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A Study of E-Waste Management Programs: a Comparative Analysis Of Switzerland And Ontario

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**A STUDY OF E-WASTE MANAGEMENT PROGRAMS: A
COMPARATIVE ANALYSIS OF SWITZERLAND AND ONTARIO**

By

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Bachelor of Applied Science Degree, Ryerson University, 2004

A thesis

presented to Ryerson University

in partial fulfillment of the

requirement for the degree of

Master of Applied Science

in the program of

Environmental Applied Science and Management

Toronto, Ontario, Canada, 2012

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Environmental Applied Science and Management

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Abstract

Electronic waste (e-waste) is being generated around the globe at a high rate. High market penetration of electrical and electronic equipment (EEE) and the fast development of more innovative designs by producers and manufacturers on a regular basis make the current electrical and electronic equipment obsolete faster than before, which contributes towards the generation of more e-waste. To combat the issue, e-waste management programs are being developed, implemented, or evaluated in many jurisdictions around the world. Ontario is one of the jurisdictions that have taken initiatives and implemented an e-waste management program to address the rising quantity of e-waste. This thesis evaluates the Ontario's e-waste management program by using Logical Framework Approach (LFA) as an evaluation framework, and focusing on the criteria for a normative e-waste management program. It utilizes the Swiss e-waste management program as a case study to provide a comparative analysis, and extract valuable lessons through the application of the lesson-drawing approach that can be applied to improve the effectiveness of the implemented e-waste management program in Ontario.

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List of Abbreviations

ARF	Advanced Recycling Fess
DfE	Design for the Environment
E-Waste	Electronic Waste
EEE	Electrical and Electronic Equipment
EPI	Environmental Performance Index
EU	European Union
EPR	Extended Producer Responsibility
GDP	Gross Domestic Product
ICT	Information Communication Technology
IFO	Industry Funding Organization
ISP	Industry Stewardship Plan
IT-Waste	Information Technology Waste
LFA	Logical Framework Approach
OECD	Organization for Economic Co-operation and Development
OES	Ontario Electronic Stewardship
ORDEE	Ordinance on the Return, the Taking Back and the Disposal of Electrical and Electronic Equipment
PBDE	Polybrominated Diphenylether
PC	Personal Computer
PRO	Producer Responsibility Organization
RoHS	Restriction of Hazardous Substances
SENS	Swiss Foundation for Waste Management
SWICO	Swiss Association for the Information, Communication and Organisational Technologies
WDA	Waste Diversion Act
WDO	Waste Diversion Ontario
WEEE	Waste of Electrical and Electronic Equipment

Chapter 1: Introduction

1.1 Background

The electronics industry includes electrical and electronic equipment and covers a wide range of devices such as information technology (IT) and telecommunications equipment, as well as large and small home appliances (Fredholm, 2008). The electronics industry has been growing steadily and advancing in the global market with continuous innovations (Bandyopadhyay, 2010). Various factors are involved in the growth of the industry such as consumers' demands for newer and more effective products, the short lifespan of electrical and electronic equipment, easier and faster interaction between manufacturers, assemblers and distributors, and accessibility and availability of electrical and electronic equipment (Noble, 2008; Babu et al., 2007; Lee et al., 2007; Saphores et al., 2006). Nowadays consumers can purchase electrical and electronic equipment online, in stores, and through many other different ways (Babu et al., 2007). The focus of the electronics industry is to come up with more innovative and cost effective equipment, which is more effective in terms of performance, rather than sustainability (Goosey, 2009; Noble, 2008;). Sustainability can be defined as fostering the strategies and activities that meet the needs of the present generation, as well as protecting and maintaining natural resources for the future generations (Goosey, 2009). The areas in the electronics industry that lack sustainability include the manufacturing, use and the disposal (Goosey, 2009). As the industry grows, the extraction of natural resources that are used in the composition of electrical and electronic equipment increases, and consequently more waste is produced, which can result in drastic impacts such as negative environmental impacts (Goosey, 2009; Babu et al., 2007). If the generated e-waste is not managed properly, air, water and soil will become polluted; and natural resources that are currently available become depleted (Babu et al., 2007; Noble, 2008; Jofre and Morika, 2005).

The rapid market growth of the electronics industry results in an increase in the use and quantity of electrical and electronic equipment followed by their fast replacement due to many reasons such as “planned obsolescence” and “perceived obsolescence” strategies that are used by manufacturers (Plambeck and Wang, 2009; Guiltinan, 2009; Cooper, 2004). According to planned obsolescence, electrical and electronic equipment are manufactured to have a short lifespan, and it would be difficult and costly to repair or upgrade them when they reach the end

of their life cycle, or a new technology comes in place (Guiltinan, 2009; Plambeck and Wang, 2009). It is simply easier, more cost effective, and convenient for consumers to purchase a new product (Cooper, 2004; Plambeck and Wang, 2009). The life cycle of a product contains a sequence of interrelated stages from the extraction of raw materials until the end of its life, when the products' functionality does not satisfy the needs of the original owner any longer (Jofre and Morioka, 2005). Perceived obsolescence is another strategy used by the electronics industry to make consumers purchase more products, not because possession of those products is a necessity, simply because they are desirable. Consumers feel the desire to possess newer and more improved products just to remain current and keep a certain social status (Cooper, 2004; Fossum et al., 1986). Rapid innovations in technology, low initial costs, and planned and perceived obsolescence have resulted in the fast growth of the electronics industry, and simultaneously resulted in the rapid generation of electrical and electronic waste around the globe due to the increased rate of disposal of these products (Bandyopadhyay, 2010).

1.2 The Increasing Quantity of Electronic Waste (E-Waste)

The total and per capita quantity of generated electrical and electronic waste is increasing rapidly around the globe (Bandyopadhyay, 2010). Electrical and electronic waste or e-waste is a global term that is used loosely to refer to obsolete electrical and electronic equipment (Luther, 2010). It is estimated that e-waste grows 3-5% each year in advanced countries (Whitney and Webb, 2008; Hirschier et al., 2005). More than 20 million personal computers became obsolete in the United States in 1998 (Pichtel, 2005). It is estimated that 75% of e-waste remain in storage simply because the owners are not aware of possible options to manage them properly (Pichtel, 2005). In 2005, the number of obsolete computers in the United States was estimated at 26-37 million, among which two-thirds were still in working order (EPA, 2007). In total, 500 million personal computers (PCs) became obsolete between 1994 and 2003 in the United States (EPA, 2011). The generated e-waste in the United States in 2005 was estimated at 2.2 million tonnes, of which 379,000 tonnes were recycled, and more than 80% landfilled (Lezinski, 2008). In 2009, 438 million new consumer electronics were sold in the United States, 5 million tonnes of electronics were in storage, 2.37 million tonnes were ready for end of life management, and 25% of e-waste was collected for recycling (EPA, 2011).

The total amount of generated e-waste in Europe was estimated at 6 million tonnes in

1998. This amount increased to 8.3 to 9.1 million tonnes in 2005 (Goosey, 2009). The disposal of e-waste is a tremendous and growing problem in Canada (Whitney and Webb, 2008). Canada generates about 4.5 kg per capita of e-waste annually (Environment Canada, 2003). In 2004, more than 14,500,000 units of e-waste were discarded in Ontario, of which only approximately 9.1% were collected for proper management (Whitney and Webb, 2008).

The increasing usage of electrical and electronic equipment, and high obsolescence rate make e-waste one of the fastest growing waste streams in the world, which leads to a pressing need for implementation of e-waste management programs (UNEP, 2007). When the e-waste is not managed properly, it can end up in the municipal waste stream and get disposed into landfills, incinerators, or sent to developing countries (Jofre and Morioka, 2005). These practices can lead to different negative impacts such as compromising human health and the environment, and losses of valuable components, material, and energy (Jofre and Morioka, 2005).

1.3 Reasons for Implementation of E-Waste Management Programs

E-waste management programs may be implemented in different jurisdictions for various reasons. First, e-waste management programs can be implemented in order to reduce the quantity of hazardous materials that end up in the solid waste stream. The implementation of an e-waste management program allows preventing the negative impacts caused by improper disposal of e-waste such as negative environmental impacts, due to the hazardous materials that are used in the composition of electronics (IWMB, 2004; Robinson, 2009). Different toxic chemicals are used in the manufacturing of electrical and electronic equipment such as plastics, lead, aluminum, gallium, nickel, vanadium, beryllium, chromium, cadmium, mercury, and arsenic (Robinson, 2009; Van de Merwe, 2009). Cumulatively since 1994, over 500 million PCs have become obsolete including 100 million in 2004 alone (Widmer et al., 2005). It is estimated that 500 million PCs contain 2,872,000 tonnes of plastics, 718,000 tonnes of lead, 1363 tonnes of cadmium, and 287 tonnes of mercury (Widmer et al., 2005). PCs account for a fraction of e-waste, and similar figures regarding the amount of toxic chemicals can be estimated for other electrical and electronic equipment (Widmer et al., 2005). If these products are not disposed of properly and are landfilled, toxic components can leach into soil, and ground water (Rushton, 2003). Upon incineration of e-waste, toxic chemicals such as dioxins and polycyclic aromatic hydrocarbons can be produced (Rushton, 2003). These hazardous materials may cause a wide

range of negative health impacts including brain damage, kidney problems, lung cancer, skin ulcers, birth defects, and death (Babu et al., 2007; Brenniman and Hallenbeck, 2002)

Second, different jurisdictions can take initiatives and implement e-waste management programs to conserve natural resources, and valuable and recyclable substances that are utilized in the composition of electrical and electronic equipment such as iron, copper, aluminum, and gold (Widmer et al., 2005). These valuable and recyclable substances are environmentally important due to the fact that they provide an incentive for recycling, and may result in human health risk or environmental pollution, if they are not extracted prior to final disposal of e-waste (Robinson, 2009). Platinum group metals are utilized in the composition of electrical and electronic equipment because of their high chemical stability and conductance of electricity (Robinson, 2009). Therefore, recovering and reusing valuable materials from e-waste can be an important way of conserving resources, and prevention of negative environmental and human health impacts.

Third, different jurisdictions may implement programs for safe handling and proper disposal of e-waste only if it is required by law (IWMB, 2004). The recyclable materials in the electrical and electronic equipment are snapped, glued, bolted, or screwed, thus making it arduous to disassemble or recycle; therefore, material recovery and recycling become costly and labour intensive (Goosey, 2009). Hence, material recovery, and recycling are not preferred e-waste management practices by the industry unless it is required by law (Luther, 2010; Herat, 2009). On the other hand, the dismantling of electronic components and the recovery of their useful materials can lead to serious environmental impacts, mainly because of their complicated physical structure and the variety of toxic elements in their material composition (Duan et al., 2011). Consequently, e-waste gets shipped to developing countries, where recycling is more cost-effective, costs of labour are lower, and less stringent environmental and health regulations are employed (Whitney and Webb, 2008; Luther, 2010). In some cases the e-waste or some part of it is falsely labelled as “reusable” or “repairable” and gets shipped to developing countries for the purpose of “reuse” (Widmer et al., 2005). However, these e-wastes end up in countries that do not practice proper e-waste management, or protect labour, environment, and the community (Widmer et al., 2005). Moreover, business owners can freely maximize their benefits by externalizing costs and shipping e-waste to impoverished countries even if this is against the rules of importing countries (Widmer et al., 2005).

Finally, electrical and electronic equipment such as laptops and cell phones may hold

private and confidential information such as information regarding credit cards, bank accounts, and emails (OES, 2008). If the e-waste is not managed properly, this information can end up in the hands of criminals, which can lead to identity theft and loss of confidential information (OES, 2008).

Given the problems associated with improper management of e-waste, individual jurisdictions and the world as a whole have to move toward environmental sustainability through the implementation of aggressive and effective e-waste management programs to reduce the generation of e-waste (Jofre and Morioka, 2005). The perspective of e-waste and e-waste management varies across the continents and different jurisdictions (UNEP, 2007). A review of current practices regarding e-waste management in different jurisdictions provides an understanding about e-waste policies and programs, which can assist e-waste management program developers in establishing more effective solutions to manage e-waste (UNEP, 2007).

1.4 E-Waste Management Principles

Various jurisdictions have implemented e-waste management policies and programs to target different aspects of waste management with regards to e-waste. These policies and programs can target the e-waste problem at the source by restricting e-waste generation through better design, enhancing recycling and reuse programs, introducing market force into waste by product stewardship programs, or by focusing on the end of life cycle solutions such as introduction of controlled landfills with liners to reduce the risk of leakage, and the consequent pollution (Horne and Gertsakis, 2006). “Polluter pays”, “prevention is better than cure”, and “the precautionary principle” are some examples of well-rounded principles that have been utilized by many governments and e-waste management program developers internationally in order to enhance the maintenance and benefits of electronics, while minimizing or eliminating their adverse human and environmental health impacts (Horne and Gertsakis, 2006; Schmidt, 2002; Jofre and Morioka, 2005). These principles have been used as policy tools in different jurisdictions and initiated the development of environmental policies and regulations that range from sponsoring of voluntary programs to more strict legislation that mandates certain courses of action (Horne and Gertsakis, 2006). The e-waste policy tools that are utilized around the globe can be explained as follows:

- **Precautionary principle:** Based on the precautionary principle in the absence of scientific evidence for existence of a hazard, when there is circumstantial evidence for a potential health hazard, it is wise to assume the worst case scenario, and legislate accordingly in order to eliminate, or reduce potential human and environmental health harms (Horne and Gertsakis, 2006). The precautionary principle is used widely for development of e-waste management policies and programs in European countries (Horne and Gertsakis, 2006). Countries such as Canada and the United States are opposed to this principle and rely on risk assessment and scientific evidence when implementing e-waste management policies and programs (Schmidt, 2002). They believe that there has to be scientific evidence that links chemicals in electrical and electronic equipment to environmental and human health harms in order to come up with restricting policies and programs (Schmidt, 2002).
- **Prevention is better than cure:** This principle focuses on the fact that it is more cost-effective to tackle a problem from a source than focusing on the end of life cycle solutions (Horne and Gertsakis, 2006). European countries are advocates of this principle; therefore, the implemented programs are aimed to target the e-waste issue from the source (Jofre and Morioka, 2005). An example is setting policies and programs that encourage manufacturers to design environmentally friendly products. Implemented e-waste management programs in Canada and the United States on the other hand, focus on the end of life cycle solutions (Horne and Gertsakis, 2006; Nakajima and Vanderburg, 2005).
- **Polluter pays principle:** Those who produce and cause the pollution have to incorporate the costs to deal with the problem into their operational costs (Horne and Gertsakis, 2006; McKerlie et al., 2006). The goal of polluter pays principle is to prevent and control environmental pollution at the point of waste generation by charging manufacturers/producers for pollutant emissions (Horne and Gertsakis, 2006).

The Extended Producer Responsibility (EPR) is considered a new and improved version of the polluter pays principle that impacts e-waste management programs, and drives pollution prevention efforts (McKerlie et al., 2006). EPR was recognized as a policy tool for waste management at the 1995 Waste Minimization Workshop held in Washington DC with the aim of reducing the quantity of generated waste (Environment Canada, 2006). Based on the EPR

principle, manufacturers/producers are in the best position to control the longevity, content and recyclability of their products by means of design and markets (McKerlie et al., 2006).

EPR has been interpreted differently in different jurisdictions; hence, the implemented e-waste management programs vary in different jurisdictions (Jofre and Morioka, 2005). In European countries manufacturers/producers are held responsible for their products through the entire life cycle of the product, while in Canada and the United States their responsibility is mostly limited to the end of life cycle of their products depending on the implemented e-waste management program (McKerlie et al., 2006).

From the legal and administrative point of view, EPR can be implemented from fully voluntary to mandatory (OECD, 2002). The manufacturers/producers' involvement varies from totally private to publicly required, with shared operations, shared control and public consultative options that fall in between the two extremes (Widmer et al., 2005). The main objectives of an EPR based program from an economic point of view are to prevent or minimize the generation of e-waste, increase the use of recycled materials instead of virgin materials in production, and internalize the environmental costs (Deathe et al., 2008; Jofre and Morioka, 2005). These objectives can be achieved by considering the environmental impacts of products throughout their life cycle, and design changes by manufacturers/producers (Deathe et al., 2008).

EPR encourages producers to conserve material and energy over the entire life cycle and design products for the environment (DfE), and reduce costs associated with waste management and material use, while enhancing reusability and recyclability (Jofre and Morioka, 2005). EPR has been a driving force for implementation of e-waste regulatory structures and programs in different jurisdictions by considering environmental and economic factors with the goal of proper disposal of e-waste (Jofre and Morioka, 2005).

1.5 E-Waste Management Initiatives

The environmental and human health concerns regarding e-waste are known and many jurisdictions have implemented programs to manage e-waste. Some programs focus on managing e-waste by targeting the problem from the source by reducing or preventing the generation of e-waste, while others focus on the end of life solutions such as recycling. E-waste management programs are not the same in terms of effectiveness. However, their overall objective is to reduce or eliminate the negative impacts associated with improper disposal and management of e-waste (Babu et al., 2007; Herat, 2009).

One of the jurisdictions that has taken initiatives and implemented an e-waste management program is the province of Ontario. Ontario occupies more than 13 million residences. A large population, along with information-oriented industries, in Ontario generate a large amount of e-waste (Van de Merwe, 2009). Ontario began taking action toward the implementation of an e-waste management program in 2004, when the Waste Diversion Act (WDA) designated e-waste as a stream of waste that required proper disposal. Ontario Electronic Stewardship (OES), an industry funding organization, was established in September 2007 for the development and coordination of the e-waste management program plan (Whitney and Webb, 2008). Hence, the Ontario e-waste management program is still in its infancy stage. To date, there has been little evaluation on the success and progress of the program. Although the program is considered fairly new, conducting an evaluation and analysis of the program at this stage, and comparing it with a well-established, and experienced program provides an insight about the program achievements so far, and also allows for the selection of interventions that can be utilized toward improvement of the program (Savage, 2006; UNEP, 2011).

Evaluation of a program can be of an interest to different groups such as government, the electronics industry, and consumers. Each group can analyse and evaluate programs for different purposes, such as transparency, and sustainability (Crabbe and Leroy, 2008). Different approaches can be utilized to examine the effectiveness of the implemented e-waste management programs based on the purpose of the evaluator, available timeframe, and resources. These approaches including the selected evaluation approach, and framework for the purpose of this thesis, are discussed in the next chapter.

1.6 Central Research Questions

To combat the problems associated with increasing amount of generated e-waste, different jurisdictions have implemented e-waste management programs. The main research question for this study is:

What measures can be implemented to improve the e-waste management program that is currently implemented in Ontario?

This research also intends to answer to the following sub-question:

Can Ontario draw lessons from Switzerland's e-waste program and feasibly implement them?

The purpose of this research is to examine the success of the implemented e-waste

management program in Ontario by examining it against the objectives set out by its original design, and providing a comparison with an e-waste management program implemented in Switzerland. In order to do so, this research discusses and analyzes e-waste management programs that are currently implemented in Switzerland and Ontario, and utilizes Logical Framework Approach (LFA) to provide a systematic evaluation and comparison of the implemented e-waste programs within the two jurisdictions. It also provides information that may contribute to further improvement of the e-waste program implemented in Ontario through lessons drawn from the implemented program in Switzerland.

1.7 Thesis Organization

This thesis is comprised of five chapters: Introduction; Methodology; Literature Review; Applying the Logical Framework Approach (LFA) in the Evaluation of E-Waste Management Programs in Switzerland and Ontario; and Conclusion. The Introduction provides a background about e-waste and its associated problems. The Methodology section describes different concepts that were considered for managing this research and finding its direction, and provides an explanation and review on methods and approaches that were utilized to provide an evaluation of the Swiss and Ontario's programs. The Literature Review explains and examines different aspects of e-waste. The fourth chapter provides a detailed analysis, and evaluation of e-waste management programs that are implemented in Switzerland and Ontario in respond to the research questions by utilizing the lesson-drawing approach and focusing on the criteria for a normative e-waste management program. Chapter five concludes the research by focusing on the results of evaluation of e-waste management programs, and providing recommendations for further academic research.

Chapter 2: Methodology

2.1 Evaluation Approach

Evaluation is a tool that can be used to judge whether a program is being implemented as planned, and to assess the extent of which the stated objectives are being achieved (Fleischman and Williams, 1996; Rossi, 2004). Evaluation of the implemented e-waste management program in Ontario allows evaluators and program developers to examine the program effectiveness, and use their findings towards program improvement by making adjustments or changes in the activities (Vedung, 2009; Rossi, 2004; Fleischman and Williams, 1996). If the result of the evaluation indicates that an activity is not being implemented based on the plan or an objective is not being met, then appropriate changes can be employed to remedy the situation (Fleischman and Williams, 1996; Rossi, 2004).

Different approaches can be used to evaluate the effectiveness of Ontario's program depending on the purpose of the evaluator, the scope of evaluation, available resources and timeframe (Crabbe and Leroy, 2008). The scope of the evaluation sets limits and identifies the components of the program and the objectives that the evaluation will focus on regardless of the selected evaluation approach (Fleischman and Williams, 1996; Vedung, 2009). Different approaches that are utilized in program evaluation include the rational or goal-oriented approach, the political interaction approach, and the institutional phenomenon approach (Crabbe and Leroy, 2008). These approaches, their perspectives, and implications are discussed further.

2.1.1 Rational or Goal-Oriented Approach

The rational or goal-oriented approach views a program as a rational process of problem solving (Vedung, 2009). In the rational approach, there is a clear problem definition, and objective setting, which leads to the development of activities, interventions or strategies to achieve the objectives. Interventions are compared and weighed against each other and the most effective one or a combination of a few options are selected and implemented (Vedung, 2009). At the end of this process an evaluation can be conducted to determine to what extent and whether the problem has been solved, and if the interventions need to be modified or altered (Vedung, 2009). In this approach a program is assessed, and optimized based on the criteria of objective achievement (Crabbe and Leroy, 2008). This concept of evaluation is influenced by

engineering and economics: searching for the most rational way of analysing and solving the problem. This approach uses a variety of methods to conduct an evaluation. Methods used in program evaluation based on this approach are described further (Crabbe and Leroy, 2008)

2.1.1.1 Reconstruction of Program Theory Method

A program is implemented based on implicit assumptions regarding the causes of the main problem, and strategies to target the causes and hence the main problem (Leeuw, 2003). In the reconstruction of program theory method, an evaluator evaluates the underlying causes of the problem by reconstructing and analysing these causes and examining their validity and reliability, analysing the problem and solutions, and identifying ways to tackle possible shortcomings (Crabbe and Leroy, 2008). The goal of this type of analysis is to upgrade the quality of program assumptions to a more rational or scientific level (Leeuw, 2003).

2.1.1.2 Predicting Effect and Effectiveness Method

A rational approach considers using techniques such as impact assessment to forecast the effect and effectiveness of a program (Crabbe and Leroy, 2008). The predicting effect and effectiveness method examines the effectiveness of a program by examining the likelihood of behavioural changes in the target groups (Glynn, 2004). It also verifies the degree of required regulation, financial stimulation or consumers' information for those changes to take place with the aim of revealing the dose-response relationship (Glynn, 2004). In this method the evaluator assumes that consumers and organizations are sensitive to the change that is caused by an implemented program and adapt their behaviour accordingly (Crabbe and Leroy, 2008).

2.1.1.3 Gauging the Effectiveness Method

The gauging the effectiveness method uses different qualitative and quantitative criteria to provide an evaluation about program effectiveness. Here, the focus is on evaluation of relationship between different program activities and their desirable and undesirable effects (Crabbe and Leroy, 2008). Program effects include program output or performance, program outcome or social change, and environmental impact or environmental change (Wideman, 1990). Program output or performance explains the quality and quantity of services delivered by implementation of a certain program (Artley and Stroh, 2001).

2.1.2 Political Interaction Approach

The political interaction approach evaluates an implemented program by using political science, in which the program is the outcome of interactions and power relations between different social and political groups (Russ-Eft and Preskill, 2001). As opposed to the rational model that views program as a problem solving strategy that is rationally designed and implemented, this approach views a program as an interaction between different stakeholders (Crabbe and Leroy, 2008). In the political interaction approach the concern is not about developing different activities and selecting them based on problem analysis and their impacts on problem solving. The objective is not to examine if a problem is solved; it is to examine the engagement and role of all stakeholders (Russ-Eft and Preskill, 2001).

In applying this approach of evaluation, a program is not examined based on effectiveness and objective attainment, since there is no clear cut objective and even if there is, it can change over time due to the interaction between stakeholders (Crabbe and Leroy, 2008; Russ-Eft and Preskill, 2001). Program evaluation with regards to political interaction is a complex process. It is a lengthy interaction and complicated political decision making, where the effectiveness of the program is not a matter of concern (Barley et al., 2003; Crabbe and Leroy, 2008).

2.1.3 Institutional Phenomenon Approach

The institutional phenomenon approach evaluates the program in terms of program process (Crabbe and Leroy, 2008). This approach examines a program as a pre-structured and characterized process and tries to identify its characteristics, which can be a complicated task (Picciotto and Wiesner, 1998). In general there are three ways of describing institutionalized characteristics of programs, which include an international comparison between two similar programs, a national comparison between two programs or cross-sector approach, and a longitudinal comparison, which is an evaluation of a specific program throughout the years and as it progresses (Crabbe and Leroy, 2008). The application of each of these methods can be very time consuming and labour intensive. The institutional phenomenon approach evaluates the institutional context of implemented programs such as financial supports rather than their effectiveness. In this approach, evaluators look at institutional patterns and how they are continually reproduced and consolidated. The institutional approach looks at typical features of a certain institutional context and the way they affect a particular program process and outcome

in one jurisdiction with the aim of drawing lessons that can be used to improve a program in another jurisdiction. It examines the suitability of the institutional context for a particular program, not the impact of a program (Fleischman and Williams, 1996).

Overall, the effectiveness of an implemented program can be defined differently based on the employed perspective in program evaluation. The first step in conducting an evaluation is identification of problems, followed by construction of scope and objectives on which the evaluation approach will focus. The selected evaluation approach for the purpose of this thesis is discussed in the next section.

2.2 Selected Evaluation Approach

A combination of rational, political interaction and institutional phenomenon approach has been selected for the purpose of this study and to evaluate the implemented e-waste management program in Ontario. The rational approach allows for conducting a systematic evaluation by providing structure and discipline (Weimer and Vining, 1999). It provides a logical and comprehensive analysis that can be used for program assessment and holding decision makers responsible (Jans, 2007). Based on this approach, the problem is identified, and solutions are chosen to tackle the problem (Pal, 1989). The evaluation process is divided into problem analysis and solution analysis (Weimer and Vining, 1999). Problem analysis determines objectives, and activities that need to be utilized to achieve objectives; therefore, the problem has to be identified, and explained clearly (Weimer and Vining, 1999). Activities or strategies are evaluated based on their ability to meet the program objectives (Weimer and Vining, 1999; Sapru, 2004). To conduct a rational approach for evaluation of the Ontario's program, a combination of methods that were discussed is utilized. Based on the reconstruction of program theory method, the causes of the main problem and solutions that are chosen to tackle the causes and consequently the main problem are identified, reconstructed, and evaluated. Utilizing the effect and effectiveness method, the impact of the implemented program in Ontario is evaluated considering factors such as consumers' education and awareness that is required for changes to take place in order for the program to be deemed effective. Based on the gauging the effectiveness method different qualitative and quantitative criteria are employed to examine quality and quantity of services that are provided by the program and to evaluate the program's outcome, performance, and impacts.

The political interaction approach is utilized to examine stakeholders, and their

engagement in the implemented e-waste management program in Ontario, and services offered by the program that facilitate the stakeholders' participation and lead to the program's success. The institutional phenomenon approach is employed to provide an evaluation of the program process in Ontario by conducting an international comparison between Ontario and a similar program in another jurisdiction. In applying the institutional phenomenon approach different characteristics of the implemented programs are evaluated by examining typical features of certain institutional contexts of each program and the way these features affect programs' process and outcome.

Overall a combination of the rational, political, and institutional approach provide a program evaluation by examining effectiveness, objective attainment, and participation of stakeholders, and contextual features that can impact the program's success.

In order to apply rational, political, and institutional approach in conducting program evaluation, an evaluation framework that can provide a systematic objective and process evaluation is required. The framework has to provide a step by step analysis of the implemented program in Ontario, and evaluate steps in terms of effectiveness, and achievements of the program objectives according to rational approach, stakeholders' participation, and their engagement in the implemented program as described in political approach, and also provide a comparison between Ontario and a similar program in accordance with institutional phenomenon approach.

Upon the selection of the evaluation approach, the next step involves the selection of a framework that provides a systematic analysis at different stages of a program. The evaluation framework is discussed further in the next section.

2.3 Evaluation Framework

An effective program evaluation is a systematic way to improve a program (Rossi, 2004). The framework provides guidance for program evaluation by summarizing and organizing essential elements of a program and comprising various steps for an effective program evaluation (Koplan, 1999). A framework can provide an evaluation by examining the outcome, or the process of an implemented program (Fleischman and Williams, 1996; Beierle, 1998). An evaluation framework that focuses on the outcome of an implemented program attempts to determine if a program's specific objectives have been achieved, while the process evaluation framework seeks to explain how a program is implemented in order to gain an understanding of

why the objectives were or were not achieved (Fleischman and Williams, 1996; Rossi, 2004). An effective evaluation framework has to be able to incorporate both the process and outcome aspects of evaluation (Fleischman and Williams, 1996). In this manner, one can determine the effectiveness of a program in terms of achievement of its objectives, understand how the program produced the outcomes, and explain how the program activities might be modified to be more effective in solving the problem, and achieving the objectives (Fleischman and Williams, 1996; Rossi, 2004).

An evaluation framework has to define the problem, set objectives, provide a description and analysis of all participants and stakeholders in the program as well as program activities and services, assess the outcome of the program, and the extension that the program has met its objectives (Fleischman and Williams, 1996; Beierle, 1998). The description of the participants and activities and services allows explaining how the outcomes were achieved and recommend changes, which may lead to the production of these outcomes more effectively (Fleischman and Williams, 1996; Beierle, 1998). An evaluation framework has to provide a comprehensive assessment of a program by describing how the evaluation is planned and carried out, set the scope of the evaluation, specify the evaluation questions, and develop data collection plan for different components of the program such as activities, and stakeholders (Fleischman and Williams, 1996; Rossi, 2004). Aside from resources and activities that are allocated to a program implementation, a problem analysis has to be conducted to determine the effectiveness of solutions in responding to the problems (SIDA, 2002).

The selected evaluation framework for the purpose of this study that is utilized in conducting an evaluation in order to provide a systematic analysis of a program is discussed in the next section.

2.4 Selected Evaluation Framework: Logical Framework Analysis or Logical Framework Approach (LFA)

The term logical framework refers to the logical connection that program developers and planners make between the objectives of the program, and available resources (Baccarini, 1999; Crabbe and Leroy, 2008). Logical Framework Analysis or Logical Framework Approach or LFA was introduced in the 1960s by the US Defence Department and was further developed by the US Agency for International Development (NORAD, 1999; Gawler, 2005). Since its introduction, LFA has been improved from a simple framework for modeling the program

objectives to a methodology for conducting an evaluation (Crabbe and Leroy, 2008). LFA has been adopted, and adapted as an evaluation tool by a large number of agencies involved in providing development assistance (Jiang-hao, 2007). An example of application of LFA in program evaluation is described in an article by Johnson (2007). The article discusses temporary housing programs and the problems they tend to provoke such as high costs and undesirable impacts on the urban environment (Crabbe and Leroy, 2008). Using LFA in evaluating these programs indicates that the unwanted effects can be reduced or eliminated through proper management of facilities, reuse of units, and initial application of unit designs that are easy to dismantle (Crabbe and Leroy, 2008). LFA was introduced as the main evaluation and management tool of the EU's PHARE Program (Poland and Hungary: Assistance for Restructuring their Economies) in the early 1990s, and was later expanded to provide financial and technical assistance to the countries of Central and Eastern Europe and prepare them for EU membership (Fujita, 2010). LFA has been utilized by German development agencies and particularly by German Technical Cooperation (GTZ) in different program evaluations and program appraisals due to the systematic structuring that it provides (Jiang-hao, 2007; NORAD, 1999). The Organization for Economic Co-operation and Development's (OECD) Development Assistance Committee has been promoting the application of LFA for different program evaluations among member countries (CIDA, 2008; NORAD, 1999). The Nordic countries and Canada have utilized LFA in development and evaluation of aid programs and in domestic public investment program evaluations (CIDA, 2008; NORAD, 1999). Other agencies that have used LFA in program evaluation include the International Service for National Agricultural Research (ISNAR), and Australia's AusAID (Jiang-hao, 2007).

LFA is a methodology for substantiating and evaluating the plans for a specific program (Crabbe and Leroy, 2008). LFA is selected for the purpose of this study due to the fact that it provides a systematic framework for conducting an evaluation (Ortengren, 2004). LFA is objective or result oriented and focuses on what need to be achieved (Ortengren, 2004). It also provides a process evaluation by summarising the program and its context in a logical manner, in a way that the connection between the activities and the expected results can be examined (NORAD, 1999; Jackson, 1997; Gawler, 2005).

LFA is useful in answering these questions about a program (Crabbe and Leroy, 2008):

- Why is it implemented?

- What is it expected to achieve?
- How is it going to achieve the objectives?
- Which factors are crucial for its success?
- Which means are required?
- How can the end results be measured?

Overall the application of LFA in program evolution can be summarized as below (Crabbe and Leroy, 2008; Mikkelsen, 2005; NORAD, 1999):

- LFA can summarize complex programs clearly and comprehensively;
- It provides a systematic and logical analysis of all elements that constitute a well designed program; therefore, allows for evaluation of a program in terms of effectiveness;
- LFA ensures that fundamental aspects of a program are examined and weaknesses are analysed to improve or redesign a program in a more effective manner;
- LFA takes into account the conditions for success of a program.

This thesis utilizes the steps in LFA in order to conduct a systematic evaluation of the e-waste management program in Ontario. The main or focal problem associated with e-waste is identified and analysed, and solutions that can be implemented to target this problem are analysed. LFA also identifies and explains causes and consequence of the main or focal problem in order to determine objectives, activities that should be used to achieve the objectives, and judges the feasibility of available solutions in achieving the objectives. The application of LFA consists of a few steps that are discussed further in the next section.

2.4.1 Utilizing LFA in Program Evaluation

LFA consists of a few steps. Through implementation of these steps it can be determined whether the program idea is relevant, and right activities are allocated to solve the main problem (SIDA, 2002). These steps are further discussed in this section.

2.4.1.1 Step1: Context Analysis

Various background factors such as cultural, economical, and environmental aspects can impact the success or failure of any implemented program in a society (NORAD, 1999). The first step of LFA focuses on defining the context, within which the programs exist such as land

area, total population size. The background, in which the programs are implemented, is examined with the aim of developing an insight about overall contextual aspect that may impact an implemented program (SIDA, 2002).

2.4.1.2 Step 2: Problem Analysis

The second step in applying LFA as an evaluation framework is identifying the major or focal problem, its causes, and consequences (SIDA, 2002). A problem tree is utilized at this step in order to illustrate the identified problems (Jackson, 1997; NORAD, 1999). As the name suggests this tool resembles a tree. Construction of a problem tree allows for the development of a cause and effect relationship between problems (NORAD, 1999). A problem tree maps out the causes and effects around an issue in a structural way by breaking down the problem into manageable and definable pieces, and provides more understanding of the problem (NORAD, 1999). The roots of the tree metaphorically represent the causes of the main or focal problem; the tree trunk at the centre represents the main problem; and the tree branches provide a representation of the effects of the main problem (Ortengren, 2004).

In the evaluation of implemented programs, a problem tree is constructed by examining problems that exist by asking the question of why the problems exist (NORAD, 1999). The focal problem is identified by conducting a comprehensive literature review of related documents and researches about an existing problem (Ortengren, 2004). Upon the identification of the focal problem, the direct and substantial causes of the focal problem are placed parallel underneath it, and the substantial and direct effect of the focal problem is placed on the line above it (Jackson, 1997). Causes and effects are further developed by utilizing the same principle to form the problem tree (Jackson, 1997; NORAD, 1999). The problem tree is shown in Figure 2.1 (NORAD, 1999). Problem analysis is conducted with the aim of answering these questions (Ortengren, 2004):

- What is the main problem that can be solved by implementation of a specific program?
- What are the causes of the main problem?
- What are the consequences or effects of the main problem?

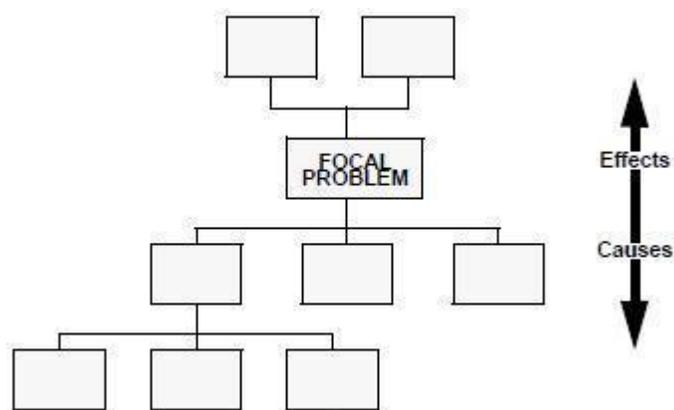


Figure 2.1 Problem tree (NORAD, 1999)

The problem tree is closely linked to the objective tree, which is another step in program evaluation. The problem tree can be turned into objective tree by rephrasing each of the problems to positive and desirable outcomes, which allows for development of plan of activities to achieve the desirable outcomes (Ortengren, 2004).

2.4.1.3 Step 3: Objective Analysis

The third step of LFA evaluation focuses on providing an analysis of the objectives. Objectives of a program have to focus on tackling the problems that were identified at the problem analysis steps. In general, the objectives are what a program is trying to achieve upon progress (Ortengren, 2004; Gawler, 2005):

- What can be achieved upon the program implementation in the long run? (Overall Objectives)
- Why is the program implemented? (Purpose)
- What can be achieved upon the program implementation? (Results)

The explanation of objectives allows for development of more effective plans that facilitate the achievement of objectives (SIDA, 2002). The objectives of a program can be explained as:

- Goal/overall objectives: The overall objectives or goal of a program contain the societal /economic benefits that would be the result of implementation of a program in a long run (Ortengren, 2004). The overall objectives can be the result of implementation of several programs at the same time (Ortengren, 2004). Therefore, it is difficult to conclude that

the occurred changes, if any, are the result of implementation of a specific program.

Hence, it is not easy to measure the overall objectives (Ortengren, 2004; Gawler, 2005).

- Program purpose: The program purpose is the reason that the program is needed and implemented. It is about a solution that implementation of a program would bring to the focal problem (Gawler, 2005).
- Output: The direct result of activities that are implemented within the framework of a program. It is about the services that a program can deliver to the beneficiaries (Ortengren, 2004; Gawler, 2005).

The focal or main problem is tackled through the fulfillment of program purpose. The achievement of the objectives at the lower level facilitates fulfilment of the overall objective of a program (Ortengren, 2004; NORAD, 1999).

2.4.1.4 Step 4: Stakeholders Analysis

Upon the identification of problems, and objectives, it is crucial to pay attention to on whom these problems can have the most actual direct or indirect impact, and what the role and interests of different stakeholders might be in addressing problem and finding solutions (Ortengren, 2004; Golder and Gawler, 2005). Stakeholders can be defined as individuals or organizations that are influenced by or can influence the implementation of a program directly or indirectly, or benefit from an implemented program (Golder and Gawler, 2005). Stakeholders can be against or for a change. Stakeholders' participation and support determines a program's success (Future Energy Solutions, 2003; Start and Hovland, 2004). Stakeholders have to see and believe in the advantages that a program can offer to them. Therefore, before planning any activity or strategy to achieve objectives, stakeholders have to be identified and analysed. A survey of a program stakeholders and their relation to the program is an important part of planning process, given the fact that stakeholders' attitude toward a program can influence its success or failure in achieving objectives and tackling problems (Golder and Gawler, 2005; SIDA, 2002).

The analysis of stakeholders provides a vision about important actors in an implemented program, which can be utilized in the activity planning step to provide and maintain stakeholders' participation and result in a program's success (Start and Hovland, 2004).

2.4.1.5 Step 5: Plan of Activities Analysis

The next step in applying LFA in program evaluation is the evaluation of plan of activities. Activities are specific actions that have to be undertaken to tackle the causes and the focal problem, and achieve objectives of a program (Ortengren, 2004). Activities and can be assessed and evaluated based on factors such as the use of available resources, environmental effects, and capability of achievement of results (NORAD, 1999).

2.4.1.6 Step 6: Plan of Resources Analysis

This step of LFA evaluation requires a detailed examination of dedicated resources. The resources plan has to include all available financial resources in order to implement activities. The more different resources are examined in detail, the higher the chance that activities achieve expected results (SIDA, 2002).

2.4.1.7 Step 7: Conclusion

The final step of evaluation includes the sum of all findings throughout the earlier steps and the conclusion regarding the success of a program in achieving its objectives (Ortengren, 2004). The overall program design is assessed, involvement and participation of all stakeholders in the program, and whether effective activities are set in terms of achievements of objectives, and whether there s a secure financing system in place (NORAD, 1999). Based on observed deficiencies, recommendations can be made for improvement or redesigning of the program (NORAD, 1999).

This study provides an analysis of the e-waste management program in Ontario to aid making decisions about the implementation of more effective activities to target the e-waste issue in Ontario by focusing on lessons that can be drawn from a more experienced program. Following the selection of the evaluation approach, and evaluation framework, a case study has to be selected in order to conduct a comparison based on institutional phenomenon approach. Next section discusses the case study followed by the selected case as a basis for the purpose of this study.

2.5 Case Study

In order to provide a proper evaluation of the e-waste management program that is

Implemented in Ontario, a combination of rational, political, and institutional approach was selected as an evaluation approach, and LFA was selected as an evaluation framework. The next step is the selection of a case study as a basis for comparison as required in institutional approach. A case study is a detailed examination of a single example, and can provide reliable information about the broader class (Flyvbjerg, 2006). It is a study of a particularity and complexity of a single case with the aim of understanding its characteristics within important circumstances (Stake, 1995). A case study provides a concrete, practical knowledge that can contribute to a scientific development and innovation without any attempt for generalization (Flyvbjerg, 2006). The advantage of the case study is that, it provides information based on real examples and tests different views directly in relation to phenomena as they unfold in practice (Flyvbjerg, 2006). Many studies regarding e-waste management strategies have relied on one case study as a source of information with the aim of making long term e-waste management planning (Su and Wang, 2003; Ahluwalia and Nema, 2007). Focusing on one case study allows for conducting a more in depth research and adopting valuable lessons that can be used to improve the implemented program in Ontario.

A case study that is chosen as a source of information and a basis for comparison has to be unique in its own way and also share similarities with the Ontario's program (Stake, 1995). The important fact about a case study is particularization not generalization (Stake, 1995). The idea of selecting a particular case study is to understand it well, and explain what it is and what it does as opposed to describing how it is different from other available cases (Stake, 1995). It is inevitable that a basic knowledge about various available cases is required in order to acknowledge the specific aspects of the selected case study; however, the emphasis is on understanding the case study itself (Stake, 1995).

Various strategies can be employed in order to select a case study including random selection, and information-oriented selection (Dooms, 2010). In random selection, an average or a typical case is selected for the purpose of obtaining general information (Flyvbjerg, 2006). When the objective of a study is to achieve the greatest possible amount of information on a given problem or subject, and to explore deeper causes behind a given problem and its consequences, a random selection may not be the most desirable strategy, due to the fact that an average case is often not the richest in information (Flyvbjerg, 2006). In utilizing information-oriented strategy, a case is selected based on the expectations of researchers regarding the

information content such as highlighting the characteristics of a case in question (Flyvbjerg, 2006).

One purpose of this study is to identify the main problem associated with e-waste and its consequences, decipher the underlying causes that lead to the main problem, and obtain great amount of information regarding e-waste management strategies from a well established program. In order to do so, this study focuses on understanding, and highlighting characteristics of a comprehensive program that is effective in managing e-waste and can be used as a reference point in order to improve the Ontario's program. Therefore, an information-oriented case selection strategy is chosen for this study.

European countries have been known for being pioneers in making environmentally sound decisions especially regarding e-waste management, and many e-waste management programs implemented in various countries around the world are driven by strategies implemented in the European Union (EU) (Savage, 2006; Herat, 2009). To come up with a case study for the purpose of this thesis several countries that are known to have a comprehensive e-waste management program were identified. Among those, the one that could provide more accessible and reliable data, and shared more common backgrounds, as well as dissimilar characteristics to the Ontario's program was selected. The objective of this thesis is not to explain how the selected case study is different from other available cases. The aim is to study the case and understand the employed strategies to manage the e-waste problem within that case that can be utilized to improve the Ontario's program. The selected case study is explained in the next section.

2.6 Selected Case Study, Switzerland

One aspect of this research is to study and understand what has already been implemented in another jurisdiction as a case study, and to use lessons learned to improve Ontario's e-waste management program. Switzerland is chosen as a case study for the purpose of this research for several reasons. First, it is one of the pioneers in taking initiatives to target e-waste issues, and making stringent environmental policies and programs. Switzerland has been involved in implementation of e-waste management strategies since 1990 and has experienced a process of trial and error to implement effective management of e-waste (Bandyopadhyay, 2010). Switzerland is the first country in the world to have established a formal system to manage e-waste (Khetriwal et al., 2005). It is also the first country in the world to have introduced

legislation on e-waste management in 1998 in the form of an Ordinance entitled -“The Return, the Taking Back and the Disposal of Electrical and Electronic Equipment” (ORDEE) (Bandyopadhyay, 2010). The landfill disposal of combustible waste including e-waste was banned in Switzerland in 2000 (EEA, 2010). Second, Swiss e-waste management program provides a simple, and transparent system, which is well designed and defined in terms of history, role of all stakeholders and their obligations, system financing, performance and performance indicators, policy, and so forth (Bandyopadhyay, 2010; Khetriwal et al., 2005). Third, in terms of performance in an international comparison, Switzerland not only meets minimum collection and recycling targets set by the EU, but also performs better (UNEP, 2007). In fact Switzerland is among the countries achieving the highest rate of recycling and recovery (EEA, 2010). Fourth, Switzerland is very active in providing information about e-waste including latest news, and events. Information regarding e-waste, associated risks, available options for proper management of e-waste, drop-off locations and other related e-waste issues is readily available and easily accessible through media, bulletins, journals, and SWICO websites (SWICO, 2010). Fifth, environmental concerns and consumer awareness are very high in Switzerland (Khetriwal et al., 2005). In a recent survey 62.6% of the citizens wanted the government to put more emphasis on environmental issues (Khetriwal et al., 2005). Sixth, with regards to the Environmental Performance Index (EPI), Switzerland has been ranked the second. EPI ranks different countries against 25 fixed indicators to provide a basis regarding each country’s contributions in establishing environmentally friendly programs (Emerson et al., 2010). Switzerland being ranked second in the globe indicates the country’s level of development, good governance, and concerted policy effort toward environmentally sound activities including taking initiatives toward e-waste management.

The long history and track record in managing e-waste, performance rate, accessible and reliable information, and high consumer awareness regarding e-waste allow the Swiss e-waste management program to be valued as a comprehensive program. Therefore, there are a lot of valuable lessons that can be learned from the Swiss program to improve the Ontario’s.

Finally, Switzerland was chosen based on factors such as the human development index (HDI), gross domestic product (GDP), and a system of government comparable to that of Canada and Ontario. The human development index is a measure of education and well-being of a society; GDP is an indicator of wealth, and economical sustainability; and the system of government is an indicator of the way that different decisions are made in a society including

enactment of environmental regulations. Both jurisdictions possess comparable level of well-being, economical sustainability and the system of government. Therefore, the procedure for approval of environmentally friendly decisions and policies are broadly comparable. Similarities in HDI and GDP indicate that both jurisdictions should possess required financial resources for implementation of e-waste management programs.

There are also common characteristics between e-waste management programs implemented in the two jurisdictions that allow for examination of the Swiss program and application of the learned lessons in the program implemented in Ontario such as responsibility of stakeholders, drop-off location, and e-waste management activities such as collection and recycling. Therefore, the e-waste management program in Switzerland is chosen as a basis for comparison that can provide valuable information in order to improve the Ontario's program.

The lesson-drawing is an approach that facilitates extraction and transfer of useful information from the Swiss program to Ontario's. Lesson-drawing and its applications is explained further in the next section.

2.7 Lesson-Drawing Approach

The lesson-drawing is an approach in which, one functional system or program in one jurisdiction is used in the development of policies, programs, administrative arrangements, institutions, or ideas in another system or program in a different jurisdiction (Dolowitz and Marsh, 2000; Spaans and Louw, 2009). While cross-national transfer of institutions, programs, policies, and lessons have long existed, in recent years there has been a growing interest among program developers and policy makers in the application of lesson-drawing due to the fact that technological advances have facilitated the communication and exchange of knowledge and ideas between program developers and policy makers (Priemus et al., 2008; Dolowitz and Marsh, 2000; Laguna, 2010). Another reason for the growth of the application of lesson-drawing is the global economic forces (Dolowitz and Marsh, 2000). As the world economy in particular is transformed by new modes of production and trade, and as transnational corporations and institutions come to experience more influence and power, policy makers and program developers increasingly look into other jurisdictions for knowledge and ideas about running different programs (Dolowitz and Marsh, 2000).

International organizations, such as the EU, the International Monetary Fund (IMF), the

OECD, and the World Bank, advocate, and at times enforce, similar policies and programs across diverse countries (Dolowitz and Marsh, 2000). An example of the lesson-drawing approach in policy and program development is the welfare-to-work and workfare policies and programs that have been transferred from the United States to Britain since 1980s (Dolowitz and Marsh, 2000). In October 1993, a report on Social Assistance in OECD Countries was issued based on lessons that could be drawn from the operation of social assistance programs in different countries (Dolowitz and Marsh, 2000). The German Standardized Appraisal program, Swiss programs in consulting individual voters, and Singapore's transit system and its curbs on free motor vehicle ownership are some of the examples of programs that have been widely utilized universally in order to develop similar programs in other jurisdictions (Priemus et al., 2008). In recent years the lesson-drawing approach has been used to study social policy (Dolowitz et al., 2000), urban policy regeneration (Wolman and Page, 2002), railways regulatory reform (Lodge, 2003a), Europeanization (Page, 2003), the reform of public utilities frameworks (Bulmer et al., 2007), single currency, tax policy and media ownership in the European Union (Radaelli, 2000), and administrative reforms (Common, 2004), among other topics (Laguna, 2010). Another example of utilizing the lesson-drawing approach in program development and improvement is the European tour that was conducted by Electronic Product Stewardship Canada (EPSC), an industry-led organization, in order to examine the take-back programs implemented in European countries and draw valuable lessons that could be utilized to develop practical solutions for managing e-waste in Canada (Widmer et al., 2005).

There are four key factors to consider when utilizing the lesson-drawing approach: The two jurisdictions have to share similar problems; the objectives within the two jurisdictions have to be the same; the program in one jurisdiction has to have the potential for offering valuable information; and the program in one jurisdiction has to have a long history of being successful in achieving its objectives (Dolowitz and Marsh, 2000).

Based on lesson-drawing approach, a program that has been able to solve a similar problem in one jurisdiction can be examined to verify what aspects of the program and to what extent are transferable to another jurisdiction (Rose, 1993). Any implemented program pursues the achievement of particular objectives (James and Lodge, 2003). The decision on how to pursue these objectives is based on a systematic and comprehensive manner by reviewing the program in the light of past experience and gathering as much information as possible to make necessary adjustments (James and Lodge, 2003). A newly implemented program can use an

already implemented program in another jurisdiction to draw positive or negative lessons (James and Lodge, 2003). If an implemented program in a jurisdiction remains in effect, and is able to achieve its objectives, it is safe to assume that the program is successful (Rose, 1993). This program can be used as a basis to improve a fairly new program (Rose, 1993).

For the purpose of this thesis the e-waste management program that is implemented in Switzerland is examined to extract and learn useful information that can be used to improve the e-waste management program in Ontario through the application of the lesson-drawing approach. Switzerland has a long history in targeting e-waste issue and being successful in achieving the program objectives, and the potential to offer valuable lessons.

The process of lesson-drawing starts with scanning a program in effect elsewhere and assessing the structural backgrounds of jurisdictions as well as factors that can impact program development (Brocklehurst et al., 2000; Rose, 1993; Priemus et al., 2008). Factors that have made the two jurisdictions comparable have to be taken in to consideration such as similar program and policy needs, financial support for running the program, and stakeholders participation (Brocklehurst et al., 2000; Van de Merwe, 2009). The next step in the lesson-drawing involves parallel scanning and analysing of programs in the two jurisdictions and drawing valuable lessons from one program that can be utilized in improvement of the other program in another jurisdiction (Rose, 1993).

The lesson-drawing approach is not an all-or-nothing process (Dolowitz and Marsh, 2000). It can be conducted by applying different methods based on the case and required information (Dolowitz and Marsh, 2000). These methods include copying, which involves direct and complete transfer of one policy or program from one jurisdiction to another; emulation, which involves transfer of the ideas and messages behind the policy or program; combination, involves transfer of a mixtures of direct and underlying messages of a programs; and inspiration, where policy or program in one jurisdiction may inspire a policy or program change in another jurisdiction (Dolowitz and Marsh, 2000; Laguna, 2010; Spaans and Louw, 2009; Rose, 1993).

For the purpose of this study, the similarities and differences in backgrounds between the two jurisdictions are examined as well as the implemented e-waste management programs. To draw valuable lessons from the Swiss program a mixture of copying, emulation, combination, and inspiration method is utilized to transfer direct ideas regarding some aspects of the program, the message behind the implementation of the program, a combination of direct and indirect

messages, and also to get inspiration of some aspects of the program that can overall improve the Ontario's e-waste management program.

2.8 Methodological Challenges

There are some challenges when conducting a program evaluation. Obtaining reliable data with regards to objective achievement is very challenging especially for programs that are fairly new. Due to proprietary rights, different organizations can refuse disclosing any technical or financial information (OES, 2008). In these cases the impact of a program can be estimated based on available evidences and decision regarding the success of a program can be made based on the previous experiences in similar situations (Weimer and Vining, 1999). However, a message can be drawn from a more experienced program by utilizing the lesson-drawing approach toward the improvement of a fairly new one. The next chapter provides a literature review regarding e-waste and its management prior to conduction of an analysis and evaluation of the implemented e-waste management programs in Switzerland and Ontario.

Chapter 3: Literature Review

3.1 History of Waste Management

Waste management and handling waste have gone through changes throughout history (Bilitewski et al., 1997). There are many drivers that play an important role in the improvement of waste management activities. The resource value of waste, which allowed people to make a living from discarded materials, was one of the historical drivers that led to the improvement of a more systematic approach toward waste management (Wilson, 2007).

In the 1850s, public health concerns and the belief that infectious diseases such as cholera and typhoid were the result of decaying organic matter were major drivers for waste management decisions (Wilson, 2007; Bilitewski et al., 1997). Upon the improvement in public health in the nineteenth century, formalized waste collection systems were introduced in developing countries (Wilson, 2007; Seadon, 2006). In the 1970s, environmental protection activities gave more attention to waste management with the primary focus of elimination of uncontrolled disposal of waste followed by increasing of technical standards (Wilson, 2007). The notion of a waste hierarchy was first introduced in 1977 in the EU's Second Environment Action Program and called for a move away from disposal towards the more sustainable options such as reuse, and recycling (Wilson, 2007; IWMB, 2004). The idea of waste management hierarchy in Ontario goes back to early 1980s and includes reduction, reuse, recycling, and final disposal in landfills or incinerators as the last resort (OES, 2008; Whitney and Webb, 2008).

Systematic waste management started by focusing on controlling waste disposal followed by environmental improving standards. In the 1990s there was a realization that just controlling the disposal, and increasing environmental standards are not sufficient for managing waste (Wilson, 2007). This led to the development of an integrated policy phase to include other important factors such as political, institutional, social, economic and financial aspects into waste management practices and focusing on the ultimate goal of preventing waste generation at the source (Wilson, 2007; McDonough and Braungart, 2002). Figure 3.1 shows the development of systematic waste management strategies (Wilson, 2007).

It is believed that the future direction in waste management activities will be to move towards a zero waste society, where products are designed to be disassembled and reused many times (Vane de Merwe, 2009).

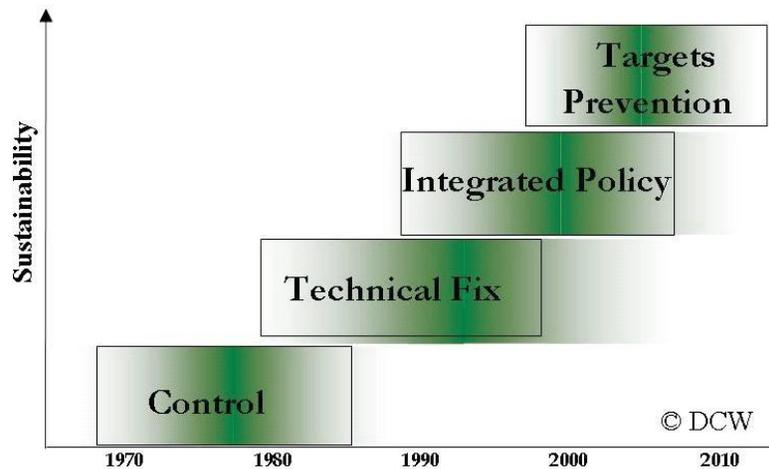


Figure 3.1 Waste management developments (Wilson, 2007)

3.2 Electronic Waste (E-Waste)

Rapid production of electrical and electronic equipment not only has led to advancements in electronic technology and product availability, it had resulted in a new type of waste, e-waste (Van de Merwe, 2009). E-waste accounts for 8% of municipal solid waste worldwide (Babu et al., 2007).

3.2.1 Definition and Categories of E-Waste

There is not a standard definition for e-waste (Widmer et al., 2005). E-waste is a generic term referred to various forms of electrical and electronic equipment that are not wanted by their owners (Widmer et al., 2005). E-waste can also be defined as any device that uses electric power supply that has reached the end of its life cycle (OECD, 2002). According to EU's WEEE Directive (EU, 2003a), e-waste includes all components and sub-assemblies, which are part of the electrical and electronic equipment at the time of discarding. This definition is accepted by the member countries of EU and other countries of Europe including Switzerland (UNEP, 2007). E-waste is defined in Ontario as electrical and electronic equipment that requires an electric current or battery to operate, and has reached the end of its intended useful life (OES, 2008; Whitney and Webb, 2008). E-waste covers a wide and expanding scope of electrical and electronic equipment that are unwanted by their original users (Puckett et al., 2002). Table 3.1 lists different categories of e-waste in accordance with the EU's WEEE Directive, which forms a standard that is accepted around the globe (Widmer et al., 2005).

Table 3.1 Categories of e-waste in accordance with the EU Directive (Widmer et al., 2005)

No.	Category	Label
1	Large household appliances	Large HH
2	Small household appliances	Small HH
3	IT and telecommunications equipment	ICT
4	Consumer equipment	CE
5	Lighting equipment	Lighting
6	Electrical and electronic tools (with the exception of large-scale stationary industrial tools)	E & E tools
7	Toys, leisure and sports equipment	Toys
8	Medical devices (with the exception of all implanted and infected products)	Medical equipment
9	Monitoring and control instruments	M & C
10	Automatic dispensers	Dispensers

3.2.2 Composition of E-waste

E-waste is composed of various materials, including bulk materials, and hazardous, and valuable substances. In general, almost 80% of the weight of electrical and electronic equipment is made of glass, iron, aluminum, and plastic (Deathe et al., 2008). Some of the substances that are used in the electrical and electronic equipment are non-hazardous in nature; however, they become hazardous after they end up in a toxic compound when used in manufacturing of electrical and electronic equipment (UNEP, 2007; Robinson, 2009). Valuable substances and hazardous materials, compared to bulk materials, account for a smaller amount in the composition of e-waste (UNEP, 2007).

The mixed composition of glass, plastics, and other materials components makes dismantling and recycling of e-waste complicated and costly (Van de Merwe, 2009). The majority of plastics used in the composition of electrical and electronic equipment are coated or mixed with different flame-retardant chemicals (Nakajima and Vanderburg, 2005). Similar to plastics, glass components are coated with colours or mixed with corrosion resistance materials. The addition of different materials to these components makes recycling and management of e-waste harder by causing different problems such as separation difficulties (Van de Merwe, 2009). The mixed composition of e-waste not only makes its management a challenging task, but also specific materials found in the composition of e-waste can cause negative health impacts (Van de Merwe, 2009; Robinson, 2009). Hazardous substances used in e-waste are known to cause cancer, respiratory and reproductive complications (Grossman, 2006; Schmidt, 2002).

They pose risks of irreversible effects on human health, including chronic damage to the brain, damage to the central and peripheral nervous system, endocrine system, digestive system, and lymphatic system as shown in Table 3.2. If e-waste is not disassembled and handled in a safe way, it can cause serious health risks such as cancer for the workers of recycling facilities, and also pollute the environment (Grossman, 2006; Schmidt, 2002; Brenniman and Hallenbeck, 2002; Robinson, 2009).

3.3 E-Waste Management Strategies

There are various strategies that can be employed to manage e-waste. These strategies can be combined through integrated e-waste management to provide maximum effectiveness (Goosey, 2009). These strategies include reuse, service or refurbish, remanufacturing, recycling, and final disposal (Goosey, 2009; Envirostris, 2000). Reuse means trade of the electrical and electronic equipment or its components in the way that they were originally designed (Jofre and Morioka, 2005). Service or refurbish means repair or maintenance, which leads to the extension of functional lifespan of the electrical and electronic equipment (Jofre and Morioka, 2005). Reuse and refurbishing provide many environmental and social advantages such as saving materials and energy by decreasing the use of raw materials in order to manufacture electrical and electronic equipment, which can lead to less required packaging; less waste production; and more importantly, diversion of e-waste from the solid waste stream (EPA, 211; Jofre and Morioka, 2005). Reuse also enables low-income individuals to have access to electrical and electronic equipment at cheaper costs (EPA, 2011; Goosey, 2009). Remanufacturing is an e-waste management strategy and consists of removing some parts of e-waste in order to utilize them in the manufacturing of new electrical and electronic equipment (Goosey, 2009). Recycling (with or without disassembly) includes substituting virgin materials by recycled components and includes recovery of raw materials, and reprocessing (Bilitewski et al., 1997; Jofre and Morioka, 2005). Recovery of raw materials is considered an important concept in application of e-waste management strategies due to the fact that it leads to conservation of valuable resources (Goosey, 2009). One of the key elements in implementing successful recycling management is to keep e-waste clean and uncontaminated, which will facilitate and enhance disassembly, and recovery processes (Goosey, 2009).

Table 3.2 Some of the hazardous materials found within e-waste (Van de Merwe, 2009)

Material	Location	Health impacts	Source
Aluminum	CRT, used in printed wiring board as conductors and connectors	Skin rash, skeletal and respiratory problems, associated with Alzheimer's disease	Grossman (2006) Schmidt (2002)
Arsenic	Printed wiring board	Allergic reactions, vomiting, abnormal heart rhythm, increase risk of cancer	Schmidt (2002)
Beryllium	Used in circuit boards as conductors and connectors	Long disease, allergic reactions, increase risk of cancer	Grossman (2006) Five Winds International (2001) Schmidt (2002)
Brominated flame retardants: PBB and PBDE	Plastics, printed circuit boards, components, cables	Increase risk of cancer in the digestive and lymph systems	Brenniman and Hallenbeck (2002) Five Winds International (2001)
Cadmium	Plastics	Affects the kidneys	Babu et al. (2007) Brenniman and Hallenbeck (2002) Five Winds International (2001)
Chromium IV	Decorative, housing of the computer	Strong allergic reactions , ulcer, liver and kidney damage, DNA damage, increase risk of cancer	Babu, et al. (2007) Brenniman and Hallenbeck (2002) Schmidt (2002)
Gallium	Semiconductors, printed wiring board	Increase risk of cancer	Schmidt (2002)
Halogenated substances: PVC and PCB	Plastics used in cabling and computer housing	Increase risk of cancer	Brenniman and Hallenbeck (2002) Five Winds International (2001)

Mercury	Printed circuit boards, batteries, CRT, printed wiring	Chronic brain, kidney, lung and fetal damage, allergic reaction, increase risk of cancer,	Babu et al. (2007) Brenniman and Hallenbeck (2002) Five Winds International (2001) Grossman (2006) Schmidt (2002)
Nickel	Printed wiring board, CRT	Reparatory problems, increase risk of cancer	Grossman (2006) Schmidt (2002)
Silica	glass, CRT, printed wiring board	Reparatory problems, increase risk of cancer	Grossman (2006) Schmidt (2002)
Vanadium	CRT	Lung and throat irritations	Schmidt (2002)

Final disposal includes landfill disposal or incineration. Landfill disposal has been the easiest and most common way in dealing with e-waste; however, it is not considered a proper approach (Goosey, 2009). Through landfilling the valuable substances are not conserved (Van de Merwe, 2009). In utilizing incineration, e-waste is collected and burned. Some incineration facilities have the capabilities of energy recovery by capturing the heat created from burning plastic parts and turning it into energy. However, incineration increases the risk of toxins and hazardous materials into the air (Van de Merwe, 2009). Burning e-waste not only releases toxins such as polybrominated diphenyl ethers (PBDEs), a type of flame retardant used in the composition of electronics, into the air, which can result in bioaccumulation and endangering the health of human and other species; it results in residual deposits such as slag, and fly ash that end up in landfills (Van de Merwe, 2009; Robinson, 2009). Even the best landfills are not perfect and leaching is a major concern (Van de Merwe, 2009). Residual deposits contain concentrations of metals that can leach into soil and water, and result in the contamination of the environment (Brenniman and Hallenbeck, 2002; Five Winds International, 2001).

Overall, all e-waste management strategies have their own benefits and limitations. The associated costs, convenience, design of the product, material composition, available resources, available technology and equipment, and environmental and social conscientiousness are some of the factors that can impact the selection of e-waste management strategies (Jofre and Morioka, 2005). Different employed e-waste management strategies provide a solution to the e-

waste problem; however the e-waste issue needs to be targeted from the source (Van de Merwe, 2009).

In order to prevent negative impacts of e-waste, and provide effective management strategies, different regulatory frameworks and programs have been implemented by focusing on EPR that holds producers/manufacturers responsible for their products.

3.4 E-waste Management Programs

Upon the introduction of EPR as a principle for waste management at the Waste Minimization Workshop held in Washington D.C, there have been international efforts to promote legislations to combat the e-waste problem around the globe (Environment Canada, 2006; Herat, 2009). The scope of implemented programs regarding e-waste management around the globe varies, while their overall objective is to reduce or eliminate negative impacts associated with improper disposal of e-waste such as environmental and human health impacts (UNEP, 2007; Savage, 2006; Babu et al., 2007). The current e-waste management programs in EU, Switzerland, Canada, and Ontario are discussed further.

3.4.1 European Union (EU)

The EU has the most advanced legislative and operational bases for e-waste management programs (Savage, 2006). These legislative and operational bases not only cover e-waste management programs that are implemented by EU members and imports and exports within EU jurisdictions, they also impact international trade (Goosey, 2009; Heart, 2009).

3.4.1.1 The WEEE Directive

The WEEE Directive 2002/96/EC was enacted in EU in order to deal with e-waste and provide harmonized solutions for responsible and sustainable management of e-waste (EUR-Lex, 2003a; Goosey, 2009). The Directive is based on the precautionary principle, the prevention is better than cure and the EPR principle. The goal of the WEEE Directive is to reduce the amount of e-waste that ends up in the solid waste stream by increasing e-waste management strategies such as recycling, and improve the environmental performances of all stakeholders that are involved in the life cycle of electrical and electronic equipment such as the electronics industry and consumers, and promote the design for the environment (Nakajima and Vanderburg, 2005).

The WEEE Directive was passed in February 2003 by the European Parliament and the Council of the EU. All EU members were required to have a take-back program in operation by August of 2004, and meet the collection and management target of 4 kg/capita/year for e-waste by December 2006 (Savage, 2006; Nakajima and Vanderburg, 2005; Herat, 2009).

Based on the WEEE Directive, all stakeholders have specific obligations. For instance, national governments of EU member states are required to create and keep a list of producers, submit a report to EU on implementation of the directive every three years, and set penalties for non-compliance. Consumers have to be able to return their e-waste free of charge through designated locations (Nakajima and Vanderburg, 2005). Manufacturers and producers are responsible for providing a take-back program, and financing the collection from collection facilities, management, recovery, and disposal of e-waste. Manufacturers and producers are also obligated to provide reports of the quantities and categories of electrical and electronic equipment in the market, collection rate, reuse rate, and recycling rate. The aim of the WEEE Directive by putting more responsibility on the industry is to encourage manufacturers/producers to design environmentally sound products (Envirosris, 2000; Kibert, 2004; Van de Merwe, 2009).

Overall the WEEE Directive provides general guidelines regarding producer responsibility, waste management standards, product labelling, and targets for collection and management of e-waste. However, each country decides on the type of programs to be implemented to achieve the required objectives (EUR-Lex, 2003a; Savage, 2006; Van de Merwe, 2009; Jofre and Morioka, 2005).

3.4.1.2 The RoHS Directive

Financial consequences are not the only drivers that motivate manufacturers to design environmentally friendly products. Complimentary to the WEEE Directive, Directive 2002/95/EC, commonly referred to as RoHS, requires “the restriction of the use of certain hazardous substances in electrical and electronic equipment” (EUR-Lex, 2003b). The RoHS Directive restricts producers in using six hazardous materials in EEE, i.e. lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyls, and certain polybrominated diphenyl ethers (EUR-Lex, 2003b; Goosey, 2009). This can facilitate recycling by reducing the need for special handling and management (Nakajima and Vanderburg, 2005).

3.4.1.3 Other EU Directives

The Energy Using Products Directive (EuP) (2005/32/EC) is another EU Directive that considers proper management of e-waste by focusing on the design of the products. The eco-design part of EuP requires all manufacturers who sell their products in European Community to conduct conformity assessment of their products in accordance with the DfE guidelines (Jofre and Morioka, 2005). EuP requires a life cycle assessment of each product and consider all material, energy and resources that are used followed by measuring emissions into the air, water; and pollutants that are generated in every stage of the life cycle of each product. It further requires manufacturers to consider environmental impacts of electrical and electronic equipment throughout its life cycle, come up with ways to enhance their environmental performances and move toward “sustainable product development” (Goosey, 2009). The implementation of an “internal design control” became mandatory at the end of 2006 and manufacturers, who comply, receive “EC label” of product certification conformity (Jofre and Morioka, 2005).

All EU Directives force change by promoting product responsibility and DfE, which not only impacts products within the EU, but also any products that are sold in the European market. The RoHS Directive takes a preventive approach by restricting the usage of hazardous materials, while the WEEE Directive prevents problems associated with e-waste by promoting proper e-waste management programs (Van de Merwe, 2009).

3.4.2 Switzerland

In 1991, the first e-waste recycling system was established in Switzerland. The focus of this system was to collect and recycle discarded refrigerators (Bandyopadhyay, 2010). Within a few years other discarded electronics joined the recycling system (CSR et al., 2005). In December 1, 1993, SWICO was established as an industry-led, voluntary system to provide e-waste management for IT and office electronics. In July 1, 1998 the ORDEE (Ordinance on the Return, the Taking Back and the Disposal of Electrical and Electronic Equipment) came into force in Switzerland (SWICO, 2011). In 2005, upon an amendment to ORDEE, consumers were able to return their e-waste to the point of sale or other collection plants for proper recycling free of charge (Swiss E-Waste Competence, n.d.; SWICO, 2011). Retailers are mandated to take back e-waste in the categories they have on sale free of charge, regardless of whether they were the original seller or whether the consumer is purchasing similar product (SWICO, 2011). Producers, manufacturers, and importers are also obligated to have a take-back program. The

ORDEE also prohibits consumers (households/firms) from disposing of their e-waste in the municipal waste stream and holds them legally obliged to return their e-waste to accredited places for proper end of life management (Swiss E-waste Competence, n.d.). Recycling plants are required to obtain approval from SWICO (Swiss E-waste Competence, n.d.; SWICO, 2011). In order to export recycled products an approval from Swiss Federal Government is mandatory (Future Energy Solution, 2003; SWICO, 2011).

Switzerland is not one of the EU member states. However, e-waste management programs in Switzerland operate in a manner that is compatible with the EU Directives. E-waste management programs were in operation in Switzerland prior to implementation of the EU Directives, therefore they could be naturally influential in shaping the Directives (Herat, 2009). The EU's WEEE Directive requires free take-back for e-waste, coming from private households, but ORDEE does not distinguish between e-waste from private users or firms. Another difference between the WEEE Directive and ORDEE is that Switzerland uses the advanced recycling fee (ARF) for all existing e-waste, whereas based on the WEEE Directive manufacturers are responsible for financing e-waste that was in the market after the Directive implemented. In Switzerland e-waste is collected regardless of brand and time of purchase, which eliminates excess costs for sorting and collection that can be imposed by the WEEE Directive on local collective authorities (Future Energy Solutions, 2003; Hirschier et al., 2005).

E-waste management programs may vary in different European countries; however, they first promote prevention, and second the reduction of e-waste by reuse, recovery and recycling activities (Nakajima and Vanderburg, 2005; Herat, 2009). Furthermore, producers are required to have a take-back program in order to ensure the proper disposal of e-waste (Envirostris, 2000; European Parliament, 2003; Nakajima and Vanderburg, 2005; Herat, 2009).

Due to the fact that Swiss e-waste management program is the selected case study for this thesis, a detailed description of the program will be discussed in the next chapter.

3.4.3 Canada

In Canada voluntary approaches have been employed toward managing e-waste, and e-waste management is at the infancy stage in comparison to European countries (Whitney and Webb, 2008). The government of Canada consists of three levels, which includes the federal, provincial, and municipal government. Each level of government has a jurisdictional responsibility (McKerlie et al., 2006). The provincial government has jurisdiction over waste

and waste management, and the creation and regulation of municipalities (McKerlie et al., 2006). Hence, there are no specific federal regulations in place regarding waste management, and programs have been enacted at the provincial and municipal levels (Van de Merwe, 2009).

In Canada, the federal government's involvement in the e-waste issue is via the Canadian Council of Ministers of the Environment (CCME) (Nakajima and Vanderburg, 2005). The CCME has set principles intended to guide provinces in developing harmonized e-waste management programs (Nakajima and Vanderburg, 2005). The principles are only principles and do not act as an official federal regulation (Nakajima and Vanderburg, 2005). The province sets legislative requirements and municipalities must fund and manage waste management programs (Whitney and Webb, 2008). Due to the fact that there are no national standards in place in Canada, and because municipalities are responsible for financing all waste programs within their region, each municipality decides on how to handle e-waste (Whitney and Webb, 2008; Van de Merwe, 2009).

Alberta was the first province in Canada that implemented its own e-waste management program (Nakajima and Vanderburg, 2005). Saskatchewan was the first province in Canada that launched an industry-led stewardship program regarding e-waste management (Herat, 2009). British Columbia started official e-waste management programs in 2007 (Herat, 2009). In 2004, Ontario's Ministry of the Environment passed Regulation 393/04 to develop a voluntary provincial e-waste program (Jofre and Morioka, 2005; Whitney and Webb, 2008).

3.4.3.1 Ontario

The Waste Diversion Act (WDA) of 2002 provides a regulatory framework under which Waste Diversion Ontario (WDO), a permanent non-government corporation, operates (Ontario Ministry of the Environment, 2010). Under the WDA, the Minister of the Environment designates materials for which waste diversion programs need to be implemented (Ontario Ministry of the Environment, 2010). In Ontario, WDO develops, implements, and operates waste diversion programs for designated materials. WDO sets industry fees to be charged, estimated costs for the program, sets targets and implementation details, and monitors the effectiveness of the programs (Ontario Ministry of the Environment, 2010). For each waste diversion program, WDO creates a sustainable funding method based on fees paid by Industry Funding Organizations (IFOs) (Ontario Ministry of the Environment, 2010). In December 2004, e-waste was designated by the Minister of the Environment as a stream of waste that requires

proper management followed by Regulation 393/04 to sets out in detail the types of electrical and electronic devices that are designated for diversion (Whitney and Webb, 2008). In June 2007, the final program request was sent out to WDO to establish an IFO for e-waste management (Whitney and Webb, 2008).

In order to develop and implement waste diversion programs, the Ontario Electronic Stewardship (OES), a “producers’ umbrella organization”, was incorporated in September 2007, and approved by WDO in October of the same year to act as an IFO for e-waste management (OES, 2009). OES is a non-profit organization that is governed by a volunteer Board of Directors that consists of brand owners, first importers, franchisors, and assemblers (Whitney and Webb, 2008). Companies that sell or distribute electrical and electronic equipment in Ontario market via brand ownership, also known as Stewards, have to register with OES, report the type and quantity of electronics supplied into Ontario on monthly basis and pay a monthly unit fee to OES (Fishlock and Chaison, 2009). Recycling plants in Ontario have to be approved by OES (CSR et al., 2005).

Due to the fact that the e-waste management program implemented in Ontario is the focus of this thesis, a detailed description of the program will be discussed in the next chapter.

The need for development of e-waste management programs is well accepted and appreciated in different jurisdictions including Switzerland and Ontario. However, the effectiveness of the implemented programs in targeting the e-waste problem is not the same. For the purpose of this thesis and in order to conduct a systematic evaluation of the implemented e-waste management programs in Switzerland and Ontario, a sense of what an ideal or normative e-waste program would be, is established. The next section discusses the requirements for an ideal or normative e-waste management system.

3.5 Criteria for a Normative E-Waste Management Program

Various e-waste management programs have been implemented in different jurisdictions. Recognizing both the benefits and limitations associated with each program makes it possible to develop specific criteria for a normative e-waste management program, and establish a sense of an ideal program that can be used as a systematic basis for a comparative analysis of current implemented programs in Switzerland and Ontario. Incorporating the information found in the literature review of e-waste management strategies, the regulatory frameworks and implemented

management programs in different jurisdictions, and steps involved in LFA as an evaluation framework allows developing of a set of criteria for a normative e-waste management program.

For the development of a set of criteria all the information extracted from of e-waste management strategies, the regulatory frameworks and implemented management programs in different jurisdictions, and steps involved in utilizing LFA in program evaluation are compiled. The themes identified for each criterion are employed as a theoretical tool for evaluation and decision-making. This set of criteria is utilized in the next chapter as a basis for evaluation of e-waste management programs in Ontario and Switzerland and include:

- E-waste issues: To come up with an e-waste management program that provides a solution to e-waste problem, problems and issues associated with e-waste have to be clearly identified and defined (IWMB, 2004).
- Objectives: Objectives of the program have to be established based on problems' definitions and identifications, before implementation of the activity plan (IWMB, 2004). Objectives have to be set clearly due to the fact the solutions to the problem and the activity plan are developed based on required objectives, and program effectiveness can be examined based on the program's success in the achievement of objectives (SIDA, 2002).
- Stakeholders' participation plays a major role in success or failure of an e-waste management program. To be successful, an e-waste management program has to consider all aspects that facilitate and encourage stakeholders' participation. These factors include (IWMB, 2004; UNEP, 2007; Van de Merwe, 2009; Golder and Gawler, 2005):
 - Stakeholders awareness: Providing information about risks associated with improper disposal of e-waste and available safe disposal options, and the importance of designing environmentally safe products to all stakeholders.
 - Stakeholders' responsibility: Increasing awareness among all stakeholders and emphasizing on the importance of their participation, and their role individually and working collaboratively with another in the success of an e-waste management program.

- Stakeholders' engagement: Facilitating consumers' participation by making collection points easily available and accessible, removing costs, and holding stakeholders responsible.
- Regulatory framework: Stringent e-waste management regulations that require compliance and mandate the participation of all stakeholders have to be implemented (Whitney and Webb, 2008; UNEP, 2007).
- The implemented plan of activities: The implemented plan of activities has to focus on the focal problem. Solving the focal problem, and the root causes of that have to be the major objectives of the plan of activities. Effective activities to achieve objectives have to be implemented based on problem and objective analysis (IWMB, 2004).
- Product scope: An effective plan of activities in an e-waste management program provides management strategies for a wide range of e-waste (Van de Merwe, 2009; OES, 2008).
- Standards and volume of collected e-waste: Adopting collection and recycling standards to provide consistency and effectiveness with the e-waste management plays an important role in effectiveness of an e-waste management program. These standards include the availability and accessibility of collection points, the volume of collected e-waste, and collection and recycling targets. A normative e-waste management program collects a high volume of e-waste through a variety of collection points. Collection and recycling targets have to be made based on the calculation of the quantity of available e-waste. Ideally all available e-waste has to be collected and managed (Future Energy Solutions, 2003; UNEP, 2007; SWICO, 2010).
- System financing: Financing the program sufficiently is an important factor when implementing an e-waste management program (Widmer et al., 2005). A normative program supports economic efficiency and sustainability of e-waste management programs by designing the products for the environment and setting additional funding through advanced recycling fees (Widmer et al., 2005).
- Performance measurement: A successful e-waste management program has to pass the performance test. A performance test can be done by examining a program against the achievement of its objectives, and in comparison with another program (Swiss E-waste Competence, n.d.; Hischier et al., 2005).

The above criteria for a normative e-waste management program are used in the next chapter as a basis to evaluate the Swiss and Ontario's programs with the aim of learning valuable lessons that may be used to improve the current e-waste management program in Ontario.

Chapter 4: Applying LFA in the Evaluation of E-Waste Management Programs in Switzerland and Ontario

4.1 Introduction

This chapter focuses on utilizing LFA as an evaluation framework, and applying its steps in order to conduct an evaluation of e-waste management programs that are currently implemented in Switzerland and Ontario with the aim of drawing valuable lessons from Swiss program that can be utilized to improve the Ontario's. In order to do so, each step of LFA is utilized to provide an evaluation regarding the Swiss program, followed by an evaluation of Ontario's program with regards to a similar aspect, a comprehensive analysis of the two programs by considering the criteria of a normative e-waste management program, and lesson-drawing from the Swiss program. The lesson-drawing approach is not utilized for the first three steps of LFA since they are simply introductory steps to the evaluation of the programs.

4.2 Step1: Context Analysis

The first step of applying LFA in program evaluation begins with an overview of contextual characteristics common to both jurisdictions, as well as their differences (Brocklehurst et al., 2000). An analysis of the contextual aspects within the two jurisdictions provides an idea about the contextual barriers, as well as facilitators that can impact the development or success of an implemented e-waste management program (Brocklehurst et al., 2000). Contextual characteristics of Switzerland and Ontario are discussed further.

4.2.1 Switzerland

Switzerland is a small country situated in the center of Western Europe with the total area of 41,290 km², land area of 39,770 km² and water area of 1,520 km² (Meier, 2010). It has a parliamentary system of government. The total population of Switzerland in 2010 was reported at 7,825,243 million people (World Bank, 2011). The annual population growth rate is estimated at 0.22% and population density (number of people per km²) reported at 185 in 2010 (Meier, 2010). Data show a decrease in the population growth rate from 2000 to 2010 (World Bank, 2011). Switzerland has a rather steady economy with a low unemployment rate, highly skilled labour force and a gross domestic product (GDP) or purchasing power equity of US \$39,924 per

capita in 2011 that is among the highest in the world (Human Development Report, 2011). In terms of environmental protection activities, Switzerland is placed among advanced countries in the world (Esty et al., 2008). The EPI has ranked Switzerland with the score of 89.1, second in the world on its 2010 ranking list, which indicates the country's commitment in making environmentally sound decisions (Esty et al., 2010).

In spite of high ownership of electrical and electronic devices, the market is still open for more novel and efficient electronic devices (World Bank, 2004). Switzerland's waste management regulations encourage the reduction, and recycling of e-waste (Khatriwal et al., 2005). In 1990, individual strategies were developed by some manufacturers and distributors in Switzerland to manage e-waste in the country (Khatriwal et al., 2005). The recycling program for refrigerators was introduced in 1991, followed by a recycling program for IT and office equipment in 1994 (Khatriwal et al., 2005). Switzerland developed legislation on e-waste management in 1998 (Bandyopadhyay, 2010). The Swiss Association for the Information, Communication and Organisational Technologies (SWICO), the Swiss Foundation for Waste Management (S.EN.S), the Swiss Lighting Recycling Foundation (SLRS), and the Lobby for Battery Disposal (INOBAT) are the industry-led organizations that manage e-waste in Switzerland (Swiss E-Waste Competence, n.d.).

4.2.2 Ontario

Ontario is one of the provinces of Canada with a parliamentary government system (Ontario Ministry of Finance, 2010). Ontario occupies the total area of 1,076,395 km² including 917,741 km² of land, and 158,654 km² of freshwater (Ontario Ministry of Finance, 2010). Ontario's population in 2010 was reported at 13,210,667 with the annual growth rate of 1.2% between 2000 and 2010 (Ontario Ministry of Finance, 2010). Ontario's GDP per capita reported at US \$37,803 in 2011 (Human Development Report, 2011). The population density of Ontario reported at 11 per km² (Ontario Ministry of Finance, 2010). The environmental performance index (EPI) has ranked Canada, with the score of 66.4: 64th in the world on its 2010 ranking list (Esty et al, 2010). Ontario's regulatory framework regarding e-waste goes back to 2004, when e-waste was designated by the Ministry of the Environment as a stream of waste that required diversion from landfill (CSR et al., 2005). The Ontario Electronic Recycling (OES) was incorporated in September 2007, and approved by Waste Diversion Ontario (WDO) in October of the same year to act as an Industry Funding Organization (IFO) for implementation of e-waste

management programs in Ontario (OES, 2008). OES is a non-profit organization that is made of major retail, IT and consumer electronics companies in Ontario (OES, 2008).

4.2.3 Comparative Analysis, Context

The background features of the two jurisdictions can affect the performance of the e-waste management programs in different ways. An analysis of the contextual characteristics of Switzerland and Ontario reveals that the two jurisdictions are comparable in many aspects, while they are different in others. These aspects are illustrated in Table 4.1, and are discussed further.

Table 4.1 Context Analysis of Switzerland and Ontario

Contextual aspects	Switzerland	Ontario
Total area	41,290 km ²	1,076,395 km ²
Total population	7,825, 243	13,210,667
Population growth rate	0.22%	1.2%
GDP per capita in 2011	US \$39,924	US \$37,803
EPI (score) in 2010	89.1	66.4 (Canada)
EPI (rank) in 2010	2	46 (Canada)
System of government	Parliamentary	Parliamentary
E-waste management	Year in operation: 1990	Year in operation: 2007

Land area and geography: Shorter distances can impact logistics and transportation costs dramatically (Savage, 2006). An e-waste management program in Switzerland would deal with smaller distances, shorter transportations, and therefore, less logistic costs, which could have a positive impact on the overall costs associated with the operation of the program (Future Energy Solutions, 2003).

Population size and growth rate: A larger population size and higher growth rate could result in higher volume of generated e-waste in the jurisdictions (Future Energy Solutions, 2003). The amount of IT, telecommunication, and office devices alone, which were available for

collection in Ontario in 2011, was estimated at 137,140 tonnes, as opposed to 56,000 in Switzerland (SWICO, 2011; OES, 2009).

Gross domestic product (GDP): GDP measures wealth or purchasing power within a country. There is an exponential relationship between wealth and the quantity of electrical and electronic usage, hence generation of e-waste (Robinson, 2009). For any given jurisdiction, the total number of generated e-waste is strongly correlated with the jurisdiction's GDP, because electrical and electronic equipment is essential for the functioning of economies (Robinson, 2009). Canada and Switzerland possess a similar GDP per capita, which highlights the countries' economic prosperity, possession of high volume of electrical and electronic equipment, and high volume of generated e-waste as a result.

Environmental performance index (EPI): A comparison between the two jurisdictions with regards to EPI shows significant gap. Switzerland is ranked second in the world, as opposed to Canada that is ranked 46th. Switzerland have a better track record in taking initiatives toward environmentally friendly activities, including the implementation of e-waste management programs, that result in reducing stress to the environmental and human health (Esty et al., 2008).

System of government: Switzerland and Ontario have the same basic system of government, which implies on the ways that different decisions are made in the two jurisdictions (Van de Merwe, 2009). The regulatory frameworks within both jurisdictions encourage the implementation of management programs to target the e-waste issue. However, the scope of these programs, their objectives, participation of stakeholders, and employed activities within each program vary (OES, 2008; SWICO, 2010).

Length of time that e-waste management organizations have been in operation: The longer that an e-waste management system has been in operation, the higher the opportunity to run the system more effectively, to work with the suppliers easier, and to rationalise costs and invest in capacity (Future Energy Solutions, 2003). Every new system has to deal with extra costs associated with publicity, poor initial budgeting, estimation of available volume, and unpredictable capital investment (Future Energy Solutions, 2003). The e-waste management program in Ontario has been in operation for less than five years; therefore, it has to deal with more introductory operational costs (Future Energy Solutions, 2003).

Overall, the context analysis of the two jurisdictions reveals that the regulatory

frameworks in both jurisdictions encourage the implementation of e-waste management programs. The smaller geographical size in Switzerland may positively affect the overall costs of an e-waste management program due to lower transportation costs. Switzerland has also been ranked high in terms of making environmentally sound decisions and the history of e-waste management activities in the country goes back to 1990. Ontario has higher population size and growth rate, and high purchasing power, which can result in high generation of e-waste. There are challenges that Ontario has to overcome as a fairly new system.

Contextual backgrounds within the two jurisdictions impact the success of an implemented e-waste management program positively or negatively. However, the lesson-drawing approach is not utilized at the context analysis step due to the fact that the contextual backgrounds are specific to each jurisdiction and not transferable. Following the context analysis, the second step in applying LFA is problem analysis regarding e-waste within the two jurisdictions.

4.3 Step 2: Problem Analysis

The second step in utilizing LFA to conduct a program evaluation is problem analysis. One of the criteria for a normative e-waste management program that were introduced in Section 3.5 is the identification of the focal problem. Based on this criterion, in order to develop an effective e-waste management program, and establish an activity plan that would target problems associated with e-waste as effectively as possible, problems have to be identified and defined. A clear and comprehensive problem analysis illustrates causes and effects and their relationship, and provides a sound foundation for development of a focused and sound activity plan, as well as objectives (NORAD, 1999). The focal problem, and its causes and effects can be identified by studying about the e-waste situation in different jurisdictions through a comprehensive review of the literature and available documents (NORAD, 1999).

E-waste has been called the world's fastest growing waste stream (Babu et al., 2007; Bandyopadhyay, 2010; UNEP, 2007; Gorssman, 2006; Osuagwu and Ikerionwu, 2010). The focal problem associated with e-waste is the increasing amount of e-waste that is generated globally (Ahluwalia and Nema, 2007). The expected annual growth rate of generated e-waste is 3-5% in advanced countries (Whitney and Webb, 2008; Hischer et al., 2005). The increasing amount of generated e-waste is a shared issue between the two jurisdictions (Babu et al., 2007; UNEP, 2007; OES, 2008; Bandyopadhyay, 2010; Khatriwal et al., 2005). The generated e-waste

is increasing due to unaccountability toward making environmentally friendly decisions by the electronics industry, consumers, and the government (UNEP, 2007; Whitney and Webb, 2008; Noble, 2008; Robinson, 2009). There are negative effects or the consequences associated with the increasing quantity of generated e-waste such as the socio-economic impacts due to the increased costs of disposal, and environmental and human health impacts due to improper disposal (Babu et al., 2007; UNEP, 2007; Robinson, 2009). For the purpose of this research, the negative environmental and human health impacts due to improper disposal of e-waste are the main focus.

The problem analysis regarding e-waste is conducted in the same way for Switzerland and Ontario due to the fact that the focal problem associated with e-waste in both jurisdictions is the increasing quantity of e-waste (Babu et al., 2007; UNEP, 2007).

The electronics industry plays a role in causing the focal problem by rapid innovation and improvement in technology, and focusing on increasing their profits and sales targets rather than designing durable and compatible electrical and electronic equipment (Babu et al., 2007; Bloch, 2008; Noble, 2008). Continuous economic growth and technological improvement have increased both the consumption of electrical and electronic equipment and the production of e-waste, and decreased the lifespan of electrical and electronic equipment (Babu et al., 2007; Lee et al., 2007; Saphores et al., 2006; UNEP, 2007). Consumers play a role in increasing the amount of e-waste by purchasing newer electrical and electronic equipment even and simply because they are more novel or make a social statement (Cooper, 2004; Noble, 2008). Upon purchasing new electrical and electronic equipment the older equipment get stored, or dumped in the municipal waste stream simply because they are too old to be resold or reused, and consumers are not well informed about the available options for proper management and safe disposal of e-waste (Schmidt, 2002). Government plays a role in increasing the amount of generated e-waste by not enacting stringent e-waste management policies and programs. Government can also impact the focal problem negatively by having a relaxed attitude and not making enough efforts to provide awareness regarding negative impacts of improper disposal of e-waste (Whitney and Webb, 2008).

Upon identification of the focal problem, the direct and substantial causes of the focal problem are placed parallel underneath it, and the substantial and direct effects of the focal problem are placed on the line above it (Jackson, 1997). Causes and effects are further developed by utilizing the same principle to form the problem tree (Jackson, 1997; NORAD,

1999). The problem tree is read from the bottom to the top, sets objectives, and allows the development of relevant and suitable activity plan to target the problems (Jackson, 1997; NORAD, 1999). The problem tree with regards to e-waste issue is constructed for both jurisdictions to allow for visualization of the causal relationships between problems (NORAD, 1999). The e-waste problem tree for the two jurisdictions is illustrated in Figure 4.1

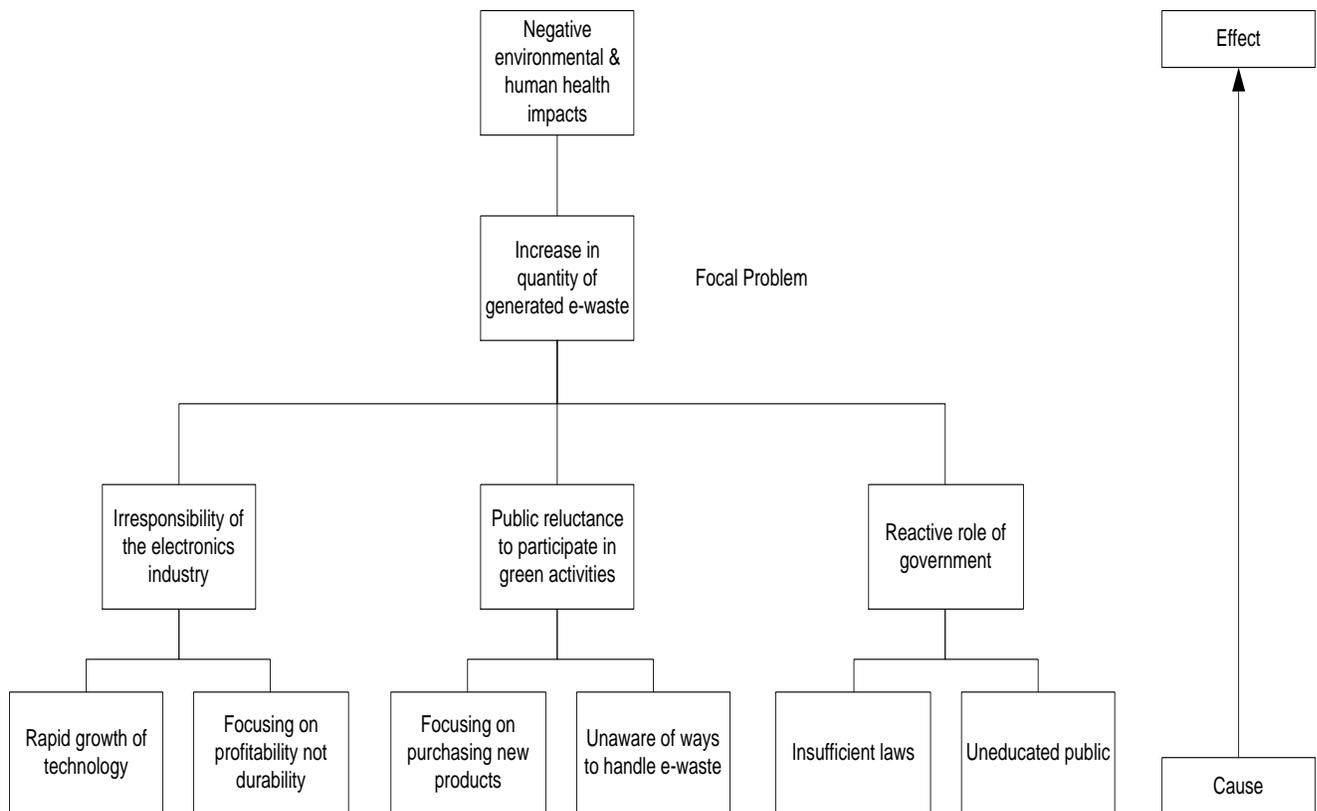


Figure 4.1 E-waste problem tree (modified from Jackson, 1997; NORAD, 1999)

To tackle the focal problem associated with e-waste, and prevent its effect, the causes including unaccountability of the industry, consumers and government have to be targeted first. The electronics industry can participate in controlling the elevating quantity of e-waste by designing products that are more durable, and easier to dismantle for recycling (Noble, 2008; Sjodin, 2006). Consumers need to make educated decisions about every purchase that they make, and the fate of their e-waste (Osugwu and Ikerionwu, 2010). Government can enact policy or programs to hold the industry responsible for their products, and inform consumers

about the impacts associated with improper management of e-waste and holding them accountable about the proper disposal of their e-waste (Noble, 2008; Sjodin, 2006).

The lesson-drawing approach is not utilized at problem analysis step due to the fact that the focal problem associated with e-waste and its causes and effect are the same in Switzerland and Ontario, and there not lessons that be extracted from the implemented e-waste management program in Switzerland at the problem analysis step in order to improve the implemented program in Ontario. However, the solution to the problem and planned activities to tackle the problem could vary considering the differences in the background within the jurisdictions and factors such as available resources, timeframe, and planned activities.

Upon the identification of problems, and the cause and effect relationship between them, objectives will be established. The objectives of the e-waste management programs for the two jurisdictions will be analysed in the next step.

4.4 Step 3: Objectives Analysis

The third step in conducting a program evaluation utilizing LFA is objective analysis. One of the requirements based on the criteria for a normative e-waste management program that were introduced in Section 3.5 is that objectives have to be clearly defined and analysed prior to the establishment of the plan of activities. Upon setting different levels of objectives including overall objective/goal, purpose/outcome, and result/output leads to the selection of proper strategies/interventions/activities to achieve objectives at each level.

In order to conduct objective analysis, the problem tree is transformed into a tree of objectives and analysed (NORAD, 1999). Starting from the top of the tree downward, all problems are restated and made into objectives (Jackson, 1997). The objective tree has the same structure as problem tree, but the negative problem statements are turned into positive objective statements (NORAD, 1999). The objective tree can be described as a positive mirror image of the problem tree (Jackson, 1997; Ortengren, 2004; NORAD, 1999). The objective tree shows the relation between means and ends. The objective tree is read from the bottom to the top, highlights three levels of objectives, and narrows down the activities to achieve each level of objectives within the available timeframe (Ortengren, 2004). The top of the tree is the end, which is desired, and the lower levels are the means to achieve the end (Jackson, 1997). Working from the bottom of the problem tree to the top, the cause and effect relationship turns into the means and end relationship in the objective tree (NORAD, 1999).

The main objective or purpose of the implemented e-waste management programs in Switzerland and Ontario is to tackle the focal problem and reduce the quantity of e-waste (OES, 2008; CSR et al., 2005; Swiss E-Waste Competence, n.d.; Khetriwal et al., 2005; Bandyopadhyay, 2010). The employed activities have to tackle the focal problem, by targeting the causes of the focal problem, and achieve the desirable results in order to meet the overall objective, which is reduction or prevention of the consequences of the focal problem.

Due to the fact that the same problem tree is constructed for Switzerland and Ontario, the objective tree would be the same for both jurisdictions. Therefore, the problem tree that was illustrated regarding e-waste issue in Switzerland and Ontario is transformed into objective tree along the same principle. The objective tree regarding e-waste is shown in Figure 4.2

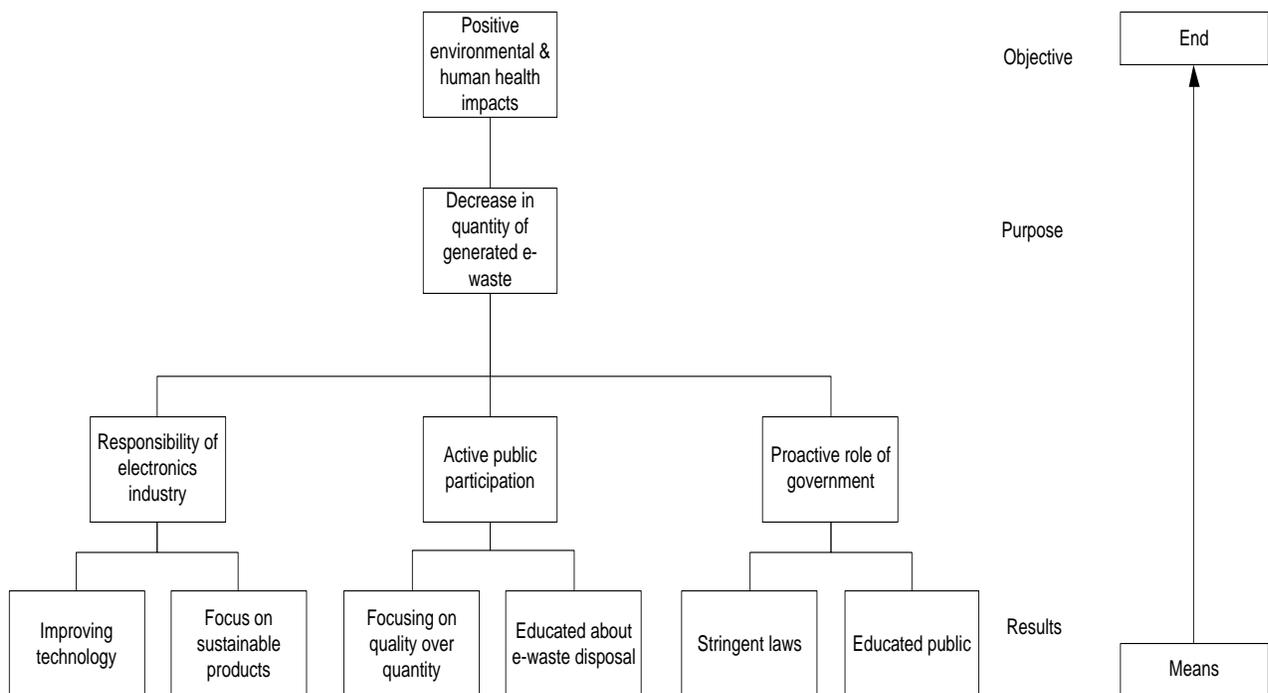


Figure 4.2 E-waste objective tree (modified from Jackson, 1997)

By transforming the problem tree into the objective tree, the objectives of e-waste management program in Switzerland and Ontario can be highlighted as follows.

- Overall objective/goal: to control/eliminate/reduce the impacts associated with e-waste (OES, 2008; CSR et al., 2005; Swiss E-Waste Competence, n.d.; Khetriwal et al., 2005);

- Purpose/outcome: to reduce the quantity of e-waste (OES, 2008; CSR et al., 2005; Swiss E-Waste Competence, n.d.; Khetriwal et al., 2005);
- Results/output: to improve environmental actions employed by all stakeholders such as the industry, consumers, and government (OES, 2008; CSR et al., 2005; Swiss E-Waste Competence, n.d.; Khetriwal et al., 2005; Noble, 2008).

To reduce the quantity of e-waste the electronics industry needs to be more responsible with regards to e-waste management by focusing on improving technology in order to produce more durable and sustainable products (Whitney and Webb, 2008; Noble, 2008; OES, 2008; Swiss E-Waste Competence, n.d.). Consumers have to get actively involved in targeting e-waste management problem by making environmentally friendly purchasing decisions and focusing on the quality and durability, and the necessity of the products rather than novelty (Whitney and Webb, 2008; Noble, 2008; OES, 2008; Swiss E-Waste Competence, n.d.). They can also make informed decisions about proper disposal of their e-waste by educating themselves about available e-waste disposal options (Schmidt, 2002). Government needs to have a more proactive role by enacting more stringent environmental policies and programs, and educating consumers about the impacts of improper disposal of e-waste and available options (Whitney and Webb, 2008; Herat, 2009 OES, 2008; Swiss E-Waste Competence, n.d.). Achieving changes in the industry, consumers, and government behaviour and attitude toward e-waste can be valued as means that facilitated the achievement of the end, which is projection of positive impacts.

The lesson-drawing approach does not have an application in this step due to the fact that the objectives of implemented e-waste management programs are defined in the same way in Switzerland and Ontario, and there are not lessons that can be learned from the Swiss program at the objective analysis step to improve the implemented program in Ontario at this step. Upon the identification of objectives, activities are implemented within the two jurisdictions to achieve the objectives.

Prior to the analysis of activities, stakeholders have to be analysed. Due to the fact that stakeholders' participation is important in success or failure of an implemented activities (Ortengren, 2004; Future Energy Solutions, 2003).

4.5 Step 4: Stakeholders Analysis

The next step in utilizing LFA to conduct a program evaluation is the analysis of

stakeholders. According to the criteria for a normative e-waste management program that were introduced in Section 3.5, stakeholders have a major impact on an e-waste management program in terms of its success or failure. All stakeholders play a role that is important from different aspects. A normative e-waste management program relies on stakeholders' engagement in the program activities by increasing their knowledge and awareness, facilitating their participation, and focusing on the importance of their role and holding them accountable to act responsibly and be actively involved. Stakeholders in an e-waste management program include but not limited to government, the electronics industry, and consumers (Swiss E-Waste Competence, n.d.; UNEP, 2007; OES, 2008; CSR et al., 2005; Noble, 2008).

Due to the importance of stakeholders in success or failure of e-waste management programs, stakeholders within the two jurisdictions are discussed further followed by lesson-drawing from e-waste management program in Switzerland to increase stakeholders' participation in the Ontario's program.

4.5.1 Government

Government gets involved in e-waste management programs through the implementation and support of e-waste management policies and programs (Seadon, 2006).

The Swiss government does not get involved directly in daily operation or financing of the e-waste management programs; however, it oversees their operation (Swiss E-Waste Competence, n.d.). The Swiss government consists of three levels including federal, cantonal or territorial, and municipal. At the federal level the government sets guidelines and legal obligations for the industry. It is up to the industry to come up with practical strategies in order to meet those requirements. The Swiss e-waste management policy does not set collection and recycling targets (Swiss E-Waste Competence, n.d.). The Swiss cantonal government's role is limited to issuing and cancelling the operational permit for recyclers, which allows the recyclers to get a contract with industry-led organizations that manage e-waste in Switzerland such as SWICO. At the municipal level there is no legal requirements for government's participation; however, they can get involved voluntarily by setting up collection sites (Swiss E-Waste Competence, n.d.).

In Ontario, the province sets legislative requirements regarding e-waste management, and municipalities are primarily responsible for funding and enacting e-waste management programs (Whitney and Webb, 2008). Therefore, municipalities decide about the type of collection

program to be established such as drop-off, permanent collection depot, and curbside collection, the frequency of collection of e-waste, and the funding system for the program through advanced recycling fee, environmental handling fee, and so forth (Van de Merwe, 2009). Different factors can impact municipalities' decisions for developing an e-waste management program such as convenience, space availability, and budget (Van de Merwe, 2009). OES was incorporated and approved by WDO to act as an IFO for e-waste management with the aim of transferring the cost burden for the management of e-waste from municipalities to Stewards (OES, 2008). OES provides funding for Ontario's e-waste management program by charging Stewards a registration fee for the electrical and electronic equipment that they put into the Ontario's market (OES, 2008).

4.5.2 The Electronics Industry

The electronics industry plays an important role in the success of e-waste management programs (Jofre and Morioka, 2005). Actors involved in the electronics industry can have a control over many factors that can lead to the success or failure of a program (Jofre and Morioka, 2005). The role of each actor within the industry will be explained more regarding each jurisdiction.

In Switzerland, manufacturers and importers are responsible for their products physically and financially (Swiss E-Waste Competence, n.d.). They are in charge of controlling costs of handling and recycling the e-waste. In practice they allocate all their responsibilities to SWICO, S.EN.S, and PROs (Producer Responsibility Organizations), and report their sales numbers and charged recycling fees to PROs. Manufacturers can also set up collection points only for their own e-waste and return them to licensed recyclers (Swiss E-Waste Competence, n.d.). PROs take the operational responsibility by providing proper management in terms of costs, collection, transportation, scope of products that are covered, and the amount of recycling fees. They also liaise with the government and report the compliance of its members (Swiss E-Waste Competence, n.d.). Retailers have the obligation of taking back the e-waste in the same categories that they have on sale, free of charge and regardless of purchasing a new product by the consumers. They can resell the e-waste, repair it or return it to licensed recyclers. Recyclers are licensed by government and PROs, and need to keep quality controls to be able to renew their contracts every two years. Refiners are located outside of Switzerland. Since there are no raw material producers in Switzerland, the recycled materials get shipped to countries such as

Sweden and Germany for final material recovery (Swiss E-Waste Competence, n.d.). Disposers are landfill and incineration facilities that deal with a small fraction of e-waste since e-waste is banned from being disposed in landfills as a whole (EEA, 2010; Swiss E-Waste Competence, n.d.). The disposal has to be done in designated landfills for hazardous materials, which can be very costly, which encourages the recyclers to recover material as much as possible to decrease their costs of final disposal (Swiss E-Waste Competence, n.d.).

In Ontario, Stewards, including manufacturers, producers, brand owners, first importers/assemblers of non-branded products for sale and use in Ontario that result in e-waste have to register with OES, pay a monthly unit fee, and report the type and quantity of electrical and electronic equipment that they supply into Ontario (OES, 2008). OES in return provides them with incentives for managing their e-waste. Producers such as Hewlett-Packard, Dell and Apple have established their own take-back programs due to the high participation costs imposed by OES (Deathe et al., 2008). Retailers' participation in Ontario is voluntarily and sometimes they hold take-back events that allow consumers drop their e-waste free of charge or with a charge (OES, 2008). Recycling plants have to be approved by OES (CSR et al., 2005). Recyclers have to meet environmental and human health and safety requirements by OES to renew their contracts every three years (OES, 2008). Information regarding refiners and disposers in Ontario's e-waste management program as a separate category is not available.

4.5.3 Consumers

Consumers get involved in e-waste management programs at the end of the life cycle of the electrical and electronic equipment. Consumers can actively participate in e-waste management programs in terms of proper disposal of e-waste, but they are not involved in making regulations or design changes or establishing take-back programs (Whitney and Webb, 2008). Consumers' attitudes and recycling behaviour play an important role in the success of any e-waste management operation (Future Energy Solutions, 2003). It is not reasonable for the government to enact e-waste management policies and programs, or for the electronics industry to design durable and compatible products that can be easily dismantled and recycled, if consumers value consumption culture, do not make environmentally friendly decisions, and do not participate in e-waste management programs (Noble, 2008). Factors that can impact consumers' participation in e-waste management programs include but not limited to education, awareness, convenience, and costs (Whitney and Webb, 2008). Each factor is discussed further.

4.5.3.1 Education and Awareness

Education and awareness is an important factor that impacts the participation of all stakeholders. However, in reality the government gets involved in taking e-waste management initiatives due to political reasons, and the industry follows the regulatory frameworks (Noble, 2008; Widmer et al., 2005). The reality behind all barriers in implementation of a successful e-waste management program is the fact that consumers are not aware of socio-economic and environmental implications that are associated with improper disposal of e-waste (Whitney and Webb, 2008). They are not aware of available options in order to make environmentally sound decisions regarding purchases and disposals of electronics (Schmidt, 2002). Therefore, increasing consumers' awareness with regards to environmental issues can positively impact their participation, and success of e-waste management programs.

The Swiss program spends a portion of the total operation costs on marketing and publicity. It also provides information through the SWICO website and media (SWICO, 2010). There is also a hotline to answer inquiries from the public regarding e-waste (Future Energy Solutions, 2003). An environment survey conducted on behalf of the Swiss Agency for the Environment, Forests and Landscapes revealed that 62.6% of respondents believed in that fact that politicians should put more emphasis on environmental issues, and 73% believed an imminent environmental catastrophe will occur unless people change their life style and make more environmentally sound decisions (Carter et al., 2009). Switzerland's track record in taking e-waste management initiatives goes back to 1990, and the existence of individual strategies by certain manufacturers and distributors (Swiss E-Waste Competence, n.d). Therefore, Swiss consumers been exposed to e-waste management thoughts for more than two decades.

In Ontario, there have been many different programs and advertising campaigns to increase public knowledge regarding environmental health issues related to improper disposal of e-waste (OES, 2009; OES, 2011). However, there is no survey or evidence on consumers' awareness in Ontario regarding available e-waste management programs and their participation in these programs (OES, 2011).

4.5.3.2 Convenience and Accessibility of Collection Points

Convenience and accessibility are other major factors that can encourage or discourage consumers to participate in e-waste management programs (Whitney and Webb, 2008). Curbside and retail collection points provide a great amount of convenience by making the drop-

off locations easily accessible for consumers, since consumers can drop off their e-waste right at their door, or at a retail facility. In a survey conducted by Public Opinion Research on Electronics Recycling (2002) approximately 61% of respondents stated that they would prefer to return their e-waste to a retailer for recycling rather than sending it to the manufacturers or transfer stations even if there is no charge (Whitney and Webb, 2008).

Curbside collection and retail drop-off opportunities are available by Swiss e-waste management program. In Ontario there are no curbside collections and retailers can participate in collection activities voluntarily. There are other collection points available such as municipal drop-off locations. Collection points are discussed further in Sections 4.6.2.1, 4.6.2.2, and 4.6.2.3.

4.5.3.3 Cost

E-waste management programs that charge consumers a drop-off fee could cause inconvenience, and could discourage consumers from participating in e-waste management programs (Whitney and Webb, 2008).

In Switzerland, consumers pay a recycling fee at the time of purchase of products that allows them to return their e-waste free of charge. This facilitates and encourages product returns (SWICO, 2010). In Ontario, the recycling fee and whether the consumers are charged or not depends on manufacturers and how they want to compensate for the recycling costs (CSR et al., 2005). This can cause confusion for the consumers and discourage their participation. The system financing and recycling fees are discussed further in section 4.7.

4.5.4 Comparative Analysis and Lesson-Drawing, Stakeholders

The Swiss e-waste management program holds all stakeholders accountable, and requires their participation in e-waste management activities. In Ontario, the role and obligations of stakeholders is not very clear due to voluntary nature of the program and the fact that the program is still fairly new. There are lessons that can be drawn from the Swiss e-waste management program to improve the Ontario's program in terms of stakeholders' participation. The Swiss program has been able to meet the criteria for a normative e-waste management program by defining, the role of stakeholders, and facilitating the engagement of consumers in e-waste management activities. Environmental and e-waste management regulations are more stringent in Switzerland (Whitney and Webb, 2008). Landfill disposal of e-waste is banned in

Switzerland, and the participation of all stakeholders in e-waste management programs is mandatory based on ORDEE (EEA, 2010; Swiss E-Waste Competence, n.d.). The Swiss program facilitated consumers' participation in e-waste management programs by making collection points easily accessible and designating retailers and curbsides as permanent collection points, removing costs of returning e-waste, imposing regulatory requirements, and increasing consumers knowledge and awareness regarding e-waste. In the Swiss program actors in the electronics industry are required to provide a take-back program free of charge and ensure that e-waste is managed properly at the end of its life cycle (Swiss E-Waste Competence, n.d.).

The lessons drawn from Swiss program emphasize Ontario's need for an active role for government and enforcement of regulations that hold stakeholders responsible and accountable, and also facilitate their participation in e-waste management programs by providing convenience and improving their knowledge. The industry could be obligated to provide free take-back programs and be responsible for proper disposal and management of e-waste. Holding the electronics industry responsible for managing e-waste encourages the industry to take initiatives to design the electrical and electronic equipment for the environment since they are the ones that have to manage their e-waste at the end of its life cycle (OES, 2009).

Stakeholders' power, influence and level of participation are important in planning activities. An activity plan that considers the power and influence of stakeholders would encourage their participation, and would be more successful in achieving the objectives of a program.

4.6 Step 5: Analysis of Plan of Activities

The next step in applying LFA to conduct a program evaluation is the evaluation of the plan of activities. Based on criteria for a normative e-waste management program that were introduced in Section 3.5, the plan of activities has to tackle the focal problem, illustrate the desirable results by targeting causes, and address the effects of the focal problem to achieve the overall program objective. Effective activities to achieve objectives have to be implemented based on problem and objective analysis (IWMB, 2004).

To tackle the e-waste problem, a plan of activities has been implemented in Switzerland and Ontario with aim of targeting the increasing the amount of e-waste by tackling the causes, and to prevent the associated negative impacts (Jofre and Morioka, 2005). An analysis of the plan of activities provides an insight about the programs in terms of the scope of e-waste that

they cover, and activities that are developed within the plans to target the problem and achieve the objectives, which may result in drawing lessons that can improve the Ontario's program.

4.6.1 E-Waste Scope

Electrical and electronic equipment include a wide range of products such as consumer electronics, telecommunication, and household appliances (Swiss E-Waste Competence, n.d.). A normative e-waste management program as described in Section 3.5 provides management for a wide range of electrical and electronic devices as well as historical and orphan products (UNEP, 2007; Swiss E-Waste Competence, n.d.).

Historical products are devices that were sold in the past before the implementation of e-waste management programs, and their manufacturers are still in business (Future Energy Solutions, 2003). An example of a historical e-waste would be electrical or electronic equipment that was produced by Sony before the implementation of e-waste management programs. The equipment was produced long time ago; however, the manufacturer or producer is still in business to provide a take-back program. "Orphan" is a term used for an e-waste that was produced before the implementation of take-back programs and its manufacturers or producers are no longer in business (Future Energy Solutions, 2003).

4.6.1.1 E-Waste Scope, Switzerland

Considering consumers' convenience and habits and in order to encourage them to return their e-waste, all e-waste in Switzerland is collected free of charge regardless of its type, brand and when it was sold (including historical and orphan products) (Swiss E-Waste Competence, n.d.). In Switzerland, SWICO is responsible for management of consumer electronics such as personal computers, IT, office and telecommunication equipment (Swiss E-Waste Competence, n.d.). S.EN.S provides e-waste management for household appliances such as refrigerators, electric tools, sports and leisure appliances (Future Energy Solutions, 2003). Disposal of lighting equipment and light bulbs is managed by Swiss Lighting Recycling Foundation (SLRS). Lobby for Battery Disposal (INOBAT) is an organization that provides management for battery disposal in Switzerland (Swiss E-Waste Competence, n.d.).

4.6.1.2 E-Waste Scope, Ontario

The Ontario Regulation 393/04 made under the Waste Diversion Act (2002) required the

management of e-waste, which is conducted in different phases (UNEP, 2007; OES, 2008). In Ontario, two phases of e-waste management program have been implemented (OES, 2008). Phase one of the program was implemented in April 2009 along with Phase two that was implemented in April 2010; and together they cover e-waste associated with IT, office and telecommunication equipment (OES, 2008). It has been estimated that the orphan e-waste in Ontario accounts for at least 10% of IT equipment and peripherals and more for other categories of e-waste (CSR et al., 2005). In Ontario handling orphan and historical e-waste varies based on the take-back programs offered by the industry or municipalities (CSR et al., 2005).

4.6.1.3 Comparative Analysis and Lesson-Drawing, Product Scope

Valuable lessons that can be drawn from the Swiss program to improve the implemented program in Ontario and meet the criteria for a normative e-waste management program include the fact that the Swiss e-waste program provides services to support the management of a wide range of e-waste including orphan and historic electronics. In Ontario, only the e-waste associated with IT, office and telecommunication equipment is covered, and it is estimated that historic and orphan equipment are only a small percentage of available e-waste for management. There are no plans for management of other categories of e-waste. In order to meet the criteria for a normative e-waste management program, Ontario could implement more comprehensive plans to provide management for a wide range of e-waste including all categories of e-waste regardless of type, brand and time of purchase.

4.6.2 Activities

In order to tackle the e-waste problem, the implemented e-waste management programs in the two jurisdictions employ various activities. The set of criteria for a normative e-waste management program as discussed in Section 3.5 includes the volume of collected e-waste, and the standards employed in the management strategies (Future Energy Solutions, 2003). These standards include but not limited to the availability and accessibility of collection points, and collection and recycling targets. Availability and accessibility of collection points have a positive impact on the volume of collected e-waste (Future Energy Solutions, 2003). A normative e-waste management program collects a high volume of e-waste. The targets for collection and recycling in a normative program are set up based on the calculation of the quantity of available e-waste. The available e-waste each year is estimated based on the quantity of electrical and

electronic equipment supplied in the market and the average lifespan of the equipment (SWICO, 2010).

The Swiss and Ontario's e-waste programs have developed a set of activities to facilitate the achievement of program objectives. Structural and operational characteristics of implemented activities within the two jurisdictions based on the criteria for a normative program including the number of collection sites, their availability and accessibility, volume of collected e-waste, the employed standards in designating targets for collection, and recycling in each program, and the programs' success or failure in achieving the objectives are discussed further in the next section.

4.6.2.1 Collection Points, Switzerland

In Switzerland, primary collection points are at the point of sale, directly through producers, and importers (Swiss E-Waste Competence, n.d.). SWICO is responsible for collection, transportation, and management of e-waste from retailers, municipalities, and large users upon agreements (Bandyopadhyay, 2010). Importers and manufacturers are financially responsible to have a take-back program, and guarantee that e-waste will be handled and dealt with properly in accordance with the regulations regarding environmental and human health (Bandyopadhyay, 2010). Traders and retailers are not obligated for financial management of e-waste unless they are the first importers (Bandyopadhyay, 2010). Most of the e-waste gets returned to retail stores (SWICO, 2010). Traders and retailers pay product delivery charges to importers and manufacturers, and in return charge customers the same amount as an advance recycling fee. In fact, traders and retailers do not make any money in this recycling process (Swiss E-Waste Competence, n.d.). SWICO operates many authorized collection points throughout Switzerland that collect all e-waste that is being dropped off by consumers free of charge (SWICO, 2010). There can also be an arrangement to pick up e-waste from consumers' houses (SWICO, 2010). SWICO system does not hold municipalities obligated for establishing an e-waste take-back program; however, it covers all finances if municipalities choose to participate in take-back programs, and if they take back more than five tonnes per annum, they will be considered one of the SWICO designated collection points (Future Energy Solutions, 2003). SWICO has agreements with a hauling firm in order to transfer all e-waste from collection points for the entire Swiss territory (Future Energy Solutions, 2003). However, recyclers can use their own logistic system to provide more efficiency (SWICO, 2011). There

are approximately 600 SWICO collection points and 6000 retailers in Switzerland for collecting e-waste (SWICO, 2011).

4.6.2.2 Collection Points, Ontario

In Ontario e-waste is managed through municipalities, not-for profit organizations, for-profit organizations, and commercial-for-profit organizations (OES, 2008). Producers, first importers, and manufacturers can take back e-waste directly or operate collecting events in partnership with retailers, local community groups, and municipalities (OES, 2008). Retailers are not obligated to have take-back programs; however, OES supports and encourages voluntary retailers' take-backs. Some retailers provide opportunity for consumers to return, or donate their e-waste (OES, 2008). There are mobile events that facilitate the collection of e-waste (OES, 2008). Many municipalities have a permanent location with a fixed infrastructure in an industrial site or a landfill that serves as a drop-off location. In order to maximize the accessibility, some municipalities arrange mobile events to collect e-waste (OES, 2008). They may collect e-waste based on product type, or a mix of e-waste. The funding for municipal collection programs is provided by drop-off fees that are charged to the consumers or through municipal revenues, or a combination of both, where consumers pay drop-off fees for some e-waste and there is no fee for others. OES provides incentives to stewards, collectors, and processors of e-waste for transportation costs of the e-waste across the province (OES, 2008). There are approximately 500 collection points in Ontario (OES, 2008).

4.6.2.3 Comparative Analysis and Lesson-Drawing, Collection Points

According to the criteria for a normative e-waste management program that were introduced in Section 3.5, the availability and accessibility of collection points can impact the success of an e-waste management program positively. The two jurisdictions are compared based on the available and accessible collection points in this section, followed by drawing valuable lessons from the Swiss program.

- Retailers: Consumers in Switzerland can bring back their e-waste to a retail store that sells the same type of device. This service is free to private households, and purchase of a new product or proof of purchase in the past is not required (SWICO, 2010).

- Producers/manufacturers: Upon the purchase of a new appliance, consumers can return their large appliances free of charge to the producers/manufacturers to be put in the e-waste management system (Future Energy Solutions, 2003).
- Municipal and third party centres: Consumers can drop off their e-waste to be recycled free of charge in municipalities that provide a take-back program in Switzerland. Some charges may apply to commercial products (Future Energy Solutions, 2003).
- Curbside collection: E-waste collection from the curbside is available in Switzerland free of charge. Some consumers can arrange pickups, which can be subjected to transport costs (SWICO, 2010).
- Commercial collection: If the weight of available e-waste is more than 250 kg, collection is free of charge and for lesser amounts SWICO drop-off sites are available (SWICO, 2010).

With regards to collection sites in Ontario, there is no cut and dry explanations about permanent collection points. Collectors in Ontario can chose the type and category of product that they are interested in collecting, but they cannot exclude a particular brand of product. The collection sites also have to be accessible by consumers (OES, 2009).

Switzerland occupies a smaller geographical area in comparison to Ontario. Ontario has a large land area, population number, GDP, and generated e-waste. However, the number of available collection sites in Switzerland is greater than the number of collection sites in Ontario. Switzerland provides collection through a variety of sites free of charge; this facilitates drop-offs in accordance with the criteria for a normative e-waste management program. In Ontario, consumers may get charged for recycling fees upon the drop-off of their e-waste depending on the type of available take-back program that is offered by the collection sites, which can be confusing and at the same time discouraging for the consumers to participate in e-waste management programs. The lesson that can be drawn from Swiss program in order to improve Ontario's program and meet the criteria for a normative e-waste management program is to increase the number of collection sites, remove the drop-off fees, and make mandatory requirements for the industry to provide permanent drop-off locations. The industry could also compensate for recycling costs by expansion of their recycling to different type of products to increase profitability, which can also improve the effectiveness of the e-waste management program by expanding the product scope (Jofre and Morioka, 2005). Retailers and curbside are

two important drop-off locations that are not paid so much attention to in the Ontario’s program as opposed the Swiss program. Retailers are widespread with many outlets, and already have logistics and storage in place, which make them viable and economic options for a take-back program (SWCO, 2011). On the other hand, in Ontario, consumers need to have some form of transportation to drop-off their e-waste in the designated drop-off locations. Therefore, a certain part of population is not able to participate in the take-back programs. Curbside collection as provided in the Swiss program provides a great amount of convenience for consumers and facilitates their participation in the program. An important lesson to draw from the Swiss program to improve the Ontario’s with regards to collection points would be to require mandatory take-back programs from the industry, retailers in particular, and to include curbside collection.

4.6.2.4 Comparative Analysis and Lesson-Drawing, Collection Target, Collected Volume

Based on the criteria that discussed in Section 3.5, a normative e-waste management program collects a high volume of e-waste, and designates collection targets (Future Energy Solutions, 2003). The volume of collected e-waste within the two jurisdictions is summarized in Table 4.2.

The Swiss e-waste management program sets out flexible collection and recycling targets (Swiss E-Waste Competence, n.d.). Based on the Swiss program, all available e-waste has to be collected, and managed (SWICO, 2010). However, the program utilizes targets set out by EU Directives as a benchmark (Future Energy Solutions, 2003; Bandyopadhyay, 2010). According to the EU’s WEEE Directive, the minimum annual target for the collected and managed e-waste is 4 kg per capita (Bandyopadhyay, 2010; Nakajima and Vanderburg, 2005).

Table 4.2 Volume of collected e-waste in tonnes through different channels

PRO/IFO	Total collection	Collection	Year	Source
SWICO	56,000 tonnes	7.4 kg/capita	2011	SWICO, 2011
OES	26,872 tonnes	2.62 kg/capita	04/2010- 04/2011	OES, 2011

The total e-waste collected in Switzerland is about double the amount collected in Ontario. In 2011, the volume of e-waste collected by SWICO was calculated at 56,000 tonnes in total, and about 7.4 kg for each citizen (SWICO, 2011).

In order to estimate the amount of expected e-waste for collection in Switzerland, the collected amount in 2010 is compared with the imported quantity in 2002/2003 considering the fact that electrical and electronic equipment has an average lifespan of eight years (SWICO, 2010). In this comparison, the proportion of e-waste collected in 2010 to the amount imported in 2002/2003 is 95%, of which 57% is collected via SWICO collection points (SWICO, 2010). SWICO achieved 85% collection through retail chains (Future Energy Solutions, 2003). The Swiss program not only met the required target by EU, it is looking into increasing the collection and management rate by 5-15% annually (Future Energy Solutions, 2003; SWICO, 2010).

In Ontario, there is no comprehensive reporting mechanism in place to assist OES in quantifying electrical and electronic equipment supplied, or the e-waste generation (OES, 2008). Ontario utilizes the reported data from e-waste programs in other provinces (OES, 2008). Following the discussions with OES, the Alberta Recycling Management Association (ARMA) agreed to provide OES with reported electrical and electronic equipment supply data by material category reported by Stewards for the 36 months that the e-waste program had been in operation (OES, 2008). The data were adjusted up by 20% for Ontario due to a projected higher concentration of commercial business activity in comparison to Alberta (OES, 2009). The lifespan for electrical and electronic equipment was taken from various sources, including previous lifespan studies and the United States Environmental Protection Agency Electronics Study (OES, 2008). The baseline data were calculated in the year 2006, and the available e-waste for collection was estimated based on the baseline data through the year 2011 (OES, 2009). The collection target for Ontario between April 2010 and April 2011 was 3.55 kg per capita of which 2.62 kg per capita was achieved, which is below the set target (OES, 2011). The Ontario e-waste management program was unable to meet its collection target (OES, 2011).

The Swiss program has been able to meet the criteria for a normative e-waste management program as described in Section 3.5 by setting out flexible collection targets based on the available e-waste for collection each year, and collecting a high volume of e-waste. The Ontario's program relies on a number of assumptions such as average lifespan for electrical and electronic equipment, and sales projections from another province to predict the quantity of available e-waste for collection, and sets out fixed collection targets (OES, 2009).

There are lessons that can be drawn from the Swiss program in order to increase the volume of collected e-waste, and improve the Ontario's program in terms of setting out realistic collection targets as required based on the criteria for a normative e-waste management program

in Section 3.5. The Swiss program provides annual e-waste collection targets by considering an average lifespan for all electrical and electronic equipment, which makes the calculation simple and straightforward, and estimates the amount of available e-waste for collection based on the sales report and the lifespan of the electrical and electronic equipment. Ontario's program should rely on the electrical and electronic sales data in Ontario rather than other provinces to be able to calculate the volume of available e-waste for collection realistically. Rather than setting out fixed collection targets, the Ontario's program should set out annual collection targets based on the calculated available e-waste for each year in Ontario.

There are lessons can be learned from the Swiss program to increase the volume of collected e-waste in Ontario. Many factors contribute to the high collection rate in Switzerland including stringent regulations such as ORDEE that requires stakeholders' participation and implementation of a take-back program by the electronics industry, high consumers' awareness and participation, and accessibility and availability of collection sites such as retail stores and curbsides (Swiss E-Waste Competence, n.d; Whitney and Webb, 2008). In order to increase the collection volume in Ontario more stringent regulations should be enacted to mandate the participation of all stakeholders including retailers in the program and mandate the industry to provide take-back programs. A high volume of e-waste is collected through retailers in Switzerland due to the fact that approximately 6000 retailers exist in Switzerland. Increasing awareness among all stakeholders and making collection sites more accessible and available can also result in the increase of volume of collected e-waste.

The next step after the collection is the application of e-waste management strategies, which is discussed further in the next section.

4.6.2.5 Comparative Analysis and Lesson-Drawing, E-Waste Management

One criterion for a normative e-waste management program as introduced in Section 3.5 is the standards employed in the management strategies such as recycling, and consideration of a recycling target (Future Energy Solutions, 2003). One aspect in application of recycling strategy is the extraction or recovery of raw materials (Jofre and Morioka, 2005). The materials that are extracted or recovered through recycling process include metals, glass, and some plastics that are identified to be desirable in the current market (OES, 2008). Recycling rate and the amount of material that can be recovered from e-waste can be affected by the type, age of e-waste, and the applied recycling process such as the use of manual or mechanical processor, smelting (OES,

2008). An important factor to consider when analysing programs with regards to recycling activities is that although there is a generic meaning for recycling, which includes processing e-waste and extraction of raw material with or without disassembly, the interpretation of recycling, and employed recycling standards vary in different jurisdictions.

In Switzerland, recycling is interpreted as separation and elimination of pollutants, recovery of metal and incineration of materials that cannot be recovered. Under Swiss regulations recycling targets are not specified. However, the Swiss program emphasizes that all collected e-waste undergo an e-waste management strategy (Future Energy Solutions, 2003). SWICO has contracts with seven recycling firms based on best price/quality offer to provide proper recycling and management for e-waste for a period of two years. SWICO is obligated to treat the total amount of the collected e-waste (SWICO, 2010).

In Ontario, recycling is interpreted as diversion of materials from landfill for end of life processing such as reuse and refurbishing (OES, 2011). OES has assumed a common level of recycling of 75% of collected e-waste as a baseline data for the year 2006 due to the limited information available (OES, 2008). OES' objective is to measure the percentage recycled each year and to increase the percentage of component material recycling annually for each subsequent year of the Program (OES, 2008). The recycling target for Ontario between April 2010 and April 2011 was 37,294 tonnes, and the recycling result was 28,304 tonnes (OES, 2011).

The Swiss program meets the requirements for a normative e-waste management program and provides valuable lessons that can be utilized in improving the Ontario's program. The Swiss program does not consider a fixed figure as a recycling target; however, the total collected e-waste has to be recycled. To meet the criteria for a normative e-waste management program, Ontario should set out realistic targets annually because of the population growth, changing lifestyles, changing technology, and other factors that impact the amount of generated e-waste. The recycling target should be set out based on the collected e-waste. The Ontario's program does not consider the recovery of valuable materials. Better identification should be provided by the Ontario's program to consider recovery rates as well.

The achieved recycling result depends on collection. OES may try to encourage recycling of e-waste, but there is no outright ban outlawing disposal in landfills as opposed to Switzerland that banned the disposal of e-waste in regular landfills (EEA, 2010). The implemented program in Ontario is relying on a voluntary approach for consumers, and the

electronics industry to consciously make the choice and effort to participate in the e-waste management program as opposed to ORDEE that mandates the participation of all stakeholders.

An implemented e-waste management program not only should be effective in managing e-waste, it should have a secure financing system. The next step in applying LFA in program evaluation is the analysis of plan of resources that make the implementation of a program feasible.

4.7 Step 6: Plan of Resources Analysis

Any e-waste management program requires a financing system to cover the costs associated with the management of e-waste. A normative e-waste management program as discussed in Section 3.5 achieves the program objectives by allocating sufficient budgets and providing financial resources for implementation of program activities by shifting of the environmental costs to producers, and designing additional funding such as ADF to improve the program (Widmer et al., 2005).

In Switzerland the e-waste management program is financed by using an ARF. In Switzerland manufacturers/importers pay the ARF to the SWICO or S.EN.S. based on the electrical and electronic equipment that they put into the market. This ARF is passed down to the distributors and retailers, who in turn invoice the consumers on the purchase of a new appliance (Swiss E-Waste Competence, n.d.). The money that is raised is spent on the management of current e-waste that exist including those that were not covered by ARF at the time of purchase (Swiss E-Waste Competence, n.d.). There is not any allocation for the future, and the electrical and electronic equipment that are being sold at the moment will be financed with the new generation of products sold at that time. At the end of a set period, costs and income will be compared, any surplus goes back to the producers, and the fee system gets adjusted for the future e-waste quantity and management costs (Future Energy Solutions, 2003).

In Ontario, Stewards register with OES, report the type and quantity of e-waste supplied into Ontario on monthly basis and pay a monthly unit fee to OES (OES, 2009). In Ontario, it is the responsibility of Stewards to determine how they can manage this fee, and reflect it in their product costs (OES, 2009). The cost of this fee may be shifted forward by raising the product price charged to the consumer, or beard by Stewards (OES, 2009). The fee is used to cover the cost of management of e-waste (Deathe et al., 2008). Economic incidence and demand and supply play a major role in shifting the costs to consumers or the industry (CSR et al., 2005).

There is a penalty under WDA for the failure to register, report, or pay fees; however, there is no penalty for not meeting the targets.

4.7.1 Comparative Analysis and Lesson-Drawing, Plan of Resources

There are lessons that can be drawn from the Swiss program in order to improve the Ontario's program. In the Swiss e-waste management program the economic efficiency and sustainability of the program is supported by holding manufacturers and producers responsible for the proper management of their e-waste, and by designating funding through ARF. The positive aspect of ARF at the time of purchase is that, it makes it easier to estimate the current cost of recycling rather than estimating future costs (Swiss E-Waste Competence, n.d.). On the other hand, since the Swiss e-waste management program is focusing on consumers' participation by implementation of consumers friendly strategies; it is believed that psychologically, consumers would not mind paying a small recycling fee at the time of purchasing a new product (Swiss E-Waste Competence, n.d.). Similar to Switzerland, Ontario could establish a clear form for system financing, ARF, that clears ambiguity for the consumers and prevents the industry from deciding on how to manage these fees. Also from the environmental point of view charging ARF by the Swiss e-waste management program may modify the behaviour of both consumers and producers (OES, 2009). Consumers may choose to consume less of a more expensive product with higher ADF, and producers may choose ways of producing products that generate lower environmental burdens, and lower fees as a result (OES, 2009). On the other hand, in competitive markets, charging consumers an ARF can encourage producers to make changes in the design of the products to reduce the environmental costs; therefore, lower the charges to the consumers (OES, 2009).

The e-waste programs in Switzerland and Ontario were examined in this chapter in terms of their context, stakeholders, activities, targets, and achievement of targets, and so forth. The final step of LFA or conclusion is discussed in the next section.

4.8 Step 7: Conclusion

The final step in applying LFA is to conclude the program evaluation. Based on the criteria for a normative e-waste management program, a successful e-waste management program has to pass the performance test by being examined against the achievement of its objectives (Swiss E-waste Competence, n.d.; Hirschier et al., 2005).

After conducting a detailed evaluation of e-waste management programs, and their objectives in Switzerland and Ontario, it can be concluded that e-waste management program in Switzerland consists of a system that is simple, consumer-friendly, promotes the design for the environment, and is based on holding the industry responsible. In the Swiss e-waste management program, the roles and responsibilities of all stakeholders are clearly defined. The program is based on a secure financing system through ARF, and by holding producers and manufacturers responsible for their e-waste (Hischier et al., 2005). It covers a wide range of e-waste regardless of type, brand, and time of sale (SWICO, 2010). The Swiss e-waste management program has been able to tackle the increasing amount of e-waste by holding all stakeholders responsible, and setting out collection, and recycling targets that are realistic, flexible and based on the estimation of available e-waste for collection.

Compared to Switzerland, e-waste management programs are not very well developed in Ontario (Nakajima and Vanderburg, 2005). OES has set out targets for collection, and recycling; however, these targets have not been achieved. There is no set e-waste management fee at the point of purchase of electrical and electronic equipment (Deathe et al., 2008). There are not stringent environmental regulations that ban disposal of hazardous waste in the landfills and hold all stakeholders legally responsible for proper disposal of e-waste. The role of stakeholders is not clear and the product scope covered by OES is limited, and not all categories of e-waste are covered.

There are lessons that can be learned from Swiss e-waste management program in order to improve the implemented e-waste management program in Ontario in achievement of its objectives. In a well designed e-waste management program such as the Swiss the program, there are supportive environmental regulations; activities are design to achieve program objectives; and stakeholders are actively involved in every aspect of the program, which can result in the program success and achieving its objectives. In a well established program, government play an active role by enacting more stringent environmental policies and programs. Consumers participation is facilitated through different ways such as increasing their awareness regarding various impacts associated with improper disposal of e-waste and available options for proper disposal. The electronic industry is obligated to provide take-back programs and manage e-waste properly. To be effective, a program should cover as many categories of e-waste as possible, collect a high volume of e-waste, set out reasonable targets through realistic predictions

regarding available e-waste for collection and management, and rely on a secure financing system.

Chapter 5: Conclusion

The industrial revolution followed by the advances in information technology and the fast production of electrical and electrical equipment within the last century has made fundamental changes in people's lifestyle (Ramachandra and Varghese, 2004). The increasing production of electrical and electrical equipment makes the electronics industry one of the fastest growing industries in the global market (UNEP, 2007). The technical prowess acquired during the last century along with the growth and development of the industry results in the generation of electronic waste (e-waste) (Babu et al., 2007; Ramachandra and Varghese, 2004).

E-waste refers to electrical and electronic equipment that is unwanted by their owners (Widmer, et al., 2005). E-waste is dangerous, due to the fact that certain components used in the composition of electrical and electronic equipment contain materials that are hazardous (Ramachandra and Varghese, 2004). There are different effects associated with improper disposal e-waste such socio-economic effects, and negative human and environmental health impacts. If e-waste is not disposed of properly, hazardous substances used in the construction of electrical and electronic equipment can leach into soil, air, and ground water, and may pose a threat to human health and the environment along with other (Ramachandra and Varghese, 2004).

The application of e-waste management strategies allows for e-waste to be handled in an environmentally sound manner so that it is less harmful to the ecosystem (Ramachandra and Varghese, 2004; Goosey, 2009). It also conserves valuable materials such as gold, iron, and copper, which are used in the composition of electrical and electronic equipment (Widmer et al., 2005).

Many jurisdictions have developed regulatory frameworks and programs to combat different issues associated with e-waste such as the increasing quantity of e-waste, various negative impacts associated with its improper disposal, and to conserve valuable materials that exist in e-waste (Babu et al., 2007; UNEP, 2007).

The regulatory frameworks around the world are mainly based on Extended Producer Responsibility (EPR), and focus on forcing the electronics industry to be responsible in providing physical and financial management for e-waste (Horne and Gertsakis, 2006). Various interpretations of EPR in different jurisdictions have lead to the implementation of different e-waste management policies and programs (Jofre and Morioka, 2005). For example, in European

countries, manufacturers and producers are held responsible for their products through the entire life cycle of the products, while in Ontario their responsibility is mainly limited to the end of life cycle of their equipment (McKerlie et al., 2006).

The province of Ontario is one of the jurisdictions that has taken initiatives toward making environmentally friendly decisions through implementation of an e-waste management program. Although the program is fairly new and still in its infancy stage, an analysis of the program at this stage reveals the current status of the program, which can lead to evaluation of the program based on achievements of its objectives, followed by modification or development of activities that can improve the program's performance.

There are different approaches that can be utilized to conduct a program evaluation. A combination of rational, political interaction and institutional phenomenon approach has been selected for the purpose of this study, and to evaluate the implemented e-waste management program in Ontario. The rational approach provides systematic evaluation by providing structure and discipline as provided by the Logical Framework Approach (LFA) (Weimer and Vining, 1999). The political interaction approach examines the interactions between stakeholders, their engagement in the implemented e-waste management program in Ontario, and services offered by the program that facilitate the stakeholders' participation as imbedded in LFA as an evaluation framework (Weimer and Vining, 1999). The institutional phenomenon method is employed to provide an evaluation of the program process in Ontario by conducting an international comparison between Ontario and a similar program in Switzerland with the application of lesson-drawing approach (Weimer and Vining, 1999).

In order to conduct program evaluation, LFA is utilized as an evaluation framework to provide a systematic objective and process evaluation. LFA provides a step by step analysis of the implemented programs in Ontario and Switzerland, and evaluates steps in terms of effectiveness, and achievements of the program objectives according to rational approach, stakeholders' participation, the role of different interest groups, and the level of their engagement in the implemented program as described in political approach, and also provide a comparison between Ontario and Switzerland in accordance with institutional phenomenon approach.

The implemented e-waste management program in Switzerland is selected as a case study, a source of information, and a basis for comparison due to the fact that the Swiss e-waste program is experienced and also shares similarities with the Ontario's program. The study of Swiss e-waste management program reveals that the program possesses the characteristics of a

comprehensive program that is effective in managing e-waste; therefore, it can be used as a reference point that can be used to improve the Ontario's program.

The lesson-drawing, similar to institutional phenomenon approach, is an approach that facilitates the extraction and transfer of useful information from the Swiss program to Ontario's. In order to conduct a systematic evaluation of the two programs, a sense of an ideal or normative e-waste program is established to examine the two programs against its criteria. The criteria for a normative e-waste management program is established through the use of literature review, e-waste management strategies, regulatory frameworks and e-waste management programs implemented in different jurisdictions, and steps required by LFA. These criteria set out the characteristics of a normative system and are utilized in analysis of the Ontario and Swiss e-waste management program.

Overall, the objectives of the Swiss e-waste management program are straightforward and clear. E-waste management program in Switzerland consists of a system that is simple, consumer-friendly, and self-financing (Swiss E-Waste Competence, n.d.). The objectives that are required under ORDEE, the Swiss policy with regards to e-waste management, are achievable, and the implemented e-waste management programs have been successful in targeting the e-waste problems (Envirosris, 2000). The roles and responsibilities of all stakeholders are clearly defined. All stakeholders are obligated to participate in e-waste management programs. Consumers are obligated to return their e-waste for proper disposal (Envirosris, 2000). The entire electronics industry is obligated for proper management and disposal of e-waste. Manufacturers and retailers have to provide free of charge take-back programs to facilitate drop-offs for consumers.

The Swiss e-waste management program is designed based on waste prevention, source reduction, and ways to encourage consumers' participation, since it is believed that they play an important role in success or failure of an e-waste management program. The system works based on advanced recycling fee and consumers are allowed to return their e-waste for proper disposal free of charge. Providing curbside collection is another option that increases public participation in the Swiss program (Envirosris, 2000; Future Energy Solutions, 2003). All available e-waste for collection is calculated, and the target is to collect and manage all available e-waste (SWICO, 2010).

The Swiss e-waste management program, in accordance with the criteria for a normative

e-waste management program, identifies the problem associated with e-waste, its causes and effect, clarifying different levels of objectives that need to be fulfilled upon the implementation of the program, engaging all stakeholders in different aspects of the program, implementing an effective strategy by focusing on the main problem and enacting stringent environmental regulations, managing different categories of e-waste, collecting high volume of e-waste, setting out flexible and realistic collection and recycling targets, focusing on material and energy recovery and designing the products for the environment, and providing a secure financing system. The Swiss e-waste management program has been able to target the increasing amount of e-waste and prevent from its long term negative effects such as human health and environmental impacts by targeting causes of the focal problem and holding all stakeholders responsible.

There are lessons that can be drawn for the Swiss e-waste management program in order to improve the program in Ontario. Similar to Switzerland, in order to target the focal problem associated with e-waste or the increasing amount of e-waste in Ontario, the causes of the focal problem such as unaccountability by consumers, government, and the electronics industry should be targeted first. Consumers play a role at the end of life cycle of the products by active participation in available e-waste management options. Increasing consumers' awareness regarding e-waste allows them to make environmentally friendly decisions regarding every purchase that they make and act responsibly by disposing of their e-waste properly.

In Ontario, consumers' participation could be improved by providing education regarding e-waste, its impacts, and available disposal options. The program should provide consumers with education, and information about local drop-off points (Whitney and Webb, 2008). In Ontario, the government should take a number of measures to create a regulatory environment that promotes the safe and environmentally sound management of e-waste (Whitney and Webb, 2008). Similar to Swiss e-waste management program, there should be mandatory requirements for stakeholders' participation, provision of free of charge take-back programs offered by the industry, and enactment of environmentally friendly regulations such as regulations that ban the disposal of e-waste in landfills. The industry could provide take-back programs free of charge with sufficient number of collection points that are easily available and accessible for consumers.

The program in Ontario should plan to manage more categories of e-waste. Similar to

Switzerland, Ontario should set out flexible and realistic targets for collection and recycling by calculating the available amount of e-waste for collection each year, based on sales number exclusive to Ontario and consideration of an average lifespan for electrical and electronic equipment. The target should be based on the collection of the available e-waste and manage the entire quantity of collected e-waste. The program should provide a clear financing system.

Ontario's program should hold the electronics industry responsible for their products through the entire life cycle of the product including, production consumer use and disposal, collection, reuse, recycling, energy recovery, and final disposal (Whitney and Webb, 2008). Holding the electronics industry responsible for managing e-waste encourages the industry to take initiatives to design the electrical and electronic equipment for the environment, since they are the ones that have to manage their e-waste at the end of its life cycle (OES, 2009). In order to achieve a sustainable e-waste management program, all stages of product development should be considered including the product design, as well as patterns of consumption, and all stakeholders should work together to provide integrated solutions to the issue (Whitney and Webb, 2008). The electronics industry has been able to develop revolutionary communication and information equipment and other electronic products that have majorly improved the quality of life (Whitney and Webb, 2008). This ingenuity now has to be applied to making these developments more sustainable by providing effective e-waste management programs (Whitney and Webb, 2008). Sustainability in the electronics industry requires accountability of all stakeholders and their commitment toward making environmentally friendly decisions.

This thesis conducted an examination and evaluation of the Ontario's e-waste management program, and enabled the identification of other issues that merit examination. Some further directions for this thesis can be recommended as follows:

- Identify consumers knowledge in Ontario regarding different impacts associated with improper disposal of e-waste, whether they are aware of available options for proper disposal, and what means are required to get their commitment;
- Determine whether a comprehensive e-waste management policy that includes enforceable targets and timetables, and requires maximum landfill diversion should be enacted by the government of Ontario;

- Examine the feasibility of enactment of more stringent environmental regulations in Ontario such as placing a ban on disposal of e-waste in landfills, and whether they impact the achievement of collection and recycling targets;
- Examine the feasibility of designating retail stores and curbsides as permanent collection points in Ontario, and whether they facilitate the achievement of program's collection targets;
- Examine the feasibility of employing various regulation and activities that could facilitate consumers' participation, Stewards compliance, and promote reuse and recycling over the extraction of virgin materials;
- Review the Ontario's e-waste management program in terms of achievements of its objectives after five years of implementation, and determine whether the set out objectives should be modified or altered upon the program's progress;
- Determine the impact and influence of the EU's Directives such as WEEE and RoHS in the design of the Ontario's e-waste management program, and whether similar regulatory requirements should be employed in the program;
- Determine how feasible the implementation of these recommendations is.

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