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Ishikawa Diagram, Gray Numbers and Pareto Principle for the Analysis of the Causes of WEEE Production in Cameroon: Case of SMEs Implementing ISO 14001:2015

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ABSTRACT

The issue of Waste from Electrical and Electronic Equipment (WEEE) in Africa lacks a concrete answer at present. This study aimed to provide an integrated approach using qualitative and quantitative research methods based on the 80/20 principle and the grey system theory, in order to address the uncertainty in the existing literature. First, through a qualitative approach, the authors analysed the environment for the management of WEEE by eight companies in Cameroon, through a literature review and observations made in the field under the framework of the ISO 14001:2015 standard. Then, the weights of the selected cause of the WEEE using grey system theory were proposed and applied, combining the findings from both the qualitative and quantitative methods. Based on the data obtained through the analysis, the research results indicate that the assessed Cameroonian companies dealing with WEEE management can implement measures to reduce WEEE.

Keywords: Waste from Electrical and Electronic Equipment (WEEE); Grey Relational Analysis (GRA); Pareto principle; Decision-making; Pairwise comparison; Cameroon

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1. Introduction

With the need for the world population to have a better life, the manufacturing of Electrical and Electronic Equipment (EEE) has led to a crucial responsibility in considering ecological disasters as part of the global challenge. The production of EEE requires the consumption of natural resources and, hence, their depletion. EEE, after its use, comprises a source of pollution for the environment and a threat to the health of living beings. EEE use is still low in African countries—compared to other developed countries globally—but has been growing at breakneck speed. For example, in recent decades, the penetration rate of personal computers and mobile phones has increased by multiple folds [1]. This penetration rate means that people benefit from cheaper access due to the intensity of trade. Seen from this perspective, the importing and marketing of EEE support the Millennium Development Goals (MDGs) in Africa to promote the use of ICTs for sustainable development.

In Africa—more specifically, Cameroon—the fight against the digital divide, initiated since the information summit in Geneva in 2003, has led to an increase in EEE. This often second-hand equipment quickly becomes obsolete and, thus, increases the quantities of Waste from Electrical and Electronic Equipment (WEEE). WEEE is also called e-waste and e-scrap [2]. EEE can be considered equipment that depends on an electrical current or electromagnetic field to function correctly [3]. Specifically, the joint decree of the European Parliament setting the specific conditions for the management of EEE, as well as their waste, defines EEE as equipment operating using electric currents or electromagnetic fields, as well as the production, transfer, and measurement of these currents and fields, designed to be used at a voltage not exceeding 1000 volts in alternating current and 1500 volts in direct current [4–6].

Furthermore, a commodity constitutes waste when the financial and physical flows go in the same direction, unlike a classic commodity in economics [7]. WEEE is electrical or electronic equipment that is waste within the meaning of Article 3, paragraph 1 of Directive 2008/98/EC. This waste includes all components, sub-assemblies, and consumables, forming an integral part of the product at the time of disposal [5]. According to the Cameroonian State, "waste" is any residue from a process of production, transformation, or use; any substance or material produced; or, more generally, any movable or immovable property abandoned or destined for abandonment [8]. In this paper, WEEE also includes Waste of Electrical and Household Electrical Appliance (WEHEA) and Professional Electrical and Electronic Equipment Waste (PEEEW), which consists of waste of electrical and electronic devices resulting from the activities of various sectors.

In addressing the problem of WEEE, there is uncertainty in determining the root cause of the problem. For a quantitative research method, there are several methods to address quantifiable uncertainties. These include probability, statistics, rough sets [9], fuzzy sets [10], evidential reasoning [11], and Grey System Theory (GST). In this research, grey system theory is used to model systems with incomplete information. Considering the formation in Africa, not only may one not be sure of the reported data on WEEE, but the data sources are also limited. According to Tervonen et al. [12], the difficult task in solving a Multi-Criteria Decision Making (MCDM) problem is estimating the weights of the evaluation criteria. This is a significant problem: Weights estimated using the conventional traditional qualitative approach typically differ from those using the quantitative approach, thus amounting to uncertainty.

In this paper, we propose a solution to address the uncertainty in weighing the causes and effects of WEEE. The main contribution of this paper is the combination of qualitative and quantitative approaches as an integrated method to account for the uncertainty in decision making, based on GST. The Ishikawa Diagram is further analysed and converted to a hierarchical diagram, which is used for the grey relational analysis. In addition, we combine both subjective and objective weights to determine the weights of both the branches and leaves of the Ishikawa diagram for WEEE. The remainder of this paper is structured as follows: Section 2 presents the literature review, which provides the context with the legal framework of the observed phenomenon, as well as works related to GST. Section 3 presents the methodology used in this research, which involves both qualitative and quantitative processes. The results and analysis are presented in Section 4. Then, a discussion that provides managerial implications and recommendations is presented. Finally, our conclusions are drawn in Section 6.

2. Literature work

2.1 EEE waste

Quantifying WEEE has become a priority, and several research works have proposed classifications and approaches for estimating WEEE. Ikhlayel [13] has offered a comparison grid of the various approaches, including consumption and use, simple delay, timestep, mass balance, and approximation methods. Vanessa [14] has stated that determining the quantities of global WEEE is challenging due to a lack of harmonization on the definition of WEEE, difficulty in measuring the flows of legal or illegal cross-border movements, elimination of WEEE in ordinary garbage cans, and informal collection and recycling practices. Other researchers have modelled the lifetime of the product using a Weibull distribution, as well as the discrete lifetime [15], and constructed initial and secondary models according to the Weibull's distribution to determine the lifetime of products [16], while collecting data from various sources each time. Recent studies on WEEE estimation have been based on the sales-stock-lifespan estimation model with the time series expansion method, the logistic curve [17,18], or the two-year average as the growth rate for smartphones and the average over ten years as the growth rate for multi-function phones [19].

WEEE has numerous impacts at the environmental, social, and economic levels. The environmental impacts of WEEE are primarily water and soil pollution. Air pollution and greenhouse gas emissions occur when incinerated without respecting green practices [20]. Economically, there has been a substantial expansion of informal recycling activities, such as collecting scrap metal and certain metals, through the demolition and open burning of WEEE. These wastes also contain strategically valuable materials, such as indium and palladium, as well as precious metals such as gold, copper, and silver. These activities usually involve the young population and low pay. The places of burning develop a black colour, with a high concentration of heavy metals (Cu > Pb > Zn > Mn > Ni > Sb > Cr > Cd), with contamination to a depth ranging from 10 to 30 cm [21,22]. Backyard WEEE recycling has detrimental impacts on the environment, polluting soil through the leaching of toxic elements and effluent discharge of acidic water. In contrast, the open burning of circuit boards leads to the emission of toxic fumes [23]. On the human side, some of the substances resulting from incineration, such as PBDD/Fs (polybrominated dibenzo-p-dioxins), are lipophilic and can bioaccumulate through the food web in the human body [24]. Many studies have also found connections with elevated rates of spontaneous abortions, premature births, and reduced birth weights due to backyard WEEE recycling [23].

Studies in most African countries have revealed a lack of specific laws or policies and infrastructure for the management of WEEE, as well as archaic recycling practices consisting of manual dismantling, open burning, and the recovery of small quantities of precious metals [25,26]. Such practices remain poorly remunerated, compared to appropriate WEEE recycling systems [27], and are subject to risks of contamination for recyclers and pollution of the soil, water, and environment [28]. In Botswana, the lack of specific WEEE policies has made it challenging to coordinate roles and responsibilities in WEEE management [29]. Nigeria has banned the import of hazardous waste without ending the flourishing import trade in electronic waste [30]. A specific WEEE management policy distinguishes South Africa through the National Environmental Management Act 107, which advocates the reuse, refurbishment, and appropriate management of WEEE [31]. Ghana passed Act 917 to support WEEE management efforts, but there has been little improvement [32].

At present, in Cameroon, the national waste management policy is oriented towards the collection, transport, and landfill of municipal solid waste [33]. A study in Bafoussam City in Cameroon has highlighted neighborhoods or areas that are more exposed to waste than others as a result of this municipal policy practice [34]. Some works have revealed that the behavior of actors is generally confused, with WEEE being incorporated with household waste and dumped in landfills for informal recycling [3,35]. In Douala specifically, a study has shown the vast potential for improvement of WEEE management, revealing that 76% of respondents declared that they dispose of their WEEE mixed with other household waste. However, 77% of them, claimed to be informed of the consequences of this waste in a sample of 400 households questioned. In summary, there is still room to investigate WEEE in Cameroon and Africa as a continent.

2.2 Grey system theory with related application

The main areas related to the work in which GST has been applied in the literature are primarily recycling, sustainability, green supply chains, environmental pollution control and waste management. In addressing the unknown demand for scrap steel, Xinping et al. [36] applied GRA and a forecasting method with a swarm optimization algorithm to predict the demand for scrap steel in China. Jing et al. [37] applied GRA to evaluate the pollution in surface water to determine its quality. The waste quality index was represented as a grey class during the evaluation. Yuan and Jian [38] proposed an improved GRA method that used the dynamic resolution ratio to evaluate the water quality in lakes such as wetlands. Lin et al. [39] applied GRA in surface monitoring technology, thereby reducing the time wasted in the manufacturing process; improving efficiency, i.e., avoiding unnecessary reworking in process management; and increasing the overall profits for the company. Chen and Chang [40] applied GRA and the AHP to assess the quality of recyclable building materials. The AHP was used to determine the weights of the evaluation criteria, and GRA was applied to rank the three machines.

Some scholars have highlighted the factors for managing waste using GST. Tao et al. [41] combined DEA and the grey incidence degree analysis method to determine the factors affecting environmental governance, using Shandong Province as a case study. Among these factors are the total investment in environmental treatment, the removal of industrial soot, conformity with the industrial wastewater discharge standards, and a controlled volume of garbage disposal. Wei et al. [42] combined GST with the theory of the recycled economy to determine the evaluation index for the grey supply chain in Guangxi Province. Liu et al. [43] identified the critical factors for remanufacturing in Gansu Province in China. They suggested that there should be greater importance associated with the annual sales of the remanufacturing industry. Also, there should be an increase in the staff with postgraduate degrees in manufacturing and research institutions. This equally suggests limiting the total building area of the remanufacturing industry and controlling investment to reduce the waste generated. Chang and Cheng [44] identified the economic, social, and environmental dimensions as the primary dimensions for evaluating sustainability in manufacturing small-scale and medium enterprises in Taiwan.

The proper handling of WEEE assists in attaining the goal of sustainability. Javanmardi et al. [45] presented a systematic literature review of the application of GST in sustainability. Over the years, the different domains covered by the researcher include urban areas, energy, business, society, agriculture, industrial tourism, sustainable products, sustainable assessment, and development. Zhao et al. [46] applied the AHP and GRA to evaluate polyvinyl chloride, polypropylene, and polyethylene for sustainable design. While the AHP was used to estimate the weights of the criteria, GRA was used to rank the alternatives. Similarly, Zhang et al. [47] applied a hybrid MCDM method to select green materials that would help reduce waste. The DEMATEL and ANP methods were combined to estimate the weights of the evaluation criteria, and the GRA and TOPSIS methods were combined to rank the selected materials. Overall, the hybrid method performed better than the traditional TOPSIS and VIKOR methods. Luthra et al. [48] identified 15 critical success factors as criteria for effectively implementing sustainability in the Indian supply chain by applying the grey-DEMATEL method and showed that the legal arm of government and community welfare and development had strong impacts. The use of automated office systems such as ERPs and HRISs reduces the use of paper in offices, reducing the number of trees needed to make paper. Esangbedo et al. [49] applied various hybrid grey MCDM methods to evaluate human resource information systems. Specifically, the grey point allocation full consistency method was used to determine the weights of the criteria; and the GWSM, GRA with grey numbers, TOPSIS with grey values, and the grey regime methods were used to rank the vendors of the HRIS.

GST has been applied as a method to predict waste emissions. Liu et al. [50] proposed and applied the fractional-order reverse accumulative grey forecasting model (FRAG-GM(l,l)) to predict the sulfur-dioxide emissions in waste gas in Beijing. Duman et al. [51] presented a grey multivariate model for WEEE prediction. Specifically, GST was combined with a nonlinear multivariate Bernoulli model, and particle swarm optimization was used to increase the forecasting accuracy in Washington State, USA. Sun et al. applied GRA with two-way variance and simple effect analysis to evaluate the interaction between the factors in cities and the environment in northern China. Among the nine factors identified, they stated that pollutant treatment and water consumption had the worst effects on the environment in urban areas compared to other factors. Sahu et al. [52] combined DAMETEL and GST to form a mixed research method, i.e., both qualitative and quantitative methodologies, to evaluate the cause of WEEE and proposed a possible solution for reducing WEEE as a framework for legislators and manufacturers in India, since WEEE contains toxic materials. Agrawal and Vinodh S. [53] presented the grey performance importance index for a sustainable manufacturing additive process. This research provided guidelines to identify weaknesses in manufacturing processes.

Considering the application of GST in developing countries such as those in Africa, Esangbedo and Che [54] combined GRA, ranking and other centroid weighting methods to estimate the weights of the index provided by the World Bank in the doing business project for evaluating the African business environment. They also developed the grey weighted sum model (GWSM) for evaluating the business environment in West Africa. The GWSM addressed the limitation of simple additive weighting with grey relations proposed by Zavaskaski. Diba and Xie [55] extended the classical Deng's GRA model to the second synthetic GRA method to select the best supplier of unprocessed milk to Satrec Vitalait Milk Company in Senegal. Varying the grey distinguishing coefficients have been adopted to evaluate the solar panel power station [56] and solve supplier selection problems in the hospitality industry [57]. To the best of our knowledge, this is the first study to combine GST with a qualitative cause and effect method to address the problem of WEEE, specifically in Cameroon.

3. Research methodology

3.1 Qualitative process

Area of study and data collection

In this study, the city of Douala in Cameroon was chosen as the place of study. It is located on the edge of the Atlantic Ocean, at the bottom of the Gulf of Guinea, and at the mouth of the Wouri River. Given its openness to sea lanes for both Cameroon and countries of the Central African sub-region, it constitutes a geographically strategic location for the establishment of businesses. According to the National Institute of Statistics of Cameroon, this justifies the presence of 11,272 modern enterprises (in the formal sector and producing a DSF) installed in the city of Douala in 2016. Our study was carried out in Cameroon, by virtue of its recognized status as a developing country and, more specifically, with ISO-certified companies in the economic capital Douala, given that this alone accounts for 39.0% of the population of modern companies [58].

Our methodology used an approach similar to hybrid exploration, repetitive observations, and a review of theoretical knowledge throughout the research. Data collection was based on reviewing related documents, observations, and the administration of a detailed interview guide. This assisted in understanding the attitudes of some organizations towards their WEEE. In this paper, the sample was focused on companies with at least one ISO 14001 certification or one specific environmental management certificate. This study was, therefore, intended to be exploratory.

Document search with observation

Our literature search consisted of in-depth browsing of documents of several types. We can cite articles, briefs, journals, reports, and texts of laws, conventions, and protocols, all dealing with WEEE both in industrialized countries and in our study area. This allowed us to build a secondary and theoretical database relating to the studied phenomenon. Another so-called direct observation, through internships and company visits, allowed us to experience the realities on the ground. We, thus, had to assess the current treatment reserved for the WEEE of these entities. In conjunction with the theories proposed by our literature review, we developed an interview guide. We created this guide after an interview to better understand the treatment allocated to the WEEE of these producers.

Sampling and guided interviews

For the sake of representativeness, our sample consisted of specific organizations based in the city of Douala. This choice was made due to Douala being Cameroon's economic pool. Businesses are more diverse there than in other cities in the country. Our sampling technique was theoretical, as it selects participants according to a rationale based on the concepts that emerge during a study. The choice was refined by focusing on certified companies to comply with the requirements and responsibilities. The relevance of our sample stems from the fact that the people with whom we spoke were authorized managers and responsible for the strategic or operational policies of these companies. Given that our study was carried out during the COVID-19 period, the accessibility and administration of an interview guide to collect qualitative data proved to be more complicated in companies; hence, we eventually obtained a reduced number of samples.

The Maintenance Guide was drawn up in a detailed manner, in order to not deviate from the orientations that we have given ourselves around the following themes: general information about the company, general information on EEE and WEEE, company culture in WEEE material, and their EA (Environmental Aspects), regulatory and normative knowledge in terms of WEEEM (WEEE Management), controls and measures to prevent and fight against WEEE, and potential difficulties related to WEEEM.

Data analysis tools

Our approach required us to first analyse and regroup the data, collected into groups or categories. The scientific instrument used for this was the ISHIKAWA diagram. It was adapted to our study according to the themes covered through our interview guide and the subject of our research, based on the findings made in the field. The diagram, therefore, highlights the groups (or subgroups) of causes responsible for the behavior of our sample towards WEEE. The occurrences in the data led us to develop a weighting system for the various factors relating to the phenomenon under study. This second step provides a sort of weighting or encryption that allows us to migrate to statistical analysis tools.

A careful classification provides us with an overview of the preponderant causes. The Pareto diagram allowed us to define an order of priority for these causes. This tool's choice was necessary to consider the priority levels likely to solve the problem. The leverage proposals were nevertheless inspired by the responses to the interview guide, taking into account the ideal future that organizations wish to allocate to the WEEE they produce. A Brainstorming session was carried out with eight actors from various organizations to elucidate these proposals. In general, understanding the attitude of companies engaged in a certification process or having been certified (concerning ISO 14001:2015) required an overall qualitative methodological approach. The main collection tools were direct observations, a document review, and the interview guide.

3.2 Quantitative process based on GST

Interval grey number comparison

Incomplete systems are represented as grey numbers, and there are different types of grey numbers; some include the unbounded, bounded, interval grey, continuous and discrete, and essential and non-essential grey numbers [59,60]. Specifically, in this research, interval grey numbers are used. An interval grey number $\otimes A$ is defined as [61] $\otimes A = \left[\underline{A}, \overline{A}\right]$; where $\underline{A}$ is the lower limit, $\overline{A}$ is the upper limit, and $\underline{A} < \overline{A}$. According to Darvishi et al. [62], Guo et al. [63] and Shi [64] in comparing two intervals of grey numbers $\otimes A$ and $\otimes B = \left[\underline{B}, \overline{B}\right]$, we can consider $\otimes A \le \otimes B$ when $\rho \le 0.5$, where $\rho = p(\otimes A \leqslant \otimes B) = \frac{\max\left(0, L^* - \max(0, \overline{A} - \underline{B})\right)}{L^*}$, $L^* = L(\otimes G_1) + L(\otimes G_2)$ and $L(\otimes G) = \overline{G} - \underline{G}$.

Weighting in group decision-making

In an ecosystem, what is considered a waste by one speciality may be considered the raw material for a different speciality. This implies that waste can be seen as a grey material. In a group decision-making environment, there is uncertainty in classifying the use of these materials, as well as uncertainty in assigning weights to the cause of these wastes. Thus, the use of GST for uncertain group decision-making was considered. The basic operations between two grey numbers have been given by Esangbedo and Bai [59]. The steps used in this research were as follows.

Step 1. Determining the causes and effects of WEEE. The Ishikawa diagram, drawn from Section 4.1, is used. The Ishikawa diagram (also known as a fishbone diagram) is represented in **Table 1**.

Step 2. Obtain the DM weights. This can be achieved using paper-based or online questionnaires.

Step 3. Normalize the preference matrix. Normalization ensures that there is an even spread of the points across the full range possible. This ensures that the DM points are less influenced by their personal exposure through the use of percentage scores.

a. For the first level-criteria,

$$C'_j(r) = \frac{C_j(r) - \min_{1\le i\le v} C_j(r)}{\max_{1\le i\le v} C_j(r) - \min_{1\le i\le v} C_j(r)}.$$

b. For the second level-criteria,

$$C'_j(r0s) = \frac{C_j(r\text{-}s) - \min_{1\le i\le v} C_j(r\text{-}s)}{\max_{1\le i\le v} C_j(r\text{-}s) - \min_{1\le i\le v} C_j(r\text{-}s)}.$$

Step 4. Compute the effective normalized points to formulate a quantitative weight matrix. The local first-level criteria (i.e., the branches connected to the spine of the fishbone diagram), then the second-level criteria (i.e., the leaves in every branch). The normalized points are the quantitative weights assigned to each cause tin; that is,

$$t_{ij} = C'_j(r) \times C'_j(r\text{-}s), \tag{1}$$

where i is the sequential index of the second-level criteria by the jth decision-maker. See the last column of **Table 1**. The effect weights computed from **Table 1** are used to construct an m × n weight matrix, consisting of m second-level criteria and n DMs, as given in Equation (4):

$$T = \begin{pmatrix} t_{11} & t_{12} & t_{13} & \cdots & t_{1n} \\ t_{21} & t_{22} & t_{23} & \cdots & t_{2n} \\ t_{31} & t_{11} & t_{11} & \cdots & t_{1n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ t_{m1} & t_{m1} & t_{m1} & \cdots & t_{mn} \end{pmatrix}. \tag{2}$$

Step 5. Determine the grey weights. The grey weight for the group of DMs is obtained by taking the minimum and maximum normalized point given by the DMs, to represent the lower and upper bounds of the grey number for every criterion, as given in Equation (5):

$$\otimes B_i = \left[\underline{\beta}_i, \overline{\beta}_i\right] = \left[\min_{1\le i\le m} t'_{ij}, \max_{1\le i\le m} t'_{ij}\right]. \tag{3}$$

The grey weights form a column matrix, which

Table 1. Tabular representation of the Ishikawa diagram.

Cause	DM_1	…	DM_i	…	DM_m	**Effect**	DM_1	…	DM_i	…	DM_m	**Index**
$C(1)$	$C_1(1)$	…	$C_i(1)$	…	$C_m(1)$	$C(1\text{-}1)$	$C_1(1\text{-}1)$	…	$C_i(1\text{-}1)$	…	$C_m(1\text{-}1)$	1
						⋮	⋮	⋱	⋮	…	⋮	1+1
						$C(1\text{-}w)$	$C_1(1\text{-}w)$	…	$C_i(1\text{-}w)$	…	$C_m(1\text{-}w)$	⋮
⋮	⋮	⋱	⋮	⋱	⋮	⋮	⋮	⋱	⋮	⋱	⋮	⋮
$C(r)$	$C_1(r)$	…	$C_i(r)$	…	$C_m(r)$	$C(r\text{-}1)$	$C_1(r\text{-}1)$	…	$C_i(r\text{-}1)$	…	$C_m(r\text{-}1)$	⋮
						⋮	⋮	⋱	⋮	…	⋮	⋮
						$C(r\text{-}s)$	$C_1(r\text{-}s)$	…	$C_i(r\text{-}s)$	…	$C_m(r\text{-}s)$	⋮
⋮	⋮	⋱	⋮	⋱	⋮	⋮	⋮	⋱	⋮	⋱	⋮	⋮
$C(v)$	$C_1(v)$	…	$C_i(v)$	…	$C_m(v)$	$C(v\text{-}1)$	$C_1(v\text{-}1)$	…	$C_i(v\text{-}1)$	…	$C_m(v\text{-}1)$	⋮
						⋮	⋮	⋱	⋮	…	⋮	*n-1*
						$C(v\text{-}w)$	$C_1(v\text{-}w)$	…	$C_i(v\text{-}w)$	…	$C_m(v\text{-}w)$	*n*

can be represented as:

$$\otimes B_i = \begin{pmatrix} \otimes B_1 \\ \otimes B_2 \\ \vdots \\ \otimes B_{mi} \end{pmatrix} = \begin{pmatrix} \left[\underline{\beta}_1, \overline{\beta}_1\right] \\ \left[\underline{\beta}_2, \overline{\beta}_2\right] \\ \vdots \\ \left[\underline{\beta}_m, \overline{\beta}_m\right] \end{pmatrix}. \tag{4}$$

Step 6. Scale the grey weights. This is to ensure that the quantitative grey weights are on the same scale as the qualitative weights.

$$\otimes \beta_i' = \left[\underline{\beta'}_i, \overline{\beta'}_i\right] = \left[\frac{\underline{\beta}_i}{\max\limits_{1\le i\le m} \overline{\beta}_i}, \frac{\overline{\beta}_i}{\max\limits_{1\le i\le m} \overline{\beta}_i}\right]. \tag{5}$$

In other words, it maintains the conversion that the sum of the effective weights is exactly one unit; that is, $\sum_{i=1}^{m} \overline{\beta'}_i = 1$.

Step 7. Tally the number of occurrences for each cause and normalize it. This involves counting the number of times each cause is discovered in the qualitative analysis process and normalizing it using Equation (8):

$$\alpha_i' = \frac{\max\limits_{1\le i\le m} \alpha_i - \alpha_i}{\max\limits_{1\le i\le m} \alpha_i - \min\limits_{1\le i\le m} \alpha_i}. \tag{6}$$

Step 8. Aggregate the qualitative normalized weights and the quantitative grey weights. This is done using the basic grey operation of two numbers:

$$\otimes c(i) = \alpha_i' + \otimes \beta_i' = \left[\alpha_i' + \underline{\beta'}_i, \alpha_i' + \overline{\beta'}_i\right]. \tag{7}$$

Step 9. Compare the aggregated weights and sort them. The grey superiority degree is applied to compare two grey numbers, as shown in **Table 2**, which is a pairwise comparison of each cause.

Table 2. Pairwise of interval grey number comparison.

Superior Comparison	$C(1)$	$C(2)$		$C(z)$	**Summation of Superiority**
$C(1)$	0.5	$p_{\otimes c(2)\succ \otimes c(1)}$	…	$p_{\otimes c(z)\succ \otimes c(1)}$	$\sum_{i=1}^{\zeta} p_{\otimes c(1)\succ \otimes c(\zeta)}$
$C(2)$	$p_{\otimes c(1)\succ \otimes c(2)}$	0.5	…	$p_{\otimes c(z)\succ \otimes c(2)}$	$\sum_{i=1}^{\zeta} p_{\otimes c(2)\succ \otimes c(\zeta)}$
⋮	⋮	…	⋱	⋮	⋮
$C(z)$	$p_{\otimes c(1)\succ \otimes c(z)}$	$p_{\otimes c(2)\succ \otimes c(z)}$	…	0.5	$\sum_{i=1}^{\zeta} p_{\otimes c(z)\succ \otimes c(\zeta)}$

4. Result and analysis

We noted the occurrences of causes out of the total number of organizations that participated in our study. Thus, we obtained, for each cause, a proportion that was assigned to it. This proportion serves as the weight for said cause, assuming that all the identified causes represent 100% of the main causes contributing to the growth of WEEE in certified organizations (and those in the process of certification). As mentioned above, analysis of the results was carried out in several stages, with the help of several scientific tools of qualitative and quantitative nature. **Figure 1** shows the flowchart used in this research.

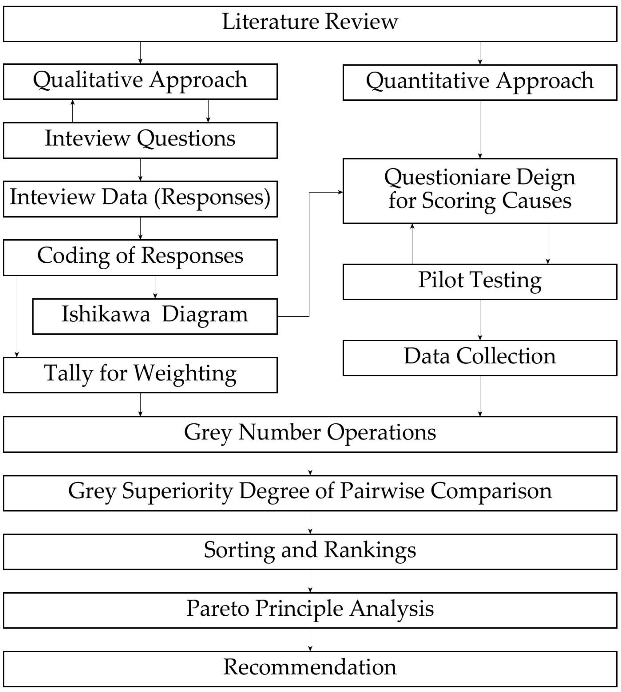

Figure 1. Flowchart of the research.

4.1 Qualitative results

A deep analysis of the verbatim provides us with a figure highlighting the causes for the increase in WEEE in our sample companies. They were categorized according to whether the causes were related to the environment, the workforce, the methods, the material, and/or the means. By definition, the Ishikawa approach aims to analyse the main influencing factors, to which we assign levels of action, on which possible obstacles will be posed (this is the term used for quality, poka-yoke, in Japanese), thus allowing us to overcome them. In our case, we recommend the use of the Ishikawa diagram to find the possible causes of a specific effect, for example: "Analyse why certified companies or those in the process of certification in Cameroon still manage to produce WEEE". The constructed Ishikawa diagram was an edge diagram, on which five families of causes are distinguished: Labour: direct, indirect, motivation, training, absenteeism, experience; Environment: physical environment, lighting, noise, layout, relationships, suppliers, market, legislation; Methods: processes, instructions, manuals, procedures; Means: finances, tools; and Materials/Equipment: raw materials, parts, assemblies, supplies, identification, storage, quality, handling; machines, tools, equipment, capacity, age, number, maintenance.

Figure 2 represents the 21 main causes that have a direct effect on the contributions of a given company to the increase of WEEE in nature. The respective number of occurrences with reference to the data of our study is shown in **Table 3**. Each of the causes belongs to a category of factors influencing the organization, both internally and externally, in its functioning.

4.2 Quantitative results

Grey weights for causes

Using the steps above, the computation process for the effects due to the causes is as follows:

Step 1. Determining the causes and effects of WEEE; see **Figure 2**.

Step 2. Obtain the DM weights. The DMs points are obtained. First, a questionnaire was designed and pilot-tested. Based on the responses during the test, it was then modified. In the research, an online base questionnaire was strictly used, to avoid person-to-person contact during the pandemic. The data were obtained from the questionnaires administered to five DMs. The DMs used in this research all had postgraduate degrees, and had a cumulative total of 72 years of work experience. The scores given to each

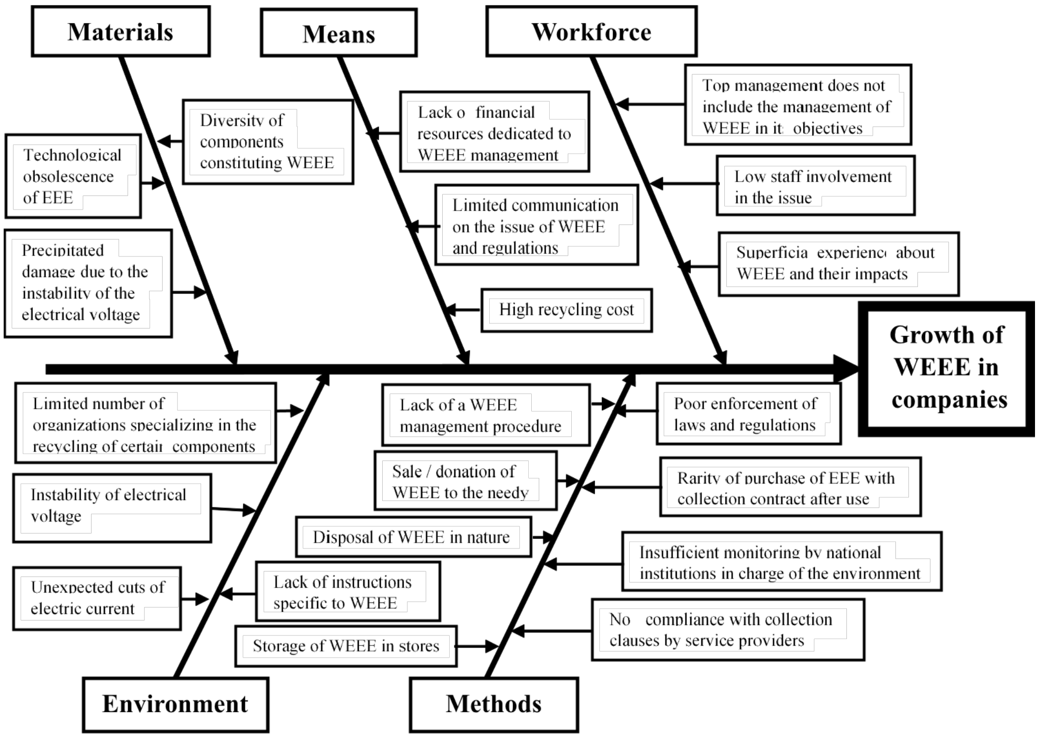

Figure 2. Ishikawa diagram.

Table 3. Summary of causes and their occurrences.

Categories	Causes		Occurrence	Percentage
Environment (C_1)	• Lack of instructions specific to WEEE	C_{1-1}	7/8	4.965
	• Limited number of organizations specializing in the recycling of certain components	C_{1-2}	8/8	5.674
	• Instability of electrical voltage	C_{1-3}	8/8	5.674
	• Unexpected cuts of electric current	C_{1-4}	8/8	5.674
Workforce (C_2)	• Top management does not include the management of WEEE in its objectives	C_{2-1}	6/8	4.255
	• Low staff involvement in the issue	C_{2-2}	7/8	4.965
	• Superficial idea about WEEE and their impacts	C_{2-3}	7/8	4.965
Means (C_3)	• Lack of resources dedicated to WEEE management	C_{3-1}	7/8	4.965
	• Limited communication on the issue of WEEE and regulations	C_{3-2}	6/8	4.255
	• High recycling cost	C_{3-3}	8/8	5.674
Methods (C_4)	• Sale/donation of WEEE to the needy	C_{4-1}	6/8	4.255
	• Disposal of WEEE in nature	C_{4-2}	5/8	3.546
	• Storage of WEEE in stores	C_{4-3}	8/8	5.674
	• Lack of a WEEE management procedure	C_{4-4}	8/8	5.674
	• Poor enforcement of laws and regulations	C_{4-5}	8/8	5.674
	• Non-compliance with collection clauses by service providers	C_{4-6}	1/8	0.709
	• Insufficient monitoring by national institutions in charge of the environment	C_{4-7}	7/8	4.965
	• Rarity of purchase of EEE with collection contract after use	C_{4-8}	8/8	5.674
Materials (C_5)	• Diversity of components constituting WEEE	C_{5-1}	8/8	5.674
	• Precipitated damage due to the instability of the electrical voltage	C_{5-2}	7/8	4.965
	• Technological obsolescence of the EEE	C_{5-3}	3/8	2.127

of the causes are provided in **Table 4**.

The obtained weight can be represented in a preference matrix (PM) as given in Equation (10).

$$PM = \begin{pmatrix} 91 & 87 & 24 & 56 & 87 \\ 79 & 90 & 30 & 61 & 60 \\ 85 & 83 & 35 & 73 & 35 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 95 & 82 & 68 & 47 & 86 \end{pmatrix}. \quad (8)$$

Table 4. Data was obtained from the decision-makers.

Index of the Causes	DM_1	DM_2	DM_3	DM_4	DM_5
C_1	91	87	24	56	87
C_2	79	90	30	61	60
C_3	94	62	61	35	20
C_4	85	83	35	73	35
C_5	67	64	57	33	87
C_{1-1}	39	88	40	35	91
C_{1-2}	53	64	58	44	95
C_{1-3}	70	74	64	37	44
C_{1-4}	85	58	69	34	95
C_{2-1}	80	93	68	59	89
C_{2-2}	54	74	71	61	34
C_{2-3}	91	73	65	72	80
C_{3-1}	16	94	67	64	68
C_{3-2}	80	72	67	58	80
C_{3-3}	75	74	75	79	69
C_{4-1}	80	64	43	76	88
C_{4-2}	85	91	68	57	81
C_{4-3}	83	87	69	58	93
C_{4-4}	78	89	41	68	91
C_{4-5}	97	73	62	39	67
C_{4-6}	46	74	70	39	60
C_{4-7}	59	82	62	57	77
C_{4-8}	73	83	72	78	76
C_{5-1}	83	85	73	74	52
C_{5-2}	95	67	44	29	73
C_{5-3}	95	82	68	47	86

Step 3. Normalize the preference matrix. In this research, the degree of importance was the only beneficial criteria: $t_{ij} = \frac{\max\limits_{1\le j\le 26} pm_{ij} - pm_{ij}}{\max\limits_{1\le j\le 26} pm_{ij} - \min\limits_{1\le j\le 26} pm_{ij}}$. Where pm is the element of the preference matrix. The normalized preference matrix is given in Equation (11).

$$T = \begin{pmatrix} 0.2607 & 0.2702 & 0.1600 & 0.2489 & 0.4307 \\ 0.2264 & 0.2795 & 0.2000 & 0.2711 & 0.2970 \\ 0.2693 & 0.1925 & 0.4067 & 0.1556 & 0.0990 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 0.2346 & 0.2055 & 0.2132 & 0.1649 & 0.2363 \end{pmatrix}. \quad (9)$$

Step 4. Compute the effective normalized points to formulate the quantitative weight matrix. This is obtained using Equation (3).

$$T' = \begin{pmatrix} 0.0380 & 0.0555 & 0.0311 & 0.0498 & 0.0911 \\ 0.0330 & 0.0574 & 0.0389 & 0.0542 & 0.0628 \\ 0.0392 & 0.0396 & 0.0790 & 0.0311 & 0.0209 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 0.0488 & 0.0644 & 0.0863 & 0.0441 & 0.0650 \end{pmatrix}. \quad (10)$$

Step 5. Determine the grey weights. These were obtained using Equation (5).

$\otimes B_i = \left[\min\limits_{1\le i\le 5} t'_{ij}, \max\limits_{1\le i\le 5} t'_{ij}\right]$ = ([0.0311, 0.091], [0.0330,0.0628], [0.0209, 0.0709], ... [0.0441,0.0863])^T.

Step 6. Scale the grey weights. The grey weights were scaled to a unit value of the upper bound, using Equation (7).

$\otimes \beta'_i = \left[\frac{\underline{\beta}_i}{\max\limits_{1\le i\le 26} \overline{\beta}_i}, \frac{\overline{\beta}_i}{\max\limits_{1\le i\le 26} \overline{\beta}_i}\right]$ = ([0.0236, 0.0692], [0.0251, 0.0477], [0.0159, 0.06], ... [0.0335, 0.0655])^T.

Step 7. Tally the number of occurrences of each cause and normalize it.

$\alpha'_p = \frac{\max\limits_{1\le p\le 26} \alpha_p - \alpha_p}{\max\limits_{1\le p\le 26} \alpha_p - \min\limits_{1\le p\le 26} \alpha_p}$ = (0.0496, 0.0567, 0.0567, 0.0567, 0.0426, 0.0496, 0.0496, 0.0496, ..., 0.0213)^T.

Step 8. Aggregate the qualitative normalized weights and the quantitative grey weights. This aggregates the qualitative normalized weight and the quantitative grey weights. This was done using Equation (9).

$\otimes c(p)$ = ([0.0733, 0.1189], [0.0818, 0.1045], [0.0726, 0.1168], ... [0.0547, 0.0868])^T.

Step 9. Compare the aggregated qualitative and quantitative grey weights and sort them. This aggregates the grey superiority degree of the causes. The grey superiority degree table was constructed, which provides a pairwise comparison of each cause.

$\sum_{\zeta,i=1}^{21} p_{\otimes c(i) \succ \otimes c(\zeta)}$ = (6.9730, 7.4903, 7.2619, 7.0642, 6.4256, 6.1398, 3.4756, 8.8435, 7.5424, 2.4087, 18.7177, 19.1784, 15.0355, 14.3786, 14.3765, 20.5000, 16.3078, 13.9125, 3.4816, 6.9191, 14.0674)^T.

Priority order of causes

The analysis of these causes by the 20/80 rule method allowed us to assess their influence to define an order of priority for policies to address the issue of WEEE. This approach is interesting insofar as it makes it possible to propose measures that could help resolve 20% of the causes, which would be responsible for 80% of the production of WEEE by certified organizations (or those in the process of obtaining their certification). This analysis phase is intended to be more quantified. To begin, the causes are sorted in a decreasing other based on the grey superiority degree, and the cumulative effects are calculated as shown in **Table 5**. It is illustrated through the Pareto diagram in **Figure 3**. This representation allows us to appreciate the causes according to their influence on WEEE growth in companies. From the 20/80 rule method, it emerged that a set of 14 causes had an 80% influence on the effect or phenomenon studied; that is, the growth of WEEE in companies.

Table 5. Computation of cumulative percentage effects.

Causes	Grey Superiority Degrees	Percentage Effects	Cumulative Percentage Effects	Calculation of Cumulative Percentage Effects
C_{4-6}	20.5000	9.30%	9.30%	9.30%
C_{4-2}	19.1784	8.70%	17.99%	9.30 + 8.70 = 17.99%
C_{4-1}	18.7177	8.49%	26.48%	9.30 + 8.70 + 8.49 = 26.48%
⋮	⋮	⋮	⋮	⋮
C_{5-1}	3.4756	1.58%	98.91%	97.33% + 1.58% = 98.91%
C_{3-3}	2.4087	1.09%	100.00%	98.91% + 1.09% = 100.00%

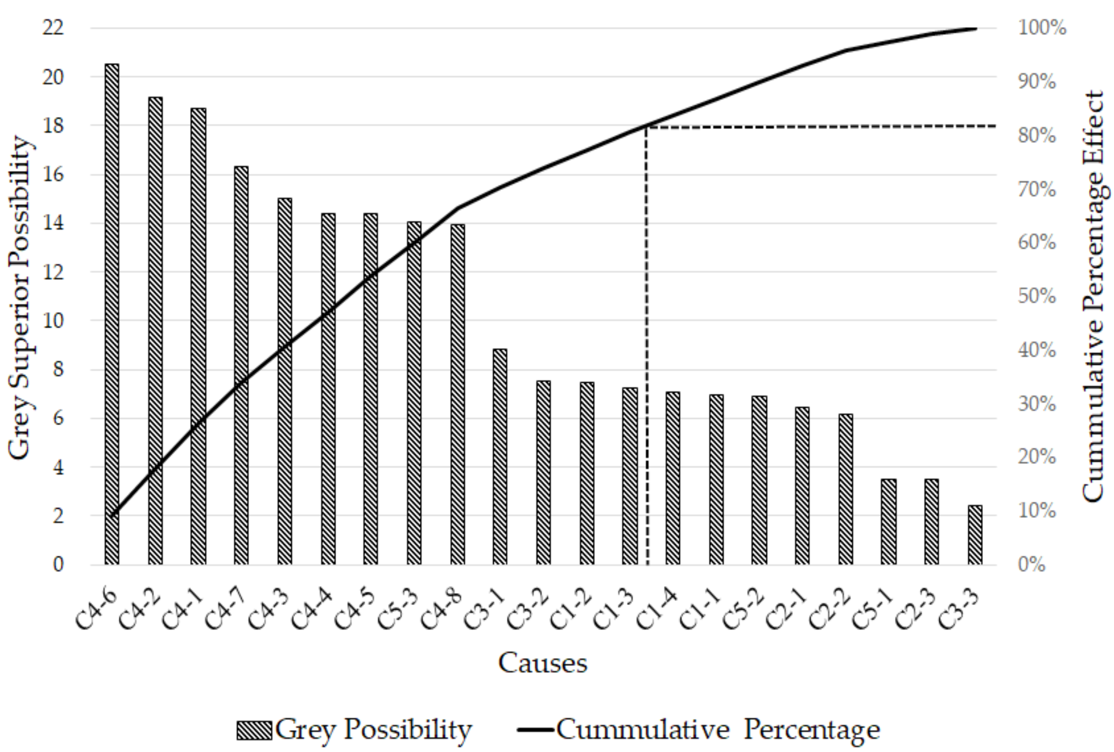

Figure 3. Pareto chart of the cause of WEEE.

5. Discussion

In consideration of priority, we should think about the approaches for reducing the effect or eliminating this set of 14 causes before focusing on the rest of the causes. To do this, in collaboration with our sample companies, we carried out brainstorming.

5.1 Causes and brainstorming

Critical causes

Both non-compliance with collection clauses by service providers ($C_{4\text{–}6}$) and the disposal of WEEE in nature ($C_{4\text{–}2}$) were among the highly significant causes. In accordance with the principle of extended producer responsibility, it is the responsibility of organizations that produce EEE to monitor their products on the market, such that they can collect them when they become WEEE. In our context, these companies were rather represented or had only sales intermediaries in the considered territory; furthermore, some, when purchasing, included collection clauses as soon as the EEE was scrapped. As no national law obliges them to collect their WEEE from consumers, nothing is done at their level to comply with the above mentioned principle. Local companies consuming EEE are left to their free will, which is to either dispose of or store their WEEE. This leads to increases in the quantity of WEEE in the environment. It emerged that the practice and respect of this principle require raising the awareness of the various parties, such that compliance with this collection clause becomes a reality. Further, sensitizing the population on the risks associated with the mismanagement of WEEE has become a necessity for the government and certain organizations responsible for it.

Discharging waste in nature is the very first reaction observed by people in developing countries, in which WEEE is not spared at all. Several companies have testified that "when they could not recover the WEEE by selling it or giving it to the needy, they felt obliged to dump it in the nearest landfills." This practice strongly contributes to the growth of the quantities of WEEE and, consequently, to the pollution of the environment. Thus, it is imperative that companies change their behavior. This requires an awareness policy on the part of the public authorities. A policy aimed at establishing structures specializing in the collection, transport, and treatment of already existing WEEE could greatly contribute to reducing the rate of pollution by WEEE and prevent companies consuming EEE from abandoning their WEEE in nature. Our Brainstorming session led us to highlight the 13 causes that produce 80% of the effect, which can be resolved by proposals for specific solutions and key players in the growth of WEEE. More specifically, 13 main causes were highlighted by the Pareto principle as the subject of the brainstorming exercise; see **Table 6**. Brainstorming is an activity that consists of bringing people together, around a concern, such that reflections are made, and proposals for effective solutions can emerge. In our case, our Brainstorming session brought together nine people around a brainstorming table. These people were eight staff members from each of the organizations in the sample and one of us. We played the role of referee and note-taker during the 45-minute session. At the end of this brainstorming, only the relevant solution proposals were retained.

Other causes

The implementation of these proposed solutions can help to address the eight remaining causes, which were found to influence up to 20% of the increase in WEEE.

Table 7 illustrates these proposed solutions, according to the eight causes. Finally, our Brainstorming session concluded with an analysis of the proposed solutions, to develop a series of actions involving various actors linked to the increase in the quantities of WEEE in companies in Cameroon.

5.2 Recommendations

It is no longer necessary to recall the consequences of the expansion of WEEE for the environment, for human life, and the socio-economic impact

Table 6. Summary of solution proposals from brainstorming.

Causes	Suggested Solution	Actors
C_{4-2}, C_{4-1}, C_{4-3}, C_{4-8}, C_{1-2}, C_{4-6}, C_{5-3}	Promote investment in the recycling of WEEE in the main cities of Cameroon and ensure a deep awareness of the subject and the risks involved	Government and organizations
C_{4-4}, C_{3-1}	Ensure the application and effective regulatory monitoring of existing laws and regulations on waste and WEEE management	Government
C_{4-7}, C_{4-5}, C_{3-2}	The institutions should organize control and monitoring activities of companies in terms of compliance with the various principles relating to waste management and the preservation of the environment and the health of the population.	
C_{1-3}	Challenge the local electricity supplier regarding the quality of the current supplied	Electric power company

Table 7. Proposed solutions according to the remaining causes.

Causes	Suggested Solution	Actors
C_{3-3}, C_{5-1}	Promote investment in the recycling of WEEE in the main cities of Cameroon	Government and organizations
C_{1-1}	Ensure the application and effective regulatory monitoring of existing laws and regulations on waste and WEEE management	Government
C_{1-4}, C_{5-2}	Challenge the local electricity supplier on the quality of the current supplied	Electric Power Company
C_{2-1}, C_{2-2}, C_{2-3}	Ensure a deep awareness on the subject and the risks involved	Organizations

that this creates. To be more explicit, we can cite the pollution of the environment due to metals and toxic products contained in abandoned WEEE; we also talk about the development of the poorly remunerated informal sector, which through clandestine practices, exposes the atmosphere and human life to serious consequences through the production of greenhouse gases which are harmful to health, and ending with the exposure of living beings to soil, air, and water pollution, which poses a widespread threat. Therefore, it is of utmost urgency that the actors cited in this article take action, as far as they are concerned, to gradually combat the causes of pollution.

This research opens up a framework for reflection on the fight against the expansion of WEEE produced by companies in the context of developing countries and calls out the various stakeholders to face their responsibilities. The governments of developed countries may also use these results to rethink their national management strategies for WEEE produced by companies operating in their jurisdiction. Entrepreneurs can see this study as an investment opportunity for the proper management of WEEE. The population in this part of the world should be made aware of the risks linked to the growth of WEEE.

This article remains beneficial for management researchers and organizations interested in subjects relating to the protection of the environment and life, or to the fight against pollution—more specifically, to the fight against pollution by WEEE—due to the techniques of sophisticated research that can be deployed in order to propose strategic solutions to fight against WEEE and its effects. According to some research, if nothing is done to combat WEEE, the world will be exposed to climate change, the destruction of the ozone layer, and the overall reduction of lifespan on Earth, among other factors.

As for recommendations, a series of actions involving several actors was proposed, taking into account the realities on the ground and the economic environment of Cameroon. The government should improve its national policy, aimed at the following:

- Promote investments in the collection and recycling of WEEE;
- Raise awareness among economic players and the population regarding the danger posed by WEEE and the need to manage them;
- Ensure the application of related laws and regulations through checks on companies; and
- Develop training in the WEEE management field.

Companies should review their methods and practices to act responsibly with regard to the waste generated (especially WEEE) through the following:

- Efficient WEEE management procedures that respect the various principles, standards and laws;
- Increasing awareness of WEEE, both internally and externally;
- Developing purchase/sale contracts for EEE through a recovery clause after use;
- Making the components of WEEE that will be useful to them available to artisanal collectors; and
- Ensure the production and distribution of quality current for the proper functioning of electrical equipment by the energy company.

5.3 Managerial implication

The current study mainly explored the question of WEEE grown in Cameron, a representative country of the developing world. We were mainly devoted to the growth of WEEE in a sensitive link in the chain of consumption of EEE, which consists of companies. Identifying the main causes of the increase in WEEE in companies allows each level of managerial responsibility to become aware of the origin of the problem and take actions that help reduce the phenomenon observed by acting on the causes. Identifying the main causes of growth in WEEE quantities is an essential asset for the managerial strategy for WEEE management.

It is of capital interest for the actors cited in this article to each take actions as far as they are concerned, with a view to progressively fighting against the causes of pollution. At the managerial level, carrying out actions aimed at reducing the impact of a phenomenon is necessary, but not sufficient to eradicate the problem. One of the most-appreciated possibilities would be for governmental institutions and entrepreneurs to find strategies to import WEEE treatment or recycling technologies and, if possible, to subsidize projects relating to the ecological management of WEEE. Managerial involvement will allow for the creation of openings for the treatment of WEEE in a clean way, which is respectful of both the environment and life.

Institutions, together with businesses, can also develop means of mutual monitoring, in order to control the quantities of WEEE produced and their fate, in compliance with relevant laws and the protection of the environment and life. For example, the government can assign “environmental controllers” who, together with the Health Safety Environment managers of organizations, monitor WEEE products and their ecological treatment. The managerial challenge lies in the control of the quantities of WEEE produced and their fate.

In addition, the policy-makers are the governmental institutions in Cameroon. They are responsible for the strategy of the territory. A clear example of a strategy is to enact laws to control the import of second-hand devices that highly contribute to the level of WEEE in Cameroon. This is because, based on our observation and findings, many second-hand devices have an extremely short life span.

Finally, institutions can develop laws to reduce the purchase or import of second-hand or end-of-life EEE. This restriction could majorly contribute to preventing the hasty creation of WEEE. Thus, the lifespan of EEE can be controlled, thus negatively influencing the phenomenon of WEEE growth. The managerial challenge is to anticipate the multiplication of WEEE quantities from abroad.

6. Conclusions

For a century, management has been described as the art of planning, organizing, commanding, coordinating, and controlling. Managing also involves anticipating phenomena through the use of relevant data or information collected to make good decisions or implement good actions. Managing WEEE consists of estimating the quantities, describing the impacts, establishing laws, or defining practices aimed at controlling the associated effects, but also identifying and understanding the source or cause of the problem and acting on the causes of the phenomenon related to WEEE. Our study focused on understanding the behavior of certified companies (with respect to ISO 14001:2015) and those in the process of obtaining certification regarding the management of WEEE in Cameroon. The literature review leads, observation, documentary research, and interviews led us to identify five five-level indicators and 21 second-level causes of WEEE. Considering its impacts on human health and the environment, these causes, collection, and recycling measures of WEEE were evaluated qualitatively and quantitatively. Our Brainstorming session led us to the following conclusion: The 13 causes that produce 80% of the effect of the phenomenon studied can be resolved through various proposals for specific solutions aimed at key players in the growth of WEEE.

The significant contribution of this paper lies in the integration of the qualitative method with GST. Our new approach provides both qualitative and quantitative hybrid analysis under uncertainty, as represented by grey numbers. Based on the Pareto principle, we proposed relevant recommendations. Furthermore, non-compliance with collection clauses by service providers (C_{4-6}), disposal of WEEE in nature (C_{4-2}), and Storage of WEEE in stores (C_{4-1}) comprised the remaining causes of the growth of WEEE in companies. Solutions and recommendations from the brainstorming session led to their means of resolution among the proposed solutions resulting from the brainstorming session. This final step concluded with the development of a set of recommended actions. As for the recommendations, a series of actions involving a number of actors was proposed, taking into account the realities on the ground and the economic environment of Cameroon. Finally, it appears that it would be interesting to act on measures such as governmental policy, responsible organization methods and practices, and the quality of electrical energy.

There exist some limitations to this research. The research working conditions are a determining factor because the size of our sample is a result. The sample size for this research would have been larger, but the study, being carried out in a context where the COVID-19 pandemic was most rampant, we were unable to obtain the support of a large number of companies. Another primary concern regarding WEEE management is estimating or quantifying WEEE generated in developed countries. Research work aimed at defining methods for quantifying and estimating WEEE quantities in Cameroon will greatly interest the scientific community.

Future research in the field may be directed towards analysing the quality of solutions to tackle the growth of WEEE in developing countries. Since without greening the supply chains in the journey towards a sustainable future won't be easy, the green supply chain should be considered in Cameroon. Another study can be done with a larger sample than ours or extended to several types of actors. Lastly, future work can investigate the longitudinal impact of implementing the recommended solutions presented in this research.

Authors' Contributions

Each author has made significant contributions to this article. The roles of each author are as follows:

- Gilson Tekendo Djoukoue: Conception/design, data collection, and qualitative analysis and results interpretation.

- Moses Olabhele Esangbedo: Application of gray system theory by using gray number and results interpretation.

- Sijun Bai: Supervision, review, and validation of the final version for publication.

Conflict of Interest

We declare that there are no conflicts of interest related to this research. None of the authors have any financial or professional relationships that could inappropriately influence the results or interpretations presented in this article.

Declaration

We affirm that this manuscript represents the original work by the mentioned authors. It has not been previously published and is not currently under review by any other journal.

Informed Consent

We confirm that we obtained consent from all study participants before its conduct.

Ethical Approval

We would like to emphasize that this study has been approved by Professor Bai Sijun, who oversees our scientific research work as the research coordinator.

We certify that all authors have read and approved the final version of the manuscript and take responsibility for its content. We hope that our submission will be considered for publication in your prestigious journal and contribute to advancing knowledge in the Waste from Electrical and Electronic Equipment Management field.

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