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Electronic and electrical waste management in Sri Lanka: Suggestions for national policy enhancements

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ABSTRACT

Waste is one of the most pressing problems faced by the whole world. Electronic waste is the latest in the Sri Lankan waste stream. Literature revealed many electronic waste management concepts, strategies and models implemented worldwide to counter the electronic waste menace, inclusive of electronic waste management policy developed in Sri Lanka to manage electronic waste generation. The purpose of this paper is to explore probable suggestions to improve existing electronic waste management practices, with special emphasis on enhancement of national policy of electronic waste management in Sri Lanka.

The research problem was approached by case study method since it facilitates an in-depth investigation. Multiple case study design was applied by employing three case studies. Cases were selected considering major types of electronic waste which exhibit high penetration rates within country: namely (1) household appliances, (2) IT and telecommunication equipments and (3) lighting equipments. Cross-case analysis and code-based content analysis techniques were applied in data analysis phase of the research. Four expert interviews were conducted to further verify proposed improvements to existing electronic waste management practices.

Case study findings revealed issues in electronic waste minimization and handling processes that need special attention. Empirical findings further revealed less government commitment and ineffective government procedures as critical issues in electronic waste management. Procedures of imports and exports, waste minimization, waste collection, storage, treatment and disposal, legal framework, capacity building and awareness, implementation and coordination mechanisms, monitoring, evaluation, reporting and resource mobilization can be identified as major areas for national policy enhancement. Consequently, the national policy of electronic waste management can be implemented as a national strategy to manage electronic waste generation in Sri Lanka.

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1. Introduction

Electronic waste is a threat to environment and health of people in the world. As Kang and Schoenung (2005) and Wenzhi et al. (2006) stated Electric and Electronic Equipments (EEEs) are developed, applied and consumed worldwide at a very high speed. EEEs have fast growing markets in the world (Hischier et al., 2005; Davis and Heart, 2008). Product life cycle, especially for electronic products has reduced significantly in recent years due to rapid advances in technology (Osibanjo and Nnorom, 2007). Thus, ever-increasing amount of Waste Electric and Electronic Equipments (WEEE) is a prominent problem in the modern world.

It represents one to three percent of global municipal waste production of 1636 million tonnes per year (OECD, 2008 cited Robinson, 2009). Many developing countries including Nigeria and the Philippines are facing huge challenges in managing WEEE which are either internally generated or imported illegally as 'used' goods (Nnorom and Oshibanjo, 2008). Electronic waste equals to an average of one percent of total solid waste in such countries (UNEP, 2007a).

In Sri Lanka, demand for electronic items is relatively high (MENR, 2008). A recent study by Ministry of Environment and Natural Resources in collaboration with Central Environmental Authority revealed that mobile phone penetration increased from 28% to 40% in past few years while annual growth rates estimated for other major electronic items such as personal computers, televisions, printers, and batteries increased from 4% to 10% (MENR, 2008). Thus, electronic waste is becoming a major threat to Sri Lanka.

It creates a need to realize the importance of managing e-waste and implementing a comprehensive strategy and a policy on electronic waste management. The aim of this study is to explore feasible attributes to improve electronic waste management

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practices in Sri Lanka with a special emphasis on enhancement of national policy on electronic waste, through three objectives viz., (1) identifying electronic waste management strategies (2) investigating organizational policies and procedures for managing electronic waste and issues in existing processes and (3) determining probable attributes and suggestions to improve electronic waste management in Sri Lanka with a special emphasis on policies and procedures of electronic waste management. Accordingly, research was confined to electronic waste management strategies applied in developing countries with special emphasis on *status quo* of Sri Lanka. Three case studies were conducted to reveal issues of electronic waste management. Probable policy enhancements to improve electronic waste management practices in Sri Lanka were identified through literature and experts' opinion.

Next section explains literature findings revealed by secondary data on electronic waste management practices in the world with special emphasis on developing countries.

2. Literature review

2.1. Electronic waste and its impact

Electronic waste is a generic term embracing various forms of Electric and Electronic Equipment that have ceased to be of any value to their owners (Khetriwal et al., 2006).

A study by Widmer et al. (2005) considered electronic waste as relatively expensive and essentially durable products used for data processing, telecommunications or entertainment in private households and businesses. Luther (2009) defined electronic waste as a term used loosely for obsolete, broken or irreparable electronic devices. A study by UNEP (2007a) reveals that definition given in EU WEEE directive (2002 cited UNEP, 2007a) for electronic waste is widely accepted by many countries. It defines electronic waste as "electrical or electronic equipment which is waste including all components, subassemblies and consumables, which are part of the product at the time of discarding." According to EU directive (2002 cited in UNEP, 2007a), electronic waste comprises of ten major categories such as (i) large household appliances, (ii) small household appliances, (iii) IT and telecommunications equipments, (iv) consumer equipments, (v) lighting equipments, (vi) toys, leisure and sports equipments, (vii) medical devices, (viii) monitoring and control instruments, (ix) automatic dispensers and (x) electrical and electronic tools.

This study was conducted by considering definition of EU WEEE directive as an acceptable explanation regarding electronic waste.

Electronic waste generates hazardous and non-hazardous materials that can adversely affect human health and environment (Joseph, 2007). Examples are lead, a highly toxic hazardous component contained in computer monitors and cathode ray tubes that can damage central and peripheral nervous systems, cardiovascular systems and kidneys and cadmium, which causes cancers, kidney and bone diseases and neural damage (Ramachandra and Varghese, 2004). Therefore, many researchers recognize that prominent attention should be paid to managing e-waste (Khetriwal et al., 2006; Nnorom and Osibanjo, 2007; Lee et al., 2007; Chancerel and Rotter, 2009). Many countries thus tend to implement e-waste management strategies as discussed at the following section.

2.2. Electronic waste management strategies

Many electronic waste management strategies are being implemented worldwide. Gottberg et al. (2005) and Lau and Wang (2009) stated that eco-design is an electronic waste management approach adopted worldwide including China, which provides opportunities to minimize waste and improve efficiency of resources use through modifications to product size, serviceable life and recyclability. Reduce, Reuse and Recycle (3Rs') is a major concept of electronic waste management adopted in developing countries such as India, Nigeria and the Philippines (Ramachandra and Varghese, 2004; Osibanjo and Nnorom, 2007; Babu et al., 2007; Carisma, 2009). National registry and inventory is an electronic waste management strategy implemented in India, Indonesia, Cambodia and Sri Lanka (UNEP, 2007b; MENR, 2008). UNEP (2007b) revealed of a collective and clearing house collection system implemented in Malaysia and South Africa that provides electronic waste management services at a reduced cost to consumers and ensure compliance at national level.

Studies conducted by Yepsen (2007 cited Yu et al., 2010), Kahhat et al. (2008) and Lim and Schoenung (2010), revealed of shared responsibility and deposit refund system as a new strategy where consumer pays an extra sum when a device is purchased, which is reimbursed when the device is returned for proper recycling. Deposits are commonly used to encourage recycling. Capacity building, training and awareness programmes are identified as potential strategies through studies conducted in India and Uganda by Joseph (2007) and MICT (2010). In a municipality centered system each municipality is held responsible for managing waste generated within its political boundaries, funded through local property taxes, tipping fees, advance recovery fees (currently only in California), state grants or item-specific charges such as recycling or disposal fees (Wagner, 2009). Researchers appreciate extended producer responsibility (EPR) mechanism in developed (Germany, Switzerland and Sweden) and developing countries (the Philippines, Nigeria, China) as an effective electronic waste management system that entails management of entire lifecycle of a product (Gottberg et al., 2005; European Communities, 2006; Liu et al., 2006; Miemczyk, 2008; Manomaivibool, 2008; Iakovoua et al., 2009; Silveira and Chang, 2010).

Absence of a special framework and infrastructure for recycling or appropriate management of electronic waste and lack of export/import regulations are factors affecting electronic waste management (Osibanjo and Nnorom, 2007). Lack of awareness on government responsibilities, easily accessible information flows, legislative/trade rules and regulatory mechanisms are among issues identified by SACEP (2007). It also identifies lack of awareness and technical capacities on environmentally sound electronic waste management processes as another relevant issue (SACEP, 2007). Absence of necessary regulations and legislation or their ineffectiveness, high level of uncoordinated importation of second-hand devices and absence or ineffective take-back programmes for end of life WEEEs are also relevant factors (Davis and Heart, 2008; Nnorom and Oshibanjo, 2008). Policy and socio economic barriers, political discourses and cultural aspects are four aspects that can also affect electronic waste management (Carisma, 2009). Studies have revealed that policy barriers impact heavily on effectiveness of electronic waste management processes in both developed and developing countries, which attempt to overcome such barriers by implementing new national policies.

2.3. Electronic waste management policies

Most developed countries and some developing countries such as South Africa, India, China, Cambodia, Malaysia and Thailand have developed national legislations and policies specifically for electronic waste management (Khetriwal et al., 2006; UNEP, 2007b). In Sri Lanka, apart from few existing regulations, a draft policy on effective electronic waste management processes remains to be implemented. The next section describes the status of electronic waste management practices in Sri Lanka with special emphasis on draft electronic waste management policy.

2.4. Electronic waste management in Sri Lanka

Generation of e-waste from general consumption of primary products such as computers and mobile phones has increased with the country's economic growth (MENR, 2008). Penetration rate of mobile phones increased from 28% to 40% with a phenomenal annual growth rate during the last ten years. The current market for personnel computers (PCs) in the country is about 300,000 units per annum and about 30% of that is served by used PCs. About 350,000–400,000 television sets and 250,000–275,000 refrigerators are added annually while about 5% of total electric and electronic imports comprise of used items (MENR, 2008). Annual growth rates estimated for major electronic items are: personal computers 8–10%, printers 5–7%, televisions 6–8%, refrigerators 4–6%, air-conditioners 4–6%, photocopy machines 2–4%, washing machines 6–8% and batteries 4–6% (MENR, 2008). Rodrigo (2011) revealed that thousands of old televisions, computers, mobile phones, refrigerators, etc., has been rendered unusable, notably during the last few years, increasing the electronic waste stream in Sri Lanka.

There are certain approaches taken to manage electronic waste in Sri Lanka. National Implementation Plan for electronic waste in Sri Lanka is a part of a pilot project on environmentally sound management of electronic waste in Asia and Pacific (MENR, 2008). There are some regulations enacted on use and disposal of mobile phones, computers and accessories and technical guidelines to manage used lead acid batteries (NER, 2008). Conducting electronic waste awareness programmes/workshops, imposing an environment conservation levy and implementing a CFL recycling system are some other approaches (CEA, 2008b). An electronic waste management policy has been developed as a national strategy for electronic waste management in Sri Lanka (CEA, 2008a).

2.5. National electronic waste management policy

It is a timely step to manage electrical and electronic equipments in a sustainable manner throughout their life cycles, developed in compliance with provisions of Basel Convention.

It contains eight statements (Fig. 1) relating to existing procedures on import and export of electronic items, electronic waste minimizing, electronic waste collection, storage and final disposal, legislative framework, awareness on electronic waste, implementation and coordination of institutional mechanisms, monitoring, evaluating and reporting procedures of electronic waste management systems and ways of mobilizing national resources for electronic waste management. This research focuses on determining probable suggestions to improve electronic waste management practices with special emphasis on enhancement of national electronic waste management policy in Sri Lanka. The next section explains the research methodology adopted to ascertain existing policies, procedures and issues of electronic waste management practices in Sri Lanka.

3. Research methodology

The research was designed to achieve objectives mentioned at Section 1. Fig. 2 illustrates several methods adopted to achieve said objectives. Literature review was conducted on major areas of electronic waste management and available strategies for managing electronic waste especially in developing countries, to appraise existing electronic waste management practices in Sri Lanka.

The case study method was adopted in qualitative phenomena because the research problem required an in-depth investigation. Case study approach is more appropriate to understand a complex issue or object and can extend experience or add strength to what is already known through previous research (Yin, 2009). Survey approach was not considered as an appropriate method to conduct this study because though surveys deal with phenomenon and context; their ability to investigate a context was extremely limited. As Yin (2009) stated, it involves analyzing numerical data to classify features, count them and construct statistical models to explain what was observed. However, in this study, as defined in objectives, final outcome is qualitative, implying that this study needs a qualitative rather than quantitative approach.

Under case study approach, multiple case study design was applied. Yin (2009) said that multiple case designs ensure a high degree of certainty and stronger effect within a research than single-case designs. Yin (2009) also stated that multiple case designs represent strong outcomes with similar results (literal replication). Hence, three cases were selected on types of electronic waste that shows highest electronic waste generation in the country such as household appliances, IT and telecommunication equipments and lighting equipments. Eleven institutions were selected under three selected cases that were involved in electronic waste management process, registered with the Central Environmental Authority (Table 1).

After selecting case studies to be conducted, unit of analysis need be clearly identified as it is a critical factor in a case study (Tellis, 1997). Thus, 'e-waste generating organization' was selected as case of the study while 'organization' was considered as unit of analysis.

Interview method was selected as the most reasonable data collection technique over many other data collection methods in case study approach such as documents, archival records, direct observations, participant observations and physical artifacts. Yin (2009) mentioned that interviewing is one of the most important sources of case study information which appear to be guided conversations rather than structured queries. Semi-structured interviews were conducted to gather data with sufficient flexibility from different respondents for data collection. Noor (2008) stated that semi-structured rather than structured interviews enable sufficient flexibility to approach different respondents while covering same areas of data collection. Further, it enabled adopting questions as necessary, clarify doubts and ensure proper understanding by repeating and rephrasing questions. Hence, semi-structured interviews were conducted with experts involved in electronic waste management processes at selected institutions in each case. Thus, an 'individual' is considered as unit of data collection. In addition to that, four expert interviews were conducted to evaluate suggestions on enhancement of electronic waste management practices in Sri Lanka (Table 1). The interview guideline was prepared in relation to electronic waste management policy statements (Fig. 1) to gather required data from selected experts.

After developing interview transcripts, key themes (codes) emerging from analysis were identified within each case to move into analysis stage. Cross-case analysis technique was used as data analysis technique in this research as it is suitable for analysis of multiple cases while others are suitable for both single and multiple case designs. It treats each case study separately and analyses data to identify interrelationships and differences among each case (Yin, 2009). In analyzing collected data of cases, content analysis technique was used as it is a technique used to gather data, codifying qualitative information into pre-defined categories (codes) to derive patterns in reporting information (Guthrie et al., 2004).

Accordingly, QSR.NVivo (copyright @ 2009 Qualitative Solutions and Research Private Limited); computer software was used in content analysis as it was successfully used in previous studies conducted in same manner. As stated by Johnstone (2007) NVivo clearly makes it possible to carry out very complex coding of texts into categories of meaning or nodes and to show, shape, filter,



Fig. 1. Elements of electronic waste management policy.

Source: Basel Convention (cited CEA, 2008a).

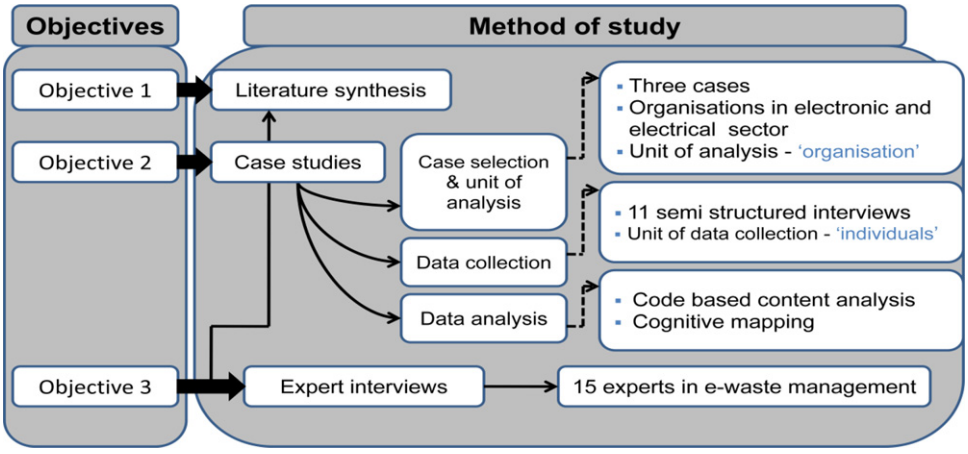


Fig. 2. Research methodology.

Table 1
Profile of case study interviews.

Cases	Type of e-waste	Agency	Type
Case A	Household appliances	A1	Importer and distributor
		A2	Importer and distributor
		A3	Importer and distributor
Case B	IT and telecommunication equipments	B1	IT service provider
		B2	IT trader
		B3	Telecommunication services provider
		B4	Telecommunication services provider
Case C	Lighting equipments	C1	Manufacturer
		C2	Importer and distributor
		C3	Importer and distributor
		C4	Manufacturer
Expert interviews		E1	Head of environment
		E2	Assistant manager
		E3	Managing director
		E4	Managing director

assay slice and dice data in various ways. Fig. 3 illustrates the coding structure of this study developed in compliance with statements in national policy on electronic waste management in Sri Lanka using NVivo software. It was used as a general framework in data analysis process of this study to identify existing policies, procedures and issues in electronic waste management practices in Sri Lanka. Moreover, among network techniques, cognitive mapping was selected for data displaying process of this study. It was used to structure, analyze and manage large amounts of qualitative data from documents which was strengthened by Nvivo.



Fig. 3. Coding structure.

4. Research findings

Findings revealed that most organizations were at a primary stage of electronic waste management approaches and there was no specific policy on electronic waste management. It is being implemented as a part of an existing waste management policy. Head of Manufacturing of C4 agency said that "*we have a general waste management policy, not specifically for e-waste. Though being an electrical product manufacturing company, such waste is handled within general waste management policies.*" E-waste management signifies a new requirement for many organizations and hence, there were no special concern by organizations to manage electronic waste though some organizations may go for it in future.

Following sections will discuss research findings of study on broad headings such as organizational policies and procedures, issues of electronic waste management practices in Sri Lanka and probable attributes on policy enhancement with regard to above mentioned areas of electronic waste management policies in Sri Lanka (Fig. 1).

4.1. Imports and exports

4.1.1. Policies and procedures

Many organizations import quality electronic items in compliance with power distribution, tropicalization and safety requirements while few others import electronic material as finished products to prevent hazardous in-house activities. Head of Manufacturing of C4 agency stated that "*we do not conduct electronic plating in-house as it uses chemicals. They are directly imported as finished goods.*" Logistics Manager of B4 agency stated "*as all brands carry a warranty, we bear responsibility for such products. Thus we only import products that comply with power distribution and safety requirements.*" However, as existing procedures do not contain specific requirements to manage electronic waste, several critical issues prevail within existing import and export procedures.

4.1.2. Issues

The empirical data of case studies indicated several issues relating to import and export of electronic items. Import related issues such as importing of electronic waste, second hand electronic items and reaching outdated systems are already addressed by existing national policy on electronic waste management. There are no specific guidelines, specifications or procedures to evaluate quality of e-products in existing electronic waste management policy. Statement of Logistics Manager of B4 agency that "*as Sri Lanka is a tropical country electronic items become e-waste at a high rate due to humidity, dust and temperature. Although imported e-items are of high quality they cannot be durable if they are not tropicalised*," shows importance of such. Head of Manufacturing of C4 agency cited ineffective government procedures as another issue stating that "*when importing compact fluorescent lamps (CFLs), one has to get star rating standards. However, there is no basic infrastructure. There is only one unit to check all imports of CFLs, thus it takes more than two years to issue a certificate.*" Accordingly, procedural issues such as absence of standards, specific guidelines or specifications on import of electrical components and ineffective quality evaluation procedures of electronic items were identified.

4.1.3. Suggestions for enhancement

In order to mitigate issues identified in existing import and export procedures, several attributes can be suggested. Electronic waste should be clearly defined and second hand electronic items shall be considered as electronic waste. Chief Environmental Officer of A1 agency said that "*though importing electronic waste is banned people import secondhand items in proper packing. Then it is not considered as waste. Electronic waste should be clearly defined to include secondhand equipments.*" Head of Operations of C4 agency proposed that "*there should be clear definitions on electrical manufacturing processes including authorized categories of components to be imported, local value addition and other boundaries.*" Managing Director of E3 agency suggested to "*increase taxes on secondhand EEEs.*" Many experts in electronic waste management said that there should be restrictions on importing e-products with lesser life spans and every e-products importing and handling organization shall be registered with the government by obtaining a business continuation certificate (BCC) to ensure importation of good quality, branded items. It is a suitable and feasible enhancement of policy to restrict unauthorized importations and establish required infrastructure and support services to obtain quality certificates.

4.2. Waste minimization

4.2.1. Policies and procedures

It is revealed that organizations adopt different approaches to minimize electronic waste generation. Many organizations import high quality products and materials to minimize electronic waste. Most organizations opt for new product designs, green procurement policies and Reduce, Reuse, Recycle (3Rs) approach to reduce electronic waste generation. As an example, Head of Manufacturing of C1 agency said that "*we use solid mercury for new CFL products without using mercury vapor, reducing mercury released to environment.*" Brand Manager of A2 agency stated that "*we only import and market good quality branded products which come through 100% recycling, 40% lesser CO_2 emission and eco friendly production processes.*"

4.2.2. Issues

Issues related to waste minimization need to be better evaluated as it is more logical to minimize generation than managing it after generation. According to empirical data, there exist several issues such as higher relevance of informal sector, uncontrolled customer behavior and lesser facilities for recycling and reuse. There are further issues related to existing practices that need be addressed through policy improvements. Ignorance of EPR by organizations is a major issue, when considering statement of Logistics Manager of B4 agency that "*we are only intermediates who import and sell electronic items. Responsibility lies with design and production organizations. As an intermediate partner we have no direct ability to manage e-waste.*" Head of Manufacturing of C4 agency said that there is no clear definition for manufacturing process of electronics that generate e-waste. "*Even if a person imports several components and assemble in-house it is a manufacturing process*," he said. Thus, ineffective government procedures, less government commitment, bad perceptions of community and absence of specific

guidelines/specifications are further issues that need be considered for policy enhancement.

4.2.3. Suggestions for enhancement

Though existing policies cover several issues related to waste minimization, it can be enhanced to address further prevailing issues that are not considered by the policy. All companies dealing in electrical and electronics items need to register their products with a relevant regulatory body by providing details of hazardous potential of products with relevant data obtained from producers. Experts suggest that government shall restrain electronic items based on their contribution to generation of electronic waste. As noted "*Items can be categorized based on their degree of contribution to generating electronic waste. They can be listed from high to low degree, establishing required controls on importation of such products.*" Expert opinion and global strategies identified through literature revealed that a government can establish national or international standards for design and production/assembling of electronic items, EPR principle and shall standardize national power supply. Additionally, regulations shall provide for display of relevant information of any electronic item as a written label or bar code.

4.3. Waste collection, storage, treatment and disposal

4.3.1. Policies and procedures

Findings revealed that few organizations have internal collection and storage facilities to collect damaged electronic equipments. However, there are no proper procedures on treatment and disposal of collected electronic waste. Collected electronic waste is returned to manufacturers or dumped into concrete pits. Head of Manufacturing of C4 agency said that "*collected CFLs are given to a company on a contract to dispose into concrete pits.*" Electronic waste collection, storage, treatment and disposal are critical areas which need to be considered by a national policy on electronic waste management.

4.3.2. Issues

According to case study findings, organizations do not prefer to collect e-waste without a national strategy on collection and disposal of electronic waste. Though the existing policy addresses issues related to unavailability of treatment and disposal strategies to a certain extent, there is no concern for CFL waste. Many organizations dispose such e-waste improperly. As an example, a Director of C2 agency stated that "*there is no disposal system in Sri Lanka for e-waste. Thus we have to address it on our own, by exporting to China. There is no disposal strategy or organizations to accept CFL waste as a raw material. Thus, we burn plastic items and crush burnt out bulbs.*" Treatment and disposal issues, wrong perceptions and ignorance of EPR by organizations, less organizational and government commitment, less involvement of local authorities and ignorance and wrong perceptions of community on electronic waste management practices also need to be addressed by way of policy enhancements.

4.3.3. Suggestions for enhancement

Existing policy need to be enhanced to address issues related to electronic waste collection, storage, treatment and disposal. Chief Environmental Officer of A1 agency suggested integration of informal collection/reuse methods with formal recycling, similar to an idea promoted by Yu et al. (2010). Local Authorities (LAs) need to be authorized to engage in electronic waste management processes and consider one day per week as an electronic waste collecting day to collect household electronic waste, coordinated through an island wide collection network. By such way, each local authority can be entrusted with the task of managing electronic waste within its geographical boundaries together with private entities and other local authorities to address issues related to existing electronic waste management processes (Wagner, 2009).

4.4. Legal framework and enforcement

4.4.1. Policies and procedures

Empirical findings revealed that many organizations do not comply with laws and regulations of electronic waste management. Further, no internal rules and regulations on electronic waste management also exist within these organizations.

4.4.2. Issues

Though present electronic waste policy contains several provisions to ensure effective legal enforcement and due compliance within country, findings depict that organizations and people do not comply duly, mainly due to unawareness. Thus, less compliance with laws and regulations and unawareness of such laws are issues prevalent within existing legal framework of electronic waste management. Environmental Officer of B3 agency said that "*it is possible to control e-waste generation. Though as a government organization we operate within a regulatory framework, still we have no idea about all applicable regulations.*"

4.4.3. Suggestions for enhancement

Creating awareness on legal framework can enhance effective regulatory mechanisms in the country. Experts opine that any violation of relevant electronic waste regulations shall be punishable by a court of law. "*There should be an entity empowered to inspect electronic waste management processes at organizations and take action over mismanagement*," said Assistant Director of E2 agency.

4.5. Capacity building and awareness

4.5.1. Policies and procedures

According to observations, though organizations do not consider much about creating awareness among communities, many adopt strategies to create awareness among employees. Though there are no special policies to create awareness among people on electronic waste management, few organizations create awareness through product promotions, customer meetings, presentations and advertisements. Chief Environmental Officer of A1 agency said that "*we conduct awareness programmes for employees of our organization and dealers and for people at showrooms about electronic waste. In future, electronic waste will be communicated as a special massage.*" Hence, there is a separate statement within policy to enhance community awareness on electronic waste management.

4.5.2. Issues

Thus empirical findings reveal that issues related to capacity building and creating awareness need to be considered when drafting a national policy on electronic waste management. Less commitment and wrong perceptions of organizations also exist as issues. Brand Manager of A3 agency stated that "*electronic waste is new for us. We are unable to conduct related programmes as we are not aware of it.*" Wrong opinions of community on electronic waste management also need to be addressed to enhance national policy in Sri Lanka.

4.5.3. Suggestions for enhancement

Several measures can be suggested to enhance awareness among organizations and community on proper management of electronic waste. Every organization shall conduct related awareness programmes which should be made mandatory by regulations for renewal of business licenses or permits. Experts suggest that government shall co-operate with media organizations to create awareness among people through national programmes. Director

of C2 agency stated that "*government has a responsibility to make people aware by media; media organizations also have a responsibility to be involved.*"

4.6. Institutional mechanisms and coordination

4.6.1. Policies and procedures

Organizations do not have internal procedures to implement internal electronic waste management systems coordinated with a national programme on e-waste management.

4.6.2. Issues

Apart from lesser involvement of provincial and local authorities and absence of a national platform and coordination committees, there are other issues such as lack of coordination among private and government organizations in electronic waste management procedures. This position was supported by Logistics Manager of B4 agency who said that "*there is no coordination between us and government thus it is difficult to continue with a process. There is no national system to coordinate with. We can introduce policies if this process will move ahead without stopping.*"

4.6.3. Suggestions for enhancements

Experts say that there shall be continuance of policies on electronic waste management processes despite changes at ministries. Logistics manager of B4 agency said "*it should be continued by all ministers appointed to the ministry. Regulatory bodies should have at least one knowledgeable engineer on electronic waste management.*" Further, there shall be room for enhanced involvement of private companies in national electronic waste management programmes.

4.7. Monitoring, evaluation and reporting

4.7.1. Policies and procedures

Monitoring and evaluating procedures on electronic waste management do not exist at organizational level. Thus, electronic waste management processes are monitored through existing general accounting and procurement systems. Head of Manufacturing of C1 agency said that "*from design stage to final production stage the whole manufacturing process is monitored through other organizational systems to maintain relevant quality standards.*"

4.7.2. Issues

Existing policy on e-waste management demonstrates a need to monitor and evaluate electronic waste management processes regularly. According to empirical findings of case studies, there are no existing national or organizational systems to monitor and evaluate performance of electronic waste management processes. Existing national information system is ineffective while organizations do not have a system to provide information about their electronic waste management processes. Environmental Officer of B3 agency said that "*we are connected to national information portal called 1919; our names and phone numbers are given to that. But still it is not successful because no one knows about it.*"

4.7.3. Suggestions for enhancement

An electronic waste management policy can be further enhanced by operation of a standardized national information portal to which involvement of each organization shall be made compulsory. Head of Environment of E1 agency suggested that "*every organizational process shall be assisted regularly by a government committee to ensure effective and correct e-waste management procedures.*" Those measures can be integrated into electronic waste management policies by addressing issues related to monitoring, controlling and evaluating procedures at organizations.

4.8. Resource mobilization

4.8.1. Policies and procedures

As electronic waste management is new to most organizations, there is no policy to mobilize organizational resources. Thus, according to empirical findings, several issues in mobilizing organizational resources for electronic waste management processes emerge.

4.8.2. Issues

Most organizations are burdened with financial issues and ineffective mobilization of resources, according to many experts. Chief Environmental Officer of A1 agency said that "*to establish an electronic waste management process in the organization we need additional space. If the programme cannot generate hard cash to offset expenses incurred for such space, management does not prefer to continue with it.*"

4.8.3. Suggestions for enhancement

There shall be due consideration to establish an electronic waste management fund, which can be used to provide financial support to implement electronic waste management processes, partly funded through environmental taxes, fines and penalties.

5. Discussion

Case study data revealed that issues exist in electronic waste minimization and waste collection, storage, treatment and disposal practices which shall be provided special attention in an electronic waste management policy. Ignorance of EPR, less government and organizational commitment and bad perceptions of community and organizations shall also be considered as such issues affect waste minimization, collection and disposal. Experts experienced in electronic waste management processes cited importation as an area that need to be addressed through policy enhancements. Experts further expressed that bad perceptions and less commitment of organizations negatively affect many areas of electronic waste management processes such as collection, storage, treatment, disposal, capacity building and resource mobilization. Empirical findings further revealed that less government commitment and ineffective government procedures increase electronic waste generation and cause ineffective utilization of national resources, thus causing further critical issues in electronic waste management that need special attention in a process of policy enhancement.

Thus, opinions and suggestions of experts and secondary data reveal several aspects for enhancement of national electronic waste management policy in Sri Lanka, as indicated below.

- Provision of clear definitions for electronic waste and electrical manufacturing processes, restricting imports, compulsory registration of organizations, as proposed by experts. Increasing taxes on importation of used EEEs, mandatory business licenses and permits and facilitation of adequate infrastructure and support services for quality inspections were identified through empirical findings.
- Experts further proposed registration of electronic items, establishing electronic waste management processes, establishing national standards for design/production of electrical items, standardizing and national power supply systems to address issues related to electronic waste minimization while product self management and EPR were identified through literature review.
- To mitigate issues in electronic waste collection and disposal, integration of informal and formal sectors, regulation of LAs, establishment of an island wide electronic waste collection network and establishment of disposal processes for CFL waste were

identified through empirical data while shared responsibility and municipal centered systems had been suggested by previous researches.

- To establish an effective legal framework to manage electronic waste, experts suggest that every person shall be bound by the policy and an electronic waste management entity shall regulate and take action over mismanagement. Conducting awareness programmes shall be made a mandatory requirement for renewal or granting of business licenses and permits. Responsible conduct of media organizations and establishment of a specific regulatory body are suggested to address issues related to capacity building and awareness procedures.

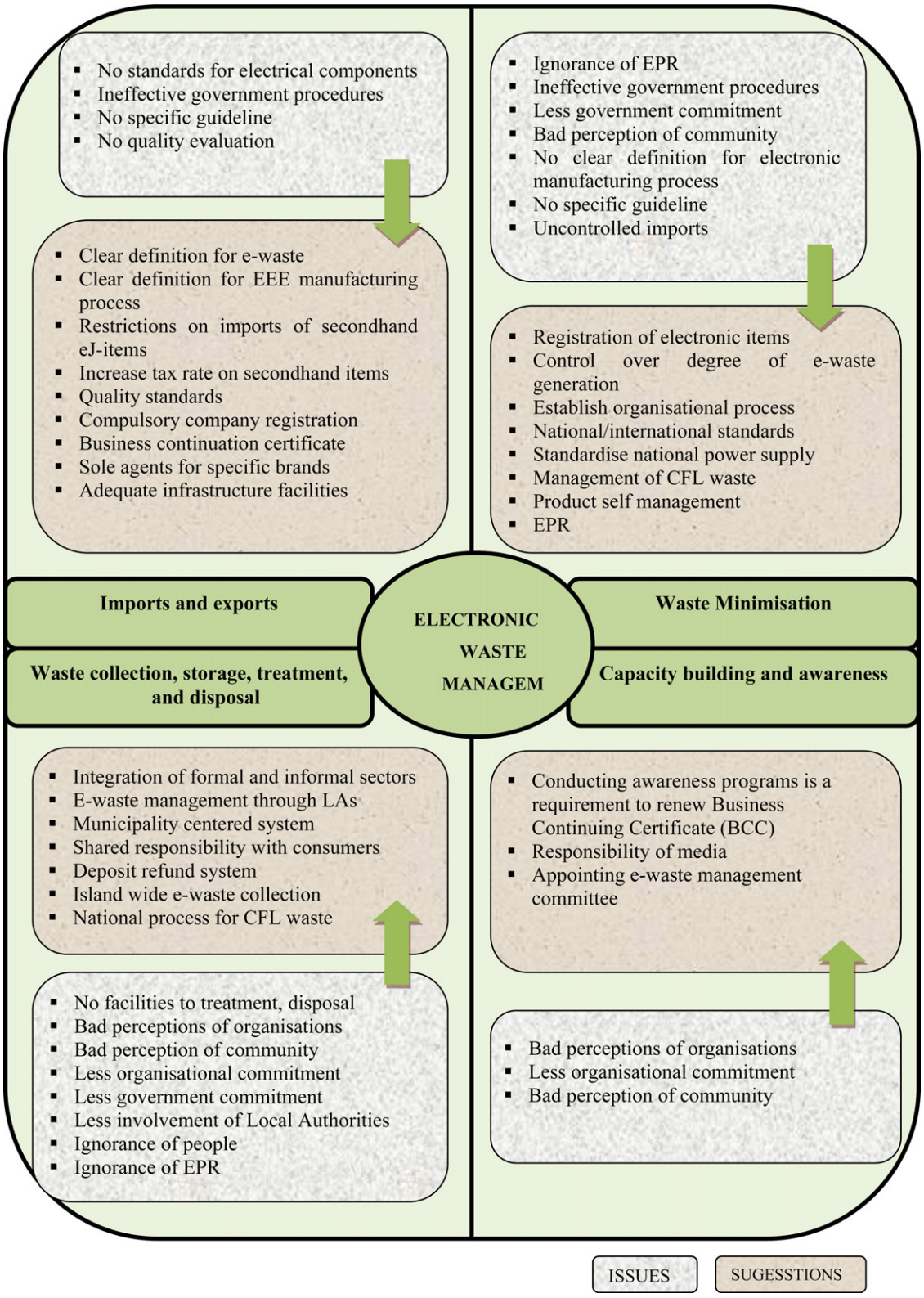


Fig. 4. Suggestions for policy enhancement.

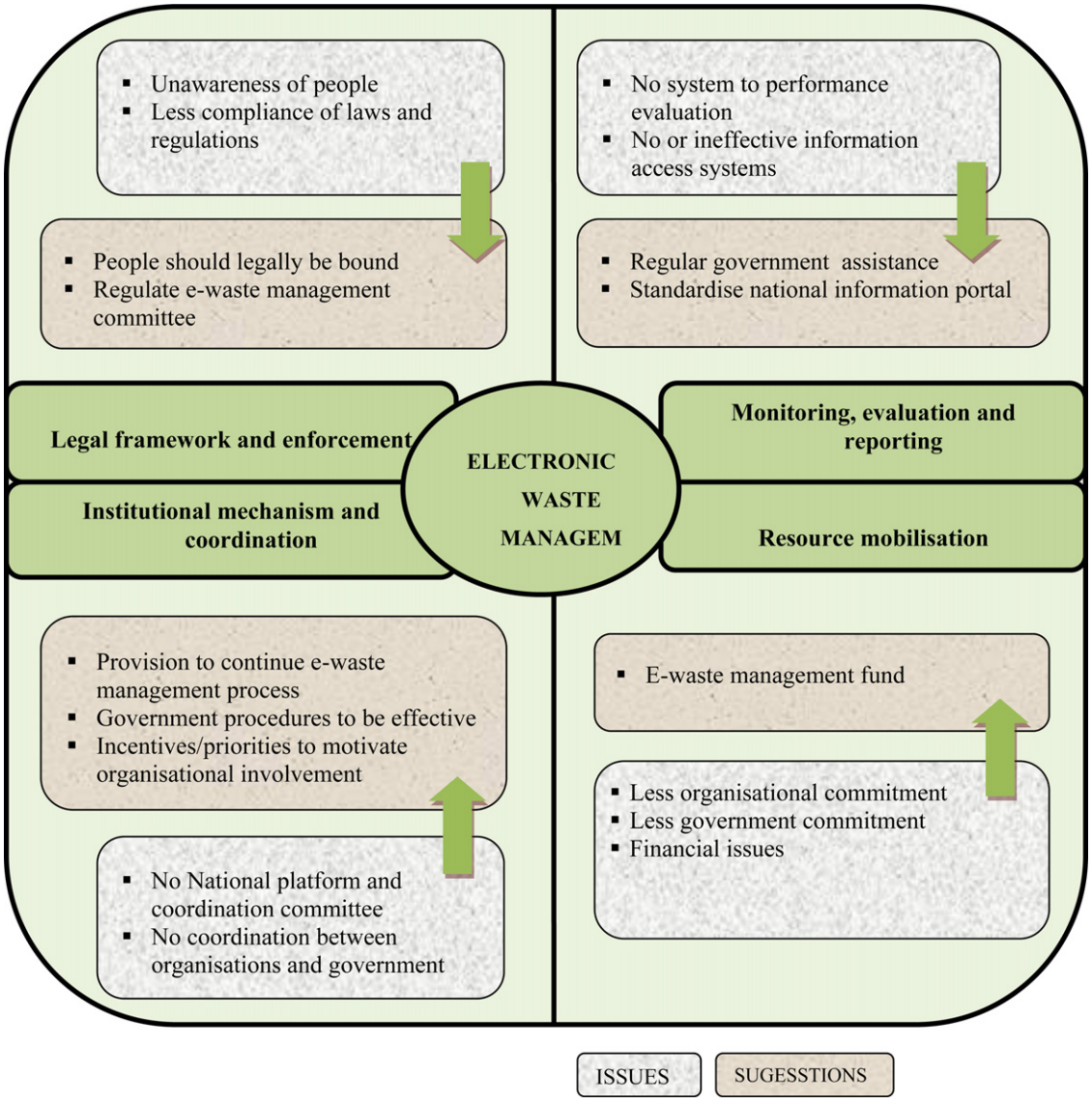


Fig. 4. (*Continued*).

- Establishment of effective government procedures and grant of incentives to motivate organizations is suggested to enhance institutional mechanisms and coordination. Regular government assistance, establishment of effective information portals and an electronic waste management fund are suggested to mitigate issues in monitoring, evaluation, reporting and mobilizing resources.

6. Conclusions

Ever increasing electronic waste generation creates an urgent need to realize the importance of managing e-waste and implementation of a comprehensive national strategy and a policy to deal with e-waste. Globally, several concepts, strategies and models of electronic waste management are being applied by many developed and developing countries to ensure effective management of electronic waste. In Sri Lanka too, there is a national policy to manage electronic waste as a national strategy. Strategy was not tested with real industry situation as it is still in progress. This research was conducted to explore probable suggestions for improving electronic waste management practices in Sri Lanka by emphasizing on policy enhancements.

According to case study data, issues related to waste minimization and collection, storage, treatment and disposal practices exist within electronic waste management practices and processes. Further, ignorance of EPR, less government and organizational commitment, wrong community and organizational perceptions shall also be considered as such aspects highly affect waste minimization, collection, storage, treatment and disposal. Import and export procedures need to be enhanced. As case studies revealed, organizations do not entertain positive perceptions on implementation of organizational processes to manage electronic waste. Conducting capacity building and awareness programmes, implementation and coordination of monitoring, evaluation, reporting and resource mobilization mechanisms can be identified as further areas that can enhance national strategies, as revealed by results of this study. Accordingly, this research contributes to knowledge by suggesting an electronic waste management framework including ways to mitigate issues in existing electronic waste management practices. Developed framework suggests probable attributes that can enhance national policy on electronic waste management in Sri Lanka (Fig. 4).

The enhanced policy can be implemented in Sri Lanka to manage electronic waste properly, before it becomes a menace. Further, it

is beneficial to converse with developing and other countries to enhance existing electronic waste management practices to ensure an electronic waste free world.

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