and computer waste in particular is not taken into account. Further studies are recommended, and a waste management system should be set up, following the example of other African countries such as Rwanda.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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