# Reviewing and Testing eWaste Policies using a Systematic Model

# R e p o r t

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## University of Technology, Mauritius

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# Abstract

Waste generation has always form part of our life but presently it is termed as a 'global phenomenon' which needs to be handled through appropriate methods and policies. It is a matter of concern since there has been a growing trend in the disposal of wastes irrespective of whether they are classified as toxic or non-toxic wastes. The term 'waste' also incorporates Waste Electrical and Electronic Equipment (WEEE), commonly known as electronic waste or e-waste, as a consequence of the rapid development in technology. Given that Mauritius is adhering to the concept of sustainability, there is a need to manage e-waste efficiently. Therefore, there is a need to adopt a two-pronged approach in an attempt to address this issue. The first approach requires reducing the generation of e-waste while the second one involves resolving the fate of such products at the end of their useful lives. These prime objectives need to be embodied within an e-waste management strategy by ensuring proper treatment of e-waste, which is safe and affordable for local authorities and consumers. In this context, an E-waste Research Programme is being implemented by the Mauritius Research Council in collaboration with University of Technology, Mauritius. This project aims at studying and developing an eWaste Policy Framework using System Dynamics.

# 1. INTRODUCTION

The term "Electronic waste", denoted in short by the word "e-waste", is a type of waste consisting of old, end-of-life or discarded appliances using electricity (Pandve, 2007). "E-waste" is also used as a generic term embracing all types of waste containing electrically powered components. Electrical and electronic wastes contain both valuable materials as well as hazardous materials which require special handling and recycling methods. The hazardous substances found in the e-waste include substantial quantities of lead, cadmium, chromium and flame-retardant plastics. For instance, cathode ray tubes and components with high lead content are considered dangerous to health. Inhaling or handling such substances and being in contact with them on a regular basis can damage the brain, nervous system, lungs, kidneys and the reproductive system. Hence, there is a need to ensure that e-waste is managed adequately. This covers technological improvement, institutional arrangement, operational plan, protective protocol for workers working in e-waste disposal, and last but not the least education of general population about this emerging issue posing a threat to the environment as well as public health. The function elements of electronic waste are computers, entertainment electronics, cellular phones and other disposed electronic items.

## 1.1 Project Aims and Objectives

When Electric and Electronic Products reach the end of their life cycle, they are most of the time discarded. The life cycle starts their initial production, until consumers buy these goods and use them. However, after using them for some period of time, these products are regarded are useless (phased out, or broken) they are set aside or disposed. At this stage, they are regarded as electronic wastes (eWastes). The environmental, social and economical impacts of eWastes have forced authorities to encourage, their reuse and recycling. The uses of electronic products are increasing significantly, and eWastes are likely to rise proportionately in the forthcoming years. Recent studies conducted by the Mauritius Research Council in collaboration with the University of Technology, Mauritius the Local Government, have disclosed the soaring eWaste trends for the coming years in Mauritius.

This project focuses on the development of eWaste policy measures using systematic model. From the previous eWaste quantification project, it was found out that eWaste has a complex cycle whereby different areas of concerned need to be addressed. A system dynamic model is therefore essential for the formulation of appropriate policy measures in Mauritius. In this project, a profound literature review is carried out in order to fathom the current policies regulating eWaste in Mauritius and other countries around the world. Key stakeholders are surveyed on present practices related to eWastes. The gathered data are processed in the form of a dynamic model, thereby consisting of all core elements involved in the system. The model houses identified policy measures that are meant to foster reuse, recycling and reduction of eWaste in Mauritius. The developed model is validated by considering activities for effective policy information.

## 2.0 LITERATURE REVIEW

### 2.1 eWaste

In general, eWastes are perceived as 'unusable computers and other IT related equipments'. However, referring to the OECD's definition, it is 'any appliance using an electric power supply that has reached its end-of-life'. Widmer et al. (2005) termed eWaste through different definitions. Sinha et al. (2005) defined eWaste as 'any electrically powered appliance that no longer satisfies the current owner for its original purpose'. eWaste comprises both of white goods ( e.g. Refrigerators, microwaves, etc.) and brown goods (computers, televisions, etc.).

### 2.2 Policy Instruments

A policy is regarded as a 'Statement of Intent' or a 'Commitment' (Wikipedia Policy, 2011).It defines the as a set of principles or rules essential for decision making and hence achieve rational outcomes. The growing amount of eWastes is of major concern to authorities around the world. eWastes pollute the environment, and generate significant cost impacts. Framing adequate policy measures is vital for the proper management of eWastes. Presently, policy measures fail to contribute towered a sustainable and efficient eWaste management system. Establishing the right policies require the understanding of responsibilities of eWastes.

### 2.3 Responsibilities

Electric and electronic wastes fall under the responsibility of everyone. However, the Waste from Electrical and Electronic Equipment (WEEE) directive assigns the responsibility of eWastes to producers (Directive 2002). As per the Directive 97/7/EC of the European Parliament and Council, producers are defined as follows (Directive 2002):

1. manufactures and sells electrical and electronic equipment under his own brand;

2. resells under his own brand equipment produced by other suppliers, a reseller not being regarded as the 'producer' if the brand of the producer appears on the equipment, as provided for in subpoint (i); or

3. imports or exports electrical and electronic equipment on a professional basis into a Member State.

The Extended Producer Responsibility (EPR) is a strategy formulated to make manufacturers of electric and electronic goods responsible for the whole life cycle of their product, thus fostering take-backs, recycling, and safe disposal (Lindhqvist, 2000). Table 1 summarises the approaches harnessed to formulate EPR policies.

Table 2.0: EPR approaches (OECD, 2001)

| Types of EPR | Types of Tools | Examples of EPR Applied |
|---|---|---|
| Product take back | Mandatory take back | Packaging (Germany) |
| | Voluntary or negotiated take back programs | Packaging (Netherlands, Norway) |
| Regulatory approaches | Minimum product standards | EEE, batteries |
| | Prohibitions of certain hazardous materials or products | Cadmium in batteries (Sweden) |
| | Disposal bans | EEE in landfills (Switzerland) |
| | Mandated recycling | Packaging (Germany, Sweden, Austria) |
| Voluntary industry practices | Voluntary codes of practice | Transport packaging (Denmark) |
| | public/private partnership | |
| | Leasing, 'servicizing', labeling | Photocopiers, vehicles |
| Economic instruments | Deposit-refund schemes | Beverage packaging (Korea, Canada) |
| | Advance recycling fees | EEE (Switzerland, Sweden) |
| | Fees on disposal | EEE (Japan) |
| | Material taxes/subsidies | |

Consumers are the generators of eWastes. As mentioned earlier, a product turns to eWaste when the latter has no more value to the consumer. As shown in Figure 2.1, consumers are responsible to dispose their eWastes, or return them for recycling or reuse. Implementing sound policy measures lead to reductions in eWastes. Consumers in most countries around the world have an inclusive recycling fee when buying any electric and electronic products (FindLaw, 2010). Studies carried out in Mauritius revealed the differences in product lifetime as per their quality. In other words, better quality products are prone to become eWastes on a much longer time as compared to inferior quality ones. Hence, eWastes generation increases as consumers favor cheap, low-lifespan electric and electronic goods. The rapid change in technology is another core element influencing eWaste generations (Website eWaste, 2010). Constant improvements in electric and electronic products compel consumers to limit the usage of their present goods, for more sophisticated ones. Although this might be beneficial for economies, yet more and more electric and electronic goods are set aside, or left unused.
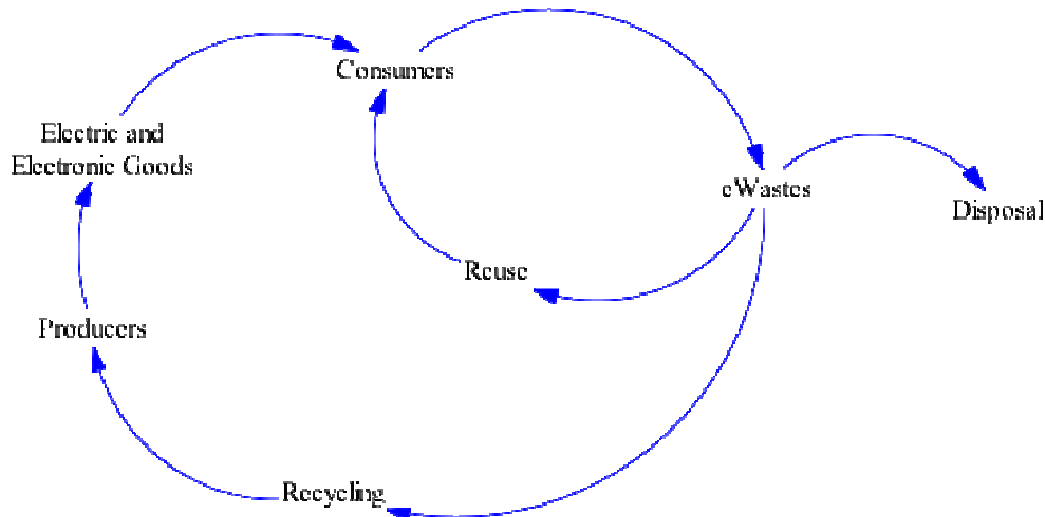


Figure 2.0: The eWaste cycle

Producers and consumers responsibilities are the starting and ending contributors to eWaste. However, in between these two key players reside a number of parties responsible for the generation of eWaste, namely; merchants, authorities, and brokers (WEEEForum, 2009). Authorities are working with industry manufacturers to manage resources in a trend referred to as "product stewardship." Product stewardship is a product-centered approach to environmental protection. It calls on those in the product lifecycle—manufacturers, retailers, users, and disposers—to share responsibility for reducing the environmental impacts of products (Wikipedia Policy Analysis, 2011). This responsibility spans the product's life cycle: from selection of raw materials to design and production processes to its use and disposal (EPA, 2011). Product stewardship also embraces the concept that products have materials in them that have a value; and that value should be captured, preserved and returned for use in commerce. Authorities are encouraging product stewardship in a number of industries, such as automobiles, packaging, and electronics.

Institutional mechanism for eWaste management system has been described in terms of three elements like collection systems, national registry and logistics. Each of these three elements has been further described in terms of different stakeholders and their respective roles/ responsibilities.

## 2.4 Collection Systems

Regulation in each country provides the basis of eWaste collection system. There are two generic categories of collection systems at national level i.e. "collective system (monopoly)" and competition based "clearing house system" for managing eWaste. The objective of both the systems is to provide eWaste management services at reduced costs to the consumers i.e. household or business and ensure compliance at the national level.

### 2.4.1 Collective System

The collective system is a system which is responsible for collection, recycling and financing of all or major part of eWaste within national boundaries. This is the general approach in the

countries with established eWaste system. Their legal status differs from country to country, but they are generally nongovernmental, not-for-profit companies which are set up and owned by one or more trade associations. They are organized into product categories in order to focus on achieving maximum efficiency in their recycling operations and to identify markets for recycled material and product reuse.

## 2.5 Clearing House System

The clearing house system is a system in which multiple partners (producers, recyclers, and waste organizations) can provide services on a competitive basis. The government ensures that there is a register of producers and it defines the allocation mechanisms, and reporting and monitoring systems. The responsibilities of a central national coordination body are to determine the collection obligation of each producer (via the national register) and to assign this obligation to the compliance scheme action on behalf of the producer. This body will also establish an allocation mechanism that enables compliance systems to indeed collect EWaste in an equitable manner from collection points throughout the territory.

## 2.6 National Registry

Any registered body/ agency, which maintains the register of producers/ recyclers/ waste organizations, inventory of eWaste has been defined as national registry. This body/ agency can also determine collection obligation of each producer and ensure equitable compliance. This body/ agency could be any government entity or a non-profit organization recognized/ supported by the government for discharging the above-mentioned functions.

## 2.7 Logistics

There are three primary channels of eWaste collection. All the three channels address "Business to Consumer" (B2C) and "Business to Business" (B2B) eWaste collection. These channels are municipal sites, in store retailer take-back and producer take-back. Generally, municipal

collection sites are usually free for households to use to an unlimited extent while take-back through retailers is usually free but can be dependent upon the purchase of a new product (both B2C and B2B). The direct producer take-back system may apply to larger commercial equipment and operates on a new for old basis (B2B).

## 2.8 eWaste Policies Worldwide

EPR or "Product Take Back" forms the basis of policy framework in developed countries. WEEE directives provide a regulatory basis for collection, recovery and reuse/ recycling targets in EU. The development of legislation and compliance structure as per EU directives is an on-going process in all EU countries. The member states have to guarantee minimum collection, recovery and reuse/ recycling targets as specified in the directive. The fundamental principle of WEEE directive is "Extended Producer Responsibility", where producers are responsible for eWaste take back. Those European countries, which are not part of EU either follow EU directive or more stringent standards based on eWaste management. Majority of countries have regulations similar to WEEE directives. Countries like Japan have regulations focused on "Reuse, Recycling and Recovery". Other countries like Canada and Australia are developing their systems based on the similar principles of EPR.

Some governments have passed laws or amended the waste management policies of the private sector in order to regulate eWaste. Government officials feel it is important that not just companies, but consumers are made aware of the issue, with many pressing for educational efforts geared at educating the public about the dangers of ignoring and the potential benefits of recycling e-waste. Many corporations and waste management companies also feel it is of prime importance that the average consumer understands which electronics need special care when it comes time to dispose or recycle them, pointing out that even though large companies do produce a large amount of e-waste the bulk comes from individuals.

One solution is that eWaste should not be considered as waste and thus be regarded as a resource. Useful materials such as glass, copper, aluminium, plastic and other components can often be extracted and reused. Some manufacturers have even referred to eWaste as a valuable

source of materials. Many landfills and waste processing plants have instituted new procedures to assure that the valuable materials found in eWaste are not accidentally buried and forgotten. Waste management services in Australia, Asia, Europe and North America have begun concerted efforts to capture these precious resources rather than let them be landfilled forever. Companies worldwide even have made a business model based on the excavation of disused landfills.

The table below depicts the varied legislations enforced in countries around the world.

Table 2.1: eWaste legislation around the world (Sinha, 2009).

| Country | Legislation | Responsibility | In force since |
|---|---|---|---|
| Switzerland | Ordinance on the Return, Taking back and Disposal of Electrical and Electronic Equipment. (ORDEE) | Manufacturer/importer | July 1998 |
| Denmark | Statutory Order from the Ministry of Environment and Energy No. 1067 | Local Govt. | December 1999 |
| Netherlands | Disposal of White and Brown Goods Decree | Manufacturer/importer | January 1999 |
| Norway | Regulations regarding Scrapped Electrical and Electronic Products | Manufacturer/importer | July 1999 |
| Belgium | Environmental Policy Agreements on the take back obligation for waste from electrical and electronic equipment | Manufacturer/importer | March 2001 |
| Japan | Specified Home Appliances Recycling Law (SHAR) | Manufacturer/importer | April 2001 |
| Sweden | The Producer Responsibility for Electrical and Electronic | Manufacturer/importer | July 2001 |

| | | | |
|---|---|---|---|
| | Products Ordinance (SFS 2000:208). | | |
| Germany | Act Governing the Sale, Return and Environmentally Sound Disposal of Electrical and Electronic Equipment (ElektroG Act) | Manufacturer/importer | March 2005 |

## 2.9 Policy Models

There exist many models meant for the creation and application of policies, namely: institutional model, process model, rational model (Report, 2006). The institutional model caters for all policies established by political institutions for all citizens at larger. The process model is a step-based model whereby problems need to be identified, proposals have to be formulated, and the most appropriate policy is selected and implemented. The process also involves an evaluation process. The rational model is a process for making logically sound decisions in policymaking. This model favours a more dynamic approach for the implementation of policies by authorities.

# 3.0 METHODOLOGY

## 3.1 Survey

In order to frame policies for eWaste reduction, reuse and recycling, surveys have to be conducted for Mauritius. Different stakeholders are surveyed, in order to identify parameters influencing eWaste generations. The framework is based on the variations of the different parameters established through the causal loop. A causal loop is a simplified model helping to determine the dependency of various factors involved in the model. On the other hand, it is an essential means to find the possible implications of policies on eWaste generations.

Three types of surveys are meant to be conducted for this project namely:

1.      Household Surveys

2.      Institutional Surveys

3.      Producers Surveys

All three surveys aim at identifying loopholes and possible implementations of new policies from both consumers and producers point of view. The actual sampling size depends on the types of surveys conducted.

### 3.1.1 Household Surveys

The household surveys are conducted on a random basis, focusing towards collecting unsystematic view points of daily e-good consumers. It should be pointed out that the policies affect mostly consumers, compelling them to reduce, reuse, and sort eWaste for recycling. The survey therefore aims at understanding behaviours of e-goods consumers, thereby identifying criteria encouraging reduce, reuse, and recycling. The target areas of the survey form are as follows:

1.      Identifying eWaste responsibilities

2.      eWaste disposal methods

3.      Criteria for purchasing e-goods

4.      eWaste management systems

5.      Means of storing eWastes

6.      eWaste recycling

7.      eWaste reuse

8.      Demographic information

## 3.2 Model Formulation

The system dynamic model is formulated based on the findings from surveys carried out. To develop the model, a Causal Loop Diagram will be established, thereby helping in formulating the Stock and Flow Model for the eWaste Policy. The dynamic model will be driven by several equations derived from the surveyed data and analysis. Following the model formulation, validations will be carried using previous data. The simulated data (backward simulation) will be verified with resent data thereby helping to calibrate the model effectively.

## 3.3 Case Study

### 3.3.1 Interview of Mr Berty Malabar

Monday 07 June 2010 (9.40 to 11.10AM) 11.10.10

For many years now, Mr Berty Malabar, owner of BEM Enterprise Ltd, a small and medium enterprise located in the midst of Beau Bassin, has been operating as a professional in the e-waste recycling business.  More specifically, he has been dealing with the collection, dismantling and exportation of electronic waste commonly termed as e-waste or Waste Electrical and Electronic Equipment (WEEE).  A face-to-face interview conducted with Mr Malabar in June 2010 revealed a number of his personal views and opinions for the betterment of our natural environment.  He pointed out that the throwing away or dumping of e-waste should be

prevented as this practice can prove to be an environmental hazard as well as a potential threat to human health. Mr Malabar opined that the present course as regards the dumping of e-waste should be repealed if a more friendly environment is to be promoted.

The main objective of BEM Enterprise Ltd as specified by Mr Malabar is to prevent parts and components of waste e-products, with specific emphasis on hazardous waste electronic products, from being disposed in the open and also to ensure that used e-products are brought back into use after the recycling process. Mr Malabar strictly commented that he wants every single waste electronic product to undergo the recycling process. He lamented that technology is becoming obsolete at a rapid pace which is accelerating the disposal of electronic goods. To be able to cope with this issue, Mr Malabar argued that there is a need for a proper infrastructure to enable a better and faster processing of waste electronic recycling.

In his discussions, Mr Malabar put forward that currently, there is no proper e-waste management system to manage waste electronic products in terms of collection, recycling and reuse. He pointed out that a number of policy measures which have been enforced in other countries need to be considered for implementation in the country to improve the current situation of e-waste management. However, only those policies which are appropriate for implementation in the Mauritian context should be considered.

Mr Malabar also recommended that a system should be introduced to enable record keeping of every single electronic product that enters the country with a view to be in a position to trace those products once they outshine their useful lives. He further argued that this exercise is crucial especially to facilitate traceability of hazardous or toxic e-products which may impact negatively on the environment if thrown away. This inventory system could prove to be a useful tool for preventing used e-products from being dumped and also to bring them back into the e-waste management cycle. In this view, he suggested that the record keeping activity should start with importers of electronic goods and the latter should take the responsibility of informing the local government of the amount of the different categories of electronic goods that they import. The importers, through retailers, should also keep track of the diverse categories of electronics being sold to consumers to facilitate recovery of same after they exceed their useful lives.

He further advised that, in turn, government should use this record for follow-up purposes to ensure that these e-products are returned back after they have been used. Also, records of hazardous products which are used in hospitals, clinics, and photo shops should be kept by the government for the ease of traceability after their use.

Another argument that Mr Malabar stressed on is the setting up of a proper collection system where emphasis will be laid on the separate collection of the different electronic products by electronic waste carriers to be transported to a dismantling plant. The dismantling plant will be responsible for the disassembling and sorting of the various parts and components from the e-goods. Parts made up of metal and plastic substances will be crushed and compressed with a view to export them for recycling and ultimately to be used in the manufacture of other products. Thus, no single electronic product will be disposed of in the landfills which imply lesser or no risk to human health and our natural environment. This will also prevent the loss of precious metals which are currently being dumped into our landfills due to the non-existence of a proper e-waste management programme.

With a view to enable better management of electronic products, Mr Malabar proposed the below system which he considers as an appropriate e-waste management cycle through which any waste electronic product should pass during and after its useful life.

(a) Importers of electronic goods should inform the local government what e-products they are importing for record keeping and traceability.

Return back used electronic products to retailers upon purchase of new e-products[1]

(b) Separate collection of used electronic products

(c) Dismantle used electronic goods

(d) Sorting of parts and components

(e) Crushing of parts

Manufacturers

Importers

**Distribute to**

Retailers

**Sell to**

Consumers

**After use**

Proper Collection System[2]

Dismantling Plant

**\*No disposal of used electronic products**

Export

Recycling Plant

Goes back to Manufacturers

After recycling

Figure 3.0: Proposed system of managing e-waste

Note:

If consumers return back the used e-products directly to retailers, then the retailers should have the responsibility of sending the collected e-waste to the dismantling plant.

Otherwise, there is a need for a proper e-waste collection system to be put in place to enable proper collection of e-waste from consumers. In this instance, the concerned authority collecting the e-waste will be responsible for sending them to the dismantling plant.

## 3.4 Take Back Scheme

Mr Malabar stated that the government should provide incentives not only to customers but also to retailers, importers and owners of dismantling plants because the returning back and processing of used electronic products involve certain costs. In this respect, the government should plan a scheme to provide incentives to retailers to implement take back schemes and also to encourage retailers to provide incentives to consumers to urge them to return back every single used electronic product to their respective retailers once the product cannot be used any longer. This will aid in creating a win-win situation for every stakeholder involved in the chain. The returning back of used electronic products by customers should be encouraged through specific schemes where an individual can return back his/her old electronic products upon purchase of new ones.

## 3.5 Corporate Social Responsibility (CSR)

The government should encourage companies to send their e-wastes for recycling instead of disposing them in landfills or simply giving them to their employees, the reason being that, at the end, they will all be discarded in the open thus leaving the problem unsolved. Mr Malabar remarked that organisations seem to be reluctant to send their e-wastes to recycling enterprises as there is an additional cost which is associated with this practice. Therefore, he proposed that companies or organizations may classify the costs associated with sending e-waste for recycling

under the CSR programme of the company given that this initiative may prevent harmful e-products from being dumped in our natural environment.

### 3.6 Carry out sensitization campaigns in schools

School children should be sensitized of the growing concern of e-waste as well as the consequences they may have on the natural environment and human health through the organisation of sensitization campaigns in schools. Children tend to take things positively and try to bring into practice whatever they are taught at school. In this respect, they may be forceful at home and may inspire their parents to implement whatever they have learnt in the sensitisation campaigns conducted at school. This will help in providing people with more information on the end result of disposing used electronic products in the nature and eventually, this can lead to a reduction in the amount of e-waste that is presently being dumped in the landfills.

# 4.0 DATA ANALYSIS

## 4.1 Household Survey

### *4.1.1 Responsibility*

8% of surveyed inhabitants think it is the responsibility of Importers/Retailers of e-products only. 12% thinks it is the responsibility of consumers only. 25% believes it is the responsibility of Local Authorities only. 14% believe that both consumers and Local Authorities should shoulder the responsibility of eWastes. 21% thinks that it the responsibility of Importers/Retailers and Local Authorities. This clearly indicates that nearly 46% of surveyed population agrees that Local Authorities are meant to be responsible for eWaste Management in Mauritius. According to the survey, consumers and importers have equal responsibilities.

### *4.1.2 Consequences of eWastes*

84% of surveyed consumers are aware of the disposing e-waste in the natural environment.
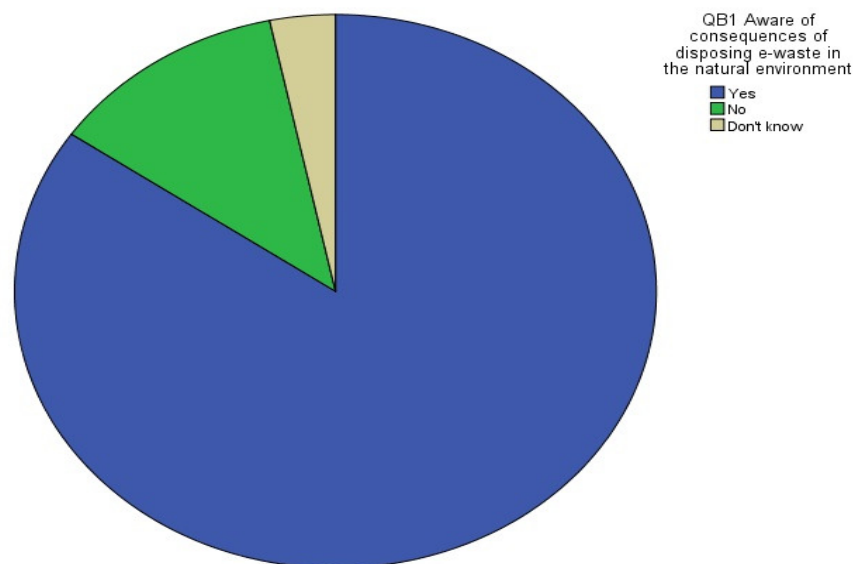


Figure 4.0: eWaste Consequences

### 4.1.3 eWaste Disposal

A significant portion (53%) of the surveyed population stores their eWastes at household level as show in the pie chart below. The discarded eWastes are streamed in the Municipal Solid Waste and disposed at transfer stations and landfill. The major reasons for consumers to throw away their electronic goods are mostly due to lack of storage space, the products cannot be re-used and they are expensive to repair.



QB2 Throw away e-waste
- Yes
- No
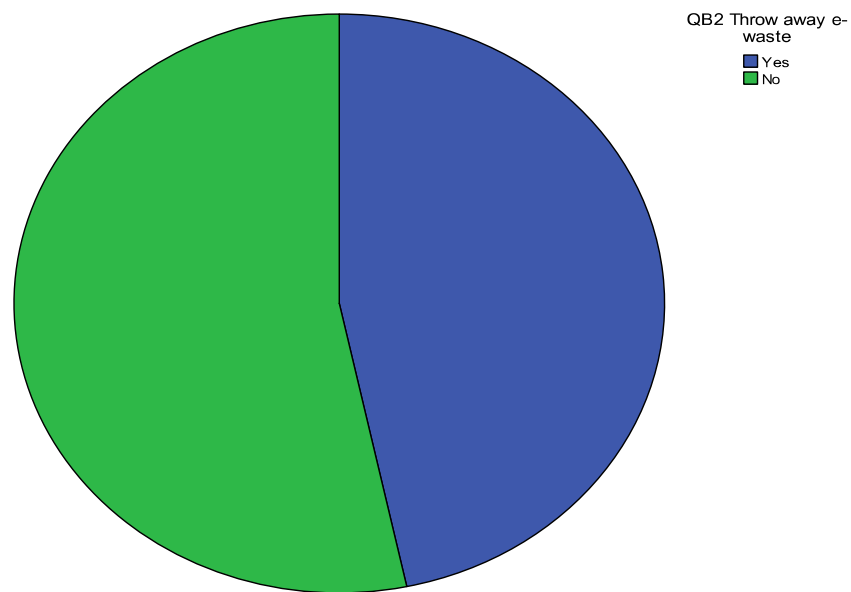
Figure 4.1: eWaste Disposal

### 4.1.4 Purchase of electronic Goods

From the survey, 64% of consumers opt for electronic goods having a longer lifespan. Likewise, those who prefer a longer lifespan of these goods also value better quality products (45%) of cheap ones. It was noted during the survey that consumers are not aware of green-tag products, but favours goods that are energy efficient. Only 5% of consumers are concerned with the disposal of their electronic goods prior to purchase.

### 4.1.5 eWaste Management System

It was noted that 98% of surveyed consumers demand that a proper eWaste management system is setup. 84% of consumers are willing to return their eWaste to retailers. The motivational factor encouraging them to return eWastes are mostly explained by the possibility of getting new discounted e-products on purchase (41%). 14% consumers are likely to return their eWastes in order to reduce environmental impacts, and 7% will do same due to lack of storage space.

However, a strong resistance (60%) to the purchase of second-hand e-products was noted during the survey as shown in the diagram below. This is mainly explained by the faulty risks involved in purchasing such products as well as their reduced lifespans. Customers agree to pay a minimal fee upon purchase of electronic goods, which will be reimbursed once the end-of-life product is returned back to the retailer. 97% of surveyed consumers are in favour of a proper collection system, and 43% of them are agreeable to pay a fee per unit of eWaste disposed, while 47% argue that the fee should be fixed to the type of eWaste disposed. It was surveyed that 69% of consumers will like to pay more for environmental friendly products.
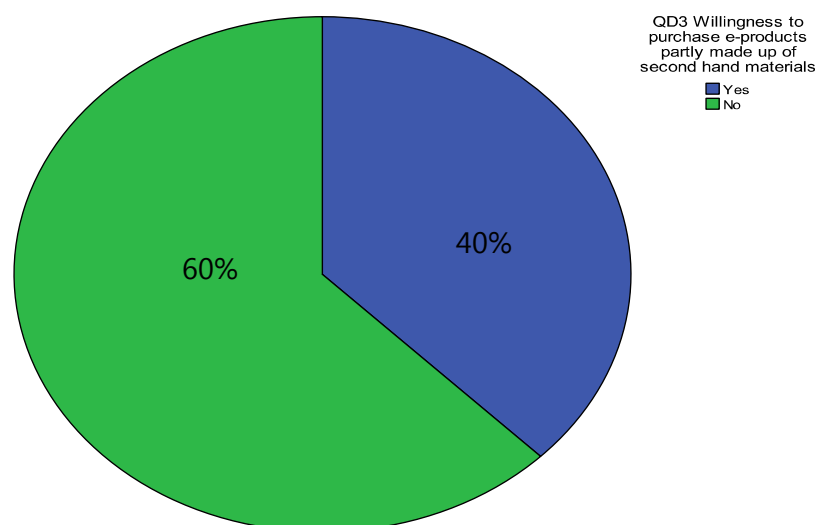


Figure 4.2: Willingness to Purchase eProducts partly made up of Second Hand Materials

### *4.1.6 eWaste Storage*

46% of surveyed consumers store eWastes at domestic level, out of which 27% of them keep their unused electronic goods for more than one year as shown in figure below. This is mainly due to lack of recycling facilities in Mauritius, no proper disposal areas for such type of waste, and inappropriate eWaste Collection Systems.
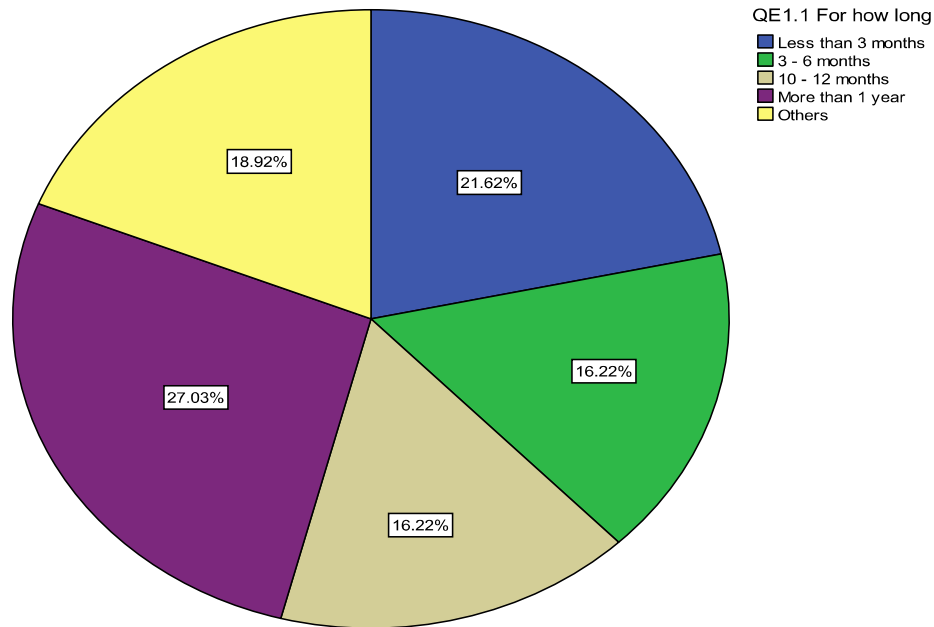


Figure 4.3: eWaste Storage

### *4.1.7 Recycling*

According to the survey, consumers will be more encouraged to recycle their eWastes if Local Authorities organise regular campaigns for collection of such type of waste. A significant number of surveyed consumers are willing to recycle their eWastes provided there are recycling centres available in their neighbourhood.

### *4.1.8 Re-Use*

64% of consumers do not re-use their electronic products, while 28% re-use part of their eWastes (see figure below). Such high percentage of consumers reluctant to re-use their

electronic goods is mostly explained by the ease of buying newer technologies. As a matter of fact, it is more cost effective to buy newer technologies, and also nearly 30% of surveyed consumers argued that they would prefer to have new and updated technologies.
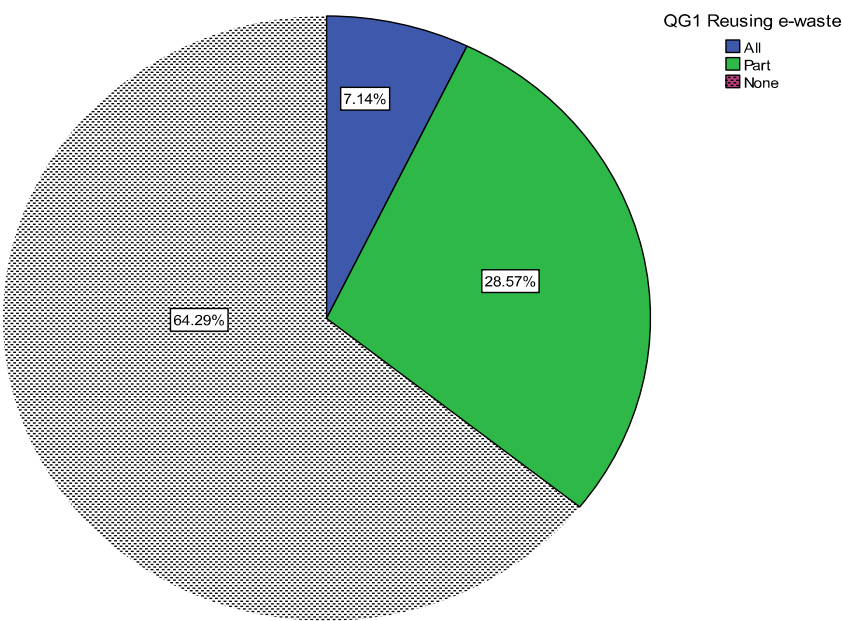


Figure 4.4: eWaste Reuse

### 4.1.9 Overall Findings

The survey clearly indicates that eWastes are disposed in an improper way or stored at household level due to lack of recycling activities. However, it has been noted that one of the major causes of such reluctance in recycling or re-using eWastes is due to lack of information provided to consumers. In fact, when compared to the different salary scales, it is obvious that high-income earners are more sensible in electronic product choices and aware of disposal methods, recycling and re-use. They are more concerned by the environmental impacts of eWastes (as shown in table below).

Table 4.0: Disposal Awareness

| QB1 Aware of consequences of disposing e-waste in the natural environment * QH3 Household income level Crosstabulation | | | | | | |
|---|---|---|---|---|---|---|
| Count | | | | | | |
| | | QH3 Household income level | | | | |
| | | Rs10001 - Rs20000 | Rs20001 - Rs40000 | Rs40001 - Rs60000 | Rs60001 and above | Total |
| QB1 Aware of consequences of disposing e-waste in the natural environment | Yes | 6 | 28 | 21 | 20 | 75 |
| | No | 2 | 3 | 2 | 2 | 9 |
| | Don't know | 2 | 0 | 1 | 0 | 3 |
| Total | | 10 | 31 | 24 | 22 | 87 |

Similar trends are noted when comparing rural and urban surveys (see table below). In fact, around 55% of urban consumers are aware of eWaste environmental impacts.

Table 4.1: Consequences of Disposing eWaste

| QB1 Aware of consequences of disposing e-waste in the natural environment * QH4 Region in which you reside Crosstabulation | | | | | |
|---|---|---|---|---|---|
| Count | | | | | |
| | | QH4 Region in which you reside | | | |
| | | Rural | Urban | Semi-urban | Total |
| QB1 Aware of consequences of disposing e-waste in the natural environment | Yes | 20 | 42 | 14 | 76 |
| | No | 2 | 7 | 2 | 11 |
| | Don't know | 2 | 1 | 0 | 3 |
| Total | | 24 | 50 | 16 | 90 |

## 4.2 Parastatal Survey

The parastatal organisations which participated in the study were mainly from the educational sector with 43.8%. The construction, ICT/BPO and, community, social and personal services each constituted a percentage participation of 12.5% and, 18.8% of the participants were from the agriculture and fishing sector.
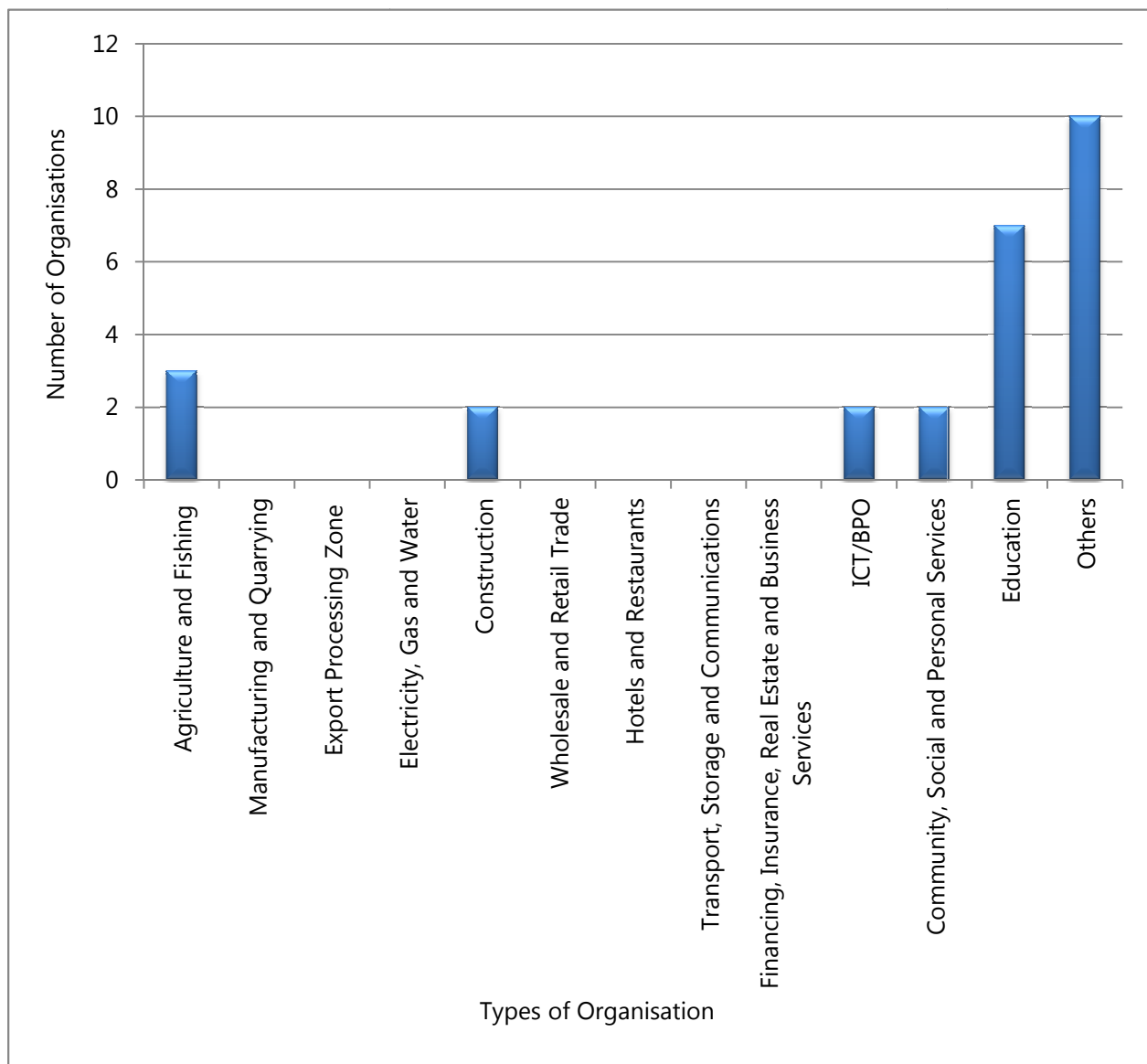


Figure 4.5: Type of activity of the parastatal body

Figure 4.6 below shows that 86.36% of the respondents agree to contribute towards the Environment/Maurice Ile Durable while only 4.55% did not agree. Thus, it can be observed that there is a positive response for the Contribution towards the Environment/ Maurice Ile Durable.
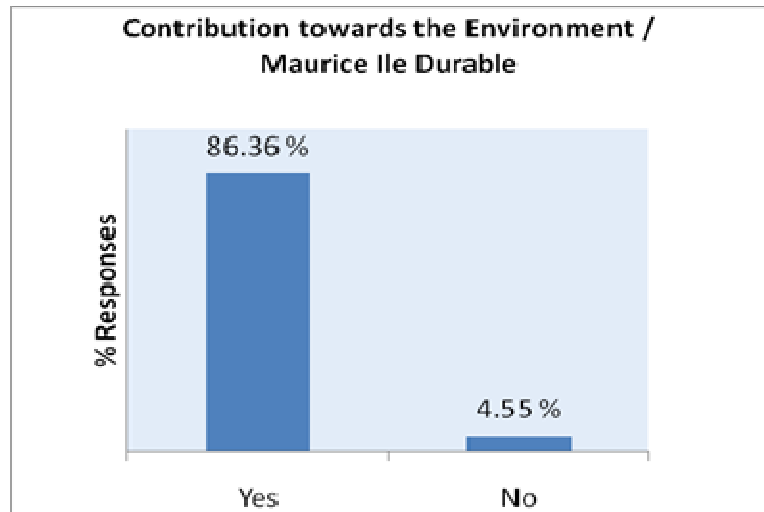


Figure 4.6: Contribution towards the environment/ Maurice Ile Durable

It can be found that 77.27% of the respondents are organisations not following guidelines for e-waste management while only 13.64% are organisations following the guidelines. As a whole, there is a high percentage for those organisations not following guidelines for e-waste management, see Figure 4.7.

Figure 4.7: Organisations following guidelines for e-waste management

Figure 4.8 below illustrates that local authorities encompass the highest percentage for E-Waste Management (68%) while importers and organisations are those stakeholders taking 55% and 59% respectively. Hence, it is observed that local authorities are more responsible for E-Waste Management.



Figure 4.8: eWaste Responsibility

Our findings show that the highest estimate of e-waste from a sample of 22 parastatal bodies was accounted by computers and computer peripherals with 10.13 tonnes, representing 59% of the total e-waste generated. 13% of e-waste is attributed by printers and printer parts and 8% by electrical and electronic tools. The least estimated amount of e-waste was observed among leisure and sports equipment, monitoring and control instruments and, automatic dispensers. The category 'Others' constituted of 2.01 tonnes of e-waste that is 12% of the total e-waste. And such type of e-waste was specified as furniture, laboratory equipment, freezer and air conditioner as shown in Figure 4.9.
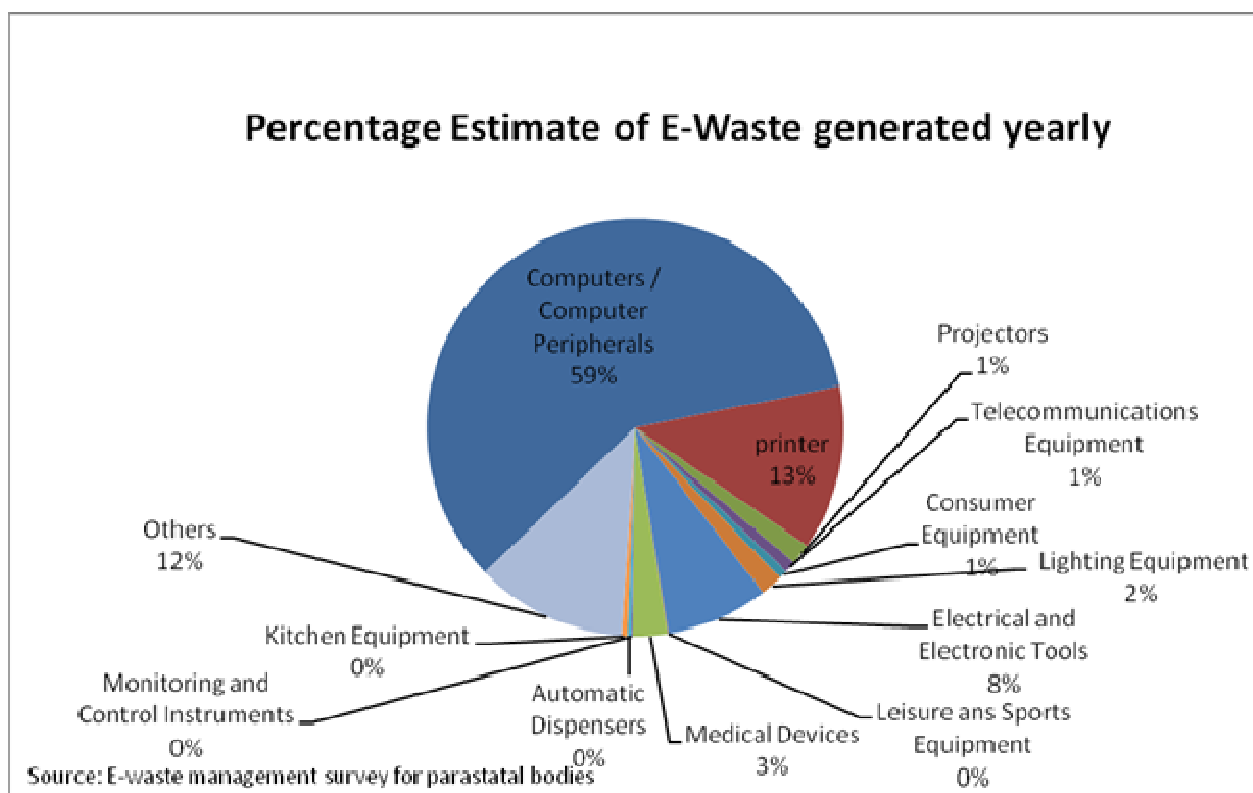


Figure 4.9: eWaste Generation

### 4.2.1 Storage of e-waste

85.71% of the respondents store their e-waste for a specified period of time prior to their disposal. The majority, 47.4% store their e-waste for a period more than 1 year while 15.8% opt for 3-6 months and 10-12 months each. This is mainly due to the internal audit control system,

to collect a certain amount of e-waste before its disposal or auction sale or even for donation to NGOs.

### 4.2.2 Segregation of e-waste

46.15% of those who do not dispose their e-waste together with other waste segregate them before their disposal. A few respondents stated that the segregation of e-waste is done according to procedures, for instance, the waste is categorized according to its composition, the use of different bins for different types of waste such as plastic and metal casings.

### 4.2.3 Open-ended questions

According to respondents, there exist certain policy measures that are enforced in their organisation pertaining to the management of e-waste, for instance, the storage, re-use, recycling and, disposal of e-waste. Policy measures internally developed were listed as follows:

**Storage**

E-waste is stored as per the specifications of the product and for certain organisations, a special space is designated within the company itself to the store the e-waste.

**Re-use**

Certain parts are re-used in similar equipment or even served as spare parts.

**Recycling**

Some of the electric and electronic parts are repaired as far as possible until they become fully uneconomical or unsalvageable.

**Disposal**

E-waste is disposed as per the financial procedure or even protocol of the organisation and the board of survey is responsible for the verification purposes of e-waste and to make recommendations for items to be either scrapped or to be put for sale.

# 5.0 MODEL DEVELOPMENT AND VALIDATION

## 5.1 Causal Loop Models

The literature survey conducted helped to identified core parameters influencing eWaste generations and disposal. Each parameter has a defined role. However, there exist multiple correlations between these elements. In order to frame policies that foster eWaste reduction, re-use and recycling, it is vital to understand the possible relationships between each parameter, as well as their potential implications on eWaste. Using System Dynamics, a preliminary causal loop has been set up, prior to the survey be conducted. This aims at setting up a core model platform, thereby accounting for the surveyed parameters. As shown in figure 5.1, eWaste is the by-product of consumed electric and electronic goods. Electric and Electronic goods (e-goods) are characterised by a particular life cycle, after which these goods are regarded as eWaste. Depending on the technological trends, the demand of e-goods fluctuates constantly. Presently, demands for e-goods are rising and in order to satisfy those needs, producers are constantly innovating their products where more e-goods are supplied to consumers. The gap between the demand and the supply of e-goods are influenced by the relentless reduction of production costs. Costs minimisation can be achieved through recycling schemes, or re-use of parts from eWastes.

One of the core factors altering the product life cycle is the product's quality. It has been observed in many cases the high quality products last longer. Nevertheless, high quality products are expensive to produce and target a small segment of the overall market. The limitations associated with high quality products has led the market to focus on e-goods with an average lifetime. Such practice has enabled the increase in the buying cycle of consumers. In simple terms, consumers renew their e-goods after a shorter period of time, thus allowing them to sustain to the changes in technology. eWastes are largely disposed. In some countries around the world, disposal laws such as pay as you through schemes have reduced disposal considerably. eWastes can be collected on a regular basis, depending on the amount generated. However, such collections are costly for authorities and private companies, thereby resulting in high recycling costs. Consequently, authorities have designed specific amenity centres, allowing

individuals to dispose their eWaste at their own cost. Such practice mitigates collection costs significantly and hence help to scale down recycling costs. As a matter of fact, recycling is the ideal means to lower the dependency on raw materials. Therefore, encouraging recycling will foster an overall reduction in cost of raw materials.

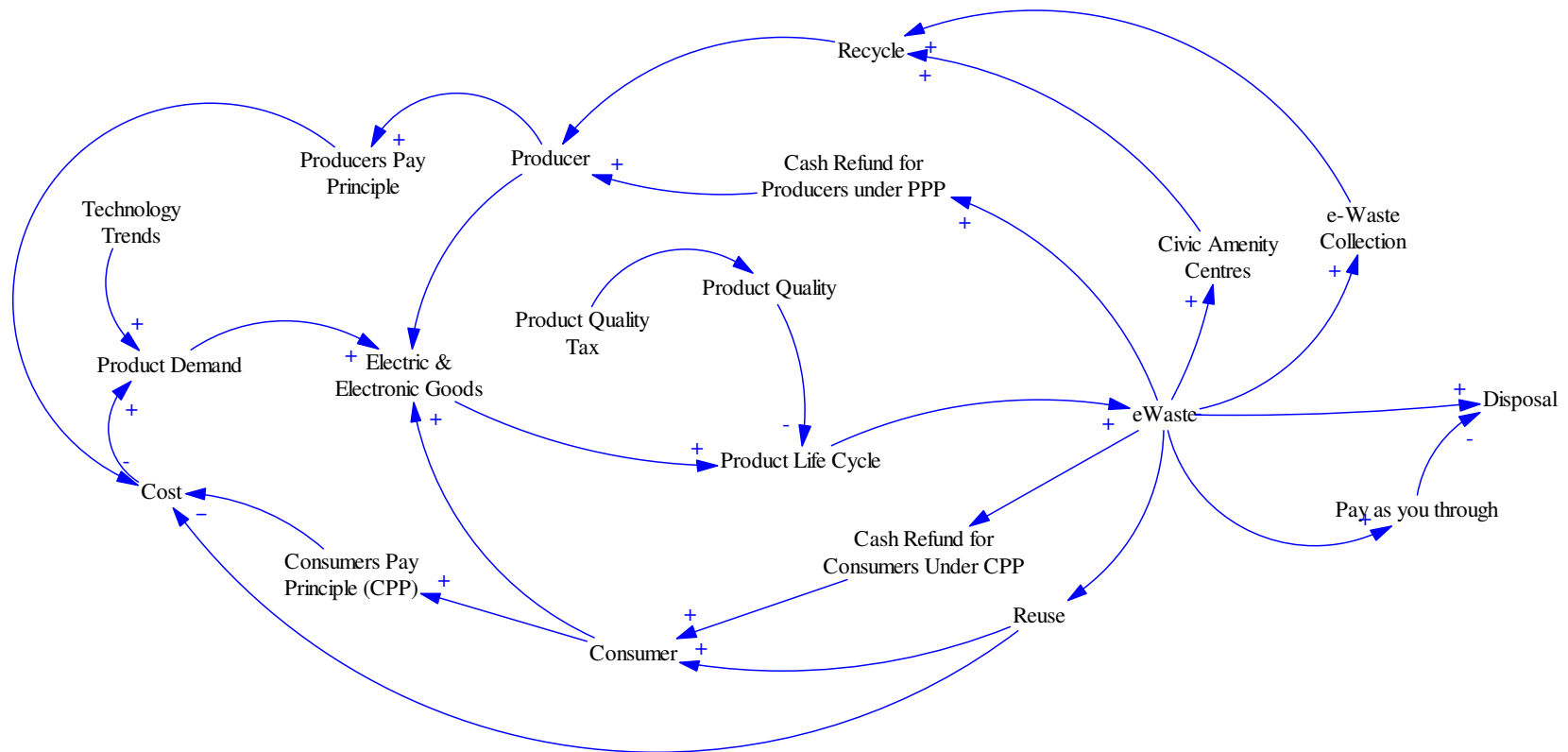
Figure 5.0: Preliminary Causal Loop

Consumers are key players in the generation of eWastes. Authorities around the world have used various means to compel consumers to reduce eWastes, or even to reuse their e-goods. The Consumer Pay Principle (CPP) defines a strategic approach towards encouraging consumers to return their e-goods once they have reached their end-of-life. This system includes a cash back mechanism. Figure 5.1 shows the causal loop diagram for the CPP.
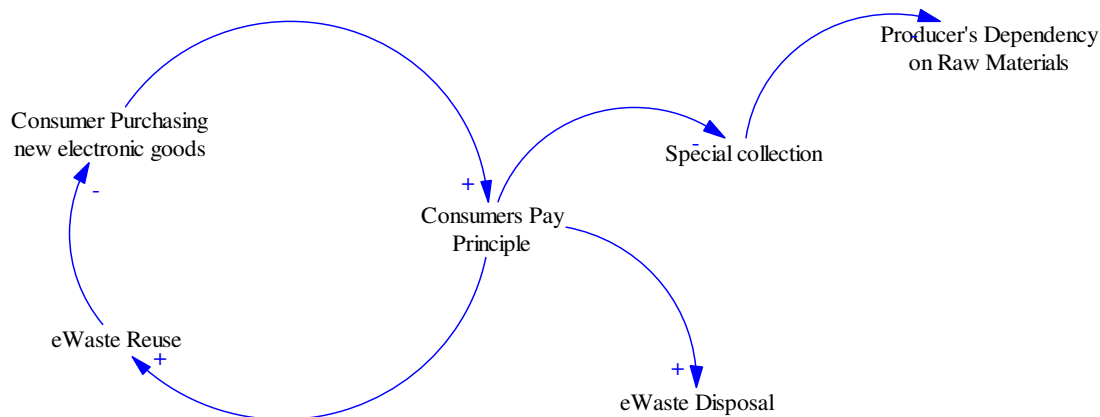


Figure 5.1: Causal Loop for Consumer Pay Principle

## 5.2 eWaste Policy Model

The Causal Loop Diagram shown in Figure 5.1, depicts the overall behaviours and interactions of core parameters related in eWaste Policy measures. Causal Loop Diagrams are normally means to help in formulating the Stock and Flow diagrams, which represents the actual dynamic model for the eWaste Policy. At this stage, the listed variables from Causal Loop Diagram are converted into appropriate stocks and flows that will create a dynamic model whereby parameters can be altered. This model is has an initial projection of about 7 years. In other words, the dynamic model is expected to forecast yearly eWaste generation and other implications based on changing policies, starting from 2012 (present year) to 2020. The 7 years projection period has been identified as correct subject to the available amount of data collected for the simulation.

eWaste generation is fundamentally dependent on two main aspects namely: the population size and the demand for electronic products. The amount (in kg) of eWaste generated per inhabitant is calculated based on overall eWaste Inflow and Outflow (as shown in diagram below). The eWaste Inflow indicates the flow and rate at which eWaste will produced on a yearly basis. The eWaste Outflow on the other hand shows the rate contributing to the mitigation of yearly eWaste generation per inhabitant.
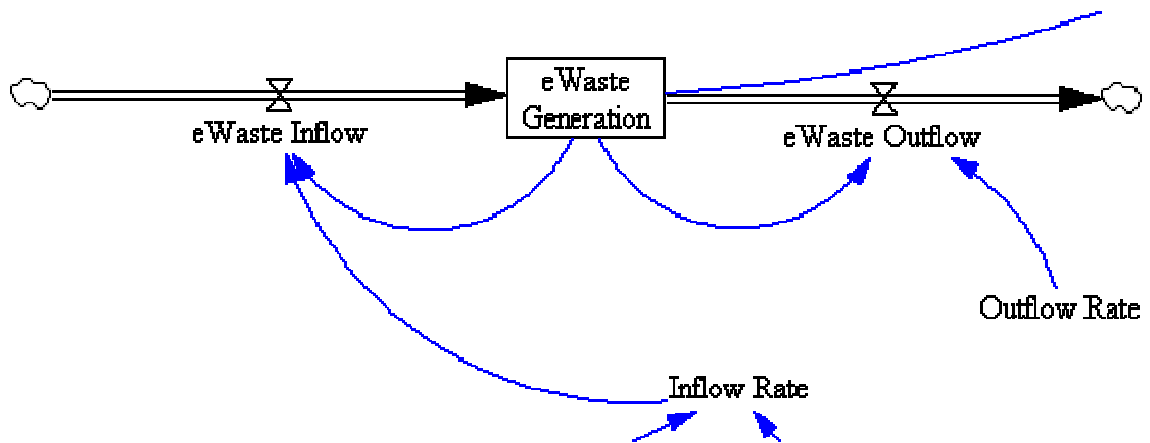


Figure 5.2: Stock & Flow for eWaste generation (in kg) per inhabitants

The initial eWaste generation amount is set to 5.5kg per inhabitants for Mauritius, as per the surveyed data for 2012. It should be noted that the outflow rate in this model is a corrective variable justifying the unknown factors contributing to prevention of eWaste generation. This rate has been established based on surveyed data. The respective equations harnessed for this model (Figure 5.2) are as follows:

eWaste Generation= INTEG (

        eWaste Inflow-eWaste Outflow,

        5.5)

    Units: kg/Year

    eWaste Generation in kg per household per year

Equation 1: eWaste Generation

eWaste Inflow=

    eWaste Generation*Inflow Rate

Inflow Rate=

    Product End of Life/Generated eWaste

Equation 2: eWaste Inflow

eWaste Outflow=

    eWaste Generation*Outflow Rate

Outflow Rate = 0.01

Equation 3: eWaste Outflow

The Inflow Rate is influenced by electronic products that have reached their end-of-life, on a yearly basis. For this purpose, the model integrates a stock and flow diagram, which will monitor the electronic product life cycle, as shown below.
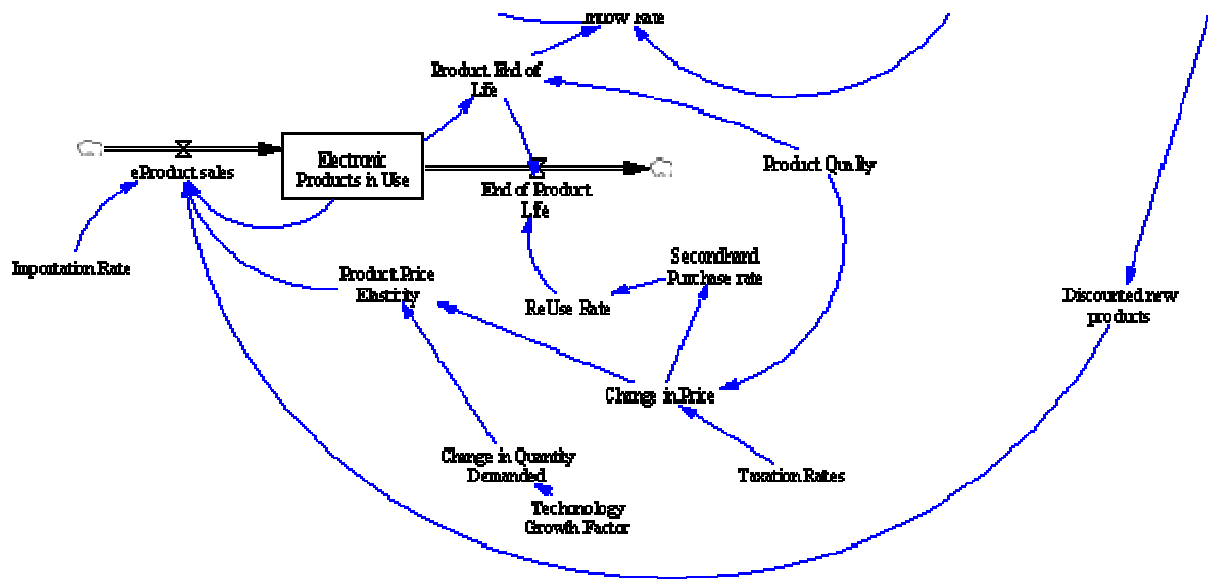
Figure 5.3: Stock and Flow Diagram for the Electronic Products in Use.

The above model stocks the Electronic Products presently in use. The stock is influenced by electronic product sales and products that have been given a new life through reuse and other means. The inflow rate is dependent on the rate at which electronic products reach their end of life. This parameter is governed by the products' lifespan. As a matter of fact the lifespan of a product is primarily driven by its quality. Quality therefore alters the duration of a products usage as well as its price. The above discussed parameters harness the following equations:

Electronic Products in Use= INTEG (

   eProduct sales-End of Product Life,

    109224)

  Units: kg/Year

Equation 4: Electronic Products in Use

End of Product Life=

Product End of Life*(0.87+ReUse Rate)

Units: kg/Year

0.87 of overall products which have reached their end of life are

still being used through re-use or extended life time through

better quality

Equation 5: End of Product Life

eProduct sales=

(Electronic Products in Use*(Importation Rate+Product Price Elasticity+Discounted new products

))*0.85

Units: kg/Year

0.85 of imported products go on sale

Equation 6: eProduct Sales

The flow rate of End of Product Life (Equation 5) is subject to changes in the Reuse Rate. An electronic product is meant to have an extended lifespan when being reused. At present, 0.13% of electronic products are being reused. The reuse rate is directly correlated to the influence of the purchase of second-hand electronic products. eProduct Sales (Equation 6) is altered by the yearly importation rates, Product Price Elasticity and Discounted new product sales. Surveys conducted on Importers revealed that 85% of imported electronic good are sold on a yearly basis. However, the sales of such products are also subject to technological trends and changes in process.

The product price elasticity is formulated by dividing the overall change in quantity demanded by the change in price. The demand for electronic goods depends on technological growth. Changes in prices are often caused by altered taxation rates and product quality as shown in the equations below.

Change in Price=

0.0434*(1+Product Quality)*Taxation Rates

Equation 7: Change in Price

Change in Quantity Demanded=

0.067+Techonology Growth Factor

Equation 8: Change in Quantity Demanded

Product Price Elasticity=

(Change in Quantity Demanded/Change in Price)/100

Equation 9: Product Price Elasticity

The overall model is governed by the estimation of eWaste stored (in kg) per year. This sub-model (Figure 5.4) forecasts the net yearly storage amount of eWaste in Mauritius and therefore gives a clear indication of eWaste treatment potentials and disposal methods.

Figure 5.4: Stock and Flow for eWaste Stored per Year

The stock is driven by the Generated eWaste and Unstored eWaste flows. The Generated eWaste flow computes the overall eWaste generation for Mauritius. Unstored eWaste describes the rates at which recycling, take backs and diposals are being carried out on a yearly basis, thus reducing the amount of eWaste stored. The equations below explain the 2 flows.

Generated eWaste=

       (eWaste Generation*Population of Mauritius)

   Units: kg/Year

Equation 10: Generated eWaste

Unstored eWaste=

   (Diposal Rate+Recycling+Take Back)*eWaste Stored per year

Units: kg/Year

Equation 11: Unstored eWaste

The figure below shows the overall dynamic model described in the section.

Figure 5.5: Stock and Flow Diagram

## 5.3 Model Validation

The model has been validated with surveyed data from previous years namely: 2010 and 2011. The actual simulated data are show in Figure 5.8. The projected eWaste generated per household for the year 2012 was 5.78% (Figure 5.6), which represented a margin of error of 4.8% from the actual figure.
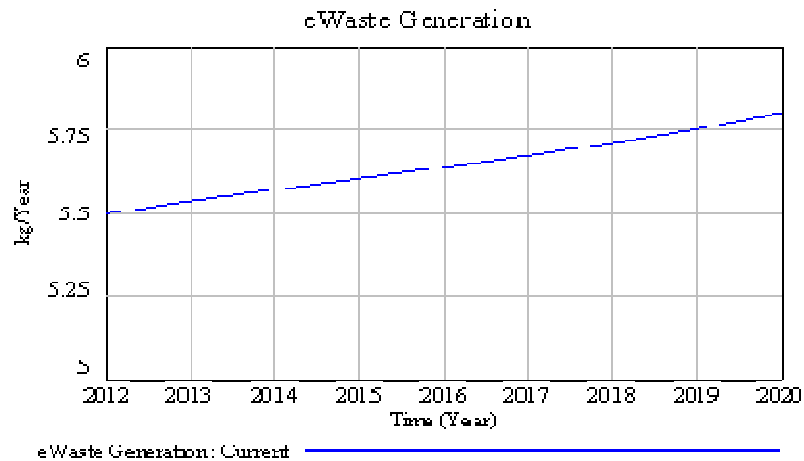


Figure 5.6: Project eWaste Generation

Similarly the overall eWaste stored for the year 2012 has a margin of 3.2% as shown in the figure below. Hence, the overall model is likely to have an overall margin of error of 3.26% when compared to present figures.
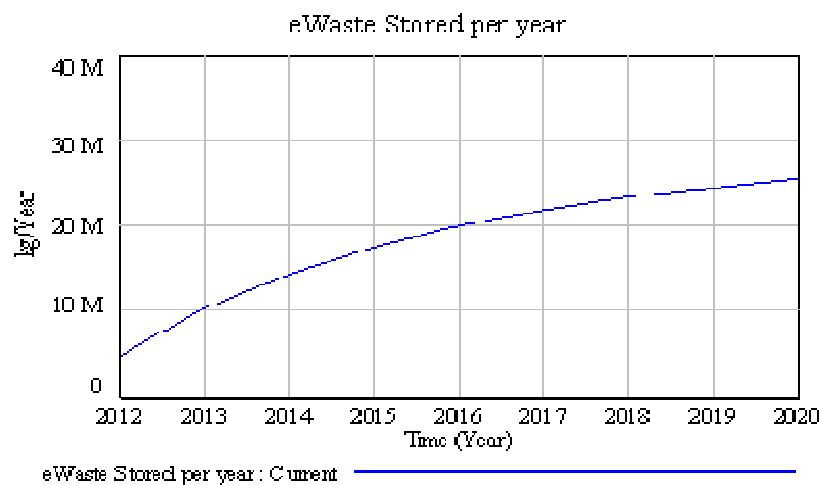


Figure 5.7: eWaste Stored per Year
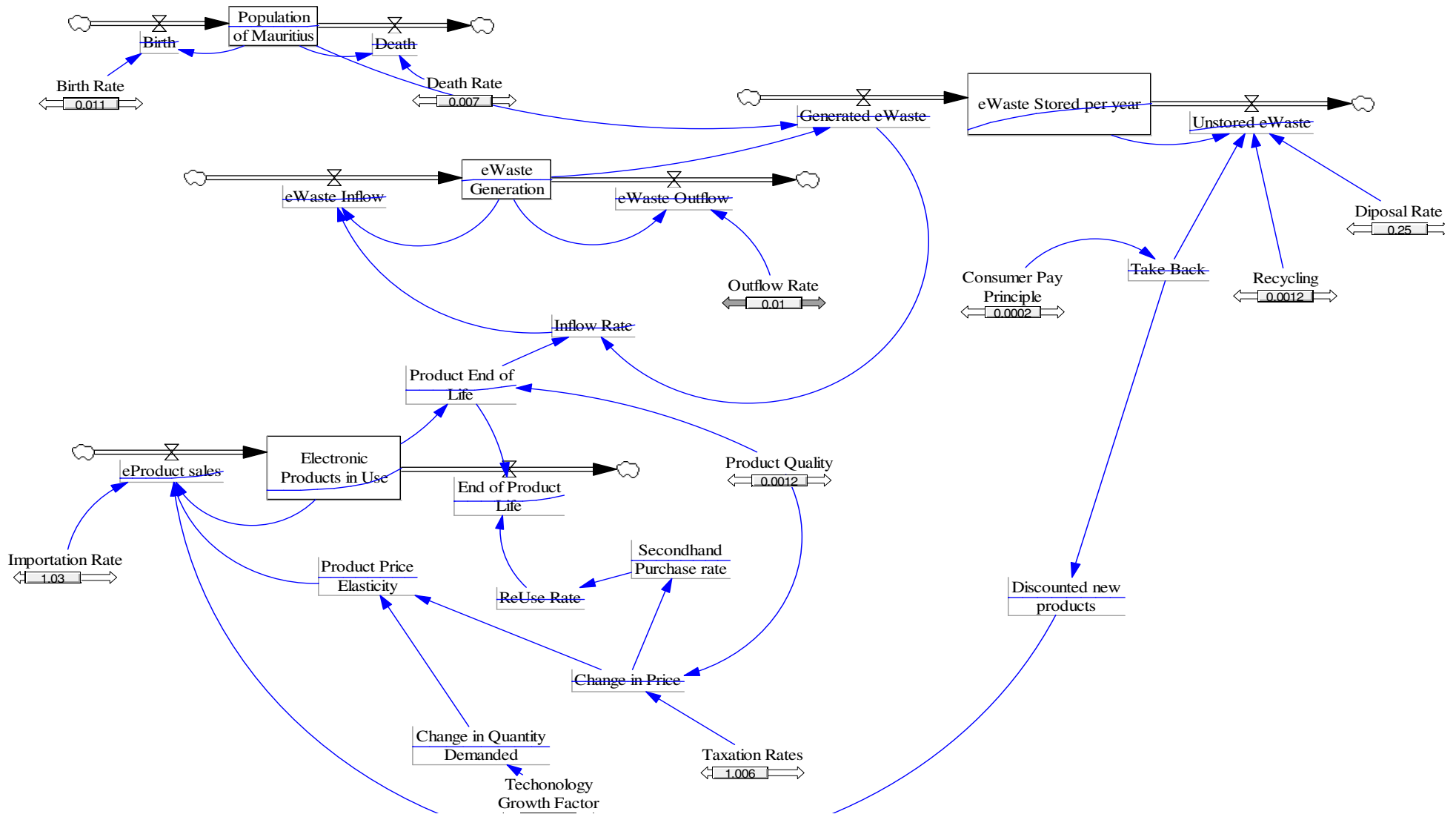
Figure 5.8: Simulated Stock and Flow

## 6.0 RECOMMENDATIONS

The validation of the model has helped to understand various implications of eWaste Policies in Mauritius. With the present consumption of eProducts (eProduct Sales shown in figure below), eWaste Generation is likely to increase by 5.6% by 2020. This increase is like to contribute to an overall increase of 300 tonnes per year, this requiring the setting up of appropriate policy measures for eWastes in Mauritius.
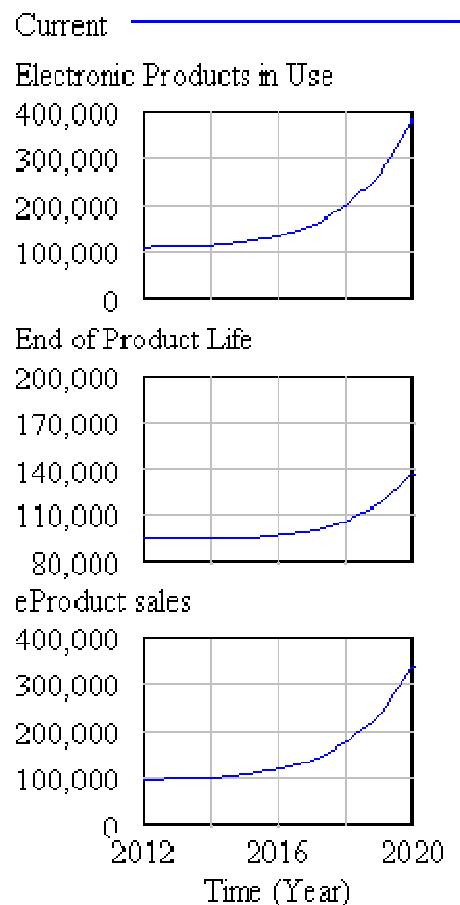


Figure 6.0: eProduct Sales

The 11 major parameters influencing the overall eWaste Generation and storage are: Importation Rate, Technology Growth Factor, Taxation Rates, Consumer Pay Principle, Take Back,

Recycling, Disposal Rate, Product Quality, Second-hand Purchases, Change in Price, and Discounted New Products.

## 6.1 Importation Rate

Reducing Importation rates by 1% is likely to mitigate eWaste generation in 2020 by 0.86%, as shown in the diagram below. However, since electronic product importation and sales are meant to increase in the coming years, trying to limit importation will be rather difficult and may also have considerable economical and social impacts. Nevertheless, an increase in eProduct importation by 2% is likely to scale overall eWaste Generation by 8.7%.
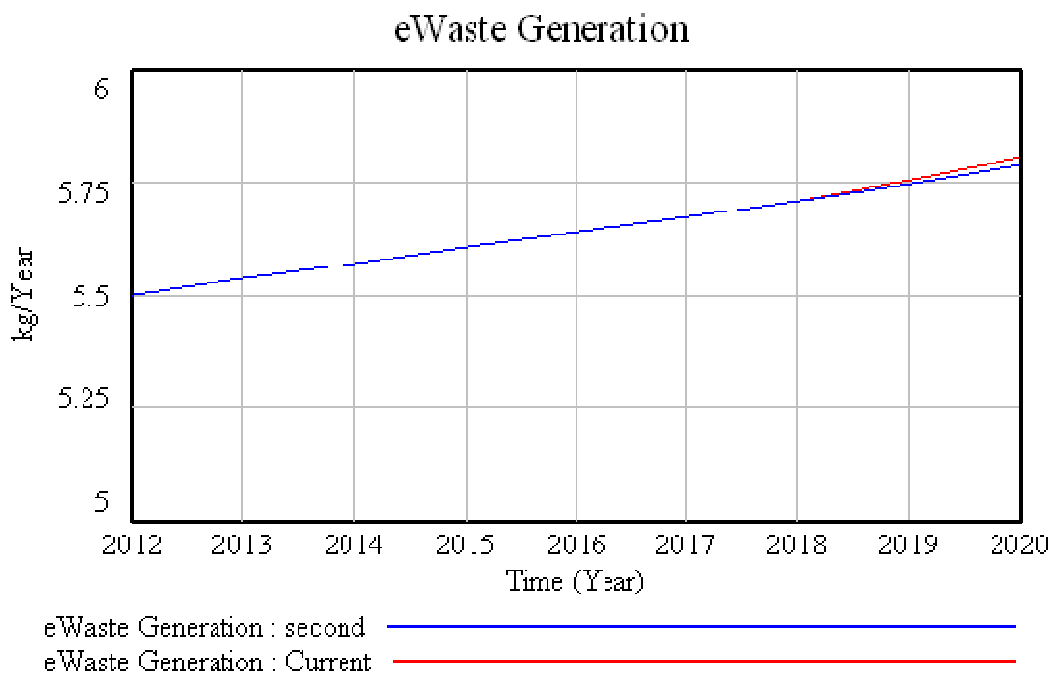


Figure 6.1: eWaste Generation comparison when reducing importation

## 6.2 Technological Growth

Technology has a scaling effect on the demand for electronic products. An increase by 3% in technological growth will increase eWaste Generation per household by 1.4%. Even though this is not significant in terms of percentage, this however represents around 80 tons increase.

## 6.3 Taxation

Taxation is amongst the most common measures employed by Government to reduce sales of new eProducts. A 0.5% increase in taxes for such product will reduce sales by 3%. This reduction is sale is partly explained by the fact that consumers will extend the use of present eProducts, thereby buying less. The figures below indicate the effect of such changes in taxes.

**Modified** ————
**Current** ————

eProduct sales

400,000
300,000
200,000
100,000
0

Electronic Products in Use

400,000
300,000
200,000
100,000
0

Discounted new products

2e-005
1.75e-005
1.5e-005
1.25e-005
1e-005

Product Price Elasticity

1
0.75
0.5
0.25
0
2012        2016        2020
Time (Year)

Importation Rate
Modified: 0.03        Current: 0.03
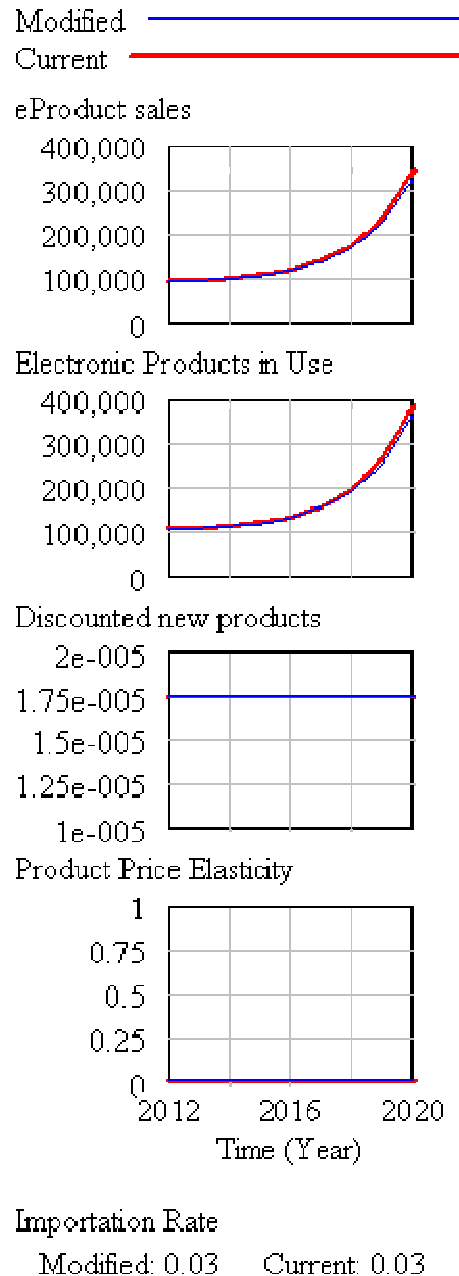
Figure 6.2: 0.5% increase in taxes for new electronic products

### 6.4 Consumer Pay Principle

The Consumer Pay Principle has a more significant impact on the storage of eWaste. For instance, assuming that the Government imposes a minimal charge of 1% on the price of any electronic goods purchased, and this fee is refundable subject to the return of the product when

it reaches its end-of-life, it has been noted that overall storage of eWaste is likely to decrease by 5.4% in 2020, as shown below.

eWaste Stored per year
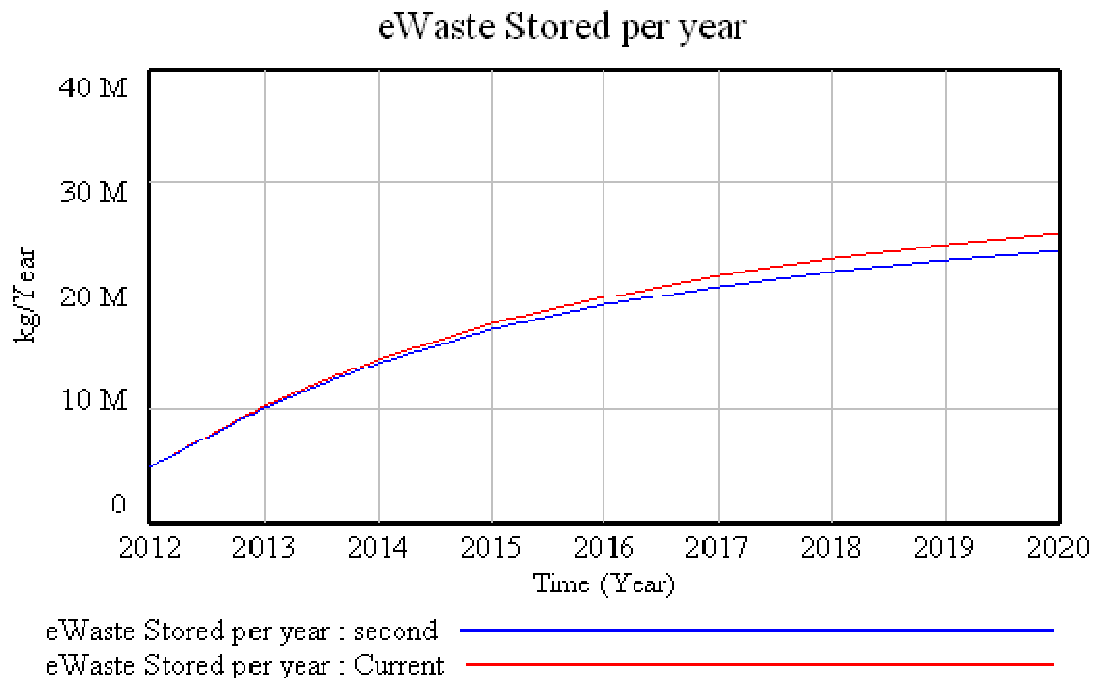


Figure 6.3: eWaste Generation comparison when increasing consumer pay back

## 6.5 Take Back

Imposing producer's responsibility to take back used electronic wastes trigger a significant reduction in overall waste storage. For instance, assuming that producers/retailers/importers offers discounted prices (take back rates estimated at 37%) for new electronic products subject to the return of used ones, it has been noted that eWaste storage is decreased by 56% as shown in the Figure 6.4.

## 6.6 Recycling

Recycling of eWaste is amongst the most promising methods in reducing eWaste storage and generation. Even though recycling is not easy to undertake in Mauritius, nevertheless, if at least

10% of eWastes are recycled, this will lead to 31% in storage of eWastes (Figure 6.5). In simple terms, people are less likely to store eWastes knowing that there exist some recycling facilities.
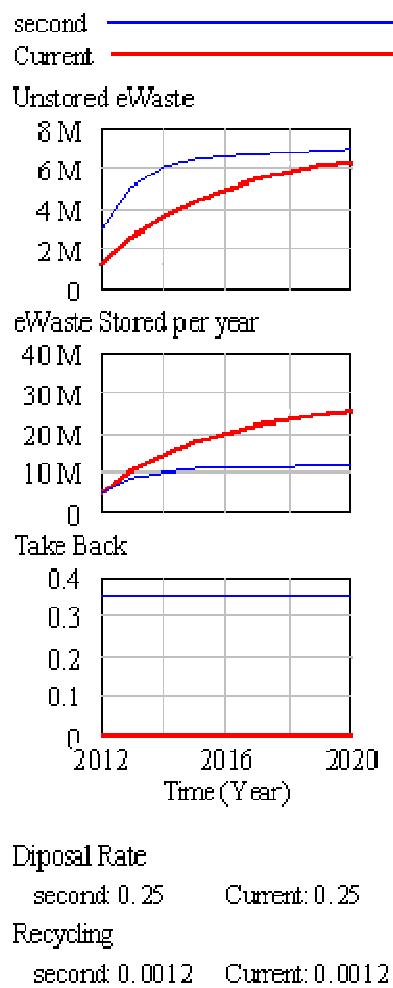


Figure 6.4: Increased Take Back Rates.
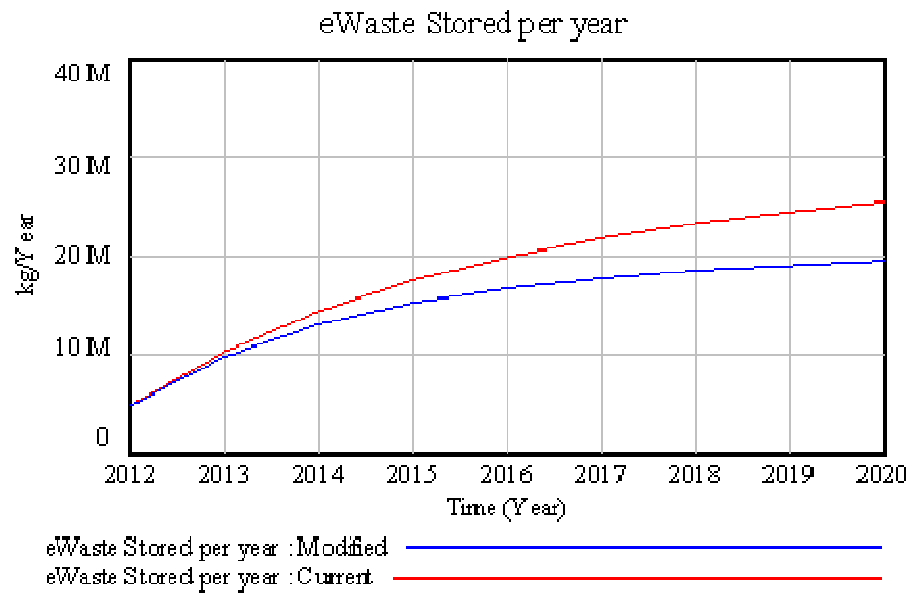
Figure 6.5: Encouraging a 10% increase in eWaste

## 7.0 CONCLUSION

Based on the surveys carried out, respondents provided their views on e-waste management scheme that they would have liked to implement in their respective organisations. The main recommendation made was the segregation of waste such that e-waste, for example, IT equipment is collected either by the Parent Ministry or the Ministry of Environment for recycling purposes.  On the other hand, electrical appliances, telecommunication equipment, consumable and spare parts can be returned back to the manufacturer for recycling purposes and, lighting and faulty bulbs can be collected by the Ministry of Public Utilities for the same purpose. It has been pointed out that there arises a need to set up e-waste professional companies to collect e-waste. It was also suggested to introduce a proper inventory system to record the life span and content of all electronic equipment so as to encourage the proper disposal of e-waste. Although respondents regard it important to implement a system to store, re-use and dispose e-waste, there emerges problems like budgetary constraints, lack of human resources, lack of training, information and guidelines on e-waste strategies and lack of office space.

By making recycling easy, we reduce the amount of toxic materials that would otherwise end up in our landfills. Re-Use: We repair what we can and give to families in the community who can't afford the latest electronics. Re-purpose: What we cannot repair, we disassemble and separate the metals that is in turn sold to reputable state recyclers.

Recycling of computer equipment and air conditioning equipment are the major e-wastes in most administrative organisations.  A local recycling centre/refurbishing centre would be useful.

eWaste should be kept in a separate place and should be sent to an organisation that deals with e-waste management from time-to-time. The employer may not be willing to pay for the disposal of e-waste. Possibility of selling e-waste like. Repairing & re-using of e-products. Barrier - high cost of repair/ purchase of spare parts. Set up a Fixed Assets Register Committee which will manage all e-waste in the organisation. Purchase only IT products which have passed the environmental friendly step. Local Authorities should manage e-waste. For our departement to implement e-waste management, additional specialised resources would be required.

eWaste is meant to increase in the coming years. This is mainly explained due to rise in electronic product demand, as well as the ever-scaling technological growth. The dynamic model formulated in this project is likely to be an important tool in helping Authorities and Decision Makers in framing policies in eWaste. The model takes into consideration various aspects of eWastes as well as their interactions with various parameters.

The eWaste Policy model is characterized by the possibility of the changing variables, which will allow decision makers to test and forecast potential implications on various areas of the framework. The model is estimated to have margin of error of 3.3%. A set of recommendations have been formulated in this report, thereby helping decision makers to understand the various changes that can be brought in order to improve eWaste generation, storage, disposal, recycling and reuse.

As a major conclusion, eWastes storage are likely to be reduced in the coming years if the Authorities emphasizes on recycling programs, collection facilities, establish producers responsibilities, and encouraging take backs. Some of these measures can be implemented in the short run, thereby mitigating eWaste generation by 14% and eWaste storage by 56%, as tested in this study.

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# APPENDICES

## ANNEX 1: Household Survey Analysis

### 1.0 Introduction

Waste generation has always form part of our life but presently it is termed as a 'global phenomenon' which needs to be handled through appropriate methods and policies. It is a matter of concern since there has been a growing trend in the disposal of wastes irrespective of whether they are classified as toxic or non-toxic wastes. The term 'waste' also incorporates Waste Electrical and Electronic Equipment (WEEE), commonly known as electronic waste or e-waste, as a consequence of the rapid development in technology. Given that Mauritius is adhering to the concept of sustainability, there is a need to manage e-waste efficiently. Therefore, there is a need to adopt a two-pronged approach in an attempt to address this issue. The first approach requires reducing the generation of e-waste while the second one involves resolving the fate of such products at the end of their useful lives. These prime objectives need to be embodied within an e-waste management strategy by ensuring proper treatment of e-waste, which is safe and affordable for local authorities and consumers. In this context, an E-waste Research Programme is being implemented by the Mauritius Research Council in collaboration with University of Technology, Mauritius.

### 2.0 Methodology

Initially, a survey is simply a data collection tool for carrying out survey research. Pinsonneault and Kraemer (1993) quoted in Glasow (2005) defined a survey as a "means for gathering information about the characteristics, actions, or opinions of a large group of people". Surveys can also be used to assess needs, evaluate demand, and examine impact (Salant & Dillman, 1994, p. 2). The term survey instrument is often used to distinguish the survey tool from the survey research that it is designed to support. In this respect, to carry out the study on E-Wastes, a survey based on questionnaires has been carried out among 92 respondents. The 92 respondents have been selected by using the convenience sampling method. This is a sampling

method in which units are selected based on easy access or availability. The advantage of the convenience sampling is the availability and the quickness with which data can be gathered. Moreover, convenience sampling is appropriate for this study since the data obtained are not meant to be representative. The questionnaire has been segmented in terms of profile of respondents; use and disposal of E-Waste; E-waste Management System and finally recycling and re-use.

## 3.0 Results

## 3.1 Profile of Respondents

Table 1 show that most of the respondents have a family size not exceeding 4 people.

*Table 1: Size of family*

|       |       | Frequency | Percent |
|-------|-------|-----------|---------|
| Valid |       | 2         | 2.2     |
|       | 10    | 1         | 1.1     |
|       | 2     | 8         | 8.7     |
|       | 3     | 22        | 23.9    |
|       | 4     | 34        | 37.0    |
|       | 5     | 15        | 16.3    |
|       | 6     | 5         | 5.4     |
|       | 7     | 3         | 3.3     |
|       | 8     | 2         | 2.2     |
|       | Total | 92        | 100.0   |

From Table 2, it can be seen that most of the respondents (64 out of 92) have 2 working people in their household.

*Table 2: Number of working people in your household*

|       |       | Frequency | Percent |
|-------|-------|-----------|---------|
| Valid |       | 2         | 2.2     |
|       | 1     | 9         | 9.8     |
|       | 2     | 64        | 69.6    |
|       | 3     | 8         | 8.7     |
|       | 4     | 6         | 6.5     |
|       | 5     | 2         | 2.2     |
|       | 7     | 1         | 1.1     |
|       | Total | 92        | 100.0   |

Figure 1 below shows that out of 87 respondents 41 of them have a household income of Rs 40000 or less and 46 respondents have a household income of more than Rs40000.
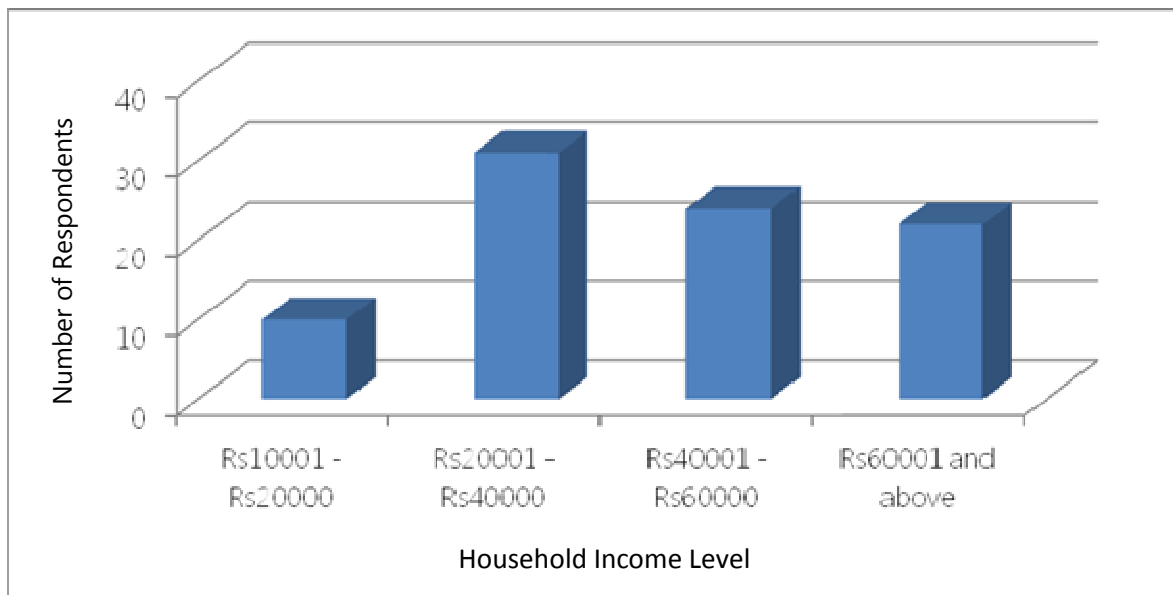


Figure 1: Household Income Level

Region in which you reside

From the 90 respondents, most of them (55%) live in urban areas. 27% respondents live in rural areas and 18% respondents live in semi-urban areas as shown in Figure 2 below.
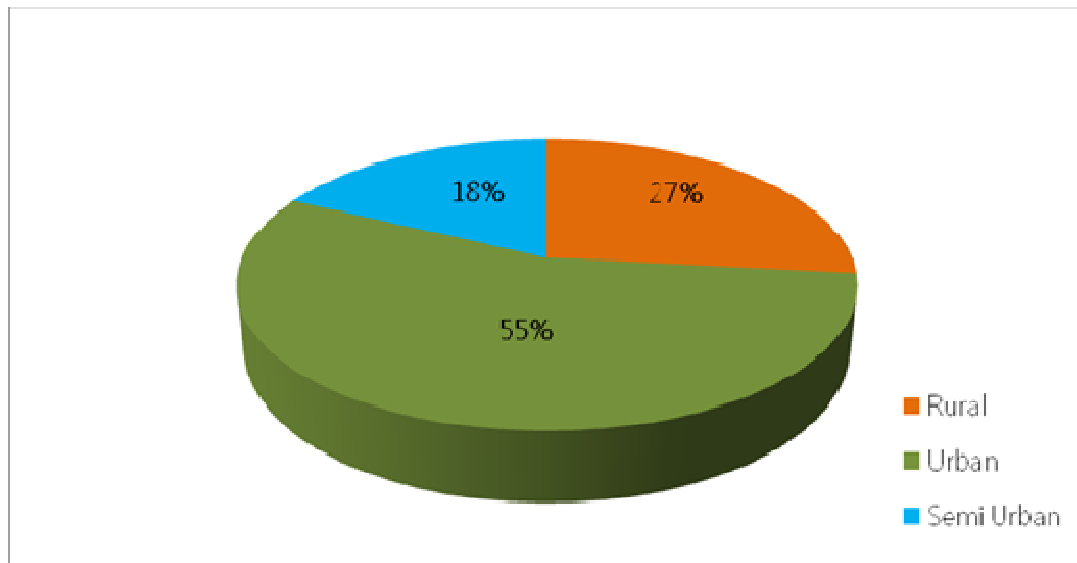


Figure 2: Region of residence

## 3.2 Use and Disposal of E-Waste

Out of the 91 respondents, a majority (77) stated that they are aware of the consequences of disposing e-waste in the natural environment. While 11 respondents affirmed that they are not aware of the consequences of such an act.

Table 3: Awareness of the consequences of disposing e-waste in the natural environment

|  |  | Frequency | Percent |
|---|---|---|---|
| Valid | Yes | 77 | 83.7 |
|  | No | 11 | 12.0 |
|  | Don't know | 3 | 3.3 |
|  | Total | 91 | 98.9 |
| Missing | System | 1 | 1.1 |
| Total |  | 92 | 100.0 |

From the 90 respondents, 42 of them throw away their e-waste and 48 respondents do not throw away their e-waste.

Table 4: Throw away E-Waste

|  |  | Frequency | Percent |
|---|---|---|---|
| Valid | Yes | 42 | 45.7 |
|  | No | 48 | 52.2 |
|  | Total | 90 | 97.8 |
| Missing | System | 2 | 2.2 |
| Total |  | 92 | 100.0 |

Criteria that individuals consider before purchasing electronic products

28 respondents out of 92 stated that they would prefer to purchase an electronic product having a longer lifespan and 26 respondents (out of 92) prefer good quality electronic products which would last longer.

40 respondents out of 87, store e-waste for a specified period of time prior to their disposal and 47 respondents do not store e-waste prior to their disposal. In general, those who store e-waste do so for more than 10 months.

Table 5: Store e-waste for a specified period of time prior to their disposal

|  |  | Frequency | Percent |
|---|---|---|---|
| Valid | Yes | 40 | 43.5 |
|  | No | 47 | 51.1 |
|  | Total | 87 | 94.6 |
| Missing | System | 5 | 5.4 |
| Total |  | 92 | 100.0 |

## 3.3 E-Waste Management System

From Table 6, it can be observed that all the 90 respondents affirmed that there is a need to put in place a proper e-waste management system.

Table 6: Need to put in place a proper e-waste management system

|  |  | Frequency | Percent |
|---|---|---|---|
| Valid | Yes | 90 | 97.8 |
| Missing | System | 2 | 2.2 |
| Total |  | 92 | 100.0 |

Out of 89 respondents, 77 of them are willing to return back their e-product to retailers once it reaches the end of its useful life. On the other hand, 12 respondents are not willing to do so.

Table 7: Willingness to return back e-product to retailers

|         |        | Frequency | Percent |
|---------|--------|-----------|---------|
| Valid   | Yes    | 77        | 83.7    |
|         | No     | 12        | 13.0    |
|         | Total  | 89        | 96.7    |
| Missing | System | 3         | 3.3     |
| Total   |        | 92        | 100.0   |

It can be observed in Figure 3 below that 72% respondents are willing to purchase e-products partly made up of second-hand materials while 28% respondents stated that they are not willing to buy such a product.
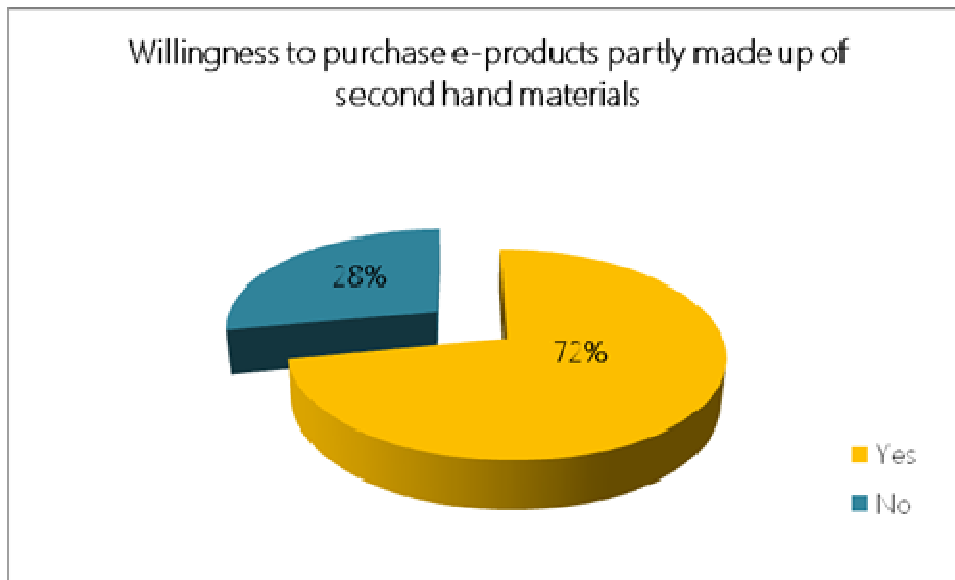


Figure 3: Willingness to purchase e-products partly made up of second hand materials

From the 89 respondents, 64 are ready to pay a fee at the time of purchasing an electronic product. However, 25 respondents do not accept to pay an extra fee.

Table 8: Acceptance to pay a fee at the time of purchasing an electronic product

|  |  | Frequency | Percent |
|---|---|---|---|
| Valid | Yes | 64 | 69.6 |
|  | No | 25 | 27.2 |
|  | Total | 89 | 96.7 |
| Missing | System | 3 | 3.3 |
| Total |  | 92 | 100.0 |

Table 9 illustrates that almost all the respondents that is, 89 out of 90, are in favor of setting up a system whereby e-waste will be collected on a regular basis by local authorities. Only 1 respondent is against the setting up of such a system.

Table 9: System to be put in place whereby collection of e-waste is carried out on a regular basis by local authorities

|  |  | Frequency | Percent |
|---|---|---|---|
| Valid | Yes | 89 | 96.7 |
|  | No | 1 | 1.1 |
|  | Total | 90 | 97.8 |
| Missing | System | 2 | 2.2 |
| Total |  | 92 | 100.0 |

Table 10 demonstrates that 48 respondents out of 88 are willing to pay a fee for the collection of their e-waste while 40 of them are not willing to pay this fee.

Table 10: Willingness to pay a fee for the collection of e-waste

|  |  | Frequency | Percent |
|---|---|---|---|
| Valid | Yes | 48 | 52.2 |
|  | No | 40 | 43.5 |
|  | Total | 88 | 95.7 |
| Missing | System | 4 | 4.3 |
| Total |  | 92 | 100.0 |

Willingness to pay more for environment friendly e-products

Figure 4 below shows that 70% of the respondents are willing to pay more for environment friendly e-products while 30% are unwilling to do so.
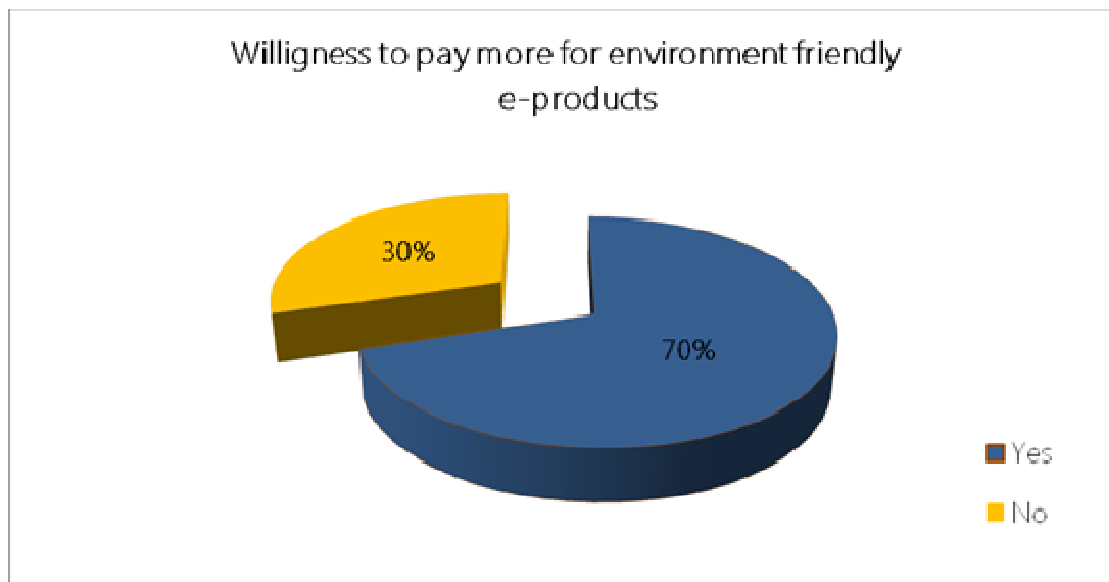


Figure 4: Paying more for environment friendly e-products

## 3.4    Recycling and Re-Use

**How would you prefer to recycle your e-waste**

31 out of 92 prefer to take their e-waste to a recycling centre while 51 respondents (out of 92) prefer e-waste collection campaigns.

**Reusing e-waste**

The pie –chart below gives a clear picture of the percentage of respondents who reuse their e-waste. It is observed that 64% of the respondents do not reuse their e-waste, 29% reuse part of it and 6% reuse all their e-waste.
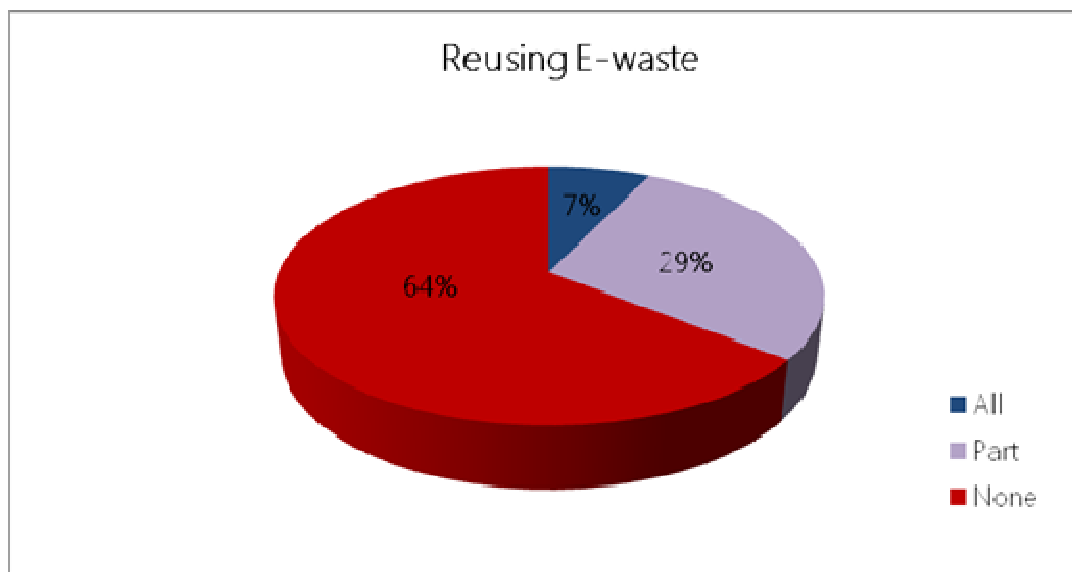


Figure 5: Reusing e-waste

## 3.0 Conclusions

The main findings from this study show that overall the respondents have a notion of what e-waste is and they are also aware that disposing e-waste everywhere might cause harm to the natural environment. The study demonstrates the reasons how people dispose of their e-waste, why they throw it away, for how long they store their e-waste and why they store it. Moreover, almost all the respondents agreed that there is a need to put in place a proper e-waste management system. Indeed, a great number of respondents are willing to return back their e-product once it has reached the end of its useful life and they are even ready to pay more for environment friendly electronic products.

# Household Survey Questionnaire

**Definition of Electronic Waste:**

Electronic waste or e-waste is defined as "**any appliance using an electric power supply that has reached its end-of-life.**"  E-waste is not necessarily items that have been trashed.  E-waste can be classified into the following 10 categories:

1. Big Household Appliances;
2. Small Household Appliances
3. IT & Telecommunications Equipment;
4. Consumer Equipment;
5. Lighting Equipment
6. Electrical & Electronic Tools;
7. Toys, Leisure and Sports Equipment;
8. Medical Devices
9. Monitoring & Control Instruments; and
10. Automatic Dispensers.

**A. Who should be responsible for e-waste management?**

A1. According to you, e-waste is the responsibility of: **(You may select more than 1 option)**

☐ Importers/Retailers of electronic products

☐ Consumers of electronic products

☐ Local Authorities (e.g., Municipalities, District Councils etc.)

☐ Others, (**Please Specify**) …………………………………………………………………………..

A1.1. Why do you think it is the responsibility of the selected category in question A1 above?

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B1. Are you aware of the consequences of disposing e-waste in the natural environment?

Yes ☐     No ☐     Don't know ☐

B2. Do you throw away your e-waste? **(If No, go to question C1)**

Yes ☐     No ☐

B2.1 Where do you throw away your e-waste? ……………………………………………………………………..

B2.2 Why do you throw away your e-waste?

☐     Storage problem

☐     Cannot be re-used

☐     Expensive to repair

☐     Cannot be sold

☐     Cannot be donated

☐     Others, (**Please Specify**) ……………………………………………………………………….

**C. <u>Criteria for purchasing electronic products</u>:**

C1. What are the criteria that you normally take into consideration before purchasing electronic products? **(You may select more than 1 option).**

    ☐    Electronic products having a longer lifespan

    ☐    Electronic products that have a green tag (environment friendly)

    ☐    Electronic products which are energy efficient (energy saving)

    ☐    Electronic products which can be easily disposed of

    ☐    Electronic products which are sold at affordable prices

    ☐    Electronic products which can be resold

    ☐    Good quality electronic products which would last longer

    ☐    Others, (**Please Specify**) ……………………………………………………………………….

**D. <u>E-waste management system</u>:**

D1. Do you think that there is a need to put in place a proper e-waste management system?

Yes ☐      No ☐

D1.1 Please provide an explanation for your answer.

 

D2. Are you willing to return back your e-product to retailers once it reaches the end of its useful life?

**(If No, go to question D3)**

Yes ☐      No ☐

D2.1 If yes, what can motivate you to do so?

☐     Price discounts upon purchase of new e-products

☐     Receive cash in exchange of old e-products

☐     Collection facilities (e.g., transport)

☐     Storage problem

☐     Environmental Stewardship (i.e., protect the environment)

☐     Others, (**Please Specify**) ……………………………………………………………………….

D3. Are you willing to purchase e-products partly made up of second-hand materials?

Yes ☐     No ☐

D3.1 Please provide justifications for your answer.

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D4. Do you accept to pay a fee at the time of purchasing an electronic product? **(The fee will be refunded to you upon return of the used e-product).**

Yes ☐     No ☐

D5. Would you like a system to be put in place whereby collection of e-waste is carried out on a regular basis by local authorities?

Yes ☐     No ☐

D6. Are you willing to pay a fee for the collection of your e-waste?

Yes ☐     No ☐

D6.1 If yes, specify the most appropriate mode of payment for you?

Per kg ☐   Per unit ☐   Per e-waste type ☐

D7. Are you willing to pay more for environment friendly electronic products?

Yes ☐   No ☐

**E. Storage of e-waste:**

E1. Do you store e-waste for a specified period of time prior to their disposal? **(If No, go to question F1)**

Yes ☐   No ☐

E1.1 If yes, for how long?

☐ Less than 3 months

☐ 3 – 6 months

☐ 7 – 9 months

☐ 10 – 12 months

☐ More than 1 year

☐ Others, (**Please Specify**) ………………………………………………………………………….

E1.2 Why do you store your e-waste?

☐ No recycling facilities

☐ No disposal areas

☐ No proper collection system

☐ E-products cannot be sold

☐ E-products cannot be re-used

☐ Others, (**Please Specify**) ………………………………………………………………………….

**F. <u>Recycling</u>:**

F1. How would you prefer to recycle your e-waste?

☐      Take your e-waste to a recycling centre

☐      Take your e-waste to a retailer of electronic products

☐      Repairing for re-use

☐      E-waste collection campaigns (e.g., E-day, collection by local authorities, etc.)

☐      Others, (**Please Specify**) ………………………………………………………………………….

**G. <u>Re-use</u>:**

G1: I reuse ☐ all ☐ part ☐ none of my e-wastes (unused electronic products)? **(Tick as appropriate)**.

G2. If you reuse part or none of your e-waste, choose the reason(s) for your action?

☐      It is more cost effective to buy new electronic product

☐      I prefer getting newer technologies

☐      It is easier to get rid of e-wastes

☐      Others, (**Please Specify**) ……………………………………………………………………….

**H. <u>Demographic Details</u>:**

H1. Size of family (in numbers):           ☐

H2. No. of working people in your household:           ☐

H3. Please specify your household income level.

☐ Below Rs10000

☐ Rs10001 – Rs20000

☐ Rs20001 – Rs40000

☐ Rs40001 – Rs60000

☐ Rs60001 and above

H4. Please indicate the region in which you reside:

Rural  _____          Urban  _____          *Semi-urban  _____

*(*A semi-urban area can be referred to as a village having characteristics of a town in terms of facilities.)*

*Thank you very much for filling in this form.*

## ANNEX 2: Parastatal Survey Analysis

### 1.0 Introduction

Electronic waste (E-waste) or Waste Electrical Electronic Equipment (WEEE) refers to old, end-of-life, irreparable or discarded appliances like televisions, computer central processing units (CPUs), computer monitors (flat screen and cathode ray tubes), laptops, printers, scanners, and associated wiring, which have been disposed of by their original users. There has been to increasingly large e-waste surpluses across the world due to advancement in technology, changes in fashion, style and status and, the end of life of electronic equipments.

E-waste encompasses ever growing range of obsolete electronic devices which contain lots of hazardous constituents such as lead, mercury, or chromium, as well as plastics treated with brominated flame retardants. As a result, toxic chemicals from e-waste impact people and the environment. Hence, in some European countries, regulations have been introduced to prevent e-waste harmful effects, but in general such legislation across the world is either weak or non-existent, particularly in developing countries.

According to the definitions in the European Union Directive, 2002/96/EC on Waste Electrical and Electronic Equipment, e-waste consists of the ten categories listed below:

1.      Big Household Appliances;

2.      Small Household Appliances;

3.      IT & Telecommunications Equipment;

4.      Consumer Equipment;

5.      Lighting Equipment;

6.      Electrical & Electronic Tools;

7.      Toys, Leisure and Sports;

8.      Medical Devices;

9.      Monitoring & Control Instruments; and

10.     Automatic Dispensers.

According to a recent survey, it is estimated that each Mauritian generates about 0.9 kilogram of waste par day, which represents about 375,000 tons of waste annually.

According to an article in Business Mega, the number of electronic products discarded in Mauritius has skyrocketed over the past few years. It was also cited that several projects are being undertaken by public bodies to ensure sound management of e-waste, including electrically powered components such as computers, consumer electronics and mobile phones. On the other hand, it was quoted that the Ministry of Local Government and Outer Islands is working on strategies to tackle the e-waste problem using a two-phase approach. Phase I consisted of an immediate solution to clear the existing backlog of e-waste from public bodies. Phase II comprised medium and long term management of e-waste to establish a framework for the management of e-waste.

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┌─────────────────────────────┐
│  Phase I: Quantification &   │
│  characterization           │
│  of e-waste in Mauritius     │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│  Phase II: A review &        │
│  classification of           │
│  international e-waste        │
│  management practices        │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│  Phase III: E-waste          │
│  management in               │
│  Mauritius: A status         │
└─────────────────────────────┘
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┌──────────────┐  ┌──────────────┐  ┌──────────────┐  ┌──────────────┐
│ E-waste      │  │ E-waste      │  │ A Case Study:│  │ A Case Study:│
│ management   │  │ management   │  │ Importers of │  │ Recycling    │
│ practices at │  │ practices    │  │ electronic   │  │ Enterprise   │
│ Household    │  │ assessment   │  │ and electric │  │ in Mauritius │
│ level        │  │ in Parastatals│ │ goods        │  │              │
└──────────────┘  └──────────────┘  └──────────────┘  └──────────────┘
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┌─────────────────────────────┐
│ Phase IV: Reviewing &        │
│ testing e-waste              │
│ policies using a system      │
│ dynamic model                │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│ Phase V: Proposing incentive │
│ schemes for                  │
│ e-waste management           │
│ enterprises                  │
└─────────────────────────────┘
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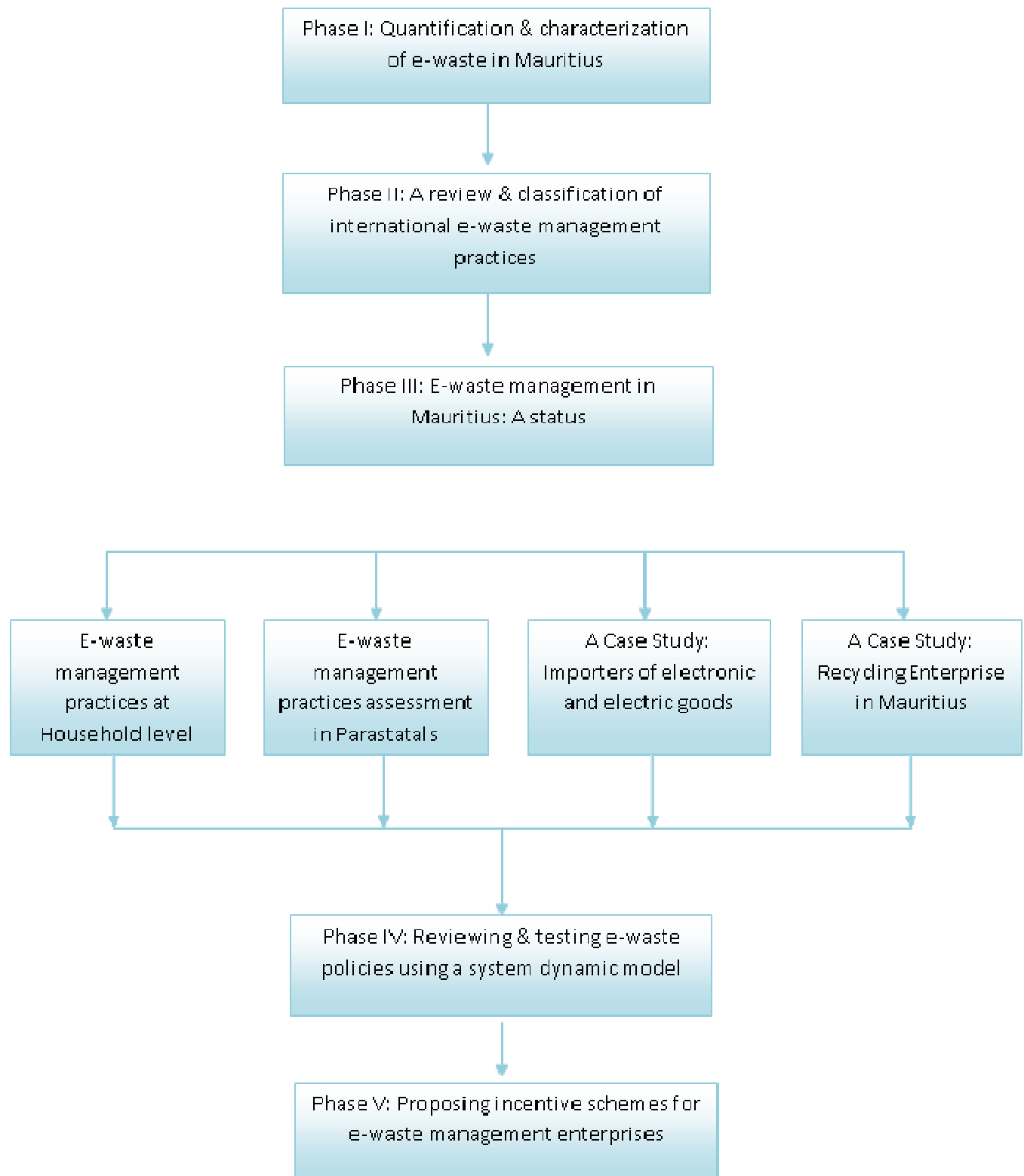
Figure 1: E-waste Management Research Programme

## 1.1 Format of Report

The report consists of five parts. Part 1 gives background information of the current situation of e-waste in Mauritius, how the study corresponds to the actual situation of e-waste management in the parastatal organisations of Mauritius and, the format of the report. Part 2 lists the objectives that are being proposed to achieve as a result of the survey and, the research questions. Part 3 describes the type of methodology adopted to conduct the study at the organizational level. Part 4 explains and discusses the results of the undertaken survey and part 5 concludes and recommends some e-waste management strategies resulting from responses obtained from the survey.

## 2.0 Objectives & Research Questions

The survey investigates how e-waste is being managed in parastatal bodies.

## 2.1 Objectives

i.      To promote environmentally sound management of e-waste in Mauritius.

ii.     To develop policies regulating the management and disposal of e-waste for a sustainable island.

iii.    To find out the current status of e-waste situation in parastatal bodies in Mauritius.

iv.     To devise appropriate e-waste management strategies to be implemented.

## 2.2 Research Questions

i.      To find out which activity/ies is/are carried out by the parastatal bodies involved in the survey.

ii.      The contribution of the organisations towards Maurice Ile Durable.

iii.     The responsibility of who is the management of e-waste?

iv.      To obtain an estimation of the amount of e-waste as specified, for example, computers, printers, projectors etc, generated yearly by the organisation.

v.       To determine whether there already exists guidelines and policy measures enforced to manage e-waste in organisations.

vi.      A description of policy measures, if exists, as enforced by authorities and/or internally developed by the organisation.

vii.     The extent to which respondents are satisfied with e-waste management in their respective organisations.

viii.    The method through which e-waste is disposed by the company.

ix.      Whether e-waste is segregated during the disposal process and if this is so, then how segregation is carried out.

x.       Whether respondents are willing to pay a fee for specialized contractor services, such as purchasing good quality products, segregation of generated e-waste or even recycling of e-waste.

xi.      Alternative methods of recycling and/or reusing e-waste.

xii.     To obtain proposed strategies that can be implemented in the organisations.

## 3.0 Methodology

The present study was undertaken to assess how electrical and electronic waste is being managed in parastatal bodies in Mauritius and to determine whether these organisations have defined policy measures enforced to the management of e-waste. The survey was conducted through the administration of a designed and structured questionnaire including closed and open-ended questions was used to collect relevant information on e-waste management in parastatal bodies. Questions were related to the organisation's details, its contribution towards a sustainable environment, an estimation of generated e-waste, the management of e-waste through pre-defined set of measures, the time period for the storage of e-waste, the method considered for the disposal of e-waste, the respondent's willingness to pay a fee for specialized contractor services, the preferred method of recycling and reusing e-waste and, propositions for e-waste management strategies.

## 3.1 Sample

The sample of the survey consisted of officers from 57 different parastatal organisations listed under the Government Listing from the website of the Government of Mauritius.

## 3.2 Data Collection

22 out of 57 sample populations responded to the questionnaire. The survey was carried out from April 2011 to June 2011. During this period, questionnaires were sent to parastatal bodies through electronic mail.

## 3.3 Data Analysis

The responses from the questionnaires were coded and the data was analyzed using SPSS (Version 18) statistical package. Open-ended responses were entered in an Excel spreadsheet for qualitative analysis.

## 4.0 Findings & Discussions

Twenty-two questionnaires were collected from parastatal bodies through email, fax and even by post.

95% of the participated organisations stated that they are contributing towards Maurice Ile Durable however, 37.5% regarded the local authorities (e.g. municipalities, district councils, etc.) having the main responsibility for e-waste management.

## 4.1 Management of E-Waste

Most of the respondents stated that local authorities are mandated for the collection of e-waste and they have the facilities for the collection and disposal of e-waste. On the other hand, some respondents noted that since the local authorities are already providing scavenging services, they should be assigned the responsibility for e-waste collection and its proper disposal. On the other hand, 32.5% regarded the organisation itself as being responsible for e-waste management. Our findings reveal that some respondents noted that the organisation should have pre-defined set of rules for the disposal of e-waste, for instance the disposal of used toners and computer peripherals which are no longer to be used. 30% of the respondents hold the importers and retailers of electronic products accountable for e-waste management. However, it should be noted that a few respondents affirmed it is the responsibility of each and everyone to manage e-waste.

The parastatal organisations which participated in the study were mainly from the educational sector with 43.8%. The construction, ICT/BPO and, community, social and personal services each constituted a percentage participation of 12.5% and, 18.8% of the participants were from the agriculture and fishing sector, see Figure 2.
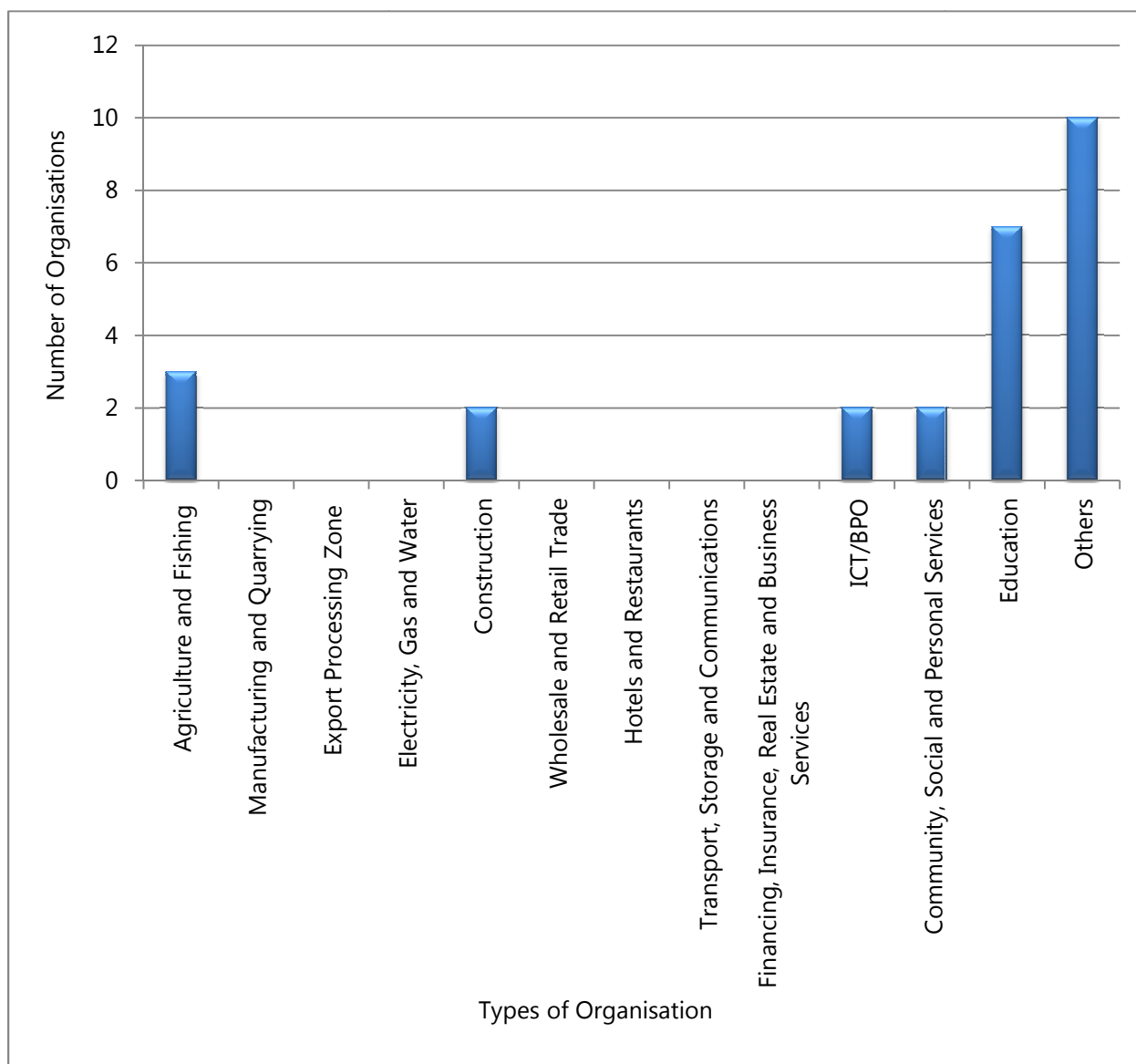


Figure 2: Type of activity of the Parastatals body

Figure 3 below shows that 86.36% of the respondents agree to contribute towards the Environment/Maurice Ile Durable while only 4.55% did not agree. Thus, it can be observed that there is a positive response for the Contribution towards the Environment/ Maurice Ile Durable.
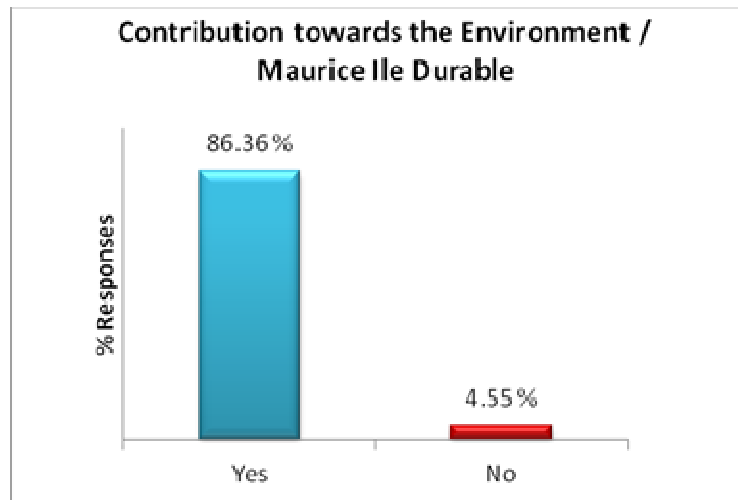


Figure 3: Contribution towards the environment/ Maurice Ile Durable

It can be found that 77.27% of the respondents are organisations not following guidelines for e-waste management while only 13.64% are organisations following the guidelines. As a whole, there is a high percentage for those organisations not following guidelines for e-waste management, see Figure 4.
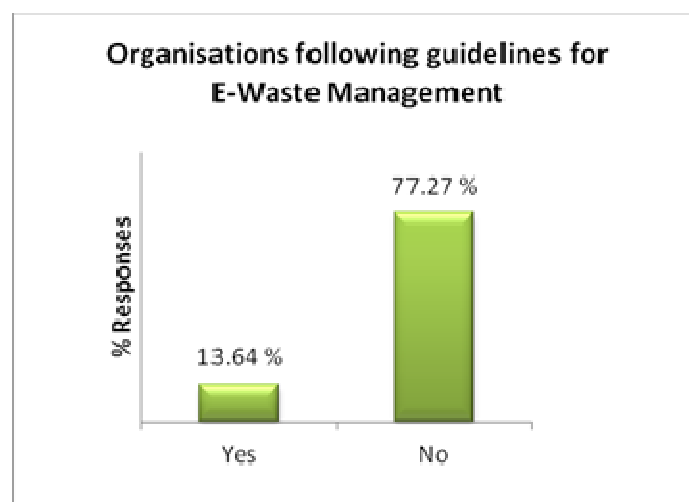


Figure 4: Organisations following guidelines for e-waste management

Figure 5 below illustrates that local authorities encompass the highest percentage for E-Waste Management (68%) while importers and organisations are those stakeholders taking 55% and 59% respectively. Hence, it is observed that local authorities are more responsible for E-Waste Management.
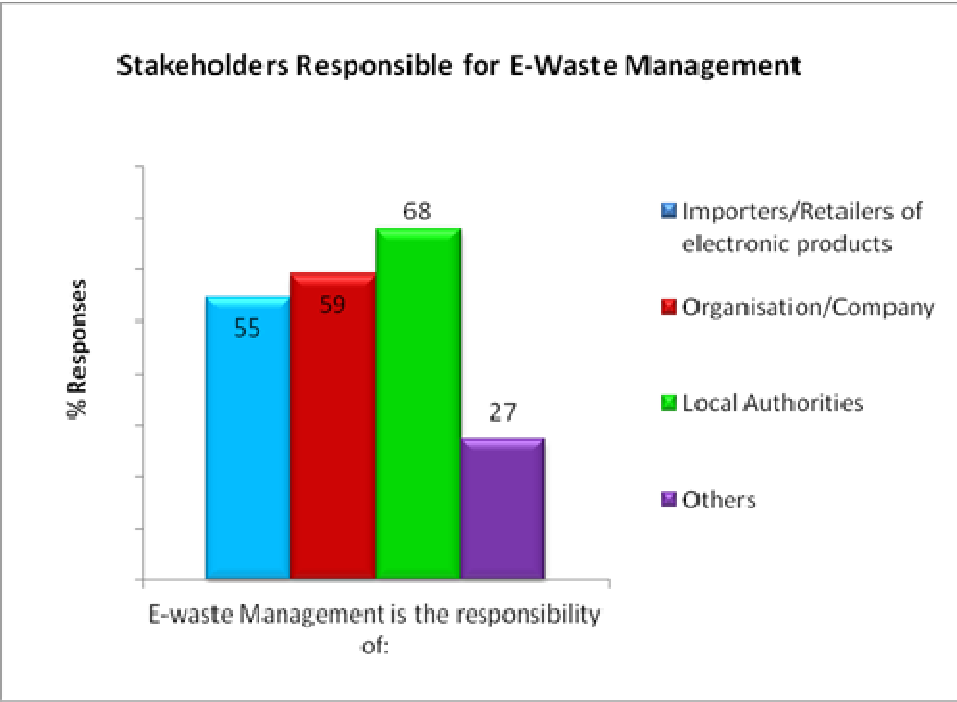


Figure 5: Stakeholders responsible for E-Waste Management

Our findings show that the highest estimate of e-waste from a sample of 22 parastatal bodies was accounted by computers and computer peripherals with 10.13 tonnes, representing 59% of the total e-waste generated. 13% of e-waste is attributed by printers and printer parts and 8% by electrical and electronic tools. The least estimated amount of e-waste was observed among leisure and sports equipment, monitoring and control instruments and, automatic dispensers. The category 'Others' constituted of 2.01 tonnes of e-waste that is 12% of the total e-waste. And such type of e-waste was specified as furniture, laboratory equipment, freezer and air conditioner as shown in Figure 6.

Figure 6: Percentage Estimate of E-Waste generated yearly

## 4.1.1 Storage of e-waste:

85.71% of the respondents store their e-waste for a specified period of time prior to their disposal. The majority, 47.4% store their e-waste for a period more than 1 year while 15.8% opt for 3-6 months and 10-12 months each. This is mainly due to the internal audit control system, to collect a certain amount of e-waste before its disposal or auction sale or even for donation to NGOs.

## 4.1.2 Segregation of e-waste:

46.15% of those who do not dispose their e-waste together with other waste segregate them before their disposal. A few respondents stated that the segregation of e-waste is done

according to procedures, for instance, the waste is categorized according to its composition, the use of different bins for different types of waste such as plastic and metal casings.

### 4.1.3 Open-ended questions:

According to respondents, there exist certain policy measures that are enforced in their organisation pertaining to the management of e-waste, for instance, the storage, re-use, recycling and, disposal of e-waste. Policy measures internally developed were listed as follows:

1.      Storage

E-waste is stored as per the specifications of the product and for certain organisations, a special space is designated within the company itself to the store the e-waste.

2.      Re-use

Certain parts are re-used in similar equipment or even served as spare parts.

3.      Recycling

Some of the electric and electronic parts are repaired as far as possible until they become fully uneconomical or unsalvageable.

4.      Disposal

E-waste is disposed as per the financial procedure or even protocol of the organisation and the board of survey is responsible for the verification purposes of e-waste and to make recommendations for items to be either scrapped or to be put for sale.

## 5.0: Conclusions & Recommendations

**Propositions of E-waste Management Strategies**

Respondents provided their views on e-waste management scheme that they would like to implement in their respective organisations. The main recommendation made was the segregation of waste such that e-waste, for example, IT equipments is collected either by the Parent Ministry or the Ministry of Environment for recycling purposes. On the other hand, electrical appliances, telecommunication equipment, consumable and spare parts can be returned back to the manufacturer for recycling purposes and, lighting and faulty bulbs can be collected by the Ministry of Public Utilities for the same purpose. It has been pointed out that there arises a need to set up e-waste professional companies to collect e-waste. It was also suggested to introduce a proper inventory system to record the life span and content of all electronic equipments so as to encourage the proper disposal of e-waste. Although respondents regard it important to implement a system to store, re-use and dispose e-waste, there emerges problems like budgetary constraints, lack of human resources, lack of training, information and guidelines on e-waste strategies and lack of office space.

By making recycling easy, we reduce the amount of toxic materials that would otherwise end up in our landfills. Re-Use: We repair what we can and give to families in the community who can't afford the latest electronics. Re-purpose: What we can't repair, we disassemble and separate the metals that is in turn sold to reputable state recyclers.

Recycling of computer equipment and air conditioning equipment are the major e-wastes in most administrative organisations. A local recycling centre/refurbishing centre would be useful.

E-waste should be kept in a separate place and should be sent to an organisation which deals with e-waste management from time-to-time. The employer may not be willing to pay for the disposal of e-waste.

Possibility of selling e-waste like. Repairing & re-using of e-products. Barrier - high cost of repair/ purchase of spare parts.

Set up a Fixed Assets Register Committee which will manage all e-waste in the organisation. Purchase only IT products which have passed the environmental friendly step.

Local Authorities should manage e-waste. For our department to implement e-waste management, additional specialised resources would be required.

**Parastatal Survey Questionnaire**

Assessment of E-waste Management Practices in Mauritius

## <u>Survey Form – E-Waste</u>

This study is conducted by the Mauritius Research Council in collaboration with the

University of Technology, Mauritius

[All information disclosed will be treated as highly confidential and under no circumstances will be divulged to a third party, and will be used exclusively for the purpose of this study.]

<u>Definition of Electronic Waste</u>:

Electronic waste or e-waste is defined as "**any appliance using an electric power supply that has reached its end-of-life**." E-waste is not necessarily items that have been trashed. E-waste can be classified into the following 10 categories:

1. Big Household Appliances;
2. Small Household Appliances
3. IT & Telecommunications Equipment;
4. Consumer Equipment;
5. Lighting Equipment

6. Electrical & Electronic Tools;
7. Toys, Leisure and Sports Equipment;
8. Medical Devices
9. Monitoring & Control Instruments; and
10. Automatic Dispensers.

A. <u>Organisation/Company Details</u>:

Name of Organisation/Company: .................................................................................................................

Type of Organisation/Company:  ☐ Private  ☐ Parastatal  ☐ Public

Job Designation of Respondent: ...............................................................................................................

Telephone number: ........................................................ Fax number: .............................................................

Email address: ...................................................................................................................................

Number of employees:  ☐

B. <u>Type of activity of the organisation/company</u>:

| ☐ | Agriculture & Fishing | ☐ | Transport, Storage and Communications |
| ☐ | Manufacturing and Quarrying | ☐ | Financing, Insurance, Real Estate and Business Services |
| ☐ | Export Processing Zone | ☐ | ICT / BPO |
| ☐ | Electricity, Gas and Water | ☐ | Community, Social and Personal Services |
| ☐ | Construction | ☐ | Education |
| ☐ | Wholesale and Retail Trade | ☐ | Others, **(please specify)**: ................................................................ |
| ☐ | Hotels and Restaurants | | |

## C. <u>Contribution towards the environment</u>:

**C1. Is your organisation/company contributing towards Maurice Ile Durable?**

Yes ☐        No ☐

**C2. According to you, e-waste is the responsibility of: (You may select more than 1 option)**

☐    Importers/Retailers of electronic products

☐    My organization/company

☐    Local Authorities (e.g., Municipalities, District Councils etc.)

Others, (**Please Specify**) .............................................................................

**C2.1 Why do you think it is the responsibility of the selected category in question C2 above?**

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**D1. Please provide an estimation of the different types of e-waste generated yearly by your institution in the table below.**

| Types of E-waste | Estimated amount of e-waste generated yearly (in Kgs) |
|---|---|
| Computers / Computer Peripherals | |
| Printers / Printer Parts | |
| Projectors | |
| Telecommunications Equipment | |
| Consumer Equipment | |
| Lighting Equipment | |
| Electrical and Electronic Tools | |
| Leisure and Sports Equipment | |
| Medical Devices | |
| Monitoring and Control Instruments | |
| Automatic Dispensers | |
| Kitchen Equipment **(please specify):** ……………………………………… | |
| **Others (please specify):** …………………………………………………… | |
| Total | |

### E. Management of E-waste:

E1. Do you follow any guideline (either from authorities or internally developed) that governs in-house e-waste management? (If Yes, skip question E1.3; If No, go to question E1.3)

Yes ☐    No ☐

E1.1 If yes, what are the policy measures enforced in your organisation/company pertaining to the management of e-waste?

| Management of e-waste | Description of Policy measures | |
|---|---|---|
| | By Authorities | Internally developed |
| 1. Storage | | |
| 2. Re-use | | |
| 3. Recycling | | |
| 4. Disposal | | |
| 5. Additional Information | | |

E1.2. To what extent are you satisfied with how e-waste is being managed in your organisation/company?

| Not satisfied at all | Unsatisfied | Neutral | Satisfied | Very satisfied |
|:---:|:---:|:---:|:---:|:---:|
| ☐ | ☐ | ☐ | ☐ | ☐ |

E1.3 What do you do with your e-waste?

☐ We store our e-waste

☐ We sell our e-waste

☐ We discard our e-waste

☐ We give it to NGOs

☐ We reuse/recycle our e-waste

☐ Others, (**Please Specify**) ……………………………………………………………………..

## F. Storage of e-waste

F1. Do you store e-waste for a specified period of time prior to their disposal? (If No, please go to Question G1)

Yes ☐        No ☐

F1.1 If yes, why do you store your e-waste?

F1.2 For how long do you store your e-waste?

☐ less than 3 months

☐ 3 - 6 months

☐ 7 - 9 months

☐ 10 - 12 months

☐ more than 1 year

☐ Others, (**Please Specify**) ...........................................

F1.3 Where do you store your e-waste? ..............................................................................

☐ Within your company's/organisation's compound (store room or any dedicated places within the building)

☐ Outside the building (backyard or any separate storing facilities)

☐ Others, (**Please Specify**) ...........................................

## G. <u>Disposal of E-waste</u>:

### G1. Why do you discard your e-waste?

☐ Storage problem

☐ Cannot be re-used

☐ Expensive to repair

☐ Cannot be sold

☐ Cannot be donated

☐ Others, (**Please Specify**) ...............................................................................

G2. Do you dispose of e-waste together with any other waste? (If yes, please go to question G3)

Yes ☐        No ☐

G2.1. If No, do you segregate the different types of e-wastes before disposing them?   (If No, please go to question G3)

Yes ☐        No ☐

G2.1.1 Please explain the process of segregation.

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☐    Hazardous substances seaping into waterways

☐    Harmful to human and animal health

☐    Waste precious metals through dumping

☐    Others, (Please Specify) ……………………………………

## H. Willingness to pay a fee for Specialised Contractor Services:

H1. Are you willing to pay more to acquire good quality electronic products (such as computers, printers etc.) which:

| (Please select as appropriate) | Yes | No |
|---|---|---|
| H1.1. may last for a longer period | ☐ | ☐ |
| H1.2. may be returned back when purchasing a new one | ☐ | ☐ |
| H1.3. contain less toxic substances | ☐ | ☐ |
| H1.4. have a green tag (environment friendly) | ☐ | ☐ |

H2. Are you willing to pay a fee for the separate collection of e-waste generated by your organisation/company?

Yes ☐     No ☐

H3. Are you willing to pay a specialised recycling enterprise to recycle your e-waste?

Yes ☐     No ☐

I. Recycling and Reuse of E-waste:

I1. How would you prefer to recycle your e-waste?

☐ I would like to take my e-waste to a Recycling Centre

☐ I would like to take my e-waste to a retailer of electronic products

☐ I would like to take my e-waste to a retailer of electronic products when purchasing new electronic products

☐ Repairing for re-use

☐ Through collection events (such as E-day, collection by local authorities, etc.)

☐ E-waste collection companies

☐   Others, (Please Specify) ...........................................

I2. Are you in favour of promoting reuse of electronic products in your organisation/company by:

(Please select as appropriate)                                                    Yes        No

I2.1 encouraging the use of phased out e-products which can still be used     ☐         ☐

I2.2 by re-using e-products after reparation                                 ☐         ☐

I3. Do you repair or replace your electronic equipment immediately when it breaks down?  Please comment.

(Tick the appropriate box and comment accordingly.)

☐   Repair                              ☐   Replace

|  |  |
|---|---|
|  |  |

I4. Do you dismantle your e-waste and remove parts that can be re-used?

Yes ☐        No ☐

J. Propositions of E-waste Management Strategies:

J1. Please comment on any e-waste management scheme that you would like to implement in your organisation/company and why?  Also, comment on the barriers that prevent you from implementing them.

|  |
|---|
|  |

*Thank you very much for filling in this form.*

## ANNEX 3: Case Study

### 1.0    Interview of Mr Berty Malabar

Monday 07 June 2010 (9.40 to 11.10AM) 11.10.10

For many years now, Mr Berty Malabar, owner of BEM Enterprise Ltd, a small and medium enterprise located in the midst of Beau Bassin, has been operating as a professional in the e-waste recycling business.  More specifically, he has been dealing with the collection, dismantling and exportation of electronic waste commonly termed as e-waste or Waste Electrical and Electronic Equipment (WEEE).  A face-to-face interview conducted with Mr Malabar in June 2010 revealed a number of his personal views and opinions for the betterment of our natural environment.  He pointed out that the throwing away or dumping of e-waste should be prevented as this practice can prove to be an environmental hazard as well as a potential threat

to human health.  Mr Malabar opined that the present course as regards the dumping of e-waste should be repealed if a more friendly environment is to be promoted.

The main objective of BEM Enterprise Ltd as specified by Mr Malabar is to prevent parts and components of waste e-products, with specific emphasis on hazardous waste electronic products, from being disposed in the open and also to ensure that used e-products are brought back into use after the recycling process.  Mr Malabar strictly commented that he wants every single waste electronic product to undergo the recycling process.  He lamented that technology is becoming obsolete at a rapid pace which is accelerating the disposal of electronic goods.  To be able to cope with this issue, Mr Malabar argued that there is a need for a proper infrastructure to enable a better and faster processing of waste electronic recycling.

In his discussions, Mr Malabar put forward that currently, there is no proper e-waste management system to manage waste electronic products in terms of collection, recycling and reuse.  He pointed out that a number of policy measures which have been enforced in other countries need to be considered for implementation in the country to improve the current situation of e-waste management.  However, only those policies which are appropriate for implementation in the Mauritian context should be considered.

Mr Malabar also recommended that a system should be introduced to enable record keeping of every single electronic product that enters the country with a view to be in a position to trace those products once they outshine their useful lives.  He further argued that this exercise is crucial especially to facilitate traceability of hazardous or toxic e-products which may impact negatively on the environment if thrown away.  This inventory system could prove to be a useful tool for preventing used e-products from being dumped and also to bring them back into the e-waste management cycle.  In this view, he suggested that the record keeping activity should start with importers of electronic goods and the latter should take the responsibility of informing the local government of the amount of the different categories of electronic goods that they import.  The importers, through retailers, should also keep track of the diverse

categories of electronics being sold to consumers to facilitate recovery of same after they exceed their useful lives.

He further advised that, in turn, government should use this record for follow-up purposes to ensure that these e-products are returned back after they have been used. Also, records of hazardous products which are used in hospitals, clinics, and photo shops should be kept by the government for the ease of traceability after their use.

Another argument that Mr Malabar stressed on is the setting up of a proper collection system where emphasis will be laid on the separate collection of the different electronic products by electronic waste carriers to be transported to a dismantling plant. The dismantling plant will be responsible for the disassembling and sorting of the various parts and components from the e-goods. Parts made up of metal and plastic substances will be crushed and compressed with a view to export them for recycling and ultimately to be used in the manufacture of other products. Thus, no single electronic product will be disposed of in the landfills which imply lesser or no risk to human health and our natural environment. This will also prevent the loss of precious metals which are currently being dumped into our landfills due to the non-existence of a proper e-waste management programme.

With a view to enable better management of electronic products, Mr Malabar proposed the below system which he considers as an appropriate e-waste management cycle through which any waste electronic product should pass during and after its useful life.

(a) Importers of electronic goods should inform the local government what e-products they are importing for record keeping and traceability.

Return back used electronic products to retailers upon purchase of new e-products[1]

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                    Manufacturers
                         │
                         ▼
                     Importers
                         │
                   Distribute to
                         │
                         ▼
                     Retailers
                         │
                      Sell to
                         │
                         ▼
                     Consumers
                         │
                     After use
                         │
                         ▼
                  Proper
                  Collection
```
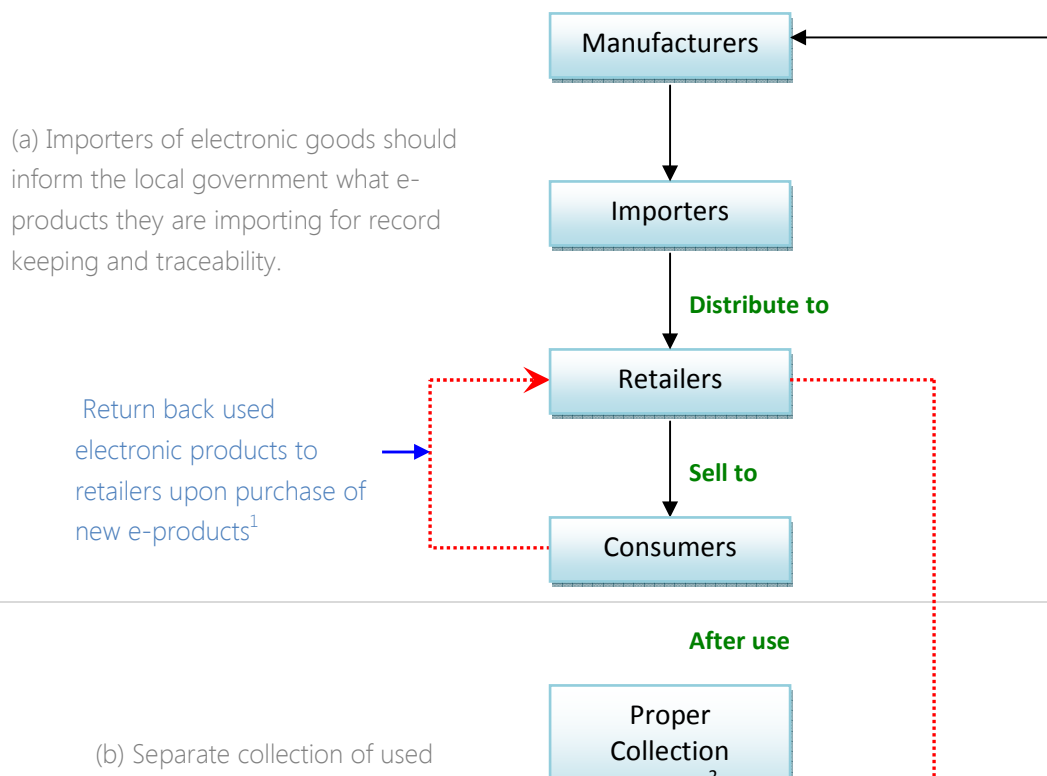
(b) Separate collection of used

Figure 1: Proposed system of managing e-wast

Note:

1.      If consumers return back the used e-products directly to retailers, then the retailers should have the responsibility of sending the collected e-waste to the dismantling plant.

2.      Otherwise, there is a need for a proper e-waste collection system to be put in place to enable proper collection of e-waste from consumers.  In this instance, the concerned authority collecting the e-waste will be responsible for sending them to the dismantling plant.

## 2.0 Take Back Scheme

Mr Malabar stated that the government should provide incentives not only to customers but also to retailers, importers and owners of dismantling plants because the returning back and processing of used electronic products involve certain costs. In this respect, the government should plan a scheme to provide incentives to retailers to implement take back schemes and also to encourage retailers to provide incentives to consumers to urge them to return back every single used electronic product to their respective retailers once the product cannot be used any longer. This will aid in creating a win-win situation for every stakeholder involved in the chain. The returning back of used electronic products by customers should be encouraged through specific schemes where an individual can return back his/her old electronic products upon purchase of new ones.

## 3.0 Corporate Social Responsibility (CSR)

The government should encourage companies to send their e-wastes for recycling instead of disposing them in landfills or simply giving them to their employees, the reason being that, at the end, they will all be discarded in the open thus leaving the problem unsolved. Mr Malabar remarked that organisations seem to be reluctant to send their e-wastes to recycling enterprises as there is an additional cost which is associated with this practice. Therefore, he proposed that companies or organizations may classify the costs associated with sending e-waste for recycling under the CSR programme of the company given that this initiative may prevent harmful e-products from being dumped in our natural environment.

## 4.0 Carry out sensitization campaigns in schools

School children should be sensitized of the growing concern of e-waste as well as the consequences they may have on the natural environment and human health through the organisation of sensitization campaigns in schools. Children tend to take things positively and

try to bring into practice whatever they are taught at school. In this respect, they may be forceful at home and may inspire their parents to implement whatever they have learnt in the sensitisation campaigns conducted at school. This will help in providing people with more information on the end result of disposing used electronic products in the nature and eventually, this can lead to a reduction in the amount of e-waste that is presently being dumped in the landfills.

## 4.1 Difficulties encountered by BEM Enterprise Ltd:

Loan problems

No proper Infrastructure (limited space)

Location problem

**Interview Questions:**

1.      Give a brief description of your company. (core functions)

2.      How and from where do you obtain the required used electronic products?

3.      How do you manage e-waste?

4.      Do you have any formal/written procedure for the management of e-waste?  If yes, please describe the procedure.

5.    In general, how do you perceive the current way of managing e-waste?

6.    What categories/types of e-wastes does your company deal with?

7.    Do you store e-waste?
      If yes, where do you store e-waste?
      Under what conditions do you store e-waste? (How)
      For how long do you store e-waste?

8.    Do you have a segregation process to separate the different categories of e-wastes?  If yes, please describe the segregation process.

9.    Can you provide an estimation of the amount of e-waste that your company deals with on a yearly basis?

10.   Do you conduct de-manufacturing of obsolete electronic equipment? (de-manufacturing – disassembly and recycling of obsolete consumer products)

11.   Do you recycle e-waste or do you send e-waste to other companies for recycling?

12.   Do you dispose of all your electronic wastes together (or at the same place)?  Please explain how and where you dispose them.

13.   How do you manage and dispose of electronic wastes which contain toxic substances?

14.   Are the operations of your company governed by any government policy or law?  If yes, please describe the policy.

15.    Do you have an e-waste management strategy in place for managing and disposing of your e-wastes?  If yes, please provide a description of the strategy used.

16.    Would you like to propose an e-waste management strategy that you think can be more effective for the Mauritian context?

17.    Do you feel that there are certain barriers that can prevent the implementation of the proposed strategy?  Please elaborate on how we can overcome these barriers.

## ANNEX 4:  Classification and Review

### 1. Introducing The E-Waste Management Research Programme

### 1.1 WEEE as a Global Phenomenon

The inevitable issue of waste generation has always been part of human life and is currently viewed as a global phenomenon which needs to be addressed through the adoption of specific and suitable methods or policies.  In this respect, the escalating trend in the disposal of wastes is a matter of great concern irrespective of whether they are classified as toxic or non-toxic wastes. The term 'waste' also incorporates Waste Electrical and Electronic Equipment (WEEE), commonly known as electronic waste or e-waste, as a consequence of the rapid development in technology.  The impacts of globalisation and the rise in the level of economic development have created an urge on the part of individuals to make use of robotised or automated products which need to be programmed to perform certain specific tasks.  As a result, electrical and electronic products are seen to have become part and parcel of our everyday lives.  Also, keeping up to date with state of the art technologies has become more of a universal fashion and has aggravated the issue of WEEE generation.

### 1.2 Definition and characterization of WEEE

There exist numerous definitions for electronic waste, but here the definition of European Union (EU) as described in EU WEEE Directive 2002/96/EC is being adopted. E-waste is defined as "any appliance using an electric power supply that has reached its end-of-life."   The EU WEEE directive further classifies e-waste into 10 different categories, namely:

· Big Household Appliances;

· Small Household Appliance;

· IT and Telecommunications Equipment;

- Consumer Equipment;

- Lighting Equipment;

- Electrical and Electronic Tools;

- Toys, Leisure and Sports Equipment;

- Medical Devices;

- Monitoring and Control Instruments; and

- Automatic Dispensers.

## 1.3 Pitching the local context

Over the last decades the amount of waste generation in Mauritius has been considered small, hence its management has not been given due recognition. The rapid economic development, the changing lifestyles of Mauritians, the growth of the ICT sector, the adherence of Mauritius to the concept of sustainable development , and the realization of the toxicity level of certain-waste components have pushed to establishing e-waste management to the fore of the waste management agenda.

There is need to adopt a two-pronged approach in a attempt to address this issue.  The first requires reducing the generation of e-waste, while the second involves resolving the fate of such products at the end of their useful lives. These prime objectives need to be embodied within an e-waste management strategy which is safe and affordable for consumers and local authorities.

One important realisation prior to the development of an e-waste management strategy is that though e-waste is an emerging environmental problem due to the toxic materials being used in certain products, it does also present a business strategy given its content of valuable materials that can be recovered. The present e-waste generation needs to be reduced through the

formulation and implementation of appropriate policies, whereas the treatment needs to focus on higher levels of recycling and the economic recovery of materials.

## 1.4 Paving the way for an eWaste Management Research Programme

Realising the importance of managing e-waste, the MRC has embarked on an e-waste management research programme since 200X. The programme comprises 5 stages ( See Figure 1.0).

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┌─────────────────────────────────────────┐
│ Phase I: Quantification & characterisation of │
│           e-waste in Mauritius           │
└─────────────────────────────────────────┘
                    ↓
┌─────────────────────────────────────────┐
│ Phase II: A review & classification of international │
│        e-waste management practices       │
└─────────────────────────────────────────┘
                    ↓
┌─────────────────────────────────────────┐
│ Phase III: E-waste management in Mauritius: A │
│                 status                   │
└─────────────────────────────────────────┘
                    ↓
┌─────────────────────────────────────────┐
│ Phase IV: Reviewing & testing e-waste policies │
│        using a system dynamic model       │
└─────────────────────────────────────────┘
                    ↓
┌─────────────────────────────────────────┐
│ Phase V: Proposing incentive schemes for e-waste │
│        management enterprises             │
└─────────────────────────────────────────┘
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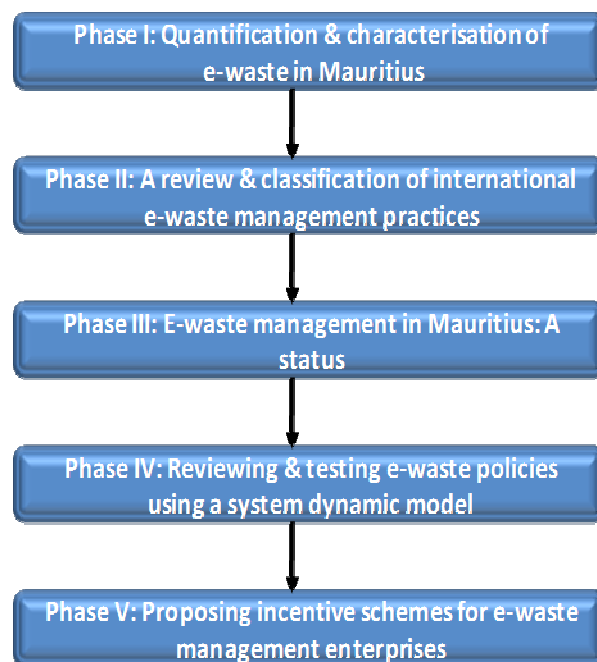
Figure 1.0: eWaste Management Research Programme

The eWaste Management Research Programme comprising 5 components, namely:

C1 - Quantification & characterization of e-waste in Mauritius

C2 - A review & classification of international e-waste management practices

C3 - E-waste management in Mauritius: A status

C4 - Reviewing & testing e-waste policies using a system dynamic model

C5 - Proposing incentive schemes for e-waste management enterprises

C1 has been completed and the findings have been disseminated. C2 & C4 are currently being implemented.

There is a range of policy instruments that can be used to foster e-waste management. The methodology adopted has been a thorough literature review of applicable policies internationally. For the sake of the present exercise these policy instruments have been classified under the following headings:

· Regulatory instruments

· Economic instruments

· Information instruments

The following sections are based on a thorough review of e-waste management practices that are being implemented internationally. The salient features of the different instruments under each of the above category are detailed and explained.

Another objective of this review is t map a typical ewaste control system. This should visually present hoe the different stakeholders along the control system are related, thus facilitating the targeting of policy instruments to better address the e-waste issue.

## 2. Regulatory instruments

Regulatory instruments are usually established by a Government to regulate a specific activity. They can be on their own or be engrossed in a system of regulations. An important specificity is the ability of the Government of the institutions representing the Government to enforce the regulations. Regulatory instruments are also called command-and-control instruments. The following sections present and describe different types of regulatory instruments.

### 2.1 Mandatory Takeback

This instrument requires the producer to take back the product once its useful life is over which means that when the product is at the point of being disposed, the producer has an obligation to take it back. The important requirement here is that the end-of-life products should be collected before they enter the waste stream. Table 2.0 shows countries where 'take-back' schemes are currently being implemented and also within which context they are being implemented.

Table 2.0: Countries where 'take-back' schemes are currently being implemented

| Country | Instruments & description of instruments |
|---------|------------------------------------------|
| India | 1. The Batteries (Management and Handling) Rules 2001: <br> (i) is based on the EPR concept <br> (ii) established to set up collection centres - to collect used batteries from consumers and dealers <br> (iv) ensures the safe transportation of collected used batteries <br><br> (iii) used batteries are returned to manufacturers or sent to registered recyclers <br> (v) create public awareness |
| Germany | The Electrical and Electronic Equipment Act (also known as ElectroG) - a combination of The Waste from Electrical and Electronic Equipment (WEEE) & The Restriction on Hazardous Substances (RoHS): <br> (i) requires producers to finance a take back system by registering with the Elektro-Altgeraete Register and paying an annual financial guarantee |

| | |
|---|---|
| | (ii) governs the sale, return and environmentally sound disposal of electrical and electronic equipment<br><br>(iii) categorises WEEE under household and businesses: (1) household users return their goods to municipal collection points; (2) Business users must arrange their own transport to the collection point. |
| Sweden | 1.Ordinance on Producer Responsibility for Electrical and Electronic Products;<br><br>(i) manufacturers, importers and retailers have an obligation to take back a wide range of electronic products without imposing a fee on consumers<br><br>(ii) most manufacturers participate and pay into a collective recycling system where the participation fees are based on the quantity and type of products available on the market<br><br>(iii) is financed through the fees its members pay - these fees are calculated depending on the volume of sales<br><br>(iv) consumers dispose electronic products at household collection centres free of charge - household collection centres are financed by local authorities<br><br>(v) Producers, manufacturers, importers, and retailers are responsible for financing the transport of household waste from collection centres and its recycling<br><br>(vi) also responsible for financing the collection, transport and recycling of WEEE from commercial consumers<br><br>(vii) provides collection services on commission & enables companies to deliver discarded products directly to the pre-treatment facilities<br><br>(viii) Commercial consumers may either return products to producers or retailers when purchasing a new product or they may deposit the products free of charge at one of the 300 business collection centres<br><br>(ix) collects disposed TVs, radios, videos and other products from stores and service worshops.  This service is free for stores which have acquired new products from producers who are members of El-kretsen.<br><br>There are 650 household collection points for Household WEEE & 300 for Commercial customers.<br>Household consumers may return WEEE to any of the collection sites that are paid and administered by municipalities free of charge<br>Electronic wastes are also collected from larger institutions and commercial Enterprises. Locally designed systems of collection such as curbside pickup and call systems are employed - financed through municipal tax and other fees |

| | |
|---|---|
| Belgium | 1. WEEE Legislation:<br>(i) ensures the obligation on the part of companies selling electric and electronic products to abide by the take-back scheme<br>2. RECUPEL (introduced in 2001):<br>(i) Manufacturers & importers of electrical and electronic equipment together with the support of the Belgian regional governments created the "Recupel" – non-profit making organisation.<br>(ii) responsible for the collection, sorting, processing and recycling of WEEE in Belgium (covers approximately 75% of Belgian territory with a minimum collection of 4kg per inhabitant on an annual basis)<br>Recupel has 5 sectoral management agencies that each focuses on one group of products:<br>(1) Recupel AV - Consumer electronics<br>(2) Recupel ICT - IT, Telecommunications & office equipment<br>(3) Recupel SDA - Small domestic electrical appliances<br>(4) Recupel BW-Rec - Large domestic electrical appliances<br>(5) Recupel ET & G - Electrical tools & electrical garden equipment |
| Netherlands | 1.EPR Legislation:<br>(i) requires manufacturers & importers of large and small-scale electronic products to establish take back systems with retailers, local governments and repair shops serving as collection sites<br>2.Collective Recycling Programmes:<br>(i) manufacturers are allowed to share take back responsibilities with other businesses<br>3.Netherlands Association for Disposal of "Metalelectro" Products (NVMP):<br>(i) For white goods, there are 5 main producers' sector organisations which have joined the NVMP<br>4.ICT-Milieu:<br>(i) has been set up for the management of grey goods<br>(ii) uses a two-tier collection system through 540 municipal collection sites & 65 regional collection and sorting depots<br>(iii) Private households may dispose of their ICT WEEE either by - (1) returning the old product to the retailer or supplier when purchasing a new product or (2) by handing in the old product to the municipality. This can be done through pickup schemes in some areas or through private consumersbeing directed to drop-off their old products at a designated collection point in the municipality or in any other areas.<br><br>NVMP & ICT-Milieu use official carriers to collect discarded goods from Regional Transfer Stations, retailers and repair companies to transport them to their recycling partners.<br><br>Business consumers wishing to dispose ICT WEEE are (1) free to sell or (2) pass on equipment to third parties or (3) exchange "old for new" products with suppliers or retailers. |

| | |
|---|---|
| | Those wishing to dispose their old products without having to purchase new products can either (1) offer their products directly to the relevant manufacturer/importer or (2) they can have them collected and be disposed by their industrial waste collector.<br><br>Though a number of manufacturers and importers take back their branded products, they do not have an obligation to take them back. |
| Switzerland | 1. Ordinance on "The Return, the Taking Back and the Disposal of Electrical and Electronic Appliances" - (ORDEA):<br>(i) Acts as a regulator for the take-back and recycling of electrical and electronic appliances<br>(ii) Stipulates that defective or obsolete devices should not be disposed together with the usual domestic waste<br>(iii) Defective products should either be delivered to specialised disposal facilities and public collection points or returned to retailers, importers and manufacturers of the product who have an obligation to accept old items from their customers for reuse, recycling or proper disposal.<br>2.SWICO Recycling Guarantee:<br>(i) Guarantees that used equipment is taken back comprehensively from sectors such as informatics, office electronics, consumer electronics, tele-communications, graphics industry and the dental industry |
| Norway | 1.Norwegian Legislation on WEEE:<br>(i) goes beyond the EU directive - it includes all types of electronics and machineries thereby not limiting itself only to consumer electronics.<br>(ii) Municipalities and distributors of electrical and electronic products are forced to accept returned EE Waste<br>(iii) Distributors also have an obligation to accept E-waste resulting from the production process against new purchases of an equivalent quantity of new products.<br>(iv) manufacturers and importers of EE products have to arrange for the collection of EE waste from distributors and municipalities from the geographical areas they have been selling their EE products and in turn ensure that materials and components of hazardous EE wastes are sorted and disposed in an approved treatment facility.<br><br>2.El-Retur:<br>(i) consists of 2 collaborating waste management companies namely: Hvitevareretur AS & Elektronikketur AS<br>(ii) Hvitevareretur AS: responsible for the recovery of professional and domestic white goods, microwaves and oil-filled heaters<br>(iii) Elektronikketur AS: responsible for the recovery of brown goods (audio-video), electrical and electronic games, medical equipment, office machinery and telecommunications equipment<br>(iii) collective programme for the transportation and recycling of WEEE |

El-Returprogramme:
(i) negotiates contracts for 3-year periods with 6 logistic companies and 12 recycling companies which provide 100% geographical coverage for Norway.
(ii) consumers may deliver WEEE free of charge & without having to make any further purchase from retailers who sell the same product to municipalities regardless of the product type involved.
(iii) commercial enterprises may return WEEE to retailers selling the same product on the condtition that they make a further purchase on a one-to-one basis.  They may also deliver WEEE to municipalities and then impose a charge for such delivery.
(iv) collection equipment including cages and containers are provided free of charge to municipalities and dealers
(v) also collects discarded EE products from commercial enterprises such as workshops, waste companies, offices, industry and associated producers without charging any fee.

Norway has 6 transport and logistic partners and 5 recycling partners each covering a certain region.
Recycling partners use sub-contractors for specialist products (CFCs) or regions.
There are a total of 12 recycling plants.
The El-Retur system operates 4 separate financing methods for different product categories - 1 in Elektronikketur and 1 for Hvitevareretur.
Each of the finance companies has chosen a slightly different model for the collection of money.  For instance, LydogBildeRetur, the finance company for EE-bransjen, which is in charge of brown goods collects money from the relevant importers/manufacturers on the basis of the type and number of brown goods sold to the Norwegian market.

IKT Retur AS which is the finance company for IKT-Norge is responsible for IT products, electronic/electrical games and office machinery.
It uses a financing model which is based on invoicing actual costs where these costs are divided between the relevant importers and manufacturers on the basis of actual market share in respect of each individual product category.

IT Retur AS, the financing company for Abelia, which is responsible for medical equipment, electronics and telecom equipment uses a financing model where actual recycling costs are based on market share in respect to each individual product category


3. Regulations regarding Scrapped Electrical and Electronic Products:
(i) producers/importers of household appliances and electronics are required to
provide take-back for the recovery of scrapped products from consumers andbusinesses..

| | |
|---|---|
| Japan | 1. Specified Home Appliance Recycling Law (SHARL): |
| | (i) In 1998, Japan enacted the SHARL which requires producers to take back television sets, refrigerators, air conditioners and washing machines |
| | Japan has been classified as one of the first countries which have known an overwhelming amount of hazardous electronic waste with over 70 percent of electronic goods produced by Japanese manufacturers. |
| Ireland | 1. WEEE Regulations 2005:<br>(i) Consumers are urged to bring their unwanted electrical and electronic equipment to their local civic amenity centres or to retailers for recycling when they purchase new equipment.<br>(ii) WEEE Ireland organises the treatment and recycling of waste electrical and electronic equipment from authorised collection points. |
| Taiwan | Take back system:<br>(i) requires retailers to accept used electronics from customers.<br>(ii) even covers equipment regardless of when it was sold. |
| Denmark | Danish Statutory Order on Management of Waste from Electric and Electronic Products:<br>(i) managed by the government and financed by tax payers<br>(ii) excludes the retailer take back schemes while placing primary responsibility on local authorities and municipalities<br>(iii) local authorities & municipalities are legally responsible for collecting, transporting and the recycling of e-waste.<br><br>(iv) 275 municipalities formed 32 joint municipal-waste management companies that coordinated regional waste service<br>(v) Larger urban areas such as Copenhagen, Arhus, Albourg and Odense formed their own waste management organisations.  These regional and city waste management organisations formed two national collective organisations: Affald Denmark, a collective of city authorities and Renosam, a collective of regional local municipalities<br><br>(vi) Both organisations were responsible for approximately 3.2 million of the total population (5.2 million) in Denmark<br>(vii) this sytem was funded by local household waste tax administered by local authorities<br><br>(viii) The level of tax varies from municipality to municipality with Industrial EE recycling being financed by the end-user. |

| | |
|---|---|
| | (ix) a majority of electronic waste was collected at collection points in containers owned and operated by local authorities<br>(x) municipalities are responsible for collection schemes and collection sites for WEEE from households<br><br>(xi) this commitment is met through "Bring Schemes" via the setting up of containers at the municipal recycling sites or through "Pick-Up Schemes"<br><br>Once WEEE has been collected, the municipalities must ensure that the waste is separated into 5 fractions:<br>(i) Large household appliances and automatic dispensers<br>(ii) Small household appliances, electrical and electronic tools (excluding large-scale stationary industrial tools, toys and sport and leisure equipment, medical equipment, monitoring and regulation instruments)<br>(iii) IT and telecommunications equipment<br>(iv) Consumer equipment; and<br>(v) Lighting equipment<br><br>WEEE system: is a private & independent non-profit organisation which is responsible for the registration and laying down of more detailed guidelines. It is also responsible for charging and collecting registration fees<br><br>Producers & importers of EEE must provide a financial guarantee to the "WEEE system" with regards to the registration and management of the scheme.<br><br>However, if a producer or importer joins a collective scheme, the WEEE system can exempt the producer or importer from having to provide a financial guarantee for equipment |
| European Union | "1. European Union Waste of Electrical and Electronic Equipment (WEEE):<br>(i) guided by the concept of Producer Responsibility<br>(ii) ensures that collection & treatment centres are in place and that manufacturers have set up financing systems to pay for collection and treatment of e-waste"<br>(iii) Producers need to finance their collection, treatment, recovery and disposal of e-waste either by setting up their own centre or by paying a fee to join a collective scheme<br>"(iv) Producers & importers of electrical and electronic products are responsible for the collection, reuse and recycling of the discarded products.<br>(v) each producer provides a guarantee when placing a product on the market showing that the management of all WEEE will be financed & that the product is clearly marked"<br>(vii) producers must mark electric equipment with the symbol of a wheeled trash bin |

## 2.2 Minimum recycled content standards

The purpose of this policy is to set a target of a minimum amount of recycled content to be used in product.

## 2.3 Secondary material utilization rate requirements

The objective of the secondary material utilisation rate requirements policy is to make use of second-hand materials, that is, materials which have been previously used but are still in good usable condition.  This policy imposes an obligation on producers by specifying the amount of secondary materials to be used in a given product (See Table 2.1).

Table 2.1: Secondary material utilization rate requirements

| Country | Instruments & Description of Instruments |
|---|---|
| Japan | "Revised Law for Promotion of Effective Utilisation of Resources:<br>(i) requires manufacturers of computers, copy machines and large electrical home appliances to design their products in a way that will facilitate disassembly and recycling<br>(ii) aims to reduce waste and to increase the life of the products<br>(iii) manufacturers are allowed to charge consumers for end-of-life waste management costs which include the costs of collection, take back and treatment." |

## 2.4 Energy efficiency standards

This is a strategy to influence producers to develop products with less environmental impact. This approach instructs producers to pay for the environmental damage caused by the products during their lifetime.

Table 2.2: Energy efficiency standards

| Country | Instruments & description of instruments |
|---|---|
| Mexico | The Ministry of Energy issued two regulations (to be applicable as from Feb 2013) that set new minimum energy efficiency standards for:<br>1. Household clothes washers; and<br>2. Light emitting diode luminaires for roads and public outdoor areas.<br><br>This standard will apply to:<br>1. automatic washers with a vertical axis of less than 45.3 litres, automatic washers with a vertical axis of 45.3 litres or more, and<br>2. automatic washers with a horizontal axis.<br>Semi-automatic and manual clothes washers will be subject to a minimum energy consumption standard ranging from 19 to 160 in kWh per year, depending on the type of washer and its capacity.<br><br>The standard requires subject luminaires to comply with a total minimum lighting efficiency of 70 lumens per watt as well as various requirements related to the |

| | variation of the nominal luminous flux, total luminous flux, correlated colour temperature and colour rendering index, power factor, total harmonic distortion, glare luminous flux, resistance to thermal shock and switching, and resistance to lightning. |
|---|---|

## 2.5 Disposal bans and restrictions

Its implementation bans and restrictions on disposal of certain materials can lead to the prevention of hazardous wastes being dumped into landfills.

## 2.6 Material ban and restrictions

Materials containing harmful or hazardous substances [e.g., mercury, cadmium, hexavalent chromium] should bebanned/phased out and safer substitutes should be found (Table 2.3).

Table 2.3: Material ban and restrictions

| Country | Instruments & description of instruments |
|---|---|
| European Union, Japan, South Korea, Taiwan | "Extended Producer Responsibility:<br>(i) Manufacturers are pressurised to design toxic free electronics requiring recycling effort.<br>(ii) Manufacturers are financially responsible beyond the point of sale"<br>"(iii) Manufacturers are required to take back e-waste and recycle them up to a defined percentage<br>(iv) However, the funding model for this activity varies from company to company" |
| European Union | "1. Restriction on Hazardous Substances (RoHS) Directive:<br>(i) imposes a ban on the use of certain hazardous substances in electronic and electrical equipment<br>(ii) (As from 1 July 2006) - new electronic and electrical equipment introduced on the EU market must not contain lead, mercury, cadmium, hexavalant chromium or the flame-retardants Polybrominated biphenyls (PBB) and Polybrominateddiphenyl ethers |

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|---|---|
| | (PBDE)<br>"<br><br>"2. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal:<br>(i) negotiated under the United Nations Environment Programme (UNEP) in 1989 & came into force in 1992"<br>(ii) regulates the import & export of hazardous waste & establishes legal obligations to ensure that such wastes are managed in an environmentally sound manner<br>(iii) the aim is to minimise the generation of hazardous wastes (in terms of quantity & hazardousness), to dispose wastes near the source of generation & to reduce the movement of hazardous wastes.<br>(iv) the Basel Convention has established regional centres for training and technology transfer in Argentina, China, Egypt, El Savador,  India, Indonesia, Nigeria, Senegal, Slovak Republic, South Africa, Russian Federation, Trinidad & Tobago and Uruguay.<br>(v) these centres are intended to help countries to implement the Basel Convention<br>(vi) also assists countries (as well as industries, companies and other stakeholders) to manage or dispose of their wastes in the proper way and it cooperates with national authorities to develop national legislation and to set up inventories of hazardous wastes among other activities.<br>(vii) However, the Convention does not state exactly as to what e-wastes are considered hazardous. |
| China | "1.Management Methods for Controlling Pollution caused by Electronic Information Products Regulation:<br>(i) developed by China's Ministry of Information Industry (MII)<br>(ii) commonly referred to as "China RoHs" to provide a broad regulatory framework for substance restrictions, pre-market certifications<br>(iii) this system mandates for a phase out of heavy metals such as cadmium, mercury, lead and hexavalent chromium as well as brominated flame retardants in future electronic products |

## 2.7 Product bans and restrictions

This instrument looks at banning or putting restrictions on certain products containing hazardous or non-recyclable materials depending on the availability of alternatives as shown in Table 2.4.

Table 2.4: Product bans and restrictions

| Country | Instruments & description of instruments |
|---------|------------------------------------------|
| China | "1.Management Methods for Controlling Pollution caused by Electronic Information Products Regulation:<br>(i) The legislation bans the import of electronic products that do not comply with the national or industrial standards for the control of toxic or hazardous substances" |

## 2.8 Waste Treatment Law

Table 2.5: Waste Treatment Law

| Country | Instruments & description of instruments |
|---------|------------------------------------------|
| Japan | "1.Waste Treatment Law:<br>(i) was enacted (by Japan) as a consequence of the amount of lead and other hazardous materials used in cathode ray tubes and printed circuit boards"<br>"(ii) this law has as objective to ensure an ""environmentally sound"" treatment of these product components<br>(iii) on the other hand, Japan relies heavily on incineration of used products" |

## 2.9 Recycling Law

Table 2.6: Recycling Law

| Country | Instruments & description of instruments |
|---------|------------------------------------------|

| Japan | |
|---|---|
| | "Japanese Government has passed a number of laws to promote recycling within Japan: |
| | 1. In 2000, Japan enacted the Basic Law for Promotion of a Recycle-Oriented Society (Law No. 110): |
| | (i) sets the basic principles relating to the creation of a recycle oriented society" |
| | "2. The Law for Promotion of Effective Utilisation of Resources (Law No. 48) - enacted in 1991 and amended in 2002 |
| | (i) sets recycling requirements for a wide range of products" |
| | "3. Specific Law for Container and Packaging Recycling, The Specific Household Appliance Recycling Law, The Construction Materials Recycling Law, The Food Waste Recycling Law and The Law for the Recycling of End of Life Vehicles: |
| | (i) these laws target recycling regimes in certain industries" |

## 3. Economic instruments

The definition of economic instruments varies in the literature. Nevertheless it appears to be some general consensus in the definition of an economic instrument as a tool or action which has the purpose of affecting the behaviour of economic agents by changing their financial incentives in order to improve the cost-effectiveness of managing ewaste.

### 3.1 Advanced Disposal Fees (ADF)

Represents a fee levied on certain categories of products based on an estimation of the costs of collection and treatment methods and is charged either from the consumers or from producers (See Table 3.0).

Table 3.0: Advanced Disposal Fees (ADF)

| Country | Instruments & description of instruments |
|---|---|
| Belgium | "1.The Recupel system: |
| | (i) managed and financed by importers and producers |
| | (ii) producers assume responsibility for the costs of collecting and recycling WEEE |
| | (iii) costs of collecting and recycling WEEE are passed onto the consumer in the form of a fixed fee known as the End of Life (EOL) fee |

| | |
|---|---|
| | (iv) As a result of the ""take back obligation"", Recupel does not reimburse retailers for their participation in the system and this is one area where Recupel differs from other retailer take back initiatives." <br><br> "(v) is financed by both: (1) a fixed fee paid by the consumer at the time of purchasing a new EE appliance as well as (2) a fee paid by the end user who provides a fixed amount towards the cost of recycling. <br><br> (vi) an important aspect - WEEE products that are not part of Recupel are not to be sold by producers, importers or retailers." |
| Netherlands | "1. Advanced Disposal Fees (ADF): <br><br> (i) Urge consumers to pay advanced disposal fees <br><br> (ii) Manufacturers are allowed to charge consumers for end-of-life costs through visible and invisible fees <br><br> (iii) Visible fees: fees which consumers pay in advance and thus account for the disposal of the product at the end of its useful life" <br><br> "(iv) Invisible fees: fees which have already been included in the price of the product at the point of sale" <br><br> "2.ICT Milieu: <br><br> (i) set up a system which was financed by a Fixed Annual Fee accompanied by a charge per kilo of equipment that is taken back and processed separately as per the different brands <br><br> (ii) The charge reflected the actual costs for collection, sorting and recycling of a specific manufacturer's products." <br><br> "(iii) However, there existed a high level of free rider & orphan products on the market (approx.44) for which manufacturers could not be charged. <br><br> (iv) due to the existence of free rider and orphan products and the issue of brand sorting (very expensive and not transparent enough) - the financing system for ICT Milieu was changed to a ""current market share"" system in January 2003." <br><br> (v) The new financing system requires a Fixed Annual Membership Fee to be paid along with a variable cost which depends on the current market share. <br><br> "3. NVMP: <br><br> (i) organises the transportation & recycling of cooling and freezing products, large white goods, TV, video products and small household items. <br><br> (ii) these goods are collected by local authorities <br><br> (iii) local authorities - responsible for organising separate collection for WEEE and establishing local collection facilities where consumers & suppliers can discard old products" <br><br> (iv) In 2003 - there were approx. 600 local collection points throughout Netherlands where consumers could bring a non-functioning product back to the supplier and in |

| | |
|---|---|
| | turn purchase a new product<br>"(v) Retailers must transport equipment from the consumer's house on payment of a removal fee<br>(vi) old products can also be deposited in a municipal waste site or can be collected by the municipality"<br>"(vii) after products are sorted, local authorities transport the waste to 69 Regional Transfer Stations (RTS) which are organised by the NVRD<br>(viii) The private sector assumes some of the financial responsibility for operating the RTS"<br>"(ix) finances the transportation costs of the products<br>(x) transportation of e-wastes for the whole country is outsourced to a single supplier<br>(xi) Recycling activities are outsourced to 4 specialist companies which make use of 8 recycling plants"<br>(xii) upon purchase of new EE appliances the end user contributes a fixed amount which is used to finance the costs of collection, transportation, treatment as well as the regional collection centres, administrative costs and communication expenses.<br>"(xiii) these contributions are paid to NVMP every 2 months on the basis of the number of appliances on the market.<br>(xiv) the level of the visible fee is set per unit "<br>"(xv) Local authorities are responsible for the collection and sorting from distributors or households while the rest of the system is financed by NVMP.<br>(xvi) Local Regional Authorities (LRA) finance the separate collection of WEEE by levying local taxes."<br>(xvii) When consumers purchase EE equipment, they often pay a removal contribution in addition to the purchase price |
| Sweden | "1.El-kretsen:<br>(i) is financed through membership fees<br>(ii) has designed various adaptations that individually fit each industry in terms of fee structuring, product range and the level of collection service."<br>"(iii) local authorities are legally responsible for the recycling of historic WEEE<br>(iv) financially responsible for all historic TVs, audio and video equipment (because the brown goods sector was withdrawn from the El-kretsen system)"<br>(v) 2 fixed fees : (1) Entrance Fee [per supplier]; (2) Annual Membership Fee<br>"(iv) In addition, members pay flexible fees based on 3 models:<br>(1) a per unit charge based on the previous months sales<br>(2) ICT products charge |

| | |
|---|---|
| | (3) other special models for certain industries (e.g., based on quarterly sales)"<br>"2.ICT Products Model:<br>(i) El-kretsen AB calculates the actual costs for collecting and recycling ICT products<br>(ii) these costs are then divided among the suppliers in proportion to each supplier's market share"<br>(iii) also allows suppliers to finance the collection & recycling of their products themselves (as long as the recycling company is approved by El-kretsen and verified through "recycling certificates") |
| Norway | "1.Hvitevareretur AS:<br>(i) finances its system by collecting fixed environmental fees from its affiliated companies & cooperates with the Norwegian Directorate of Customs and Excise.<br>(ii) Each affiliated company notifies products that are subject to fee via the ordinary import and production customs clearance system<br>(iii) the fees are paid in connection with the companies' payment of duties (e.g., VAT etc.) - In 2002, environmental fees accounted for NOK 87 million with regards to the collection and recycling of WEEE."<br>"(iv) Visible fees of a voluntary nature are recommended<br>(v) However, industries are not allowed to impose the visible fee on retailers (but most retailers choose to display the visible fee)"<br>"(vi) Recycling fees are based on costs determined for 44 product groups & are applied in terms of the actual collection and recycling costs.<br>(v) Handling fees are included in the municipal waste fees for WEEE deposited at municipal collection sites and the general administration of municipal collection is financed by local taxes." |

## 3.2 Material taxes and removing subsidies for virgin materials

It involves the imposition of material taxes with a view to reduce the use of virgin, non-recyclable and toxic materials and ultimately make use of secondary, that is, recycled or less toxic materials.

## 3.3 Deposit / Refund

This deposit refund schemes could prove to be a very beneficial concept in encouraging reuse (See Table 3.1).

Table 3.1: Deposit / Refund

| Country | Instruments & description of instruments |
|---|---|
| Korea | "1.Producer Deposit System (1992):<br>(i) Producers of home appliances, tires, lubricants, batteries, paper goods and metal cans have to pay a deposit to the government so as to receive refunds in line with the amount of recycled products and product waste"<br>"2.EPR (official launch in 2003):<br>(i) introduced as part of a government aim to establish an economic system of cyclical resources where waste generation is minimised through resource conservation and efficient resource use & where the generated waste is recycled."<br>(ii) product manufacturers have an obligation to take full responsibility for the recycling and disposal of their products<br>(iii) a pilot project for EPR was launched for home appliances and fluorescent light bulbs - the results put forward that EPR does not only promote recycling but also compels manufacturers to improve the design of their products in order to minimise waste generation<br>"3. Volume-Based Waste System:<br>(i) requires residents to separate goods that can be recycled from garbage<br>(ii) local governments also encourage the separation of recyclable waste<br>(iii) local governments set up waste storage containers and facilities" |
| Denmark | "(i) legislated against the use of non-refillable beverage containers<br>(ii) implemented Mandatory Deposit Schemes on refillable ones<br><br>As a result, the selling of beer, soft drinks & other beverages (in cans) are considered as illegal"<br>An amount of 1 to 3 Krone equivalent to 17 to 51 US cents per bottle had to be deposited.  This approach led to 97% of beer & soft drink packaging being reused or recycled. |

## 3.4 Environmentally preferable products procurement

It acts as an incentive in the form of tax relief or subsidy on the use of environment-friendly materials and products and thus, could encourage the use of recyclable products and product innovations.

## 3.5 Advanced Recycling Fees

Table 3.2: Advanced Recycling Fees

| Country | Instruments & description of instruments |
|---|---|
| Belgium | "1.Recupel:<br>(i) at the time of purchasing a new electrical or electronic appliance, the end user has an obligation to contribute a fixed amount which corresponds to the actual cost of recycling"<br>(ii) the amount to be paid is determined based on the type of appliance the user is acquiring and may range from 20 Euros for cooling and freezing equipment to 9 Euros for PCs and 0.1 Euro for smaller goods<br>(iii) manufacturers and importers associated with this system have to pay an amount representing the recycling contribution to Recupel for each appliance which is placed on the market |
| Switzerland | "1. The Swiss Information and Communications Technology Industry Association (SWICO):<br>(i) funds the collection and disposal of appliances by charging an advance recycling fee which is added to the purchase price of new appliances"<br>(ii) Recycling operations are financed by consumers who pay an amount in the form of an Advanced Recycling Fee (ARF) when the purchase of new equipment is made and this fee ranges from 10 to 20 Euros for TV sets and 1.37 Euros for portable equipment |
| Norway | Classification of white and brown goods exists for EE waste for which visible Advance Recycling Fees (ARF) are paid by consumers ranging from no fee at all for small products to 17 Euros for refrigerators. |
| Japan | "1. Specified Home Appliance Recycling Law (SHARL):<br>(i) consumers have to pay a collection or recycling fee when they leave the product at the collection point or with the retailers"<br>"(ii) the consumer also hands over a recycling ticket bought from the post office or the retailer which represents a receipt for the collection fee<br>(iii) Also, upon purchase of a new appliance from a retailer, the consumer can return back the old product"<br>"(iv) Retailers take back discarded appliances and pass them onto manufacturers along with the recycling ticket. |

| | (v) The retailer and the manufacturer have the discretion to decide the amount of the recycling fee"<br>(vi) According to law, recycling rates should vary from 50 to 60 percent and this could only be achieved by reusing and recycling product components. |
| --- | --- |

## 3.6 Annual Recycling Fee

Table 3.3: Annual Recycling Fee

| Country | Instruments & description of instruments |
| --- | --- |
| Switzerland, California (USA) | "1. Annual Recycling Fee (Government Responsibility):<br>(i) End consumers are taxed a recycling fee on the purchased product<br>(ii) This tax (ARF) is used to fund the e-waste collection and recycling activity"<br>"(iii) Government is responsible to administer and collect e-waste<br>(iv) However, there is no incentive for manufacturer to create cleaner designs and e-waste is not likely to reduce as manufacturers do not have any liability" |

## 4. Information (education) instruments

Education aims to help people to develop the attitudes, skills and knowledge to make informed decisions for their own benefits and that of others; and more importantly to act upon those decisions. Information is available on ewaste management; the key is to share and use this formation in a productive manner through awareness-raising an educational initiatives so that people make informed decisions to improve the protection of human health and the environment.

## 4.1 Advanced Disposal Fees (ADF)

Represents a fee levied on certain categories of products based on an estimation of the costs of collection and treatment methods and is charged either from the consumers or from producers (See Table 4.0).

Table 4.0: Advanced Disposal Fees (ADF)

| Country | Instruments & description of instruments |
|---|---|
| China | "1. Management Methods for Controlling Pollution caused by Electronic Information ss or elements and recyclability so that these products could be imported." <br> "China is also developing a version of the WEEE legislation which will address regulations on recycling of used household electrical products and computers |

## 5. Conclusions

The main finding from this review is that an ewaste management system does not comprise of one instrument, but of rather of a plethora of regulatory, economic and information (education) policy instruments.
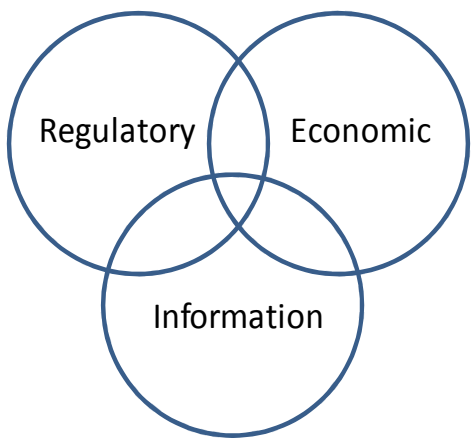
Regulatory

Economic

Information

Figure 5.0: Conceptually illustrates this approach.

Therefore when it comes to designing an ewaste policy, it is not simply a question of choosing either regulatory, economic and education instruments in isolation. Rather there is a need to adopt a harmonious mix of all three, to come up with a policy that best reflects the local reality. The contribution of particular instruments to the overall ewaste management system would depend on factors pertinent to the context in specific countries. The second major finding is that specific policy instruments usually target specific points of the ewaste control system.

This review has highlighted the various schemes that have been adapted in various countries that manage ewaste along its life cycle. A follow-up to this work would be to find out which of the above instruments would best fit the local conditions. It is first of all important to assess what is currently being done locally pertaining to ewaste management and targets the country wants to achieve in terms of ewaste management. This review can provide a basis upon which policy makers can lean to choose relevant implementable instruments (across types and along ewaste management system) to bridge the gap between actual and targeted ewaste management.

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