Systems Approach to Health-care Waste Management:

Understanding system functionality using VSM - the case of Guyana

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"If you haul on a single thread of nature, you will find it attached to the rest of the world" John Muir.

Preeya Rampersaud

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Abstract

This thesis attempts to examine the situation of health-care waste management in Guyana using a systems approach and to understand the roles of government in mandating, facilitating, and initiating a reduction of the adverse impacts related to human health and environment. It examines the existing situation of health-care waste management using the principles of the viable system model to guide the analysis and to identify the function(s) and level of interactions among the actors.

Health-care waste management is of serious concern in Guyana. Region 4, which includes the capital city of Georgetown, is the largest generator of health-care waste in the country and the country's largest hospital, the Georgetown Public Hospital Corporation is the main contributor. Moreover, smaller facilities such as Health Centres are widely dispersed throughout the country thereby increasing the risks in the absence of environmentally sound management. The research focused on private and public hospitals and health centres in Georgetown and the rural region of West Demerara.

In Guyana waste separation is a recent phenomenon for health-care facilities. However it is limited and depends on awareness and the availability of necessary equipment such as bin liners and sharp boxes. These facilities lack the requisite standards and procedures for waste management. In the absence of treatment, poor handling practices and rudimentary methods for disposal, there are adverse effects on public health and environment.

Interventions by government are necessary in order to achieve environmentally benign behaviour. The government has a key role in collaborating with the stakeholders involved in health-care waste management as well as changing behaviour through regulation and increasing the level of awareness. This research therefore concludes the key role of government is to mandate changes through mandatory instruments to immediately address the situation of health-care waste in Guyana.

Executive Summary

Health-care waste is characteristically different from other types of waste. As a result, it requires special treatment and management along the waste chain (generation to disposal). Health-care waste contains infectious and hazardous elements that have adverse effects on the environment and human health.

The quantity of waste produced per day depends on a number of factors such as the type of services, number of beds (in-patient capacity), the hazardous and infectious content and the level of waste management. Therefore quantification of waste is an essential factor in implementing environmentally sound management. In developing countries, cost related to waste management and disposal methods can be a challenge given the hazardous and infectious content of the waste (WHO 1999).

The management of health-care waste is of serious concern in Guyana. Poor disposal practices can lead to the release of pollutants directly into the air, water, and soil (WHO 1999). Of the 315 health-care facilities with over 2,000 beds (MoH 2004), the majority can be found in Region 4, making this administrative region the largest generator of health-care waste in the country. The main contributor is the Georgetown Public Hospital since it is the largest hospital in the country. Moreover, smaller facilities such as Health Centres are distributed countrywide thus increasing the risk in the absence of environmentally sound management.

Source separation is a recent phenomenon and has been affected by a number of factors such as the availability of equipment (bin liners). The risks related to health and the environmental impacts from health-care waste vary from the point of generation to disposal depending on the level of separation. For example, handlers are placed at risk in the absence of protective equipment when handling, collecting and transporting infectious and sharp waste.

Disposal of health care waste, particularly from hospitals and health centres is a burning issue in Guyana. Many disposal sites are located on the coast and close to population centres. Health-care waste in Georgetown is currently disposed by burial at the city's dumpsite without treatment. The waste is mixed with animal carcasses and abattoir waste. The lack of lining, soil cover or gas control increases the risk of ground water contamination (PAHO/WHO 2004). Waste in outlying areas is disposed by open burning or incineration-releasing dioxins, furans and heavy metals into the environment (Emmanuel, Hrdinka, Gluszyński, Ryder, McKeon, Berkemaier, and Gauthier 2004). These issues are further compounded by the fact that the majority of the population resides on the narrow coastal area.

This study was conducted in hospitals and health-centres in Georgetown and West Demerara. The actors involved in the research included government agencies such as the Environmental Protection Agency, Ministry of Health, Ministry of Local Government & Regional Development, private disposal companies, private and public hospitals and health centres. The research focused on the public sector, mainly governmental actors in order to understand their role in managing and improving the current situation.

A literature review was conducted to bring the issues related to health-care waste into the context of current research in the field. Policy evaluation literature was perused to select policy evaluation criteria. The system organization in hospitals in Sweden (cases of Lund and Malmö) provided a guide to understand the organization of a fully functioning system. As well, waste minimization and other policy elements were used along with systems theory literature to develop an analytical framework. This analytical framework was used to analyze the data obtained from the case study.

The research examines the complexity of issues in the health-care waste management system using a systems approach. The research attempted to understand the roles of government in mandating, initiating and or facilitating improvement of the existing situation. It examines the situation of health-care waste management in Guyana using the principles of the viable system model. The Viable System Model (VSM) was used as a tool to structure the health-care waste management system and to guide the analysis of the thesis. The five functional areas of the model correspond to key functions in the health-care waste management system and used to understand the interrelations between the system components.

VSM is built on a hierarchal structure with five system levels exhibiting core functions and based on recursion, all five system elements can be found within each sub-systems. **System 5** is at the highest level and it provides the identity or 'steer' to the entire system. This level is based on a normative framework or policy. **System 4** has its basis in research and development and provides the strategic direction to the system. **System 3 and 3*** refers to internal control or regulation of the system. By extension 3* monitor and audit the activities at the lower level system, relaying this information to system 4 and through feedback mechanisms manage the lower level systems. **System 2** has a coordinating function and coordinates the activities of system 1. **System 1** corresponds to the operation level. This is the core of the system and the level facilitating all system activities, without this level the system will collapse (Lewis 1997; Leonard 1999; Schwaninger & Koerner 2004; Schwaninger 2006; Espinosa *et al* 2007). System imbalance occurs in the absence of one or more of the system element, lack of coordination or lack of capacity in the system (Schwaninger 2006).

The research found that many different elements contribute the level of complexity in the current system. These include the low level of awareness, no clear policy direction for the generators, lack of coordination among the actors and initiatives taken only at the disposal stage ('end of pipe' approach) in an attempt to address the situation. The key findings are summarized as follows:

- The lack of clarity at the level of policy in health-care waste management system has a direct effect on the operational level. The facilities therefore are unable to function effectively resulting in the current system - increasing environmental and health impacts in absence of environmentally sound management of health-care waste.

- There is no separate policy for health-care waste and it is not included in the current environmental policy. Two regulations are in place to address some elements related to the management and disposal of health-care waste: the Environmental Protection (Hazardous Waste Management) Regulation 2000 and the Health Facilities Licensing Regulation 2008. The level of awareness among the governmental actors related to coverage of health-care waste by the legislations is low.

- Responsibilities for health-care waste management are distributed among the Ministry of Health, Ministry of Local Government and Regional Development and the Environmental Protection Agency. The ownership or responsibility for the public hospitals and health centres is also distributed. The Ministry of Health ensures quality health-care however; the Ministry of Local Government and Regional Development through the regional administration has responsibility to provide finances for operation of public health-care facilities in the respective administrative regions. The municipalities and regional administrations are responsible for the collection and disposal of all waste.

- The lack of coordination among the responsible agencies is high to the extent that institutions duplicate efforts in managing health-care waste.

- There is low level of awareness among the actors of the risks to environment resulting from poor management of health-care waste. However, actors were aware of the health risks associated with contaminated needles. The Ministry of Health's drive to reduce the number of HIV/AIDS cases in the country led to some level of awareness among health-care workers of the health risks from poor handling practices. This also led to the separation of needles from other waste.

- There is a high dependence on external support to provide basic equipment such as sharp boxes, bin liners for source separation. Source separation in public facilities is affected by timely distribution of sharp boxes and bin liners by the responsible authority in the outlying regions. Cost constrains private hospital to source the required bin liners, thus affecting the level of source separation.

This research supports one of the principles in the theory of the VSM - the need to have all five system components in place for an effectively functioning system. It further supports the principle of recursion in the hierarchal system and the need to define the goal; standard and policy - to define its purpose and at the same time provide an identity for the operational systems. Coordination, information flows and responsibility are necessary conditions for an effective HCWMS.

Due to the infectious and hazardous content of health-care waste and the importance of health-care facilities, it is pertinent to implement measures to change current practices. Therefore the government agencies have a critical role to mandate standards to regulate the health-care facilities supported by an intensive information and education programme. The provision of information is critical to creating awareness and to achieve environmentally benign behavior. The way forward includes the following key recommendations:

1. Increase awareness at the national and operational level in the Health-care Waste Management System (HCWMS).

2. Develop a health-care waste policy with clear objectives and targets building on the hazardous waste inventory conducted by the Environmental Protection Agency.

3. Enforcement of the EP Hazardous Waste Regulation 2000 and closer collaboration with the Ministry of Health through the Environmental Health Unit to regulate and monitor public and private facilities.

4. Develop standards and guidelines for disposal; procedures and guidelines for waste segregation, labeling, handling, storage and collection of waste. Once finalized, it (the guidelines) should be incorporated into the permitting or licensing process of the Ministry of Health and EPA for it to be legally binding.

5. Facilitate private sector involvement in the provision of services for the treatment of waste. Alternative treatment technologies can be explored, in particular, the use of mobile autoclaves for each region.

6. Regulate the activities at the operational level to improve health-care waste management by:

- Increase awareness at management level of the health and environmental effects of current practices.

- Incorporate environmental considerations and waste management into the standard operating procedures. Waste segregation for efficient source separation, labeling, securing bags, secondary containment where necessary should also be included in the procedure. A policy for environmental management and waste reduction through source separation should be in place for all facilities.

- Mandate the use of the colour coded system, particularly for private facilities.

- Health and Safety Officers should be employed at all hospitals and define responsibilities to include environmental considerations and waste management. This responsibility should be transferred to the head nurse or medex for health centres.

- Training and awareness for health-care workers including lower level unskilled workers should be conducted periodically by management.

- Hospitals should undertake waste accounting - inventory of all waste types and quantities and monitor waste generation patterns across departments and wards if possible. Further, separate records of cost associated with waste collection and disposal should be kept and develop reporting mechanism with the regulatory agencies.

- Shift away from open burning and incineration by increasing awareness of the human health and environmental effects of such rudimentary practices and investing in alternative treatment technologies.

It is evident from this research that the current practices will not lead to an environmentally sound health-care waste management system as long as 'business as usual' continues. Unless there is a serious effort made by all involved towards effectuating environmentally benign behaviour these problems will continue to occur. To move away from this, either the structure of the system changes to adapt to the current situation or there is a complete paradigm shift in the management of health-care waste.

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1 Introduction

The health care sector is an important and critical sector for the wellbeing of the population. The sector provides a range of services and contains a number of facilities that use a variety of inputs to produce a wide array of health-related outputs. However, similar to facilities that consume resources the generated outputs that are no longer useful become waste. Such waste originating from health-care facilities[1] has been an issue and is of serious concern due to its harmful effect on the natural environment and human health.

Worldwide, large quantities of waste are generated on a daily basis from health-care facilities. According to WHO (1999), waste fractions from health-care facilities include general waste, infectious wastes[2], sharps[3], pathological waste, pharmaceutical wastes etc. The hazardous and contagious characteristics of such waste and its effect on the environment and human health constitute to one of the most hazardous type of waste. The World Health Organization notes (WHO1999:13) that typical health-care waste[4] generated in Latin America and the Caribbean per day is 3 kg/bed while in North America it is alarmingly around 7-10 kg/bed as compared to 3-6 kg/bed in Western Europe. Even though 3 kg/bed is minimal in comparison to the other regions, if not managed through environmentally sound methods, the consequences would be severe (WHO 1999; United States Agency for International Development (USAID) 2003).

The quantity of waste produced per day depends on a number of factors such as the type of service, number of beds (in-patient capacity), the hazardous content and infectious nature and the level of waste management. Quantification of waste is crucial for proper management and it is even more vital in developing countries. Cost related to disposal and proper disposal methods can be challenging for these countries. Given its special characteristics poor disposal practices can lead to the release of pollutants directly into the air, water, and soil (WHO 1999; Hassan, Ahmed, Rahman, Biswas 2008).

The largest fractions, 75% to 90%, of total waste by volume produced from health-care facilities are considered as general waste such as paper, food, packaging etc. with no serious environmental consequences. The rest, 10-25%, if not treated with care and managed in an environmentally sound way, can cause serious harm to human health and environment due to its infectious and hazardous nature (WHO 1999:2). Direct risks to human health involve the transmission of deadly infections such as Hepatitis B and C as well as the Human Immunodeficiency Virus (HIV). These infections are commonly spread by needle-stick injuries resulting from poor handling of needles and sharps (WHO 1999). The risk of infection can also propagate downstream the waste chain to waste handlers, waste pickers and wider community as a result of poor waste management practices. In 2000 alone the WHO estimated worldwide, 21 million cases of Hepatitis B and 2 million cases of Hepatitis C of which 32% and 40% respectively were new infections caused by infected needles. Additionally, 5% of new infections relating to HIV resulted from contaminated needles

[1] According the World Health Organization (WHO) classification, includes health care establishments such as hospitals and health centres, research facilities, laboratories and health care administered in homes, (WHO 1999).

[2] This includes solid materials used for cleaning wounds such as bandages, swabs etc, materials in contact with bodily fluid, and materials in contact with highly infectious patient (WHO 2005).

[3] Sharps are considered as objects that cut or create wounds easily such as needles, scalpels, knives, broken glass, infusion sets, nails, hypodermic needles and blades (WHO 1999).

[4] Defined by WHO as "the total waste stream from a health care facility that includes both potential infectious waste and non-infectious waste materials" (WHO 2005).

increasing the number for that period to 260,000 (WHO 1999; WHO 2004; WHO 2005; USAID 2003).

Health-care waste management can be a challenge for developing countries. On one hand there is the need to provide foremost adequate health care for the population and on the other hand, protecting human health and the environment, which is essential, given the lack of environmentally sound waste management practices due to limited resources (WHO 2004). In a survey conducted by the WHO in approximately 22 developing countries in 2002, it was concluded that 18% to 64% of health care facilities in these countries lack adequate disposal methods for disposal of waste (WHO 2005). Consequently infectious and hazardous waste is often dumped in open, uncontrolled areas accessible to the general public and mixed with municipal waste. In many of these countries, disposal methods for health care waste include open unlined pits either close to the water table or other water bodies, open burning, indiscriminate dumping, or incineration with no emission control. Often these countries lack the resources and technical capabilities to adequately manage waste originating from health care facilities particularly hospitals (Brent, Rogers, Ramabitsa-Siimane & Roher 2006; Chaerul *et al.* 2008).

Hospitals are known to be a major source of health care waste (WHO 1999). Wastes generated from hospitals originate from various sources within the hospital such as the offices, kitchen, operating rooms, various wards, laboratories and diagnostic centres, pharmacies etc. (WHO 1999; Chaerul, Tanaka, & Shekdar 2008). A large number of the population reside in outlying, rural areas requiring the government to establish programmes to provide health services through health centres and health posts. However, environmentally sound disposal methods are often not in widespread practice at these facilities. These countries will continue to generate large quantities of waste in relation to population size from hospitals and health centres because of the general lack of adequate systems to regulate and manage such wastes. Thus, there is a high risk of an increase in the generation of health-care waste in the future. Population growth and the lack of adequate management further exacerbate the environmental and health related issues.

Given the severity of the issues highlighted, it is imperative to find ways to reduce the impact on the environment and human health. Policy intervention and environmentally sound management through waste minimization, the reuse and recycling of materials and technologies to treat waste before disposal are possible measures that can be applied to reduce the quantity of waste generated and risk associated with this hazardous waste stream.

Guyana was selected as a case study in order to understand the issues relating to health-care waste in the context of a developing country, since many of the problems highlighted above are evident there.

Guyana, located on the South American coast has a total population of 751,223 (2002 Census) and land area of is 214,970 $km^{2.}$ (Refer to map in Appendix 1). The country has ten administrative areas or Regions further broken down into districts, municipalities, towns and vilages. The highly populated regions are found on the coast inclusive of Region 4 (Demerara-Mahaica) and Region 3 (Essequibo Islands-West Demerara). The capital -Georgetown is a part of Region 4 and this region accounts for 41.3% (310,320) of the total population while Region 3 accounts for 13.7% (103,061) (2002 Census). The coastal area is vital for the country not only in relation to population and infrastructures but also it is the hub for economic activities and development.

1.1 Problem Definition

The management of health-care waste is of serious concern in Guyana. Waste is generated both from public and private hospitals as well as out-patient centres and community health centres. The quantity of waste generated by these facilities depends on the services provided. Separation of waste at source, even though a recent phenomenon, has been affected by a number of factors such as the availability of equipment (bin liners). The potential health risk and related environmental impacts from health-care waste will therefore vary along the waste chain. The degree of impact downstream of the chain depends highly on the level of separation that occurs at the point of generation of waste. Handlers are placed at risk in the absence of protective equipment when handling, collecting and transporting infectious and sharp wastes.

Disposal of health care waste, particularly from hospitals and health centres is a burning issue. Health-care waste in Georgetown is currently disposed of by burying in the Mandela dumpsite[5] without any treatment. Waste from hospitals is mixed with animal carcasses and abattoir waste. The disposal site has no lining, soil cover or gas control (PAHO/WHO 2004) thus there is a potential risk of ground water contamination.

Waste is disposed of by either open burning or incineration in the outlying regions of the country. Emissions released directly into the atmosphere from burning affect the surrounding population since these facilities and the location of the burnt boxes or incinerators, are upwind of residences. Further, burning of such waste is known to emit toxic pollutants such as dioxins, furans as well as heavy metals (lead, mercury) either directly in the air or from burying of the ash (Emmanuel, Hrdinka, Gluszyński, Ryder, McKeon, Berkemaier, Gauthier 2004).

The issues related to health-care waste are further compounded by the majority of the population residing on the small coastal area (approximately 10% of total land area). Additionally, the coast lies approximately 0.5 to 1 meter below the sea level and is prone to flooding both from heavy rainfall and during high tides. Ground water is the main source of potable water for many in the outlying areas and the population in Georgetown relies on surface water from the Lamaha Canal. Poor disposal practices of health-care waste can contribute to ground water contamination during flooding. The consequences of climate change could add to an increase in the incidence of diseases in particular, water borne illnesses (Sookdeo 2008). Heavy rainfall in January 2005 led to the worse flooding event recorded in Guyana's history. It brings attention to the country's low lying coastal vulnerability and lack of preparedness in relation to flood control. Three main regions in the country, inclusive of the city were affected. These areas encompassed 75% of the total population and were inundated for over three weeks[6], resulting in evacuation of persons, unsanitary conditions and increase in diseases such as leptospirosis. Of the 87 leptospirosis cases reported, 23 resulted in deaths during this time (USAID 2005; PAHO 2007). The water level in many communities during the flood ranged from 1.2-2 m. Health centres in these areas were also inundated. Wastes (solid waste and animal carcasses) were found dumped at random in the same area as the population (Bynoe 2008).

The situation relating to health-care waste management in Guyana is further complicated by the lack of interaction among the various stakeholders availability of resources (human,

[5] The Mandela dumpsite is the only disposal area in the city. It is located west of Mandela Avenue hence the name 'Mandela site' or 'Mandela dumpsite'.

[6] Rainfall during this period exceeded the normal average rainfall rate (1108.2mm or 43.6 inches). In fact it was six times that of the 30-year average (Bynoe 2008).

technical, financial) and the lack of clearly defined roles and responsibilities. To improve the current situation towards a level where the risks are minimized it is necessary to develop a favourable environment that will facilitate the involvement of key actors. Availability of resources, incentives for change and access to information along with commitment (of all involved) are necessary conditions for any kind of improvement. It is also critical to have some level of intervention to regulate the activities that pose a threat or damage the environment and human health. From this perspective there is a need to have a central player as the driving force for change and to foster collaboration between state and non-state actors.

In general, government[7] is recognized as an important actor in the waste system, particularly in health-care waste through the administration and regulation functions. Inclusive in their role is decision-making and enforcement of these decisions, goal-setting and priorities, provision of services and regulation of activities to maintain order in the overall system (Clayton & Radcliffe 1996). Additionally, government has an essential role in fostering collaboration among actors. Koontz *et al* (2004), claims that government has multiple roles in collaboration for environmental management. They can stimulate, initiate and/or follow in establishing cooperation and alliances. Therefore understanding the key functionally of responsible public institutions may be the key to changing the current situation related to health-care waste management in Guyana.

In order to understand what measures government can undertake, there is a need to analyze the existing situation relating to health-care waste management and to understand 'what' the problems are and 'why' they occur.

1.2 Research Objective and Questions

The main objective of this research is to examine the situation of health-care waste management, specifically the complexity of issues in the health-care waste management system in Guyana using a systems approach. This thesis attempts to understand the key functions of the responsible public agencies and the role of facilitating, initiating and/ or mandating the improvement of the current situation. The following research questions were examined in order to achieve these objectives:

1. What is the existing situation relating to the management of healthcare waste in Guyana?

2. What policies are in place to address the issues of health-care waste management?

3. What are the initiatives taken and challenges evident from the implementation of these initiatives in health-care waste system?

4. What policy measures can be implemented to address these problems?

1.3 Scope and Limitations

This study examines the issues related to waste generated from hospitals and health centres from the policy implementation and management perspective. It is intended to provide a comprehensive approach to increase the understanding and knowledge in this field in general

[7] For the purpose of this thesis, government according to Sterner (2003:13) is used to mean a *"series of public-sector bodies with distinct structures, motivations and modes of operation at different levels".*

and specific to Guyana. The results of this research can be used by decision-makers in the country through policy intervention to improve the management of waste at source.

Guyana was selected as a case based on the author's familiarity to and understanding of the local system as well as similarity of the institutional elements to most developing countries. Hospitals in selected cities – Lund and Malmö in the southern region of Sweden, were used as references to understand the management of health-care waste within the hospitals since Sweden has over the years advanced itself in environmental management. Additionally, the ease to which information can be obtained based on the Swedish rule "Offentlighetsprincipen" (the 'Principle of Public Access to Information'), the location of the Lund University and access to the hospitals provided the basis for selection of these cities. The intention is not to replicate the Swedish system within the Guyanese context but to understand the intricacies of a successful system and to benefit from their experience.

The study focuses on the management of 'special' or hazardous waste streams[8] that originate from health care facilities. It is limited to **the solid waste fractions** from hospitals and health centres and does **not** include genotoxic (cytotoxic) and radioactive waste. General or ordinary waste will be excluded from the scope of study but will be considered as part of the overview of healthcare waste when relevant. The study is oriented along the waste hierarchy and its implementation in hospitals and health centres in order to reduce the quantity and toxicity of waste generated.

The study areas are confined to Georgetown - the capital of Guyana found in administrative region 4 (Demerara-Mahaica) and the West Demerara Region located in administrative region 3 (Essequibo Islands West Demerara). The scope of study in Region 3 is limited to the coastal areas (West Demerara) and does not include the islands of Wakenaam and Leguan. The selection of Georgetown was based on several factors: it is a highly populated area containing approximately 40% of the total population (2002 Census); the main public hospital and most of the private hospitals are located there thus the city is a large generator of health-care waste; the offices of most stakeholders are located in the city thus the ease of access to contact persons and it is the location of the main disposal site. The coastal area of Region 3 was selected on the basis of accessibility to the district and regional hospitals and health centres. It also provides a good representation of the situation regarding regional hospitals and health centres in the remainder of the country. Stakeholders were selected based on their roles and responsibilities for waste management in general and specific to hazardous and health-care waste. These persons are at management levels within their respective organizations and therefore their views were considered valid.

To understand the current situation, health-care facilities and disposal companies managed by private and public administrations were examined. Practices at large, medium and small scale facilities (Regional and District Hospitals and Health Centres) were examined. However Health Posts[9] were excluded from the scope of study as these facilities are located mostly in the interior regions and minimal activities occur there according to the Ministry of Health (MoH) classification system. This classification system for health-care facilities are according to the Ministry's five levels of care administered within the heath-care sector. These are health post (lowest level), health centre, district hospital, regional hospital and national hospital (highest level). The Georgetown Public Hospital is at the highest level and is the main public

[8] Defined according the World Health Organization (WHO) as consisting of sharps, highly infectious wastes, genotoxic or cytotoxic waste and radioactive wastes (WHO 1999)

[9] Classified according to the Ministry of Health as the first level of care in the provision of simple 'curative and preventive' action for common diseases and only staffed with community health workers, (NDS 2000).

hospital in the country. It provides a wide range of services and has a capacity of approximately 937 beds (National Development Strategy (NDS) 2000).

The main limitation encountered during this study is availability of field data regarding the quality and quantity of waste generated from health-care facilities, including the hazardous component and transportation of same along the waste chain. To address this limitation the average per patient per bed ratio was used to estimate the quantity of waste generated per facility. This information was obtained from previous assessments made by the Pan American Health Organization (PAHO).

Additionally, it was not possible to conduct a cost analysis or to discuss cost implications related to the systematic approach due to the unavailability of cost information in Guyana.

In some interviews at hospitals and health centres in Guyana, the author encountered interviewees having responsibilities in public relations or administration thus providing general information. It was the policy of the facility to limit the interactions with the public to their administrative/human resources or public relations personnel. Further details relating to information collected from health-care facilities and other stakeholders are provided in Section 1.4.

Meetings with key management staff of the Georgetown Public Hospital Corporation to discuss the propose autoclave and shredder/compactor system project were unsuccessful. The author attempted to address this limitation by obtaining as much information as possible from the contact person (provided by the GPHC) in relation to the project as well as sourcing project document from the funding institution.

1.4 Methodology

This thesis took the form of a case study. Case study approach allows for a particular phenomenon to be studied in detail in order to observe various relationships, specifically the 'cause and effect relationship' (Stake 1995). Therefore the case study method was found to be the most appropriate method to apply in this context[10]. It is a qualitative study and examines the current situation regarding health-care waste through the application of systems thinking and more specifically using the principles of the viable system model to guide the analysis. It examined the interactions within the health-care waste system and the existing policy and institutional framework. This thesis was conducted with the assistance of Environmental Health Unit of the Ministry of Health in Guyana. The research was conducted in three phases.

1.4.1 Phase 1: Development of preliminary conceptual framework

Information in the field of health-care waste management were perused and collected during the preparatory stage from various sources such as books, articles, academic literature, and publications etc. Contact was made with the Environmental Health Unit in Guyana to develop the project concept. This also led to the development of a preliminary conceptual framework. On May 27, 2008 a visit was conducted at the Lund University Hospital. Meetings were held with persons working with health-care waste management and environmental issues to gain insight into a fully functioning, well established system. Contact persons for the Lund University Hospital were obtained from the professors at IIIEE. Face-to-face interviews were

[10] The main limitation of case study method is its lack of flexibility. This limits the magnitude of generalization that can be applied in academic writings (Stake 1995).

conducted, as well as the observation method was applied during the visit to the waste transfer stations and main waste collection point.

1.4.2 Phase 2: Information Collection

The second stage primarily focused on data collection from the study areas. Data collection in Guyana took place between June 6, 2008 and June 27, 2008.Primary data were collected from the main actors involved in the management of healthcare waste through semi-structured interviews. The interactions were through face-to-face interviews and by telephone. Interview questions were developed to have an understanding of the practices of sorting, storage, collection and handling of waste and classification system used. The dialectic approach was applied at times, in particular in interviews with sector agencies. Field observations at public and private facilities were conducted to develop an insight into the current practices and disposal methods undertaken at various hospitals and health centres. Aside from visiting the main public facilities in West Demerara and Georgetown, private hospitals were visited and personnel interviewed. Private facilities were randomly selected based on accessibility and availability for meetings. Contact persons within the hospitals were identified through telephone contact with the administration or human resources division requesting interview with the person responsible for waste management. In most cases this was the occupational safety and health officer or matron with responsibility for safety issues. Some hospitals requested a letter informing of purpose of meeting from the University before allowing any interactions with the author. Additionally a random selection of health centres for both areas were conducted and interviews were held face-to-face and by telephone. Table 1-1 shows the number of facilities contacted for data collection and total number (of facilities) found within the study areas. The sample size taken for hospital was 77% and 37% of the total for health centres. Appendix 2 provides further details of interviewees from each facility as well as other stakeholders. Table 1-1 shows the number of hospitals per classification in each area.

Table 1-1 shows the number of facilities contacted for data collection and total number in study areas

Type of Facility		**West Demerara Region**	**Georgetown**
Hospital Classification*	District	1	0
	Regional	1	0
	National	0	1
	Private[11]	0	4
Number of hospitals visited		2	5
Total number of hospitals in study areas*		2	7
Number of Health Centres contacted		5	5
Total number of health centres in study area*		15	12

Source : Ministry of Health (MoH) Statistical Unit 2008

In a few cases respondents were hesitant to provide names and in other cases the administrative staff provided information. Other key stakeholders involved in the waste chain

[11] There is a total of 6 private hospitals in Georgetown (MoH, 2008), 4 were taken as part of this study.

were selected based on their roles and responsibilities relating to health-care waste management. Meetings were held with government representatives from the Ministry of Health, Georgetown Municipality, Environmental Protection Agency among others, Guyana Safer Injection Project (GSIP), Pan American Health Organization (PAHO) and private disposal companies - Franklin-Singh Disposal and Pooran waste disposal service[12]. Contacts were established with most institutions by telephone to schedule a specific time for meetings. Additionally, other resource persons were recommended from these meetings and initial contact made to ascertain availability for interview.

Data were obtained from key persons in Malmö University Hospital on July 21, 2008 through face-to-face interactions. Contacts were obtained through the professors of the institute (IIIEE) and a meeting was arranged via electronic mail. Additionally, contacts for the Lund Municipality were obtained from browsing their web page as well from the author's supervisor. Contact was made and information provided by electronic mail. Information from the Malmö University Hospital and the Lund Municipality further assisted the author to understand the Swedish system as indicated in section 1.4.1.

Secondary data such as policy documents and health-care waste information were collected from the various government departments as well as the available literature based on the scope of work as outlined in section 1.3.

Policy evaluation literatures were perused to develop evaluation criteria to determine the value of the policy. Policy literature discussed the elements necessary for its success and the basis for sustainability. A number of common criteria were found in literature for evaluating environmental policies. The evaluation in this thesis was performed against selected criteria based on the most relevant criteria applicable to the case at hand. Refer to section 2.2.4 for further details of the evaluation criteria used.

1.4.3 Phase 3: Analysis

The third stage involved the analysis of both the primary and secondary data. A framework for analysis was developed from existing literature and is elaborated in section 2.3. Figure 1-1 presents an overview of the research process.

Primary and secondary information were analyzed using a descriptive approach to arrive at answers for the research questions stated in section 1.2. A systems approach was used to analyze the issues surrounding health-care waste from hospitals and health centres to achieve the research objectives. The viable system model (VSM) guided this analysis through specific areas at the policy, management and operational level to identify the roles of the relevant agencies and the use of policy to improve waste generated at source.

Specifically the application of the waste hierarchy developed by the Organization for Economic Corporation and Development (OECD) that focuses on minimization (source separation) for volume and toxicity reduction within hospitals and health centres was discussed. Benchmarks from the hospitals in Lund and Malmö were established based on the organization of the system in Sweden and measures that can be taken in Guyana to improve the existing situation.

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[12] Out of the three main disposal companies operating in the study area, representative from two companies were available for interviews. The manager for the third (Cevons Waste Disposal) was never available for an interview. Other staff in this company decline to interact with the author.

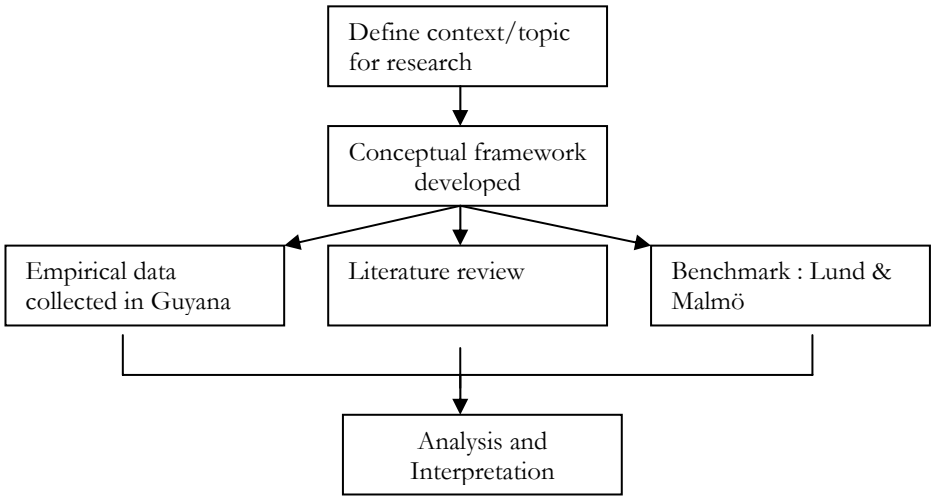

Figure 1-1 Thesis research design

The sustainability principles and sustainable policies also formed part of the discussion for improving the current situation and the drive towards a sustainable health-care waste management system. Conclusions were drawn from the analysis of the case and answering the research questions outlined in section 1.2.

1.5 Thesis Outline

The structure for this research took the format as illustrated in figure 1-1 and the content of the remaining chapters are described below.

Chapter 2: describes the systems theory and systems thinking. It provides a description of the viable system model, its structure, functional areas and principles for operation. This chapter describes the sustainability principles and policy, content of environmental policy and the requirements for waste policy. It further outlines the basis for policy evaluation and the criteria used.

Chapter 3 describes the environmental and human health issues associated with poor health-care waste management. It further elaborates the international classification system and describes the organization of health-care waste management in Lund and Malmö.

Chapter 4: presents the case of Guyana and describes in detail the situation relating to health-care waste management. It includes the policy framework, institutional arrangements and initiatives taken by the institutions to address the health-care waste.

Chapter 5 presents the case in context of using the hierarchal structure and functional elements of the viable system model to highlight the complexity of the interactions and relations with the various system components of the HCWM system.

Chapter 6: outlines the challenges, functions and responsibilities of the involved agencies and examine the roles of government in the health-care waste management system towards reducing the human health and environment impacts.

Chapter 7: outlines the main findings and provides recommendations.

2 Systems & Sustainability

This chapter provides an overview of systems thinking and systems theory. It further outlines the Viable System Model as a tool applicable to socio-technical systems and its principles used in organizational management. Sustainability principles and policies are further elaborated. These concepts are linked in the analytical framework used to analyze the case of health-care waste in Guyana.

Sustainable practices within the health-care waste management system are necessary to ensure the protection of human health and environment. Effective management of health-care waste, a way to ensure sustainable practices are implemented, can be achieved through systems thinking.

2.1 Systems Theory and Systems Thinking

The theoretical systems literature has put forward a number of different explanations for systems and applicability of systems thinking. General systems theory, discusses *inputs* and the *interactions* with the various components or subsystems within the *wider system* to effectuate *outcomes*. A key characteristic of systems in general, is the integration of information and information flows from one level to the next. It is necessary to ensure that this information is understandable and translated into a language understandable to the receiver. This is particularly relevant with social systems (Clayton & Radcliffe 1996; US EPA, 2001; Olsson & Sjöstedt 2004; Schwaninger 2006).

Systems become complex according to Schwaninger and Koerner (2004:558) by displaying different patterns of behaviour or variety within the system. The level of uncertainty, in relation to the effects of changes in the external environment (technologies, legislations, new information), increases or constrains the decision-making process within the system (Schwaninger and Koerner 2004:558). Highly complex systems tend to generate high level of uncertainty.

In order to understand complex systems, various schools of systems theory were developed and models were applied to study the relations of the theory with an aspect of the real world. Theories of viability have been discussed widely in systems theory literature and more specifically in the context of addressing complex issues in socio-technical organizations. Two main theoretical approaches (schools of thought) of viability were proposed: the Living Systems Theory (LST) developed by Jim and Jessie Miller and the Viable System Model (VSM) by Stafford Beer. Both are comprehensive theories, qualitative in nature, and rooted in the concept of viability but with different approaches. The LST[13] is rooted in general systems theory while the VSM has its roots in cybernetics (Schwaninger, 2006).

Cybernetics, a branch of systems theory, has been applied significantly in operational research and looks at the essential conditions required for functional systems. It is a study relating to "*self-regulating or autonomous systems (organizations) of control and communication in natural and man-made organizations within complex and uncertain environment*" (Lewis 1997:265). It looks at both

[13] The LST is based on seven hierarchal levels similar to "*life processes*" starting from the point of a "*cell*" to a "*supranatural*" level where each acts as subsystems within systems. Further subsystems were identified known as *"critical subsystems"*. However, these subsystems either include all of the subsystems or can interact with other subsystems to have contact with the other *"life forms of the system"* (Schwaninger, 2006).

organismic[14] and mechanistic[15] organizations (Lewis 1997:265). Cybernetic approaches to environmental management have been proposed by Meadows (as cited by Espinosa, Harnden & Walker 2007:637) and emphasized the importance of feedback loops in order to find different ways to address the problems. Espinosa *et al.* claims that this approach will provide deeper understanding of the system and its functions. Lewis (1997) claims that organizations are capable of recognizing and responding to various changes in their environment and over time will be able to adjust to these changes. Management cybernetics according to Lewis (1997) is a way in which the principles relating to self-regulation, control and communication within complex systems can be applied to organizations. He argues that previous management theories claim organizations should function independent of its environment (closed-system[16]). But the development of the open-system[17] model in later years provided a better way of understanding the functions and interactions of the organizations- the organization and the environment within which it operates was now viewed as a system. Information flow is a vital element in this context along with the interaction of the organization and its environment giving the basis for cybernetic theory (Lewis 1997). Morgan (1986) as cited by Lewis (1997) proposed 4 principles to support cybernetic theory in communication and learning. He claims that (1) "*the system should have the capacity to sense, monitor and scan significant aspects of their environment; (2) the system should be able to relate this information to the operating norms that guide system behaviour; (3) the system should be able to detect significant deviations from these norms; (4) and finally corrective actions should be initiated when discrepancies detected*".

2.1.1 The Viable System Model (VSM)

The viable system model is noted for its applicability in complex systems (systems within systems). The model will not be described in-depth in this thesis, only to the extent of providing some information pertaining to its functionality. This theory has been proposed by Beer in the context of social organizations and management science (Espinosa *et al.* 2007) and thus will be used only to represent the health-care waste management system in Guyana as a 'system' in order to apply systems thinking. It is a useful tool to holistically structure the system and to identify areas for intervention by looking at sub-systems in relation to their functionality, corresponding to the five system components (functional areas) of the model. Further, it adds clarity and understanding of the interactions of each sub-systems (among themselves) and also with their external environment. Figure 2-1 below shows the basic structure of the viable system model developed by Beer and represented by Espinosa *et al.* (2007).

The Stafford Beer viable system model as described by Espinosa *et al.* (2007) "*is a system or complex entity capable of maintaining an independent existence – not an existence totally separate from an environment but one where the structural changes take place without loss of identity and without severance from its niche*". They put forward the analogy that viability is closely related to sustainability since both "*result from the organization dealing with the environmental complexity in the course of its own dynamic changes and development. Thus, lack of viability (or separation from its niche) indicates the end of the life*

[14] According to Kreitner (2005) organi[smi]c organizations are flexible in structure and adaptive to change.

[15] According to Kreitner (2005) mechanistic organizations are rigid with strong bureaucratic qualities.

[16] In closed systems the components remain unchanged even though they can achieve equilibrium but over time they will reach a point where it is not possible to have any further changes (Clayton & Radcliffe 1996:20). Further, closed system does not interact with its environment, interaction is only among the system elements (Olsson & Sjöstedt 2004).

[17] Open systems interacts with its environment through the exchange of flows such as "materials, energy or information" and through continuous exchanges the system is able to maintain balance. This is how systems are able to maintain or sustain themselves (Clayton & Radcliffe 1996:20).

form". To be sustainable or viable, organizations must be able to exist with available resources, aiming to adapt over time to the changes in the environment by improving and strengthening their functional capabilities. Thus, a viable system facilitates a continuous process of improvement and strengthening of its sub-systems to guarantee an environmentally sound, socially acceptable and economically viable system (Espinosa *et al.* 2007).

The fundamental principles of the model in organizational and management systems thinking are as follows (Lewis 1997; Leonard 1999; Schwaninger & Koerner 2004; Schwaninger 2006; Espinosa *et al.* 2007):

- **Independence** or Autonomy – is the ability if the system or subsystem to exist reasonably on its own or to have some degree of self-sufficiency in dynamic and highly complex environment (rapid changes and high uncertainties). VSM states that the organization should be able to adapt to the changes in its environment without any hindrance. Thus delegation of authority and responsibility (timely decision-making and allocation of resources) are necessary and vital elements to ensure viability of the system.

- **Feedback** – the concept of feedback is based on the flows to and from the system creating a strengthening or balancing effect to understand and address problems. Monitoring of the activities in the system allows for the administration or control of activities that causes system imbalance and information redistribution to ensure efficient functioning of the system.

- **Recursion** – is based on the understanding that each sub-system can be an autonomous system in itself interacting with its own environment which is a part of a wider system interacting with its environment etc. This can be classified as the 'hierarchy of viable systems' (Lewis 1997) where all the functional attributes (explained in section 2.1.1.1) can be found in each level of the system. Additionally, Lewis (1997) noted two significant observations regarding recursion in systems. First he stated that viability at the highest level in the system is dependent on the viability of the lower level sub-systems. Secondly, each functional attribute must align with its corresponding functional attribute at the next sub-system level.

- **Requisite Variety** - in order to maintain the balance in the system and thus its viability, it is important to recognize that the controlling system must be able to generate (at a minimum) as much variety (different states) as the system to be controlled. Depending on the diversity of the lower level sub-system (or the number of issues to be solved at this level), the corresponding level (next level sub-system in the system) must be able to have methods in place to deal with these issues within a given time to prevent system imbalance.

- **Viability** – is the fundamental concept of VSM. The viability of a system lies in its ability to structurally arrange and manage its sub-systems, merging with clear functions and defined inter-relationships. According to Lewis (1997:267) Beers' characterized six conditions necessary for a viable system. These are based on the functional attributes of the sub-systems and are operations, coordination, control, monitoring, research (strategic), and policy (normative).

2.1.1.1 Structure of the Viable System Model

The functional attributes can be classified in the five basic levels or sub-systems of the model that interacts with each other and their external environment. The first level, **System 1** is central to the viability of the system. It is the *operational* (action) stage, without this, the system will collapse. It is action oriented; all daily activities occur here and there is a deeper interplay with the local environment. Additionally, this level can have many sub-systems all interacting with each other and their environment to achieve define or specific tasks. **System 2** has a *coordinating* role. It coordinates the activities of system 1 and maintains information flows and implementation of decisions thus allowing system 1 to achieve its objectives. It is a lower level of management but an important part for a fully functional system. **System 3** refers to the internal and immediate *control* within the organization. This is the decision-making stage for the day-to-day activities and allocation of resources and optimization of system 1. System 3 also overlooks system 2 activities. System 3 is extended to contain another loop called system 3*. This is part of the feedback system and supports the other levels. M*onitoring* or auditing is conducted at this stage to ensure accountability and transparency. Control is administered formally through monitoring performance and supervision of System 1 and 2 to ensure functionality and implementation of the overall goals and objectives of the system. This monitoring and control can be through evaluations, reports, meetings etc. **System 4** projects towards the external environment and into the future. Its basis is *research and development* (intelligence) and examines the effects system 1-3 has on the external environment, the influences of the external environment on the system and the future implications of these. This is the strategic centre for the system. **System 5** provides the 'steer' of the system. This level is based on norms, *policies* and other founding principles for effective decision-making and transparency. It provides the guidance and support to system 3 & 4 and also defines the structure and purpose of the system to ensure its identity (Lewis 1997; Leonard 1999; Schwaninger & Koerner 2004; Schwaninger 2006; Espinosa *et al* 2007). Absence or lack of clearly define structure or functional areas, lack of capacity and coordination among the system components affects system viability and function at the lower levels. As a result, system imbalance occurs (Schwaninger 2006).

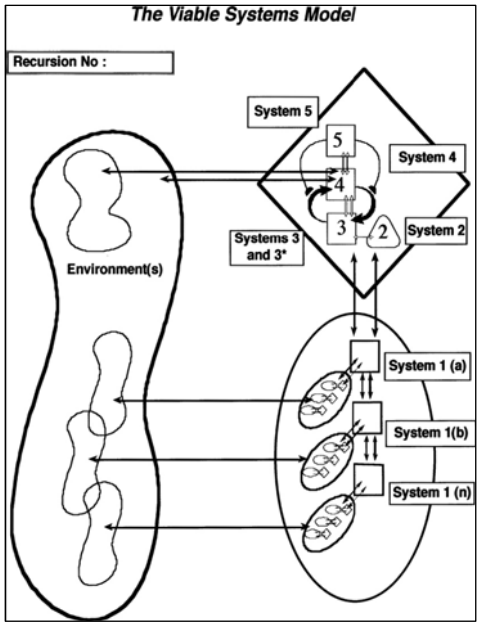

Figure 2-1 Structure of the Viable System Model Source: Espinosa et al. (2007)

2.2 Sustainability Principles

Improvements in the situation regarding health-care waste are necessary to move towards an environmentally sound health-care waste system and eventually a sustainable health-care waste management system. It is therefore essential to address operational areas at the generators and downstream (end of life) side or disposal stage. The fundamental principles of sustainable development - efficient and responsible use of resources and protection of the natural environment - support all other principles. Implicit are the elements of waste minimization

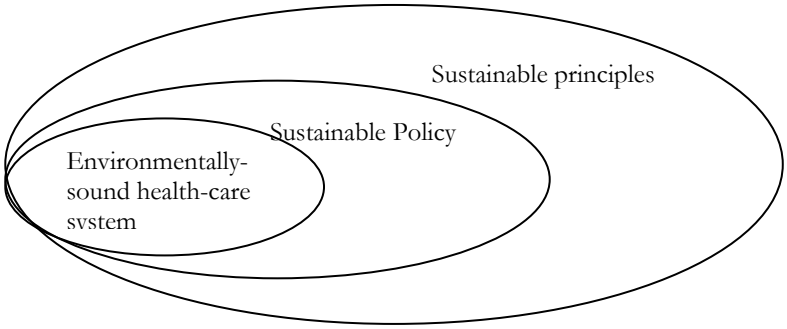

Figure 2-2 Base for environmentally sound health-care system

and prevention, polluter pays principle[18], precautionary principle[19] and environmentally sound management (ESM)[20]. The fundamental principle guiding waste policy is the waste hierarchy (refer to section 2.2.1.1) with emphasis on waste minimization and prevention. A successful policy should include these principles and elements thus; providing the basic elements for any environmental policy and specifically waste management policy. Having such a framework in place is a step towards an environmentally sound health-care system as shown in figure 2.2. Implementation of the sustainability principles and sustainable environmental policies will not only protect the environment and human health but at the same time reduce the burden on the future generations and conserve resources[21] (Tammemagi, 1999:14-15, OECD 2000).

2.2.1 Public Policy

Public policies according to Hill (1997) relate to a number of actions taken together by government to solve a particular problem or to achieve a desired outcome. Implementation occurs over a period of time through the application of a number of methods to achieve the goals or objectives stated in the policy. Mostly these methods, commonly known as instruments in policy literature, are implemented by government with the intention of changing behaviour or accomplish a particular response (Vedung, 1998; Hill & Hupe 2002; Hayes 2007). Vedung (1998) discusses different proposals regarding the classification of policy instruments and the development of the *"threefold typology of public policy instrument"*. This led to the classification of policy instruments as *regulations* (administrative) *economic* and *information* (Vedung 1998). Administrative instruments are measures taken by government agencies to steer individuals to respond in a particular way by applying a set of defined rules and directives. Individuals are mandated by government to operate in agreement with these directives, rules, standards, etc. and if not followed charges or other sanctions can be administered. Economic instruments have their basis in providing or taking away resources. These can be financial or other forms of support (in kind) and undertaking an activity can either be inexpensive or costly. The implementation of the measures however is left entirely up to the entity. Information instruments also known as "moral suasion" attempts to influence behaviour of individuals by increasing their awareness in a particular area or transference of knowledge (Vedung 1998; Hayes 2007).

[18] "The polluter should bear the cost of preventing and controlling pollution to ensure an acceptable environmental state" (OECD, 2000:123)

[19] "The lack of scientific certainty shall not be used as a reason for postponing measures to prevent environmental degradation" (Carter, 2001:6)

[20] OECD (2007) working definition of ESM "a *scheme for ensuring that wastes and use and scrap materials are managed in a manner that will save natural resources, and protect human health and the environment against adverse effects that may result from such wastes and materials*".

[21] Reduce the consumption of finite resources and reuse and recycle useful resources (Tammemagi, 1999).

2.2.1.1 Environmental Policy

Environmental policy, a form of public policy provides the overarching direction or strategic vision and consists of a number of actions to achieve a desired outcome or to stimulate changes towards environmental benign behaviour. The policy can stipulate specific goals, objectives and targets to be achieved in a given timeframe. These actions are translated into specific activities achievable through the implementation of policy instruments as discussed in section 2.2.1. These instruments can either be implemented separately or in combination depending on the situation of the country and the environmental problems to be addressed (Barde 1995; Gouldson & Murphy 1998). While the combination of policy instruments is important in addressing the environmental problem, the effectiveness of the policy according to Dalhammar (2007) can be influenced by the policy development process, the need or cause for the policy and its stipulated purpose or objective.

The legislative framework is supported by a set of laws, regulations and standards established by government to address environmental issues by reducing or preventing pollution. The economic instruments can be implemented either to change behaviour by reducing pollution through the application of a tax, for example, or incentives to encourage innovation and development of appropriate solutions to address environmental problems. Information is provided to increase the awareness among the stakeholders and wider public and to support the implementation of the other policy instruments (Barde 1995, Field 1997, Tammemagi 1999, Sterner 2003).

Sustainability and the principles of sustainable development provide the basis for the development of any environmental policy. Environmental policy developed in the 1960/70's focused mainly on regulatory controls due to the emergence of environmental issues worldwide. Environmental policy aims to address a number of anthropogenic issues which can cause harm to human health and environment. The polluter pays principle, precautionary principle and principles related to waste prevention and minimization among others can be included in the policy framework (Barde 1995, Tammemagi 1999).

Waste generated from human induced activities if not managed properly can lead to environmental degradation as well as risks to health. Policies to address these issues in the waste sector can vary from country to country but in general it can be included in the broad framework of the country environmental policy or can be addressed as a separately issue.

The waste hierarchy (refer to Appendix 3) is propagated and has been used as a guiding principle for waste policies. It promotes prevention, reduction (minimization) as the most preferred options followed by re-use and recycle (and energy recovery) and finally environmentally sound disposal as the least preferred option. Waste prevention involves strict avoidance and reduction at source (OECD 2004). It refers to reducing the use of hazardous materials or avoiding toxic materials and conservation of resources at the time of processing to prevent the generation of hazardous waste resulting in reduce waste quantity during processing and in the use phase (Narayan 2001, Manomaivibool 2005). This practice not only leads to the protection of environment (through the generation of less toxic waste) but can also reduce the costs related to waste management for facilities (WHO 1999). The main emphasis of waste minimization is through source reduction by separating the waste types.

2.2.2 Waste Minimization

Waste minimization is a broad concept which encompasses several strategies and changes to induce environmentally benign attitudes and behaviour. It focuses on the entire life cycle by applying measures upstream - at the point of sourcing materials and systems processes, and

downstream at the point of end of life (WHO 2005). Thus, waste minimization includes waste prevention. The OECD (2004) defines waste minimization as *"preventing and/or reducing the generation of waste at source, improving the quality of waste generated such as reducing hazard and encouraging re-use, recycling and recovery"*. Source reduction is an important component of waste minimization and can be achieved in health-care facilities though separation of waste fractions at the point of generation. Waste minimization emphasizes waste segregation in order to separate the different waste streams and to ensure that each waste fraction is stored separately. Waste segregation must take place at the point of waste generation for it to be effective. It is important that the person generating the waste is responsible for its separation so as to contain it and prevent any secondary sorting. As a result, each waste stream can be treated separately, in particular the hazardous and infectious waste. Environmentally sound management (ESM)[22] can then be applied to the remaining waste for final disposal. Other strategies applicable to health-care facilities include strict operating practices, inventory for materials (purchase and waste type generated) and changing and/or substituting toxic products for non-toxic etc. (Emmanuel *et al.* 2004).

2.2.3 Environmental Policy Evaluation

Even though policies are created to address pollution and to influence changes in behaviour, the situation in reality can be the contrary. Implementation of these policies can be hindered by one reason or another. OECD (2000) states that waste policies may fail due to the lack of information and environmental awareness among the actors, understanding of the system within which they operate (systems thinking) and the lack of clear economic cost-benefit thinking. Sterner (2003) also supports these claims but from a general perspective in addressing natural resources. He further adds that policies are sometimes created by governments with conflicting interests (political and economical). However, these failures can be addressed and one way is through policy optimization (Sterner 2003). The method of evaluation can be applied to assess the status of implementation of the policy, gaps and whether it has achieved its goal or set objectives.

Evaluation is particularly useful in the area of public policy. The basic concept of evaluation is to assess the usefulness or value of the policy, plan or programme implemented by governmental institutions (Vedung, 1997). A number of different criteria were found in environmental policy literature however only the most relevant criteria were selected applicable to the case at hand. These refer to the extent of the policy achieving its objectives, the enforcement and whether the policy has been accepted by the wider stakeholder group. The criteria used in this thesis and as presented by Barde (1995) and Field (1997) are as follows:

- **Enforceability** refers to the ability of the institutions to monitor for compliance against standards and permits and to apply charges in cases where there is non-compliance.

- **Acceptability** refers to the extent to which the policy is accepted by the stakeholder groups (industries, public, authorities etc) since the institution developing the policy is different from the implementing institution.

[22] OECD (2007) working definition of ESM "a *scheme for ensuring that wastes and use and scrap materials are managed in a manner that will save natural resources, and protect human health and the environment against adverse effects that may result from such wastes and materials*".

- **Effectiveness** (environmental) is the extent to which the policy is able to achieve the intended objective or have a positive environmental outcome.

Field (1997) stated that environmental policy criteria for policy evaluation are based on several factors. First and foremost, one must recognize that polices are developed to achieve a particular goal or outcome for example pollution reduction followed by the ability of the policy to encourage innovative solutions to address the problem. Finally the implementation of the policy is based on its acceptance by those involved.

2.3 Analytical Framework

The solution to environmental problems is not straight forward due to the complexity of these problems and number of actors involved. Therefore it is pertinent to understand the context within which these problems occur. The application of systems thinking to health-care waste management assists in highlighting the complexity of these issues. The Viable System Model is a useful tool that guides the understanding of this complex system. The management functions of each element of the model links together forming the system structure and its viability depends on having all system components in place that exhibit characteristics or principles as explained in section 2.1.1. The intention is not to model the health-care waste management system using the viable system model but rather to guide the analysis along the lines of the five system components, listed in table 2-1, to understand its the interconnections of the various components, extent of involvement of actors and to examine their function or role. The health-care waste management system in this study excludes the upstream chain of resource and materials input. The system boundary encompasses the point of generation of waste from the hospitals and health centres inclusive of all stages to the point of disposal.

Table 2-1shows the VSM system structure and functional areas

VSM System structure	VSM functional areas
System 5	Policy (Norms)
System 4	Strategic development
System 3 & 3*	Control (optimize) & Auditing (monitoring)
System 2	Coordination
System 1	Operation[al]

VSM helps to understand the health-care waste management system in a structural format in order to have a systematic view. This holistic approach provides a full perspective of the interplay among the actors and interactions with the external environment. The VSM functional areas correspond to similar functionality in the health-care waste management system. It is pertinent to understand the principle of recursion in the health-care waste management system where each subsystem must include the five levels of system elements that correspond with its similar element at the next level.

The sustainability principles and policies are integrated and discussed within the functional areas of policy and strategic development. These principles and policies form the basis or provide the purpose for a sustainable health-care waste management system and a fundamental component of a viable system. The policy evaluation is discussed within the functional areas of strategic development, control and coordination in order to examine the system's ability to be monitored and regulated. The application of waste minimization (source reduction) through strategies for efficient separation of waste streams is applied at the operational level in the health-care waste management system. The operational level system consists of the generators (health-care facilities), collectors (waste) and waste disposal. Figure 2-3 represents the framework for the analysis showing only the functional areas of VSM within a hierarchal structure and key areas for analysis.

The fundamental assumption taken in the application of systems thinking to the health-care waste management system is based on institutions being able to understand their environment, the effect they can have on the external environment and the interdependence of each sub-system in order to ensure viability.

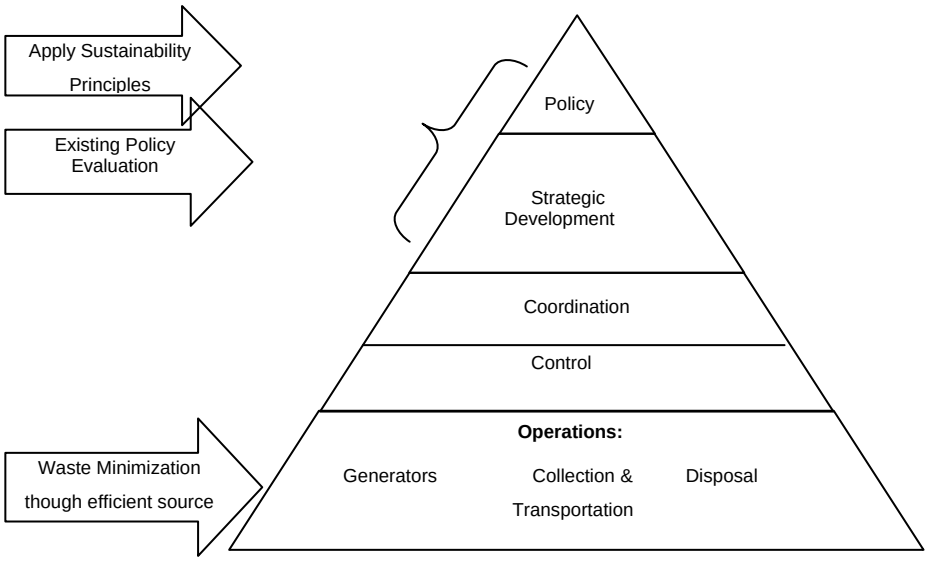

Figure 2-3 Analytical framework showing the functional areas and system hierarchy according to VSM.

3 The Dilemma of Health-care Waste

This chapter provides a general overview of the situation regarding health-care waste. The section describes international definitions and classification from the World Health Organization (WHO) and the adverse environmental and health impacts related to poor waste disposal practices. The chapter further elaborates on the organization of the health-care waste system in Lund and Malmö.

The very nature of health-care facilities such as hospitals and health centres is to protect human health and to prevent the spread of diseases while at the same time to improve the well-being of the population. Such facilities therefore have a moral right and a duty to the population where they serve to take all measures possible to secure the lives of people and to protect the environment. However, in reality the operation of these facilities are not free from negative impacts. Many such facilities generate waste in large quantities that affect the environment and human health if not managed using environmentally sound methods. Waste generated from health-care faculties is characteristically different from other sources of waste. Its unique properties (physical, chemical and biological) set it apart from the other waste streams and this constitutes a serious threat to the environment and human health. The risk is embedded in the infectious and hazardous nature of some of the constituents resulting in highly dangerous waste. This kind of waste is known to contain pathogens-viruses, parasites and bacteria that can accumulate in concentrations large enough to cause diseases in vulnerable hosts (WHO 1999)[23] and toxic compounds from hazardous chemicals and radioactive materials (Galtier & Békaert 2002).

3.1 Definition and Classification

The international definition of health-care waste proposed by the WHO (1999:2) covers *"all waste generated by health-care establishments, research facilities, and laboratories"* and classifies this waste into two main categories: "*non-risk general waste*" and "*hazardous health-care waste*". Both categories can be further classified into different waste fractions. The latter classification (hazardous waste) is further broken down into several sub-categories by WHO such as: *infectious waste*, *pathological waste*, *sharps*, *genotoxic waste*, *radioactive waste*, *pharmaceutical waste*, *chemical waste*, *waste with high content of heavy metals* and *pressurized containers*. The first five sub-categories are known to be highly hazardous waste and the first three will be further elaborated here. Infectious waste from health-care facilities contain pathogens and originates from laboratories example cultures, wards and operating rooms where materials contaminated with bodily fluids and any instrument or equipment in contact with infected persons. Pathological waste such as organs, tissues, fetuses, blood, bodily fluids and body parts[24] can also be considered as infectious wastes. Sharps consist of needles, scalpel, blades, knives or any thing that can cut, stab or create a puncture (WHO 1999).

3.2 Risk to human health and environment

The key problem areas along the waste chain are at the source of generation, collection and transportation (within the facility as well as out of the facility) and at the stage of disposal as a

[23] This waste includes materials originating from laboratory such as cultures, waste materials from operating rooms and surgery such as tissue or materials contaminated with blood, infectious waste from isolated patients and instruments used (WHO 1999: 2).

[24] Recognizable human body parts can be referred to as anatomical waste (WHO 1999).

result of the methods used. The issue of health-care waste is two-fold – there is a direct environmental effect from emission into the air, water, soil and this eventually feedback to affect the health of surrounding population and the direct transmission of pathogens from contact with any part of such waste.

At the source of generation, poor practices in handling of health-care waste can increase the transmission of disease to medical staff, waste handlers, patients and even the wider community. Transmission of pathogens can occur through several routes such as a cut or puncture from sharps, inhalation, and ingestion or contact with bodily fluid that act as a conduit for the transference of microorganisms into the human system (WHO 1999). Blood borne diseases such as HIV can be transmitted from an infected patient to a health-care worker through accidental needle stick injury. The WHO has indicated that there is substantial evidence to support the transmission of HIV, Hepatitis B and C viruses through contact with health-care waste. Furthermore exposure to the infectious and hazardous elements of health-care waste can lead to respiratory and gastroenteric problems, ocular infections and skin infections (WHO 1999, 2005). Thus, anyone in contact with health-care waste is at risk.

The ability for pathogens to survive in the environment depends on the microorganism itself, its environmental condition (temperature, humidity, organic matter etc.) and its resistance to those conditions (WHO 1999). According to the World Health Organization (1999), viruses such as the Hepatitis B and C can survive in different conditions. Hepatitis B can survive in dry air for several weeks and both strains of viruses can survive for a week on blood contaminated needle. HIV on the other hand, is not so resistant and can only survive at ambient temperature for almost a week (WHO 1999). Pathogens also evolve over time and due to environmental factors and in particular the effects of climate change, new strains of diseases (severe acute respiratory syndrome (SARS), Influenza H5N1, Lyme disease etc.) have materialized that have severe effects on humans (Townend & Vallini 2008). There is a potential risk for many countries particularly developing countries because of poor infrastructure and waste disposal practices. It is therefore pertinent to take precautionary measures to protect human health and environment, especially if there is some uncertainty of risk, high level of risk, or in the absence of information related to transmission of pathogens from infectious waste (Hassan, Ahmed, Rahman, Biswas 2008).

3.2.1 Environmental Management

The focus of many countries has been at the disposal stage for health-care waste. This end-of-pipe approach attempts to deal with the waste by applying various technologies, often, the cheapest option is selected. Common practices are dumping and incineration. Open dumping and landfilling increases the risk to the environment and human health. Wastes such as needles and sharps can puncture waste pickers and in the process transfer pathogens. Decomposition of waste release fumes and gases that contribute to air pollution. Other compounds are also released that leaches through the soil eventually finding its way into the water systems. Incineration has been historically applied as an option to manage health-care waste (Chaerul *et al.* 2008) but over the years many countries have been implementing other methods (Emmanuel *et al.* 2004). Incineration of medical waste emits dioxins, furans, heavy metals (lead and mercury[25]) particulate matter and other harmful pollutants. Even if measures are in place to reduce the emissions, pollutants still persist in the environment by transforming to the solid phase such as the ash or slag. Disposal of the incinerator residue still remains an

[25] Mercury can be found in equipment such as thermometers. It is imperative to handle and dispose these using environmentally sound measures to prevent it escaping in the environment and its effects on vital organs such as the brain and lungs.

issue and is frequently disposed by burying in pits or landfills. Thus, the heavy metals are released further contaminating the soil and water systems (Emmanuel *et al.* 2004).

Frequently found in developing countries are the De Montfort incinerators funded by international aid agencies to address the problem of waste disposal. It is small-scale, affordable and can be constructed locally using simple materials (Health Care Without Harm (HCWH) 2002). While this technology has been endorsed by aid agencies as a suitable method of disposing health-care waste, the environmental consequences have been ignored. The De Montfort incinerator requires constant maintenance for it to be efficient and needs constant monitoring to address issues related to poor combustion. Lack of maintenance can affect the required temperature for complete combustion and in the process contribute to the formation of dioxins and furans. This requires staff to be well trained to understand the requirements for operation and maintenance, identification of problem areas and ways to address these. However, the operation of the incinerator in developing countries is often the job of a low skilled person. Furthermore, the incinerator utilizes large amounts of fuel for operation and has no environmental control mechanisms to reduce the harmful content of the emissions and ashes (HCWH 2002).

Despite the intrinsic nature of the polluter pays principle requiring producers to take responsibility (legally and financially) to manage waste using methods that would reduce the impact on the environment and public health (WHO 1999), responsibility is often transferred to the disposal company to find ways to dispose of health-care waste (Chaerul *et al.* 2008) compounding the challenge of waste management. Furthermore, many countries lack the legal framework and standards for disposal to manage such waste.

To improve the situation, it is pertinent to shift focus and thinking from the 'end-of-pipe' approach to waste management. A structured system or framework approach through the integration of many different options is necessary. Environmentally sound management of waste will result in risk reduction within the health-care facility as well as outside the facility. In this way generators take the responsibility for the waste under the duty of care principle[26] to ensure the waste is not a threat to the environment and human health after leaving the premises (Johannessen, Dijkman, Bartone, Hanrahan, Boyer & Chandra 2000). The key element is source separation of the different waste fractions, in particular, risk or hazardous waste at the point of generation (Johannessen *et al.* 2000; Kaiser, Eagan & Shaner 2001; Karaca 2002). The application of source reduction is fundamental to an effective and sustainable waste management system and should go hand-in-hand with other approaches such as training for workers to ensure safety and waste accounting (recording the quantity of waste generated and allocation of finances for waste management).

In addition to improving the management of waste within the health-care facility, it is essential to select options for disposal that will not contribute to any added environment and health related burdens. As already noted in the preceding paragraphs, landfilling and incineration should be least options for waste disposal. In looking at viable options to manage waste considerations should be given not only to the resultant environmental effects of the disposal method and the proximity of the facility to population but also the quantity of waste produced and the nature or characteristics of these and finally to whether there are any other waste treatment facility in close range to the health care facility (WHO, 2005). The cohesive structure in the waste system is a strong policy and legal framework to support the health-care waste management system in order to ensure its sustainability.

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[26] The duty of care principle according to WHO (1999) states that "*any person handling or managing hazardous substances or related equipment is ethically responsible for using the utmost care in that task*"

3.3 Lessons from Lund and Malmö

Sweden has a decentralized health-care system. The legislation, policies, operational guidelines and principles are set by the Central Government and these are implemented by the local government consisting of the Regional Administration, County Councils and Municipalities. The County Councils through the Regional Administration and municipalities provide various services (health) to the population. Most of the financing for the provision of health-care comes from taxes while the government provides the remainder and a very small percent gained through patient fees. The Region of Skåne has the responsibility to provide health care to the population through the services of 10 hospitals and about 100 health centres of which Lund and the Malmö University Hospital are a part (Karlsson & Öhman 2005; Swedish Health-care 2007).

The Region of Skåne has a goal to ensure that all hospitals are implementing Environmental Management Systems (EMS) by 2009. This is in keeping with the Swedish EMS Directive that stipulates all public institutions must implement the fundamental elements[27] of EMS (Sammalisto 2007).

3.3.1 Lund University Hospital

The Lund University Hospital (LUH) is the oldest hospital in the Region of Skåne and serves a population of 105,286 according to the 2007 population statistics (Statistics Sweden 2007). In addition to health care, the hospital is integrally involved in research and education. The hospital has an in-patient capacity of approx. 1,176 beds and out-patient services of 72,000 (Lund University Hospital 2007). In a day the hospital serves approximately 870-inpatient, 2,900 patients through clinics, performs 710 X-rays, carries out 120 operations and delivers about 10 babies (LUH 2007) leading to the generation of a significant amount of waste. Waste is classified into 2 general categories; general and risk waste according to the hospital procedures (Holm 2008). General waste is further broken down into fractions such as food, glass, paper, confidential waste, plastic, metal etc. Risk waste is further broken down into solid fractions such as sharps, infectious waste etc. chemicals and contaminated liquid waste. Environmental issues are important to the hospital and are managed through an environmental management system. The Hospital is currently pursuing ISO 14001 certification and intends to have it in place by the end of 2008 or early 2009 (Holm 2008; Nelsson 2008). Its main environmental objective for the period 2006-2008 is to *"reduce wastage of drugs, reduce the use of harmful chemicals to health and environment, improve waste sorting at source, increase recycling of waste and reduce energy consumption"* (Lund University Hospital 2007).

3.3.2 Malmö University Hospital

The Malmö University Hospital (MUH) provides a range of service to the 280,801 residents (2007 population statistics[28]) and surrounding areas. It is included in the WHO network for "health promoting hospitals" and can treat over 2000 patients on a daily basis. The hospital has a daily in-patient capacity of about 50,000 persons and can facilitate about 24,000 persons in surgery (Karlsson & Öhman 2005). As part of the overall drive by the Region of Skåne to have all hospitals certified by ISO 14001, MUH has been assiduously perusing certification and expects to have this in place before the end of 2008. The classification of waste is similar

[27] These are the environmental policy, important environmental aspects, environmental objectives, manageemnt commitment (Sammalisto 2007).

[28] www.scb.se

to that of the Lund University Hospital – general or non-risk waste and risk waste. General waste has several waste fractions and consisting of materials such as paper, glass, plastic, metal for recycling and combustible waste such as food. Both the general and risk waste fractions are further broken down and separately reported. Risk waste, aside from the solid fractions of sharps and contaminated materials also include detail list of chemicals, instruments, electronic scrap and batteries. Separation of waste at the MUH started in 1995. Until recently (2006) electronic waste was included as part of the general waste (MUH 2006).

3.3.3 Organization of the Waste Management System

Both LUH and MUH have in place detailed procedures for its operation inclusive of dealing with environmental issues and specific to waste generation, sorting, handling and storage. The system is organized in such a way to achieve general reduction of waste by volume and in particular toxicity as it relates to risk waste. The environmental policy of both hospitals specifies waste sorting and the packaging of waste in secondary containment to prevent contamination while handling (Holm 2008; Bengtsson2008). Moreover, as a policy, the hospital communicates the information regarding efficient sorting and storage to all staff. Information in relation to cost, waste types and quantities are recorded and form a major part of the management system to ensure effective sorting and reduction of waste. Classification and definition of waste is pursuant to the Swedish Rules as well as procedures regarding waste handling and labeling.

3.3.3.1 Standard and Regulation

The broad classification system for health-care waste implemented by the municipalities is general waste, hazardous waste and waste for recycling (Wallin 2008). A number of laws address issues relating to waste particularly hazardous waste and there is a specific regulation that provides guidance on the disposal of infectious waste (Wallin 2008). Specific to waste from hospitals, the National Board of Health and Welfare (NBHW)[29] stipulated the Regulation and Guideline (SOSFS 2005:26) on the Disposal of Infectious Waste from Swedish Health Services. The regulation replaced the previous regulation and guideline (SOSFS 1999:27) developed by the National Board of Health. This regulation covers specifically *"disposal and labeling of infectious waste generated by activities covered in the Swedish Health and Medical Services Act (1982:736) and Swedish Dental Care Act (1985:125) or by other medical facilities"*. It further includes the definition of infectious waste, details on *'responsibility'*, *'pre-treatment'*, *'collection'* and *'transportation'* of the waste from the facility (NBHW 2006).

The regulation stipulates the need to develop and implement procedures for waste handling and assigning responsibility for waste management within the health-care facilities. The regulation further mandates that waste should carry the international symbol for biological hazard as well as the words *"infectious waste"* or *"sharp-edged or sharp-pointed waste"* (for sharp waste)(NBHW 2006).

Health-care facilities are mandated by the legislation to pre-treat infectious waste before disposal. Even though the legislation allows flexibility for the facilities to select options suitable to the situation, it also identifies the use of autoclaves, microwaves and other treatment methods. Infectious waste not treated, according to the regulation, shall be incinerated (NBHW 2006).

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[29] The Swedish Waste Ordinance, Swedish Government Ordinance and the Infection Control Ordinance authorize the National Board of Health to develop guideline and regulations as part of its function.

3.3.3.2 Generation and Sorting

In both hospitals waste is sorted at source by fully trained staff and separated into different fractions. All sharp materials, materials contaminated with bodily fluid, chemicals and pharmaceutical products, radioactive materials are classified as risk waste. A colour coded system for the sorting of waste is applied. Depending on the hazardous or infectious characteristics, waste can be further packaged in special colour coded secondary containers by cleaners[30]. Containers are then labeled to indicate waste type and its origin (ward or department) according to the hospital procedure and policy, taped (sealed) and transported for temporary storage in designated areas. However in the case of MUH, only the sharp containers are labeled. Needles are not separated from syringes and containers used to store (needles) are large enough to fit horizontally.

3.3.3.3 Collection and Storage

Waste is stored at designated areas or transfer stations within the hospitals. There are approximately 40 such stations around the Lund hospital complex for the storage of waste. Each fraction is stored in a separate section in the storage room, awaiting removal by waste handlers in both hospitals. There is a special section for risk waste. In particular, LUH has a system that if the handlers notice some discrepancy in the packaging (incorrectly packaged or labeled), contact is made with the respective department or section to have the matter corrected (repacked or labeled) before it is removed from the transfer station. The waste is then transferred to the designated area for pick up by the disposal company.

Waste for recycling and general waste is stored separately. Compartments are located along the corridors for the storage of plastics, glass etc. and other materials to be recycled.

Waste is removed every 24 hrs and in the MUH hazardous waste is placed in cold storage at a maximum temperature of +8ºC.

3.3.3.4 Transportation, Handling and Disposal

Waste is transported from the transfer stations to the main collection point of the hospital complex to be picked up by the disposal company. The transportation route for the waste is completely separate from the rest of the hospital. The equipment used, such as carts, to move the waste is designed to avoid spillage and easy to clean. Only the generators and waste handlers (cleaners) and the handlers from the internal transportation department are in contact with the waste. Materials are manually collected from the transfer stations but transported using carts and other similar vehicles. Handlers use protective gears to prevent direct contact with the materials.

At the collection point risk waste is further packed in cardboard boxes and sealed to prevent any leakage or contamination. Risk waste is collected on a daily basis at the LUH by separate trucks and transported for incineration. A freezer is on hand at the MUH to store risk waste beyond 48 hours since collection is three times per week. Glass, plastic and other material waste is collected for recycling.

[30] This is not the same for all the cleaners in the Lund University hospital; the extent of the cleaners' responsibility in packaging waste differs by section and department. In some cases, the assistant nurse takes the responsibility of packaging waste and must be labeled in accordance with the procedure.

3.3.4 Summary

The drive by the Swedish Government to ensure its public sector is committed to improve environmental management in an effort towards sustainable development is emulated in the way these hospitals are organized. The legislation and standards are in place to address health-care waste from hospitals. The regulation provides definition of waste and responsibility for key persons within the facility. It also provides details for storage, handling and transporting waste.

Both hospitals are pursuing ISO 14001 certification. Environmental management is an integral part of the organization with separate section having this responsibility and commitment by management. There is a detailed system of classification of waste and procedures for handling as well as targets for waste reduction (both for volume and toxicity). Both hospitals have environmental policy in place.

The system of separation, collection, handling, transportation and storage is well organized in both hospitals. The transfer stations are designed to allow for separate storage of the different fractions. Separate routes are used for the transportation of waste from the transfer points to the waste collection area to avoid unwanted contact with patients, staff or other persons as well as to reduce moving waste through clean areas.

4 Health-care Waste Management: The Case of Guyana

The following chapter describes the current situation of health-care waste in Guyana. The description of this chapter follows the functional structure of VSM (table 2-1, section 2.3) as represented in the analytical framework in figure 2-3. The policy framework as discussed provides the overall context of the health-care waste and the normative framework in place to address these issues, if at all. The institutional arrangement to manage health-care waste is also discussed to provide a background of the interactions of the agencies and issues related to the management of health-care waste. At times, reference is made to solid waste since the institutional arrangement is the same. Further, an overview of the solid waste management system is present to provide insight of the situation in the wider context. The organization of the waste system by the hospitals and health centres and initiatives taken by the institutions to address the issues related to health-care waste are further elaborated.

4.1 Policy Framework

There is no separate national policy for health-care waste (or solid waste for that matter). Conflicting information arose with regard to whether a draft national solid waste policy exists. A few documents refer to the draft policy prepared by the Ministry of Local Government and Regional Development around 2001. This policy was never finalized or implemented. The draft policy according to PAHO/WHO (2004) is not an umbrella policy for the development of solid waste management but outlines the activities to be undertaken and does not provide any responsibilities or timeframe. However, the Ministry counters the existence of such document and the Municipal Solid Waste Management Department has indicated that a draft solid waste management bill has been prepared during that time (Urlin 2008). The draft bill is still with the Ministry of Legal Affairs.

In addition, waste issues are not separately managed by one authority but integrated into many functional areas of several agencies. These issues are covered under the general context of environmental issues with the Environmental Protection Agency (EPA) having a coordinating role for waste management. Therefore within this context, it is necessary to examine the environmental policy to understand the proposal made for waste management. Figure 4-1 provides a graphical representation of the context of health-care waste within the wider system of environmental management in Guyana.

The policy framework that guides government agencies towards achieving a particular environmental quality by 2010 has been prescribed in the National Development Strategy. The environmental policy's overall objective is achieving sustainability by *"promoting sustainable management of natural resources and preserve a healthy environment"* (NDS 2000). The policy has its basis in the National Environmental Action Plan (1994) and the

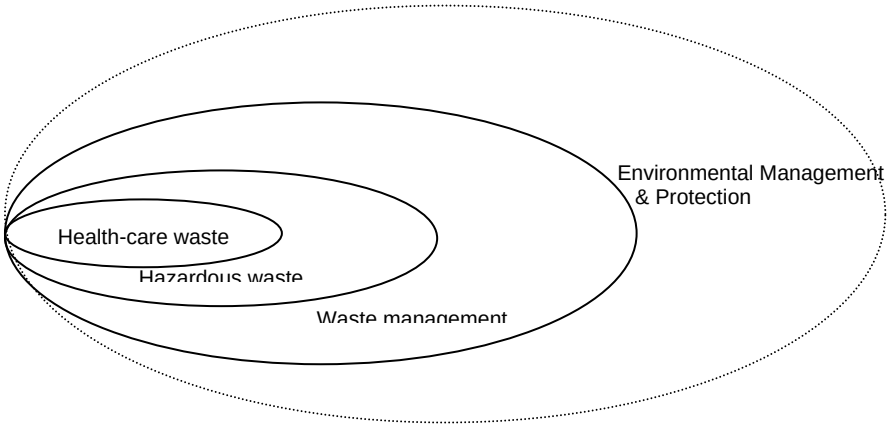

Figure 4-1 the health-care waste management system in context of environmental management in Guyana

Environmental Protection Act 1996. A greater part of the responsibility for implementing the policy lies with the EPA. The main objectives outlined in the environmental policy for Guyana as are as follows (NDS 2000):

- *"to contribute to the process of* ***improving living standards through the environmental health dimension****";*
- *"to ensure that the natural resource base for economic growth continues to be available in the future";*
- *"to widen the dimensions of our living standards through the conservation of unique habitats, natural treasures, biodiversity and our cultural heritage"*

Nine broad areas are covered by the policy addressing several issues. Waste management and pollution control is included as one of the nine areas and therefore is an integral part of the environmental policy. The policy further bestows the EPA with the responsibility of developing waste management programmes (for specific pollutants) particularly in the urban areas and coordinating solid waste management (NDS 2000).While the environmental policy makes reference to solid waste management and hazardous waste in particular, health-care waste has not been explicitly addressed. These issues are embedded in the overall framework of the waste management and pollution control section[31]. The policy stipulates that priority will be given by the government to address the issues affecting public health (NDS 2000).

The regulatory framework for solid waste management in general exists in several legislations. The Environmental Protection Act no. 11 of 1996 defines a comprehensive framework for environmental management. It includes policy development and standard setting, monitoring and enforcement, and developing and issuing guidelines and licenses (PAHO/WHO 2004). The Public Health Ordinance Act Cap 145 Laws of British Guiana 1953 edition, passed in 1934, has been in use by the municipalities and regional administration for the management of solid waste and provides the basis for the municipal by-laws. The by-laws provide the scope of operation for the municipalities and regional administration (PAHO/WHO 2004; Monteiro 2008a).

The regulatory framework for health-care waste is stipulated in the Environmental Protection (EP) (Hazardous Waste Management) Regulations 2000 and the Health Facilities Licensing Regulations 2008. The EP Hazardous Waste Management Regulations 2000 defines health-care waste and provides the regulatory framework for authoring and managing of hazardous waste. The Health Facilities Licensing Regulations 2008 serves as the mechanism for licensing health-care facilities and outlines the standard operating procedures for these facilities.

4.2 Institutional Arrangements

The responsibilities for solid waste are integrated into a number of government ministries and the municipalities. The responsibility for primary health care rests with the Ministry of Health in addition to making policies related to health-care, setting standards, permitting private facilities, monitoring and evaluating its vertical health programs etc. These are implemented through different programmes executed by various departments (NDS 2000; MoH 2004; PAHO 2007).

[31] This section covers liquid, solid, agricultural, ship generated waste and industrial and other waste. The lack of information on the quantity and characteristics of waste generated still persists as the main constraint today. However the policy noted that potential hazardous waste generated from industrial activities were disposed in the dump site in Georgetown (NDS 2000).

The Ministry of Health

The Ministry of Health, aside from providing primary health-care through its different programmes implemented by the various departments, also provides technical advice to the municipalities and administrative regions in relation to waste management. The Environmental Health Unit (EHU), a functional department of the MoH with regional representatives has the responsibility to facilitate technical guidance. Each Environmental Health Officer is responsible for a public health district[32]. However, for a number of years the Environmental Health Unit has been functioning without a head of department. Over the years the Unit slowly dissolved until 2007 a head of department was appointed to revive its functions. The EHU through the implementation of the Public Health Ordinance coordinates the activities of the Environmental Health Officers in each Administrative Regions. Each officer manages a specific area in the Region and is responsible for providing technical advice and guidance to municipalities, individuals (approving sanitary facilities, waste management options etc) and other industries/businesses in these areas. All environmental health matters are managed by the EHU, a function made possible through a Memorandum of Understanding between the Environmental Protection Agency and the Ministry of Health (PAHO/WHO 2004; MoH 2004).

The regional health service department coordinates with the Regional Health Officer located in the respective administrative regions. The department also allocates staff, develops standard operating procedures for the hospitals and health centres in the regions and supervises the quality of health services (MoH 2008).

National Oversight Committee

As part of the Ministry of Health strategic development in the health sector a national health plan (2003-2007) was prepared. Sexually transmitted infection (STI) - HIV/AIDS is listed as a priority area which led the Ministry to focus on needle use, disposal and substitution, where applicable, of oral medication instead of injections. This led to the formation of a Medical Waste Oversight Committee with responsibility to, among other things; develop health-care waste guidelines in Guyana. Representatives from various sector agencies as well as PAHO are part of the committee. Unfortunately, the level of priority given to the committee has been minimal even though the Guyana Safer Injection Project has prepared a draft operational guideline for the handling and disposal of health-care waste (Anderson 2008; Lewis 2008; Sookdeo 2008). Scheduling of meetings was noted to be irregular since it depends on the availability of the Chief Medical Office (CMO) (Lewis 2008; Sookdeo 2008). The draft guideline is generic for health-care facilities and includes areas such as waste classification and separation, procedures for handling, storage and disposal of waste. Before this guideline can be implemented it has to be approved by the Ministry of Health.

Materials Management Unit

The reform of the Ministry of Health as part of the Health Sector Reform programme (1999-2005) led to the establishment of the Materials Management Unit (MMU) to improve the system of procurement and supply of medications to the various health facilities. The MMU provides service to the MoH under contractual agreement (MoH 2000).

The Ministry of Local Government and Regional Development (MoLG&RD)

The Ministry of Local Government and Regional Development through its local administration is responsible for solid waste management. This function is administered through Regional Democratic Councils (RDC), Neighbourhood Democratic Council (NDC)

[32] A public health district consists of a number of villages.

and municipalities. The municipalities and RDCs/NDCs collect waste directly and at times contract private disposal companies. There were cases of regional authorities engaging in illegal dumping and burning of waste (Municipal Solid Waste Management Department 2006). In Georgetown solid waste management is the direct responsibility of the Public Health Department (PHD) of the Georgetown Municipality and to some extent the Engineering Department. Waste is collected and disposed by the public health department while the engineering department is responsible for the cleaning of drains and canals (IDB 2002). Additionally, the Georgetown Municipality is responsible for the management of the Mandela waste disposal site. The Ministry provides financial support to the municipalities and RDCs for their activities including budgets for managing the health centres and hospitals (PAHO 2007). The regional bodies have the responsibility for health care within the region. Each Region has a Regional Health Officer. The officer reports to the regional authority and to the MoH on technical matters (as well as receives technical guidance from the MoH). Despite the Ministry of Local Government and Regional Development having the responsibility for waste management, the roles and responsibilities of the RDCs and the NDCs in executing this function is not clear. The RDCs and NDCs depend exclusively on the support and direction of the central ministry (NDS 2000; PAHO/WHO 2004).

Environmental Protection Agency

The Environmental Protection Agency (EPA) has the overall responsibility for environmental protection and management and was established under the Environmental Protection Act (1996). The Agency became operational in 1998 and coordinates with a number of sector agencies and stakeholders in executing its responsibilities. Environmental issues were shared between the Ministry of Health (MoH) and the Ministry of Agriculture prior to 1996. The MoH Environmental Health Unit (and Regional Environmental Health Services) managed environmental health and pollution control. However, some operational aspects (and structure) still remained within these ministries, in particular, environmental health. The EPA thus coordinates through memorandum of understanding with the MoH.

The EPA has a crucial role in the area of waste management. It is directly responsible for administering and regulating the management of waste, setting parameters for waste management systems and permitting landfill sites and other methods of disposal. Moreover, the Agency is in charge of developing regulatory frameworks, monitoring and enforcement, regulation of discharges from facilities, standard and guidelines development, control of pollution (PAHO/WHO 2004).

Guyana National Bureau of Standards

The Guyana National Bureau of Standards works in collaboration with the various agencies to develop standards. Specifically in the development of environmental standards, the Bureau collaborates with the EPA.

Pan American Health Organization

The Pan American Health Organization (PAHO) collaborates with the Ministry of Health in areas of environmental health and sanitation. PAHO supports in areas of pilot projects, policy development, technology transfer and provision of technical information. Currently PAHO's medical waste strategy is limited to needle use, safe and environmentally sound solution for disposal.

4.3 The Solid Waste Situation

Before describing the situation regarding health-care waste it is necessary to present a brief narrative of the issues related to solid waste management to better understand the intricacy of

the health-care waste management system; given that health-care waste management is part of a wider system as outlined in figure 4-1.

Solid waste management continues to be a challenge in the country. The lack of clear roles and coordination among the various ministries and responsible agencies contributes to this mismanagement.

Efforts have been made over the years to improve the situation; however, the institutional capacity of the respective agencies serves as a deterring factor added to high project/external support. And as a consequence, institutions fall into the trap of inertia. Financial resources allocated by Central Government at times are not sufficient for effective functioning of the institutions. To that end, institutions find it necessary to source external funding through projects, donation or loans to fill the gap and to implement programmes or to address particular issues and to even facilitate some operational aspect of the institution. Many such 'situations' are short term or focus on one particular area.

The Environmental Protection Agency's working definition considers two broad categories for waste[33] - municipal solid waste and special waste. Municipal solid waste (MSW) includes non-hazardous waste originating from households, commercial enterprises, industries, institutions, agricultural and sewage sludge while special waste encompasses hazardous waste, clinical waste, aircraft waste and ship generated waste. The Georgetown Municipality further includes in the understanding of municipal waste – abattoir and market waste, trees/wood, construction and demolition waste and street and drain cleaning (PAHO/WHO 2004).

Enforcement against illegal dumping is lacking even though the basis for monitoring and enforcement at the regional level is set in the municipal laws. A systematic collection and disposal system in many areas is absent resulting in high level of unfettered or illegal dumping. At times even a few regional authorities were associated with burning of waste in open dumps (Monteiro 2008a).

The quantity of solid waste generated in the various regions is based on estimates due to the lack of empirical data. Additionally, little or no information is available regarding characteristics of municipal waste. Private disposal companies contracted by the municipality provide about 95% of the services for the collection of MSW in Georgetown while the Georgetown Municipality takes care of the remaining 5% from specific areas in the city and includes the collection of clinical waste, abattoir and market waste. Infrequent collection of waste by private disposal companies and the Georgetown Municipality occurs since the municipality lack adequate financial resources (to pay private contractors on time) and equipment. There is no specific cost recovery for the services provided for waste collection and where fees are charged it is on an irregular[34] basis and set by the municipality and local government[35] (PAHO/WHO 2004). The main disposal site -Mandela dump site[36] is an open-air dump. It has long outlived its capacity and is now encroaching on the La Repentir

[33] Outlined in the criteria for identification and approval of landfill sites for solid waste disposal in Guyana (PAHO/WHO 2004)

[34] The fees charged in Georgetown directly relates to fees for the disposal of waste from hospitals, disposal of waste such as asbestos, expired pharmaceuticals and food products, oily waste etc. and fees from companies for the payment of disposal services (PAHO/WHO 2004).

[35] In principle this cost is somehow factored in to the property tax payable to the municipality and local government (RDCs & NDCs). It does not take into account the volume generated and the setting of this 'tax' is on an ad hoc basis.

[36] The Mandela dumpsite is the only disposal area in the city. It is located in the city and according to the author's experience, west of Mandela Avenue hence the name 'Mandela dumpsite'.

Cemetery (the largest burial site in the city) (IDB 2002). In the remainder of the country the Regional Democratic Councils of the various regions through their Neighbourhood Democratic Councils (NDC) have the responsibility for waste collection and disposal. In many areas the NDCs lack the capacity for adequate collection of waste in a timely manner resulting in many households and industries burying, burning or illegally dumping waste.

4.4 The Health-care Waste Situation

The Ministry of Health (MoH) has the overall responsibility for providing primary health care in the country and ensuring effective management of the health-care system. The majority of the health-care facilities are public and the Ministry has responsibility either directly or indirectly for management. A few health centres in the city are under the management of the Georgetown Public Hospital Corporation and a few located in Regions 3, 4&6 belong to the Guyana Sugar Corporation (GUYSUCO)[37]. The Ministry's strategic approach for the provision of improved health care as outlined in the national health plan 2003-2007 is to strengthen the lower level services (at health posts, health centres, district and regional hospitals) and to increase access to the populace. The intention is to prevent the by-passing of these immediate services so as to reduce overcrowding at the national hospital (MoH 2003; MoH 2004).

Approximately 315 health-care facilities can be found throughout Guyana with a total of 2,187 beds (MoH 2004). PAHO has estimated the total quantity of health-care solid waste generated per region in Guyana. This estimation was conducted based on the WHO weight/bed/day ratio using the average of 3kg/bed for developing countries in Latin America and Caribbean region. To estimate the amount of hazardous content of health-care solid waste in Guyana, PAHO used the WHO 25%-40% minimum and maximum range for hazardous waste content (depending on the rate of separation). PAHO estimated on a daily basis a total of 6,561kg/day health-care solid waste generated. The hazardous content of this total ranged from 1,640.25 - 2,624.40 (PAHO/WHO 2004). However, in 2004 the Ministry of Health re-estimated the total quantity of health-care solid waste. As a result it was found that Guyana generates a total of 4,898.7kg/day health-care solid waste. The difference in the latter estimation is the use of the average daily quantity generated by the Georgetown Public Hospital (with 601 beds) as a baseline. This baseline of 1350kg/day resulted from the estimation made by PAHO in 2003 for the Georgetown Public Hospital. The Ministry estimated a rate of 2.24kg/bed/day generated by the Georgetown Public Hospital which was then used to estimate the total amount of health-care solid waste for facilities across Guyana (MoH 2004).

In both cases Region 4 is the largest generator of health-care waste followed by Region 6 and Region 3. For the purpose of this thesis, the estimation made by the Ministry of Health in 2004 will be used as it is closer to the actual situation. An estimated total amount of **2130.2 kg/day** health-care solid waste is generated in Region 4 and **409.9 kg/day** in Region 3. Hazardous waste from health-care facilities in Region 4 ranges from **532.5 – 853.1 kg/day** (25-40%) and Region 3 as **102.5-163.9** (25-40%) kg/day. Table 4-1 provides an overview of the estimated amount of health-care waste generated per region. The total amount of hazardous health-care waste generated per day varies from 1230 kg to 1960 kg per day (MoH 2004).

[37] Guyana Sugar Corporation is responsible for the cultivation of sugar cane and the production of sugar. Free medical care is provided to its workers and their immediate family as part of the workers benefit. GUYSUCO therefore owns and operates 19 health centres and dispensaries to provide health-care services for its workers (NDS 2000).

Table 4-1 showing the estimated amount of health-care solid waste per Region

Regions	Total number of hospital beds	Hazardous waste (kg/bed) (25%-40%)*		General Waste (kg/bed) (60%-75%)*		Total waste (kg/day)
		25%	40%	60%	75%	
1	85	47.6	76.2	114.2	142.8	190.4
2	107	59.9	95.9	179.8	179.8	239.7
3	**183**	**102.5**	**163.9**	**307.4**	**307.4**	**409.9**
4	**951**	**532.5**	**853.1**	**1,278.1**	**1,597.7**	**2,130.2**
5	37	20.7	33.2	49.7	62.2	82.9
6	554	310.2	496.4	744.5	930.7	1240.9
7	56	31.4	50.2	75.2	94.1	125.4
8	28	15.7	25.1	37.6	47.0	62.7
9	40	22.4	35.8	53.8	67.2	89.6
10	146	81.7	130.8	196.2	245.2	327.0
Total	**2,187**	**1,224.7**	**1,959.5**	**2,939.2**	**3,674.0**	**4,898.7**

Source: Ministry of Health (2004) ***** WHO minimum - maximum range

Definition

Health-care waste is divided broadly into infectious and general (non-infectious) waste by most health-care facilities as part of this study. On the other hand, it is classed under the general definition of **hazardous waste** depending on its hazardous content or infectious characteristics according to the Guyana Environmental Protection (EP) (Hazardous Waste Management) Regulations 2000. The Regulation categorized this type of waste (from health-care facilities) as **clinical waste** and is defined as:

> *"(i) any part of the human body including tissues and bodily fluids, but excluding fluids, extracted teeth, hair, nail clipping and the like that are not infections; (ii) any part of the carcass of an animal infected with a communicable disease; (iii) non-anatomical waste infected with communicable disease; or (iv) any waste that is generated in the diagnostic, treatment or immunization of human beings or animals and related activities that include research or autopsies;"*

Moreover, the regulation further narrows the definition of waste from health-care facilities, separately classed as **medical waste** and defined as ***"any waste that is generated in the diagnostic, treatment or immunization of human beings"***. Thereby, classifying medical waste under the category of clinical waste, however, the regulation does not provide any detail classification of the various waste streams. Many persons working in this field were not aware of the EP Hazardous Waste Management Regulations 2000 and its inclusion of health-care waste, a notable observation made during this study.

As a consequence the Guyana Safer Injection Project (GSIP) developed and implemented a system to categorize waste. This is currently in use by most health-care facilities based on the three categories (GSIP 2008):

1. **Infectious waste**- for example, bandages, gauze, blood, IV lines, vials etc. These are placed in **red bags** in containers with covers or pedal foot bins.

2. **Non-infectious or general waste**- for example, paper, bottles, food, cans. These are placed in **black bags** in ordinary containers.

3. **Sharp waste** such as needles, infusion sets, scalpels, broken glass, retractable syringes, blades. Sharp boxes are either yellow or white cardboard boxes or red plastic bottles.

This categorization system was developed as part of a five-year project funded by the USAID (further elaboration is provided in section 4.2.4.1) and implemented by GSIP through their education and awareness program. The focus is on the public hospitals and health centers. Private hospitals were not a part of its training programme, although some health centres owned by the Guyana Sugar Corporation (GUYSUCO) benefited from training.

Approximately 32 hospitals[38] in total can be found in Guyana with the majority located in the city of Georgetown (private and public). The Georgetown Public Hospital Corporation is located in the centre of the city (it is the only public hospital in Region 4) while the private hospitals are scattered around the city. Only public hospitals can be found in the remainder of the country, two on the coastal area of West Demerara with the West Demerara Regional Hospital being the main hospital in Region 3. Health centres are widely dispersed across the country and the number of centres varies in each region. Public hospitals and health centres provide free services to the general public.

4.4.1 Hospitals

Public and private hospitals are found in Georgetown and only public hospitals in the West Demerara area. Private hospitals obtain an annual operation license from the Ministry of Health. The quantity of waste generated by hospitals is proportional to the size of the hospital and the services provided. The Georgetown Public Hospital (GPH) is the largest in the country and the hospital that generates the most waste per day (MoH 2004).

Procedures & Responsibility

Hospitals have written procedures relating to standard operating practices for the provision of health services. One particular private hospital included as part of its procedure the separation of needles and sharps and stressed the 'no recapping' of needles rule (Hinds 2008). At other private hospitals, written procedures were lacking or not fully developed as far as the author was aware. These hospitals were reluctant to provide such documents for perusal. Standard operating and handling procedures were in place for two out of the three public hospitals. At one hospital the procedures were in draft format and not available and this hospital has started to prepare a waste management plan (Rachpaul 2008), the other hospital only referred to handling of needles and in the latter case the respondent was not aware of any procedure. Occupational health and safety officers were employed only within the GPH and one private hospital. In all the other hospitals, matrons[39] were responsible for occupational health and safety matters and in particular waste separation. There is a general lack of awareness of environmental issues related to the operational activities in the hospitals waste management in particular. Health and safety was found to be the main focus and in particular safety from accidental needle or sharp injury. All the respondents in hospitals were not aware of the

[38] Figure obtained from Ministry of Health Statistical Unit (2008) and it includes both private and public hospitals where public hospitals are at the Regional (large hospital servicing the entire Region) and District hospitals (smaller hospital servicing the District of 10,000 inhabitants or more) levels (NDS 2000).

[39] Matron is a designation given to a head nurse in hospitals.

environmental issues related to improper disposal of health-care waste or the consequences related to open burning, dumping or incineration of waste.

Waste Classification

Each hospital as part of this study has its own understanding for classifying waste. These hospitals considered a classification of hazardous- non-hazardous; medical-domestic; general-domestic- medical. But in principle the understanding exists among health-care workers that materials contaminated with bodily fluids pose a serious health risk and should be treated as infectious (hazardous) waste. With the exception of the GPH, categories were not stipulated as part of the hospital procedures. The GSIP waste categories (refer to Appendix 4) were provided in poster format and have been placed in the public hospitals to increase the awareness of nurses and doctors for waste separation.

Sorting and Storage

Waste separation is a recent phenomenon for hospitals. Since health-care workers benefited from training administered by GSIP, some level of waste separation has been implemented in the hospitals. Private hospitals started to separate due to influences from the Ministry of Health. In addition, some health-care workers at management level from public facilities are now employed with private facilities thereby facilitating knowledge transfer of waste separation, even though it is limited to needles and sharps. In general, it was found that waste is separated into the three categories – infectious, non-infections and sharps in all the hospitals visited as part of this study. The system promulgated by GSIP encouraged health-care workers to place infectious waste in red bags, non-infectious waste in black bags and sharps in sharp boxes (yellow or white cardboard boxes or red plastic bottles). However, the GPH has advanced its sorting by separating dietary waste (kitchen & food waste) from general waste. Dietary waste is placed in white bags. The West Demerara Regional Hospital (WDRH) attempts to separate its paper waste but on an ad hoc basis. This hospital and one private hospital also have special storage containers for food waste within the wards.

Representatives from three out of four private hospitals[40] and even the public hospitals in Region 3 mentioned that availability of red bags is an issue. The shortage of bags (bin liners) resulted from irregular delivery and late request made by public facilities (procurement of bags) in Region 3. Cost is the main constraint deterring its use in private hospitals. Black bags were cheaper to source and used to store infectious waste. It is a common practice in private hospitals to find the use of black bags for waste as well as improvised sodium hypochlorite[41] (household bleach) containers used as sharp containers. Similar practices can be found in public hospitals if sharp boxes were unavailable. Even though there is some degree of waste separation, it is still challenging for these hospitals.

In the past both infectious and non-infectious waste along with needles and sharps were placed together by public hospitals for disposal. The practice, until recently, was the same for the private hospitals.

Collection and Handling

[40] Representative of the fourth private hospital claimed it was not an issue for this hospital (Narine 2008).

[41] Household Bleach is a common disinfectant used in health-care facilities. It is a 3-6% concentration of sodium hypochlorite (NaOCl) solution.

Both sharp boxes and bags must be removed for disposal once 75% limit of storage capacity has been achieved. All facilities undertake to remove infectious waste on a daily basis sometimes twice per day from the wards. Where improvised bottles were used for the collection of sharp waste, these were capped and labeled (to contain sharps) before removal from wards. One private hospital used household bleach containers exclusively in the wards but sharp containers were used only in the laboratory (Narine 2008).

The cleaners have the responsibility to remove waste from the wards of the GPH. It is transported by porters using small carts and containers to the central temporary holding compartments for further removal to the permanent storage area. Sharp boxes are usually sealed, taped, placed in bags and transported to the storage area to be collected along with infectious waste. The permanent storage area is compartmentalized to store infectious waste, general waste, sharps and dietary waste separately. Each area is labeled for a specific waste fraction and can be accessed separately by collectors and handlers. The estimated total storage capacity of the compartment is approximately 40-50 bags per day. On a daily basis the hospital generates an average of 50-70 bags (capacity ~23 kg) (Rachpaul 2008) thus exceeding the storage capacity and over crowding of some compartments. There is a risk of mixing with general waste if black bags are used to store infectious waste. Collectors not being aware can confuse this waste with general waste thus, mixing of the waste stream. Bags placed in these compartments were not sealed or tightly secured resulting in spillage. At the time of visiting, materials such as needles, gloves, contaminated petri dish, blood contaminated waste and food waste were observed in the storage compartment for infectious waste. The author was informed that these materials will be collected by the cleaning staff and placed in red bags for disposal (Rachpaul 2008). At the time of visiting the hospital, the municipality was collecting infectious waste and from observation, the bag was open. Cleaning the storage area is undertaken once the waste has been removed and any remaining solid materials will be placed in bags. However, the liquid waste, even if contaminated with blood, is discharged directly into the sewers. Other waste, such as cardboard boxes, construction materials etc. are stored in a separate area and collected by a private disposal company.

Public hospitals on the West Demerara apply a similar collection system without the central temporary holding compartments. Both hospitals are equipped with two incinerators each. A recently constructed De Montfort incinerator funded by PAHO (for both hospitals) and the other a concrete furnace. The waste is removed from wards twice per day and taken along with sharp waste for incineration. The infectious waste is incinerated in the old furnace at both hospitals. Sharp waste is incinerated using the De Montfort incinerator. General waste is placed in containers and collected by private disposal company once per week.

At least two private hospitals have a structured system for collection of filled sharp boxes. One hospital applies a tracking system. Filled boxes must be taken to the central stores where the person (returning the box) must sign before issuance of a new sharp box. The filled boxes were stored in a separate area in the central storage room. These will be packed together using secondary packaging (cardboard boxes) sealed and taped (using adhesive) before transport to the main storage area to be collected by the municipality. This storage area is secure to prevent access by unauthorized persons (Isaacs 2008). Extra precaution must be taken during handling to prevent rupturing of bags and spillage of contents by doubling (placing one bag in another), depending on the weight of the bag (Isaacs 2008). The second hospital, sharp boxes (household bleach bottles) are collected, labeled, placed in red bags and transported to the designated area within the hospital compound for storage in covered drums (Hinds 2008).

Transport and Disposal
Infectious waste is collected by the municipality. The frequency of collection differs for public and private hospitals in Georgetown. The collection system is provided in further details in section 4.4.3. Only the practice at the public hospitals on the West Demerara will be discussed here. It is common practice at these hospitals to transport waste from the hospital to the incinerator using carts and wheel barrows. The ash and unburnt materials after incineration is removed and disposed of by burying in the hospital compound. The material is placed in a deep pit (~1.5m) and covered each time. However, it is not often practiced; for example, at the Leonora District Hospital the author was informed that the ash and unburnt materials were not covered after deposited in the pit (Jefers 2008). The pit was inundated at the time of visiting the hospital.

4.4.2 Health Centres

Health centres are both public and private and provides a range of services that eventually result in the production of waste. The quantities generated per day vary and depend on the service provided and level of separation.

Procedures
Centres lack written procedures related to the handling of contaminated materials, needles and waste. Most nurses, medical extension (medex) workers or health workers attempt to transfer the knowledge to the other workers orally or through the posters provided by GSIP.

Sorting and Storage
Similar to the hospitals, waste separation has been implemented only recently. This resulted after health-care workers responsible for the health centres, participated in awareness training conducted by the Guyana Safer Injection Project (GSIP). Some health centres started implementation only a few months ago while others benefited approximately one year ago. However, the separation of sharps and needles from other waste has been well advanced in some centres (under direct responsibility of the MoH or Georgetown Public Hospital Corporation) in Georgetown as a result of the Ministry of Health's focus on the reduction of HIV/AIDS cases and its transmission via needle stick injury. Medical extension (Medex) workers from Guyana Sugar Corporation (GUYSUCO) recently participated in the GSIP training programme. As a result most health centres have started to separate the needles and infectious waste from general waste.

The same colour coded system as described in section 4.4.1 for hospitals is also applied to the health centres. The situation with the availability of red bags is slightly different for health centres[42]. Some centres found it difficult to access the required bags and sharp boxes depending on where they are located. The availability of bags depends largely on the ability of the responsible administration to deliver materials in given time. Therefore, black bags were substituted for red bags. The practices at the private health centres were similar regarding the use of black bags for the storage of infectious and general waste. Private centres have improvised, in similar way to the hospitals described in section 4.2.1, by using plastic containers once used for storage of household bleach. The same holds for public facilities in the absence of sharp boxes. Moreover, some private facilities use an antiseptic solution in the

[42] Public facilities obtain sharp boxes from the Ministry of Health and bags through the responsible administration. The Georgetown Public Hospital and the MoH has the responsibility for some centres in the city while in the outlying regions, the regional administration has the responsibility for the public health facilities. The regional administration procures equipment and medical supplies from the Materials Management Unit while the private facilities source sharp boxes and bags from private suppliers in the city.

bottles to treat the sharp waste (Ganga 2008), an additional practice noted at a particular private centre.

Prior to GSIP intervention all solid waste (infectious and non-infections) were collected together for disposal. The practice at the private health centres was also similar. All solid waste generated from these facilities were collected and stored together including sharps and needles.

Collection and Disposal
Infectious waste is removed daily from all health centres by the cleaner. All health centres in the West Demerara Region dispose of infectious and general waste by burning. These centres either use an open concrete furnace (burnt box-refer to pictures in Appendix 5), or burn waste directly on the ground. These facilities are located in residential areas, often upwind of residents. It is also a common practice for the waste to accumulate in these structures for a few days before burning. Ash and unburnt materials are often buried in a shallow pit in the health centre compound (Dabadin 2008; Griffith 2008; Ali 2008). Open burning of waste can be affected by the weather during the wet season. It is common practice during this time to either increase the quantity of fuel used or bury infectious and general waste without treatment or securing the bags (Ali 2008; Griffith 2008). In Georgetown, some centres only provide vaccination services where the swabs were disposed with general waste. The other centres that were part of this study provide a range of service and infectious waste is collected by the municipality for off-site disposal.

4.4.3 Organization of the health-care waste management system

4.4.3.1 Financial

Hospitals pay for the collection and disposal of waste in two ways. Most common is the payment for the services for collection and disposal of waste from the hospitals on a monthly basis or by taking waste directly to the municipality for disposal. On average a monthly fee of approximately US$ 450-525 is paid to the municipality by the Georgetown Public Hospital Corporation for collection and disposal of waste (PAHO/WHO 2004; Rachpaul 2008). The information regarding the fees paid by the private hospitals were not available. The municipality charges US$1.50 to dispose every 13.6 kg (30lbs) of waste (including sharps) taken directly to the land fill by private operators (Ratan 2008).

4.4.3.2 Collection

The municipality and private contactors collect waste in Georgetown. The Municipality collects infectious waste from all the hospitals and some health centres (Ratan 2008). The frequency of collection by the municipality varies for the Georgetown Public Hospital and private hospitals. At the Georgetown Public Hospital, infectious waste and sharps are collected daily. Special trucks and /or tractor trailers are used to transport infectious waste (Ratan 2008). The municipality collects infectious waste and sharps from private hospitals 2 to 3 times per week. The waste is transported in a similar way as the Georgetown Public Hospital. Direct observation has proven that handlers only use gloves when handling waste. Each storage site found at the hospitals in Georgetown requires handlers to manually remove waste from the storage area to the waste collection vehicle thus, increasing the contact with the waste. A challenge for the handlers however, is to be able to distinguish general waste from infectious waste when all are placed in black bags. Private contractors collect general

waste from the other hospitals at least twice per week and disposed at the waste disposal site in Georgetown[43]. The Ministry of Health also collects sharp waste from health centres under its responsibility. This waste is transported to the Georgetown Municipality for disposal in the Mandela dump-site. There is no fixed time for the collection of sharp boxes, these occur whenever the Ministry staff delivers supplies to health centres.

On the West Demerara, private contractors collect general waste once per week from both hospitals. Sharp waste from health centres on the West Demerara is collected by the West Demerara Regional Hospital attendants for incineration at the hospital. Similarly, there is no scheduled time for the collection of filled sharp boxes. This occurs when the attendants visit these health centres to deliver materials. Boxes are usually stored in the centres until such time that an attendant visits the health centre. The private centre, at the time of this study, had just started to use the containers for needles. It was indicated that container will be disposed of by means of incineration and burying the remains in the compound (Ganga 2008).

4.4.3.3 Transport

A challenge for the waste collectors is to ensure infectious waste is collected and transported for disposal as soon as possible. This requires the need for collectors to be aware of the shortest possible route from the point of collection to the disposal area. The hospitals included in this study are located in the city surrounded by active roadways thus increasing the risks of transporting infectious waste.

4.4.3.4 Disposal

The disposal site in Georgetown is located in more or less an urban housing area with residents on the northern and eastern side; where residents can be found within 100m to the north. The disposal site is surrounded by trenches and canals and the Lama canal which is used as a source of potable water to service the city is located 1500 meters from the dumpsite along with other drinking water wells (Environmental Protection Agency, 2004). The site lacks impervious lining, soil cover and gas control (PAHO/WHO 2004), and thus there may be contamination of the ground water due to leaching from decomposition of organic materials. There were times when the landfill site combust and due to the ever presence of methane gas and the lack of daily soil cover, dousing the fire is usually an arduous task resulting in prolonged air pollution for the surrounding residents (PAHO/WHO 2004). The immediate surroundings, in particular, west of the dump site can become swampy during heavy rainfall as it is known to accumulate storm water.

The disposal site is operated by a private contractor under the management of the Municipal Solid Waste Management Department of the Georgetown Municipality (Ratan 2008). Private disposal companies are required to obtain a pass from the municipality (after paying for the disposal of waste at the transfer station) before entering the Mandela disposal site (Ratan 2008). Infectious waste, sharp waste, anatomical waste (body parts) from some hospitals, pathological waste (placenta, fetuses etc) along with animal carcasses and abattoir waste were disposed without any treatment in the disposal site (Ratan 2008). According to Ratan (2008) the waste material is placed in deep pit (12m x 6m) sprayed with disinfectant at the end of the day and covered with soil or whatever material is available onsite. The pit takes about 3-4 weeks to be filled and is separate from the MSW pit (Ratan 2008).

[43] The Mandela dumpsite is the only disposal area in the city. It is located in the city and according to the author's experience, west of Mandela Avenue hence the name 'Mandela dumpsite'.

Anatomical waste originating from the Georgetown Public Hospital and West Demerara Regional Hospital is buried in the cemetery. The practice at one private hospital is to return the waste to the relatives for burial.

In the outlying regions, waste is disposed of by burning in the open. These practices were discussed in section 4.4.2.

Incineration
The focus has been on the disposal of sharps. De Montfort incinerators were recently constructed for the Leonora and West Demerara Regional Hospital funded by PAHO. These incinerators are commonly used for small scale operations and applicable to facilities with no more than 400 beds (refer to picture in Appendix 6). The capacity is 12kg/hr and applies only for incineration of sharp boxes. Moreover, the incinerator specification states that additional fuel will not be required after the warm up period due to the high 'calorific' properties of the syringes. The combustion chamber is large enough to only incinerate one box at a time and each box is expected to take 10 minutes (Picken 2004).

However, based on the interviews a different situation exists in reality regarding the operation of the De Montfort incinerators. The incinerator is not in use at one facility due to the unavailability of fuel (dry wood). Wood is not stored on site and usually requires effort to source (Jeffers 2008). It is the responsibility of the operator to source suitable wood for fuel and to chop into very small pieces. At the other facility, while it has been in use, there is a risk of flooding during the wet season since the incinerator lacks sufficient elevation, therefore hindering its use. The attendant mentioned that vials were placed in sharp boxes, a practice not recommended unless broken, which caused explosions (of the containers) during the process of incineration (Jodhan 2008). This practice is against WHO requirements where vials (if capped) were not recommended for incineration as explosions can occur and uncapped vials can melt thus blocking the incinerator grate (WHO 2005). While the De Montfort Mark 8a was designed to incinerate one box in 10 minutes (Picken 2004), in practice, the average time taken is approximately 30 minutes per box (Jodhan 2008). The principle of burning one box at a time is to reduce the amount of smoke generated and the quantity of liquefied plastic at the bottom of the incinerator (Picken 2004). It also requires precise timing to insert additional boxes – when the smoke level of the first burnt box is decreasing. Thus, there is a need for training, constant monitoring and awareness. At the moment, both facilities use the old furnaces to incinerate infectious waste.

4.4.4 Specific Initiatives

Several initiatives have been taken or are underway to address some aspects of health-care waste. The lack of a systematic approach to address health-care waste however led to duplication of efforts by a number of agencies and institutions. Fundamentally, too many agencies have functional responsibilities for waste management with no one agency taking the lead. As it is, these agencies try to deal with some aspect of the health-care waste problem resulting in piecemeal management due to the lack of coordination. The following initiatives indicate some efforts taken to address the situation regarding health-care waste.

The Georgetown Solid Waste Management Programme – a Government of Guyana (GoG) IDB funded programme, implemented currently by the Ministry of Local Government through the Georgetown Municipality (as the executing agency). The programme will address the issue of solid waste by upgrading the Cleansing Department of the Georgetown Municipality (GM) to the Municipal Solid Waste Management Department (MSWMD 2006). This department will operate under delegated responsibility from the GM. However it also

functions as a semi-autonomous body and reports through a steering committee to the Ministry of Local Government (Urlin 2008). A part of the committee's function is to address issues outside the jurisdiction of the GM (MSWMD 2006). The department is intended, in addition to implementation of the project, to handle all solid waste matters in Georgetown. The Georgetown Solid Waste Management Programme has four components (IDB 2002);

- Capacity building and institutional strengthening
- Public Awareness
- Construction of a sanitary landfill and closure of the Mandela dump-site
- Consultancy to examine the current situation regarding industrial hazardous and health-care waste and to identify alternative cost-effective technologies to treat and dispose of such waste in Georgetown and its environs as well as to implement the most suitable method. Moreover, the consultancy is expected to examine current practices, develop an inventory of hazardous waste and strategy for hazardous waste management. This part of the programme is intended to also procure a waste collection vehicle. Furthermore, under the project the MoH and the MSWMD will be responsible for the supervision of this component as well as the implementation of the recommendations from the study (MSWMD 2006).

The MoH in its National Health Plan (2003-2007) stipulated the need to address waste from hospitals in particular. The approach undertaken by the Ministry, through externally funded projects, has been to equip hospitals in Regions 3, 6 & 10 with incinerators to dispose of waste from the hospitals. Health-care waste in Region 4 will be managed through the Georgetown Solid Waste Management program implemented by the Georgetown Municipality. In its drive to reduce the number of HIV related cases[44], the Ministry has undertaken a 'single use needle and syringe' policy as well as the substitution of injections with oral medications in order to reduce needle stick injuries by health-care workers. PAHO assisted to the MoH with financial resources for the construction of three incinerators in Region 3 and 5 recently. PAHO expects to undertake other alternatives for needle disposal such as entombing in the future, as well as to develop a strategy and proposal to address the issues regarding medical waste. Moreover, PAHO has guaranteed a 20 year arrangement with the MoH to supply sharp boxes to the public facilities (Monteiro 2008b).

To increase awareness among health-care workers regarding the risks related to transmission of HIV/AIDS and other diseases (blood borne) from needle stick injuries and to increase injection safety, the MoH launched a five year technical assistance project (2004-2009) supported by USAID[45]. The Guyana Safer Injection Project (GSIP) focuses on the handling, use and disposal of needles from public health-care facilities. A tangible output of the project is to develop a strategy to improve injection safety and waste management. Thus far a draft generic operational guideline for the handling and disposal of health-care waste has been developed with a focus on sharps. A notable role of the project is the initial provision of equipment such as different types of waste receptacles, bin liners (bags for disposal of waste)

[44] In general, the second leading cause of death in Guyana is attributed to HIV/AIDS. The prevalence of HIV in the country has increased over the years taking Guyana to the second highest rate in the Caribbean (USAID 2005).

[45] The program is part of the US President Emergency Plan for Aids Relief (PEPFAR) that supports the prevention of transmitting HIV/AIDS and hepatitis by focusing on the safety of injections and reducing accidental and unsafe sharp injuries (Anderson, 2008).

needle removers etc. to public health-care facilities. Facilities are subsequently expected to budget for continuous supply of equipment.

Georgetown Public Hospital Corporation with financial support from the IDB in the immediate future will undertake the construction of an autoclave, shredder and compactor system to treat all infectious waste generated from the hospital. This facility is also expected to treat infectious waste from health centres under the responsibility of the hospital (Rachpaul 2008).

Under the United Nations Development Programme, the EPA has implemented a countrywide project to develop a national inventory for hazardous waste. The inventory will form the basis for the development of a hazardous waste strategy to manage all hazardous waste. The project has been executed in two phases – the first phase, ongoing at the moment, will develop the database and the second phase will outline the strategy. The strategy is expected to set a comprehensive framework to guide the management of all hazardous waste (Thompson 2008).

4.4.5 Summary

There is no policy framework in place for health-care waste management. The issues related to health-care waste are integrated into the wider system for environmental management and protection. The environmental policy does not include aspects for health-care waste but one of its objectives is intended to add to an improved standard of living through environmental health. Some component of health-care waste is included in the Environmental Protection (Hazardous Waste Management) Regulations 2000 and the Health Facilities Licensing Regulations 2008.

Responsibilities for health-care waste management are distributed among the Ministry of Health, Ministry of Local Government and Regional Development and the Environmental Protection Agency. The ownership or responsibility for the public hospitals and health centres is also distributed. The Ministry of Health ensures quality health-care however; the Ministry of Local Government and Regional Development through the regional administration has the responsibility to provide financial resources for operation. The municipalities and regional administration is responsible for the collection and disposal of waste.

Approximately 315 health-care facilities can be found in the country with a total of 2,187 beds (MoH 2004). The total amount of hazardous waste generated per day ranges from 1230 kg – 1960 kg tonnes/day. Region 4 generates the largest quantity of waste since most of the facilities are located there. In addition, the Georgetown Public Hospital-the largest hospital and generator of waste in the country, is located in this region. The total quantity of waste generated in Region 4 has been estimated at 2130.2kg/day and 409.9 kg/day in Region 3(MoH 2004).

Definitions and the understanding of health-care waste vary among the health-care facilities. The categorization system used by most health-care facilities has been propagated by GSIP. There is a general understanding among health-care workers that any material contaminated with bodily fluid should be treated as infectious waste. Operational procedures for the provision of health services are in place in some hospitals but procedures fail to address waste management (sorting, handling, labeling etc.) in health-care facilities. One out of three public and one out of four private hospitals have operational health and safety staff. At the remaining five hospitals, the matrons have responsibility for health and safety issues.

There is some level of separation of waste into the categories-infectious, general and sharp but the degree of separation is affected by the availability of bags. A colour coded system is in place for waste separation. However, accessing the red bags can be a challenge for some facilities. The private hospitals are constrained by cost and the public facilities, timely distribution. As a result, infectious waste is placed in regular black garbage bags in the absence of red bags and can result in mixing of general and infectious waste. In the absence of sharp boxes, health-care facilities improvise by using house hold bleach bottles. Waste is not treated before disposal.

Disposal practices range from open dumping, open burning, burying and incineration. The wet season affects open burning and as a consequence a larger quantity of fuel is added for combustion. The disposal site in Georgetown is located close to housing areas. The site lacks impervious lining and gas control and therefore there may be contamination of the ground water.

A number of initiatives have been undertaken by some institutions to address the health-care waste. The Municipal Solid Waste Management Department will undertake an assessment, as part of a larger project funded by the IDB, relating to industrial hazardous and health-care waste and the development of strategy for hazardous waste management. This project is also expected to identify a cost-effective treatment method and implementation of this technology for the treatment of all hazardous waste. The department and the Ministry of Health will supervise this study as well as implement its findings. At the same time, the Environmental Protection Agency has implemented a countrywide project to develop a national inventory for hazardous waste focusing on key sectors. Health-care waste is a part of this project. The results will be used to develop a strategy for the management of all hazardous waste. Separately, the Ministry of Health through externally funded projects has facilitated the construction of incinerators for regional hospitals in Regions 3, 6 & 10. PAHO has provided financial resources for the Region 3 incinerators and also funded an incinerator in Region 5 to dispose sharp waste. The Guyana Safer Injection Project is implemented through the Ministry of Health to conduct training and increase awareness among health-care workers relating to poor use and handling of needles to reduce needle stick accidents. Training and awareness is focused on the public hospitals and health-care facilities were provided with the initial equipment for waste separation, for example, bins. The Georgetown Public Hospital Corporation through financial support from the IDB will construct an autoclave, shredder and compactor system to treat its waste.

5 Situation Analysis and Discussion

This chapter brings together the issues relating to health-care waste management from a systems perspective using the five functional areas of the viable system as outlined in the framework in section 2.3 and table 2-1. These five functional areas of VSM correspond to the key functions of the health-care waste management system and are used to structurally represent the system so as to guide the analysis. The organization of the contents in this chapter is in line with the hierarchal structure as represented in figure 5-1. Further, the principle of recursion as explained in section 2.1.1 implies that each sub-system must contain all five functionalities. A fully functioning system depends on having all system components in place to allow for interactions with similar component at the next level. Therefore while each section in this chapter will represent the main system element (in the hierarchy of the health-care management system) its contents will also include elements of the five functional areas to show the interactions or the lack of it in the system. However, there may be areas of overlap in some sections and a bit of repetition as a result of referring to preceding sections when describing the system elements.

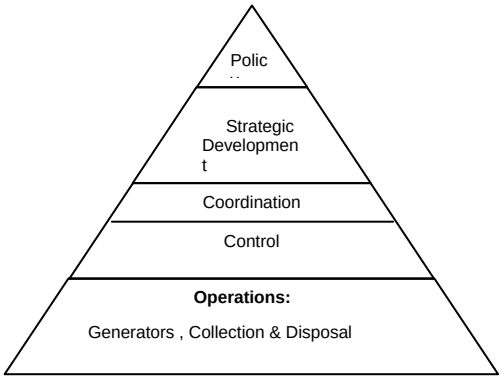

Figure 5-1 Hierarchical representation of VSM functional areas as presented in section 2.3

5.1 Health-care Waste Management and Viable System

Cognizant that the waste system does not exist in vacuity means that for the system to function at least in some capacity there must be interactions. Management of the health-care waste system occurs at different levels such as policy or norms, strategic planning, coordination, control and operation. The health-care waste management system as illustrated in Appendix 7 represents the overall system at the operational level and consists of hospitals and health centres - generators, collection, transport and disposal as subsystems. The interactions with the various departments of the responsible agencies require some level of coordination and regulation. The higher level management of the Ministries provides strategic direction for the lower level subsystems (the facilities and disposal level) building on norms and values of environmental protection that ensures a balance and a fully functioning effective system.

At each site (hospitals, health centres) some level of autonomy is expected; however, it is greater for the private hospitals than the public facilities. The latter, with the exception of the Georgetown Public Hospital (GPH), depend on the direction of the Ministry of Health, Regional Authorities and in the case of some health centres the GPH. It is important to understand this difference since it influences the principles of feedback, recursion and to a large extent the ability of the system to maintain its balance. Additionally, the absence of one or more of the five functional system elements from a subsystem or the lack of clearly defined structure and capacity as well as the lack of coordination among the elements will affect the viability of the health-care management system (Schwaninger 2006).

5.1.1 Policy and /or Norms of the health-care waste management system

Section 2.2 describes the sustainability principles and the elements that must be considered when developing a sustainable policy. The extent of incorporation of these principles and elements contributes to the success of any environmental policy and health-care waste policy in particular[46]. A sustainable health-care waste policy therefore must incorporate the waste hierarchy and in particular the elements of waste minimization and prevention. The polluter pays principle, the duty of care principle and the precautionary principle are essential to support the health-care waste policy. This framework underscores an environmentally sound health-care waste management system-the way things should be at the optimal level to ensure environmental protection and to lead to a state of sustainability. The sustainable health-care waste management policy defines the purpose and identity of the system and the function of its subsystems through the identification of roles and responsibilities. It also provides support for regulatory framework in this system.

Section 4.1 describes the current environmental policy in Guyana and the context of health-care waste within the system of environment. Environmental management and protection is the main function of the EPA and this is the highest level of recursion in the health-care waste management system (figure 4-1). Further, the Environmental Protection Act 1996 and the environmental policy prescribe this function. Using the functional structure of VSM and corresponding figure 4-1, it is evident that the Environmental Protection Agency (EPA) is the main agency to lead and define the policy direction for each recursive level to ensure environmental management and protection. The EPA therefore has the responsibility to define the purpose and identity of this system so that the facilities at the operational level can function. The role of the EPA in the management of health-care waste has been non-existent thus far. Moreover, executing this role in waste management in general and specific to hazardous waste and health-care waste has been ill-defined. The functional elements described in the following sections are at the level of the EPA to identify its role in each system component and interactions at the corresponding component in the wider system.

5.1.1.1 Policy

The lack of clarity at this level of the health-care waste management system has a direct effect at the operational level. The facilities at this level are unable to function effectively resulting in the current system -increased environmental and health impacts from poor management of health-care waste. The subsystems (generators, collection, transport and disposal) depend on the level of direction that should be provided at the policy level. Unless the EPA recognizes its role in policy development related to health-care waste and defines a strategic direction, the role of heath-care facilities in waste management and source separation will remain unclear. Further, this level of the system (policy) also interacts with the subsystems at the strategic, regulation and coordination level to guide and support decision-making based on the ethos of the entire system. However, it is necessary to understand the context of health-care waste within the wider system and the extent to which the current environmental policy addresses health-care waste.

[46] Other factors also influence the success of the policy such as the driver for policy development, effectiveness of the policy instruments selected, the long term goals and the interactions of the involved actors (Dalhammar 2007).

5.1.1.2 Policy Evaluation

Noting that the impacts of health-care waste are two fold – affecting both the environment and human health and cognizant of the environmental policy's key objective for improvement in the standard of living through environmental health, the evaluation will examine the implementation of this objective within the context of the current situation. Further a common characteristic for developing countries is the development of legislation that is commonly referred as 'policy' to address an issue. As outlined in section 4.1, there are two pieces of legislation that address health-care waste–the Environmental Protection (Hazardous Waste Management) Regulations 2000 and the Health Facilities Licensing Regulations 2008. The evaluation of these regulations will be undertaken using the criteria described in section 2.2.3.

The main objective of the environmental policy (outlined in section 4.1) includes the preservation of a healthy environment. Attaining this goal it stipulates a change towards environmental benign behaviour that will eventually contribute towards improved living standards. While the aim of the environmental policy is to ensure a general reduction of environmental pollution and to attain a sustainable state for natural resources, it does not provide clear mechanisms to achieve this. In general, these objectives are ambiguous and do not provide clear guidelines for implementation. However, the policy identifies responsible agencies to address key focal areas. The creation of the EPA has been the key element towards the implementation of the overall policy. Thus, a greater part of the responsibility for its implementation lies with the EPA. As part of its role, the EPA is expected to coordinate with the other functional agencies (with some responsibility for environmental management) to develop policies, plans, develop solutions, monitoring and enforcement and use the policy as the basis for other agencies to develop workplans. However, it is an arduous task in reality, possibly originating from the institutional inadequacies of agencies.

While the section on waste management and pollution control examines the issues and problems related to different types of waste (refer to footnote 31) the recommendations mainly focused on solid waste management and in particular municipal solid waste. The policy lacks achievable targets or baseline but rather stipulates the EPA to develop standards. Emission and ambient level standards are prescribed. The EPA is yet to develop standards related to emissions from waste facilities and disposal but has developed general water and air quality standards (Alladin 2008). Waste minimization, recycling or controls over waste disposal are not included as part of the policy. In the general context of waste management the policy provides the basis for the use of tradable permits. However, the mechanism to achieve or the capacity in implementation is yet to be worked out.

There is some level of intrinsic commitment by the government to prioritize issues that affect public health. The initiatives undertaken by the Ministry of Health have been catalyzed by the high HIV related cases evident in the country. The ministry places emphasis on needle use since accidental needle stick injury pose a high risk to transmission of pathogens. As a result measures were implemented by the MoH to reduce this risk and to protect the public health. This approach by the Ministry has a spin off effect on the implementation of the environmental policy through the embedded effect in preventing the risks to human health.

A common characteristic of the public sector in most developing countries is the lack of priority in addressing environmental issues. Most often the public sector focuses on other pressing problems such as issues related to health and education. As a result, environmental issues are either not addressed or the public sector develops legislation and establishes institutions to execute these legislations for the most serious environmental problems (NDS 2000). Further, institutions are at times created and legislations developed without defining

fully the mechanism for its implementation and enforcement. The EP Hazardous Waste Management Regulation 2000, over the years, has suffered from lack of enforcement. According to Barde (1995), it is common to develop command and control measures (standards, regulations, guidelines etc.) to mandate behavioral change and these are often used in anticipation of preventing an environmental hazard or permanent damage but require some level of proactive and forward planning.

Taking into consideration the sustainability principles and the content of sustainable policy as outlined in section 2.2, this environmental policy in addressing waste management and controlling pollution in Guyana is weak. It only incorporates the polluter pays principle. However, the extent of implementation of this principle remains questionable, given the low level of penalties, fines and charges stipulated in the municipal legislations and weak enforcement of the environmental protection legislations. The policy on the other hand, provides the basis for the application of user fees in the provision of services such as waste collection in general. It can be assumed that the policy focused on the most evident issue at the time of development– solid waste – and since environmental issues in Guyana were in its embryonic stage, the axiomatic approach has been to protect the natural resources. Overall, it is difficult to ascertain if the specific objective under scrutiny is effective given its ambiguity.

5.1.1.3 Environmental Protection (EP) (Hazardous Waste Management) Regulations 2000

The Environmental Protection Act 1996 provides the framework for the EPA to execute its mandate through coordination with sector agencies to manage and protect Guyana's natural resources. The Environmental Protection (Hazardous Waste Management) Regulation 2000, made under the Environmental Protection Act 1996 and implemented by the EPA is the only legislative instrument addressing all hazardous waste and has some reference to health-care waste.

The objective of this regulation is to manage and regulate hazardous waste through the provision of authorization for the generation, treatment, storage, disposal and or transport of hazardous waste and the development of guidelines for *"proper disposal, treatment, storage, or any other activity related to the handling of hazardous waste"*. The regulation lacks a definition for "proper disposal" but stipulates disposal as activities that may affect land, water and air[47]. It outlines a system of classification for hazardous waste and provides a framework for regulation including health-care waste[48]. Moreover, the regulation prohibits the storage for disposal and transport of hazardous waste without the requisite approval from the EPA. The total amount of hazardous waste stored at any one time must be prescribed (by the EPA) and all facilities generating hazardous waste must be authorized by the EPA. The regulation further prohibits the disposal of hazardous waste in open dumps and landfill other than a hazardous waste landfill.

The intention of the regulation is to protect the environment and subsequent public health through the management of hazardous waste. Its intrinsic application to the hazardous or infectious content of health-care waste should be noted. It therefore requires that anyone generating hazardous waste or with intentions to treat, store, dispose or transport, must apply

[47] The Regulation defines disposal as *"the discharge, deposit, injection, dumping or placing of any hazardous waste into or on any land so that it ma enter the environment, be emitted into the air or discharged into any waters, including groundwater"*.

[48] As noted in Chapter 4 depending on the hazardous content or infectious nature of the waste it shall be classified as hazardous waste (Environmental Protection (Hazardous Waste Management) Regulations 2000).

for an authorization from the EPA. As part of the authorization the generator is expected to report to the EPA and to inform of waste minimization, pollution prevention and treatment measures applied to the waste.

It further stipulates that the holder of such authorization should maintain and report on -*inter alia* :

- Different type of hazardous waste generated and quantities;
- Information regarding off-site transport;
- Standards applied to the treatment of hazardous waste;
- Efforts taken by the generator to minimize waste;
- Plans on pollution prevention.

Source separation is not explicitly stipulated. The regulation makes reference to waste minimization but it is left up to the generator to interpret and apply methods. Further, it is the responsibility of the EPA to stipulate as part of the permit the requirements for reporting on such matters. The regulation also provides some flexibility to the generator to find innovative ways to treat waste and to identify the extent of pollution prevention. The EPA is yet to develop standards related to the various components in the management of hazardous waste.

Using the basis of implementation of other hazardous waste, the regulation was only applied in the transport and disposal phase in the city and on an irregular basis. It requires that the MSWMD provides an authorization for the disposer to enter the Mandela dumpsite to dispose of the waste, however, before the authorization can be issued a permit is necessary from the EPA. Officers from the MSWMD were present to ensure that the hazardous waste (asbestos, waste oil) is entombed. However, while there is implementation of the regulation for some type of hazardous waste, there is no implementation regarding this regulation to health-care waste.

Enforceability

Establishing the regulation is not sufficient to addressing environmental issue. The ability to enforce the regulation translates to control of impacts that affect environment and human health and thus achieving its environmental objectives. The EP Hazardous Waste Management Regulation 2000 has suffered from lack of enforcement, in general and in particular the health-care sector due to the limited human resource capacity of the EPA[49]. The lack of treatment facility for hazardous waste and financial resources also compounds this issue (Alladin 2008) and limits the enforcement capacity of the legislation. Barde (1995) noted that enforcement of command and control measures are usually *"weak and difficult"*, mainly resulting from the lack of human resources, as evident in the case of EPA, for monitoring the provisions of the regulation. Other factors also contribute to low level or no enforcement such as *"administrative requirements, number of controls and legal procedures for non-compliance"* (Barde 1995).

Acceptability

[49] The EPA's Environmental Management Division, with a staff of approximately 15 environmental officers for the entire country, suffered over the years from high staff turnover. The absence of legal staff as part of the EPA further adds to the constraint of the Agency (Alladin 2008).

An important observation made during the interactions with the interviewees (with the exception of the representative from the EPA) is the absence of knowledge of this regulation and its relation to health-care waste. The acceptability of the regulation depends on a number of factors according to Barde (1995). These are *"cost, simplicity, transparency, and public participation"*. The implementation of the regulation has been constrained by resources, in particular, technical (human resources) and to some extent financial for the monitoring and enforcement. The regulation was promulgated country wide in 2005 by the EPA; however, given the lack of use of the regulation, the level of understanding by the wider public still remains questionable thus, affecting its acceptance and transparency, in particular by industry. Further in the author's experience, absence of treatment facilities for the treatment of hazardous waste also adds to frustration and low level of acceptance. The level of acceptance for command and control approaches, due to its usefulness in the prevention of environmental impacts and hazards through bans or emission levels has traditionally been favoured by policy makers (Barde 1995). However, the intention of establishing legislation by government maybe varied thus affecting it acceptance by the community at large in terms of equity.

Effectiveness
As already indicated in the first few paragraphs under section 5.1.1.3, the regulation covers the various components of the management of hazardous waste. However, its application and implementation in health-care sector has been nonexistent. The intended outcome in the implementation of this regulation is to protect public health and environment from hazardous and infectious materials and substances. On this basis the regulation in achieving its environmental objective to manage the hazardous content and infectious nature of health-care waste has not been achieved, even though this legislation has been in force since 2000. While the legislation manages the stages in hazardous waste, it does not stipulate any limit or standards to maintain a certain emission level except prohibiting the disposal of waste in open dumps. Postponing the development of standards and guidelines only further weakens the regulation, thus it becomes less effective in maintaining the environmental quality.

A factor that affects the effectiveness of the legislation is the level of awareness related to its role in the health-care sector. The general lack of a mechanism by the EPA to regulate health-care facilities also contributes to its lack of effectiveness.

5.1.1.4 Health Facilities Licensing Regulations 2008

The Health Facilities Licensing Regulations 2008 made under the Health Facilities Licensing Act 2007 and implemented by the Ministry of Health came into force May 1, 2008. It outlines the framework for operation of heath-care facilities. This regulation and the Health Facilities Licensing Act (2007) repeal the Private Hospital Act (1972) for obtaining annual licenses and the standard operating procedures necessary for all health-care facilities in the delivery of health services.

The objective of this regulation is to manage health-care facilities. While it targets private facilities, its application to public facilities is questionable. It is intended that health-care facilities should have standard operating procedures in place for the provision of health services and patient care. As part of its safety requirement for patient care, the regulation includes storage of infectious materials. Moreover, it provides specifications for handling and disposal of health-care wastes and makes reference to the storage of infectious materials within the facilities. It specifies that receptacles should be clearly marked and should meet the design requirements (for storage) of the Guyana Bureau of Standards. The regulation specifies the following:

- Sharps must be disposed in accordance with the requirements of the Guyana Solid Waste Management Division.

- Materials contaminated with bodily fluid should be treated as infectious waste and stored in "*double impervious plastic bags each at least 2mm in thickness*". Bags should be *"tightly secured, labeled infectious waste and should not exceed 25 pounds*". Infectious waste must be transported in containers clearly marked "*infectious waste*" and if possible treated on site before disposal or store in a secure area separately from all other waste if collected by municipality.

- The regulation refers to the disposal of infectious waste by methods other than land filling. However, disposal should be in accordance with requirements set out by the Solid Waste Management Division.

Given that this legislation only came into force May 1, 2008, it is too early to conduct an ex-post evaluation. However, the following observations were noted. The regulation addresses the issues of health-care waste from a safety perspective related to in-house contamination. It stresses the need for safe storage and handling of infectious materials. However, there is no definition of infectious waste as part of the regulations even though it refers to infectious waste as *"materials contaminated with blood and other bodily fluid"*. An interesting observation is the reference to the MSWMD[50] for guidance and requirements to transport specimen obtained from patients and the disposal of infectious waste. However, as identified in section 5.1.1.3 the responsibility for disposal and transport of materials considered to be hazardous and infectious is under the EPA but this regulation omits any such reference.

Source segregation is not stipulated as part of the regulation nor any method to reduce the amount of waste generated.

5.1.1.5 Strategic Direction

The EPA also has the responsibility to define the strategic direction for health-care waste management through coordination with responsible agencies (at the wider system level). However, this function is also not clearly executed by the EPA. In the author's experience, lack of involvement and coordination by this institution implicitly transfers this responsibility to the other functional agencies. Since many agencies have responsibility in this area, the EPA allows the operational institutions such as the municipality and regional administration to define the strategic direction and policy for the waste management system, for example, the Municipal Solid Waste Management Department is expected to develop a strategy for hazardous and health-care waste. The issues related to strategic direction and the role of the EPA is further elaborated in section 5.1.2 addressing strategic direction of the waste management system.

5.1.1.6 Control, Coordination and Operations

The functional responsibility for control, coordination and operation of the health-care facilities, collection, transportation and disposal exists within the operational subsystem (Environmental Management Division) of the EPA. These functions depend on the ability of the EPA to regulate its licensing process and enforce legislation. Unless the Environmental

[50] The regulations refer to the Guyana Solid Waste Management Division of the Ministry of Local Government which is now the Municipal Solid Waste Management Department (MSWMD) and this is under the responsibility of the Georgetown Municipality (a local administrative arm of the Ministry of Local Government).

Protection (Hazardous Waste) Regulation 2000 is implemented and enforced facilities will continue operating "as business as usual" generating large quantities of waste.

On the other hand, the EPA coordinates through its operational subsystem with the environmental health unit of the Ministry of Health, the municipality and regional administrations to address issues related to public health and solid waste respectively. Further, through its licensing process new facilities (health-care) are required to obtain a permit from the EPA and the EPA provides some level of control by stipulating requirements for these facilities with regard to health-care waste. The challenge for the EPA is monitoring to ensure control not only for new facilities but to regulate the existing facilities.

5.1.2 Strategic Direction of the health-care waste management system

The strategic approach for quality health care in the health-care sector rests with the Ministry of Health (MoH). However at the national level, the waste generated in this sector from health-care facilities involves the MoH and EPA. Strategic planning, research and development and future outlook for health-care waste management is not defined or not in place in the current system. The preceding sections identified the importance of the EPA for health-care waste management and policy development. The EPA also has a coordinating function and is the key actor to define the strategic direction for health-care waste management.

5.1.2.1 Policy

The lack of a policy framework for health-care waste management hinders the strategic direction to be undertaken at the national level.

5.1.2.2 Strategic Direction

The Environmental Protection Agency and Ministry of Health have key responsibilities for strategic direction. Using the structure of VSM and its functionality, it is evident that strategic direction is influenced by the policy, norms etc. of the higher system level in the hierarchy. Therefore without having clear purpose, goals and objectives at the highest level, the functions and responsibilities at the other systems level will be affected. And as a result the effectiveness of waste management, in particular source reduction at the operational systems will be affected.

The general argument by persons interviewed is the need to establish a separate agency for health-care waste management and policy development (Monteiro 2008; Urlin 2008; Lewis 2008). These respondents claim that the lack of clear direction and many responsibilities (for waste management) can be addressed by having a focus agency. The risk of many agencies having operational responsibility leads to no one agency taking the lead, resulting in lethargic approaches or individual agencies having piece-meal management resulting in duplication of efforts and high level of inefficiency as is currently evident. Such an approach indicates the lack of coordination and responsibility at the strategic level in the system. There is a high level of uncertainty due to the environmental and health effects. To reduce these effects, information loss through awareness must be addressed as information flows have been significantly affected. A principle of VSM is working towards viability within given resources. This is implicit in understanding that the components of the system should be well defined, thus allowing for clear responsibility and functionality allowing for efficient use of resources.

Thus, in the authors' view another tier (separate agency) will only create an added level of bureaucracy and further increase inefficiency. The current system allows for one agency to define the purpose (policy development and strategic direction) of the system thus building on the existing structure and responsibility of the EPA.

The lack of enforcement of the legislation and the lack of standards has an impact on the level of uncertainty in the system. Since there is no regulation of health-care waste, the system left on its own has spun out of control resulting in problems that feedback to affect environment and human health. To address these problems initiatives were taken by different agencies but at the 'end-of-pipe' stage. The focus has been to deal with the disposal side of waste chain instead of understanding the source as an important component. By placing little attention to the source, waste continues to be generated unregulated. At the same time, resources are expended by different agencies to conduct projects with similar components as identified in section 4.4.4. Of interest, in the Health Facilities Regulations 2008 is the reference for *"disposal of infectious and sharp waste in accordance with requirements of the Solid Waste Management Division"* (now the Municipal Solid Waste Management Department) a responsibility that is clearly under the EPA as per the Environmental Protection (Hazardous Waste Management) Regulation 2000.

Further, the Ministry of Health has been taking initiatives to address the issues of health-care waste. To that end, the ministry took the lead to develop guidelines for the management of health-care waste through the National Oversight Committee. As this is not the main function of the Ministry and the representatives of the committee, the commitment to develop the guideline is minimal. The guideline is voluntary and does not provide any basis for monitoring and enforcement. Therefore, its effect in minimizing the waste quantity and hazardous and infectious constituents will be minimal if at all.

Strategic direction for the sector is still an area that needs clarity. Unless there is a direct linkage of all the systems components – the site level systems, system of collection and disposal, coordination and regulation- system viability will not be possible. Information and information flows through the feedback system is a key characteristic of any system. However, there is a high degree of information loss in the current system due to lack of monitoring. Research and development facilitates the garnering of information from external sources as well as interaction with other stakeholders and interested parties. Very little resources if any at all goes into research and development. While it is a focal area of the EPA, its ability to conduct research has been handicapped due to a low priority.

A common constraint noted by persons interviewed relates to availability of financial resources (Lewis 2008; Urlin 2008; Montiero 2008; Sookdeo 2008). To that end agencies depend significantly on externally funded projects to fill operational gaps as well as to execute projects. Hence, the high dependence of Ministry of Health on PAHO to provide sharp boxes and Guyana Safer Injection Project to provide training, awareness and the initial equipment for public facilities. Moreover, the GSI Project ends in 2009 but the continuance of its activities is an important factor to consider as this would affect the system functions.

5.1.2.3 Control and Coordination

The Ministry of Heath and the EPA through its regulations have direct influence in the control and coordination of the health-care facilities and the collection and disposal systems. Further explanation is provided in section 5.1.3.2.

5.1.2.4 Operational

The operation subsystem of the EPA and the Ministry of Health interacts with the health-care facilities. To ensure environmental management and protection of public health at the facilities level, the operational subsystem of the EPA and the Ministry of Health need to have a clear understanding of their role. Further, in order to regulate the system it is necessary to have defined norms of what is expected from these facilities.

5.1.3 Control (Regulation) function for the health-care waste management system

The function of control and regulation is not clearly defined in the current system. However, using the structure of VSM and the function related to this level of the system, it was found that the Ministry of Health and the EPA operational subsystems (the Environmental Health Unit and the Environmental Management Division respectively) are the main actors that have control of the operational system. The operational subsystem of the municipality and regional administration also has functional responsibility for the collection and disposal of health-care waste. The following sections describe the control functional areas as it relates to the health-care waste management system.

5.1.3.1 Policy and Strategic Direction

As outlined in sections 5.1.1 and 5.1.2, policy and strategic direction is lacking in the current system. In a functional system the corresponding functions within the VSM structure would interact, communicate information, coordinate and oversee the functions of the lower level.

5.1.3.2 Control

Recognizing the principle of recursion (hierarchal system), the controller is mainly responsible for regulating the activities occurring at the stage of coordination and operation in the system. It is important to understand the hierarchal structure of the model allowing for all five system elements (functional areas) in each subsystem in the current context. While there is a structure in place at the EPA and the Ministry of Health through the Environmental Management Division and Environmental Health Unit to coordinate with the controlling function at the health-care facilities, the collection and disposal system, this function has not been fully executed.

Through the licensing process both the EPA and the Ministry of Health is able to regulate the activities at the health-care facilities. The MoH has a direct influence on the private hospitals through the Health Facilities Act (2007) and Health Facilities Regulations (2008) for the licensing of private facilities. The implementation of this regulation will now have a significant impact on the management of waste generated by private facilities. While it facilitates some level of management that can possible increase the efficiency of waste management, its success depends on monitoring and feedback mechanisms to address any non-compliance. The regulation define specific standard for bags to store infectious waste (refer to section 5.1.1.4) and the way the bags should be handled. However, the reporting mechanism is lacking in the regulations. It is uncertain how the Ministry of Health will regulate these facilities to ensure adherence to the regulations and the implications for public facilities have not been considered. This brings some disparity between the private and public facilities and act a as disincentive for private facilities to improve their environmental performance, given that most of the health-care facilities are public and to some extent under the sphere of the Ministry.

On the other hand, the Environmental Protection (Hazardous Waste Management) Regulation (2000) has a direct influence on the health-care facilities (generators), waste collection and disposal as well as the development of guidelines relating to different facet of hazardous waste management. It is applicable to all facilities allowing for fairness and creates some level of transparency and accountability; the functions required according to the VSM structure necessary for control. However in the current system, EPA only manages to have some control of new facilities through its licensing process (Alladin 2008) the challenge for the EPA is to regulate the existing facilities. As discussed in section 5.1.1.2, the enforceability of the regulation has been affected by the ability of the EPA to fully execute its function of monitoring and control. However it is evident that the greater part of the responsibility for control rests with the EPA.

The primary function of the municipality and the regional administration in the capacity of local government is to regulate activities within its jurisdiction and coordinate with the main ministry and other sector agencies. But traditionally the major function has been the provision of services for waste collection and is considered by most persons interviewed as the primary function for the local government. This dual role – regulation and provision of services can contribute to the inefficiency that currently exists at the level of the local administration and creates conflict of interests. The Georgetown Municipality (GM) and the Regional Administrative bodies are involved in the collection and disposal of waste. The GM also manages the Mandela disposal site. The head of the municipality and the regional administration is responsible for the coordination and decision-making of its sub-systems. Given that the administrations consider their sole responsibility is collection, transportation and disposal of waste, the subsystems will only execute and expend resources to achieve these tasks. The primary role of regulating waste management is not fulfilled and thus eventually overlooked. Efforts related to reporting and feedback in this system from the subsystems will be significantly affected. Another factor that affects the functioning of this system is the lack of clear goals or norms for guidance. The Public Health Ordinance (refer to section 4.1) has been in place since the 1930's and is still in use today. This outdated legislation aids the level of system failure as it lacks the basis for effective monitoring or standards for disposal. Since the administration also provides the service for the collection of infectious waste from health-care facilities, the ability for monitoring and regulating is significantly affected. In Lund these services are contracted to private companies which are regulated and monitored by the municipality (Wallin 2008). In Guyana, private companies are involved in the collection of municipal solid waste but on a contractual basis by the local administration. However, the private companies are not independent and still depend on these administrations for payment of services (PAHO/WHO 2004).

5.1.3.3 Coordination and Operation

The coordination and operation system level is elaborated in sections 5.1.4 and 5.1.5. Activities at the operation system level of the waste management system are coordinated by the licensing process of the Ministry of Health and the Environmental Protection Agency. The level of interaction between the municipality (and regional administration) and the EPA as well as Ministry of Health for the management of health-care waste is not well defined or does not exists. Disposal practices are not regulated by the EPA. The Ministry of Health capability though the Environmental Health Unit (and Environmental Health Officers in the Region) is limited due to restructuring of the Unit.

5.1.4 Coordination of the health-care waste management system

Health-care waste management is not regulated in the current system. Using the structure of VSM and its functional areas in relation to the waste management system in Guyana, it is evident that the EPA, along with the municipality and regional administration coordinates the activities of the operational system.

5.1.4.1 Policy, Strategic Direction and Control

Lack of a defined goal and strategic direction, enforcement of the regulation and the lack of coordination of the actors increases the level of uncertainty and complexity in the system. The control function by the responsible agencies to manage and monitor the health-care waste management system depends on the ability to understand the issues, generate or provide solutions to fully address and solve each problem that occurs. Autonomy of the organization/agency/department is important for decision-making.

5.1.4.2 Coordination

The function of coordination is carried out by the various units of the Environmental Management Division of the EPA. These units are expected to monitor facilities for compliance with the regulations and conditions of permit. The decision regarding issuance of permits, requirements etc. are carried out at this level. There is a clear structure within the current system to regulate and coordinate the health-care waste.

The system of collection is an important link between the health-care facilities and their external environment. The municipality and regional administration coordinates the collection, transportation and disposal of waste. The level of coordination for collection of waste in the current system is inefficient. While the municipality collects infectious and sharp waste from most health-care facilities in the city, the Georgetown Public Hospital and the Ministry of Health collects sharp waste from health centres. At the same time the municipality is still required to collect other waste from these facilities.

5.1.4.3 Operation

The operational level for the coordinating function in the health-care waste management system is carried out by the lower level staff. The tasks and responsibilities should be clear at this level, otherwise this system will not function. This level of the organization must have some degree of independence to create the balance required by the system. There is a direct hierarchal link with the highest level in the system. In other words, the staff at this level must be in sync with the competencies and direction, policy of the higher system components. This is necessary in order for the institution to function effectively and for this level of the system to achieve its intended purpose. Another factor that affects the function of the operational level within this system component is the lack of human capacity in the EPA and this has a direct effect on the functioning of this system. In the author's experience, often one person has the responsibility for specific area, thus the institution becomes heavily dependent and in their absence the system falls apart highlighting the lack of continuity.

5.1.5 Operational Level of the health-care waste management system

The operational level is an important component in the health-care waste management system since all the activities occur there. The interaction at this level with the external environment is most significant. This is the core component for viability of the system, without which the

system will collapse. Thus, maintaining the viability at this level is critical to the effective functioning of the HCWM system. Based on the hierarchal structure and the principles of recursion, the system at this level must be able to have autonomy and in sync or harmonize with the strategy, goals, norms, policies etc. of the entire system (Lewis 1997). Within the structure of VSM, health-care facilities (generators), the system of collection and transportation and disposal occurs at the operational level.

5.1.5.1 Policy and Strategic Direction

Lewis (1997) claims that at the lowest level of recursion, health-care facilities in this case, will have a basis or *'legitimacy'* through a policy for their operation. For the facilities to execute daily tasks, all at this level must be aware thus information flow and communication are important components. Lewis (1997) further adds that the strategic direction at this level is higher given the tasks specific operation, short term goals with a localize focus. Therefore, health-care facilities depend on the ability of their management to recognize the need and importance of implementing waste minimization at the operational level.

In the current system, while this functional area is somewhat clear for the provision of health services by facilities, it is rather hazy or non-existent for the management of health-care waste. The legislation, policies and programmes developed by the Ministry of Health provides guidance to health-care facilities for standard operation so as to fulfill the main purpose of providing health services to the general population. The identity of the facilities lies in the type and quality of service provided. The subsystems have management support and there is some structure in place to achieve this purpose. However, no guidance has been provided or mandated for the management of waste in health-care facilities, therefore the facilities are not aware of environmental requirements.

The Swedish Government has taken a policy to improve the environmental performance of its public institutions including hospitals. To that end the Region of Skåne mandates all hospitals to implement environmental management systems by 2009. A clear objective for hospitals, additionally, the legislation and standards are in place to address health-care waste from hospitals. The regulation provides definition of waste and responsibility for key persons within the facility. It also provides details for storage, handling and transporting waste.

The Lund University Hospital and Malmö University Hospital have procedures in place for the management of health-care waste as part of the EMS. The level of management commitment for waste management is high since the facilities generate hazardous and infectious waste with adverse effects on environment and human health. The organizational structure in these hospitals includes a separate section focused on environmental management. EMS not only assists in environmental improvement but it provides the mechanisms to facilitate communication among all the involved actors (Sammalisto 2007). Further, EMS allows for management and employees to work together towards achieving a define goal-in this case improve source reduction. This level of commitment is vital for the success of programme and gives a clear indication of the level of commitment by management. Employees therefore feel motivated and through effective training and awareness will be able to execute their functions (Sammalisto 2007).

EMS in these hospitals provides a structural way of organizing the system and this reduces the effect the waste has on its external environment. There is an overall goal for the hospitals to work towards, given the policy directive by the government.

In the case of Guyana, there is a lack of information flow from the regulators and other stakeholders such as Guyana Safer Injection Project (GSIP) to the generators. The main issue is the general lack of a national definition and detail classification system. The categories developed by the GSIP have been in use only recently. However, the focus is mainly on the handling and separation of needles in public facilities. Further, the Environmental Protection (Hazardous Waste) Regulations 2000 defines clinical and medical waste but steps are yet to be taken to transfer this information to the operational level. While the Health Facilities Licensing Regulations 2008 refers to infectious waste, it does not provide a definition. Referencing the Swedish regulations SOSFS 2005:26 clear definition of infectious waste and detailed description of its application in managing health-care waste including the allocation of responsibility within the facilities is outlined. The information in the Swedish legislation is communicated by the hospitals to employees in such a way that employees understand. Increasing awareness though knowledge has an impact on behavioral changes and therefore improving environmental performance through effective waste minimization.

5.1.5.2 Control and coordination

The Health Facilities Regulation 2008 stipulates that each health-care facility should have a health and safety person as part of its administration but does not define responsibilities. While the regulations noted policy for the facility and procedures should be in place for standard operating practices, waste management has been omitted. It is necessary however to understand the need to report to the regulators and to have a formalize system of reporting. This can only be established through the licensing process. Conversely, the policy, procedures and reporting mechanism as stipulated by the regulation primarily target private facilities. The majority of the health-care facilities existing in the country are public. In a matter of fairness, these facilities must adhere to the same level of standards as the private facilities in the management of health-care waste given that this is an issue affecting human health and environment.

The function of coordination and regulation within the health-care facilities is conducted by the head of the section; in some hospitals it is the matron and medex (for health centres). Monitoring is conducted by the matron, medex and health and safety officers. The activities at the operational level are coordinated and regulated (controlled) by the system of feedback through monitoring and audit. However, the monitoring and feedback mechanisms are not clear at this level. A possibility is the level of awareness and the roles of responsible persons in executing these functions within the health-care facilities. While it is possible to assume that some level of monitoring occurs in order to ensure that daily tasks are executed, the extent of the monitoring in terms of waste separation and activities related to waste segregation is non-existent. It is pertinent to understand the need for monitoring. This function provides information for System 2 (coordination of activities at the operational level) & 3 (control through decision-making) to regulate and balance the activities and contribute towards viability of the health-care facility. Accountability and transparency are characteristics of functional system. However, the clarity of these characteristics depends on the extent or usefulness of the information generated from monitoring (through reports, evaluations, meetings etc.) and whether this information is fed to the lower levels through corrective actions to address discrepancies improves performance and behaviour. The level of recursion within each facility is highly dependent on each subsystem in the facility and the interaction of the facility with its external environment. In other words, for the facility to be viable it is necessary for management to be committed, have clear roles and responsibilities for waste management and the environmental and health issues associated with poor waste management practices. Additionally, the operational system – at the point of waste generation, must understand the requirements necessary to segregate waste so as not to create problems at the

lower levels in the waste chain. In the case of hospitals in Lund and Malmö these lines of responsibilities and reporting mechanisms are well defined through procedures such as EMS and regulations that support the effective functioning of the system.

With the exception of the Georgetown Public Hospital (GPH), all other health-care facilities only concentrate on the issues related to safety of needle use. The GPH according to Rachpaul (2008) conducts monitoring for the collection, storage and handing of waste as well as monitoring at the point of generation. Some disciplinary actions have been taken at the GPH and one private hospital for non-compliance with the use and handling of needles and for GPH when procedures were not followed. In the case of Malmö University Hospital, the environmental department has direct responsibility for monitoring related to health and environmental issues (Bengtsson 2008) and this is also extended to their out patient centres and health centres. These representatives are responsible for all environmental and health and safety issues at these facilities and monitor the activities and interacts with, reports to, the environmental division of the hospital.

The codification system while streamlined in principle, in practice is ad hoc, in particular at the private hospitals and health centres. The WHO recommends a colour coded system that has been adapted in Guyana. As mentioned in Chapter 4, infectious waste is placed in red bags, general waste in black bags, sharps in standard sharp containers. However, the use of the bags is not consistent both for the private hospitals and public faculties in the absence of standard for monitoring and regulating the system. This inconsistency affects the handlers as well as collectors to ascertain the contents of the bags leading to mismanagement of its contents and risk of contamination.

Another important factor is the chain of custody from the point of collecting waste at the producers to the point of disposal. Necessary authorization is required for this process and along this chain with the change in ownership and responsibility. The Environmental Protection (Hazardous Waste) Regulations 2000 has a framework in place for the movement of hazardous waste. However, the implementation of this system to date by the EPA has been weak. Infectious waste under the definition of clinical and medical waste, depending on its nature can be classed as hazardous waste. While authorization is provided for some hazardous materials such as asbestos, the mechanisms for health-care waste is not in place. Permitting of health-care facilities is crucial in the management of the waste generated.

5.1.5.3 Operations

Most respondents from health-care facilities associated risks of health-care waste to needle use. This limitation in the level of understanding of risks related to health-care waste can have a direct impact on the level of separation that occurs. Separation of waste is necessary in order to reduce the volume and toxicity of waste generated. Detail sorting and separation also lead to a reduction in uncontrolled emissions and production of ash at the point of disposal (Tudor, Noonan, Jenkin 2004).

Effective waste separation requires responsibility of management and designated responsibility within the hospital to manage issues related to environment and health. The SOSFS 2005:26 regulations in Sweden stipulates responsibility within the health-care facility, development of clear procedures and place the head of the hospital directly responsible for all activities, in particular, waste management. In general, management of these facilities is responsible not only to provide the services of health care but also to protect the population from the infectious and hazardous content of the waste. To that extent, it is even more important to adequately allocate resources such as necessary equipment for the system to function. In

Guyana, the lack of resources as in the case of some private hospitals and health centres (in the absence of red bags) generate uncertainties in the system. Further the absence of procedures and direct responsibility for waste management contributes to some level of inefficiency. If this trend continues, it can affect the other system levels, increasing system imbalance. There is a level of dependence both in terms of responsibility and waste flows along the system. At the site level, the responsibility lies with the generator of the waste at the point of generation. Source separation is the most important step in this process and requires knowledge in order to adequately segregate waste. Additionally it is the responsibility of the internal staff to secure the ends of the bags (bind tightly at the neck) (WHO 1999) when 75% filled, labeled and place at the transfer station for removal. Access to information regarding procedures is vital. Procedures for segregation, removal and schedule for removal form the cornerstone of an internal system at these facilities. The health-care faculties have the responsibility to ensure the information is communicated to staff. Most importantly, facilities need to be aware of these requirements and the need to comply with standard and regulation; otherwise it is futile to establish such system within the facilities.

WHO (1999) indicates the hazardous content of waste ranges from 10-25% which can be further reduce by applying a detail classification system. There is a high potential to further separate the waste streams such as food, plastic, glass and paper. Lee, Ellenbecker and Moure-Eraso (2002) found there is potential for separation of these waste streams in health-care facilities. While the perception of risk of infection from recycling or reusing plastic, paper and glass from health-care waste exists, Lee *et al* (2002) claims that areas such as offices and cafeterias have a high potential for detail sorting to reduce waste volume. Even though recycling and reusing of glass and plastic containers is possible from places like the emergency room and the facilities (such as patient room), a high cost is associated with treatment and cleaning. However it is easier to intervene to have recycling of materials from the cafeteria due low probability of risk (Lee *et al* 2002). It is pertinent though, to have the supporting infrastructure to recycle these materials and for recycling to be effective and practical. Both hospitals in Lund and Malmö apply a detailed system of separation, including the recycling of paper, cardboard, metal, plastic and glass. In the case of Guyana, the recycling system is not formalized but ad hoc by a few small entrepreneurs mostly for PET and corrugated cardboard (PAHO/WHO 2004). Although some hospitals have started to separate food waste and paper, it is inconsistent. Only the Georgetown Public Hospital has in place a separate stream for food waste.

The packaging of waste is a vital component in the process. In Lund for example, the hospital applies a detail codification system and secondary packaging for waste. The staff in the hospital further package waste in secondary containers to prevent any contact by hand and spillage (Holm 2008, Bengtsson 2008). This level of security prevents spillage of the contents during handling and collection by waste collectors. WHO (1999) also recommends secondary containment for infectious and highly hazardous waste. However, secondary packaging can increase the cost associated with waste management both at the point of procuring materials for waste separation and for the disposal (WHO 1999). On the other hand, WHO recommends the use of cardboard packaging or galvanized containers for secondary containment. To some extent it is already in use by one private hospital in Guyana for the packaging of sharp containers. However, increasing the packaging of waste may have a potential consequence on the disposal fees for of health-care waste due to increase in weight.

In Lund and Malmö the hospitals adhere to the standard stipulated in the SOSFS 2005:26 regulations for labeling of all infectious or hazardous waste generated from the health-care facilities. WHO (1999) also recommends that bags and other containers should be labeled before removal. Labels should indicate **source of generation, contents, destination and**

date of collection. This process is lacking in Guyana and as a result it leads to a disruption in the functioning of the system due to information loss. Labeling is important, in particular, when transporting waste. Issues related to liability may arise when the responsibility of the waste is transferred to the waste transporter. Under the duty of care principle[51] the transporter has the responsibility to take all measures practicable to prevent harm to the environment and human health during transportation of waste.

The regional, district hospitals and health centres depends highly on the ability of the Regional Administration to allocate a separate budget to source equipment for waste segregation. Health centres located in far reaching areas have a greater dependency on the coordination of the regional administration and the regional hospital (for example Region 3) to distribute materials and collect sharp waste for disposal. This level of external control creates unwarranted uncertainties within the system that cannot be managed at the administrative level in public health-care facilities. The level of complexity increases with the MoH distribution of sharp boxes to the main hospital in the region for further distribution to the health-care facilities. Effective separation of waste from these facilities therefore is dependant on the ability of the facilities to have equipment (bags and boxes) in reserves and timely distribution by the external authorities. In particular, health centres in Georgetown depends separately on the MoH and the GPH (for those heath centres under its care) to collect sharp waste as well as to distribute equipment. Even though these centres are located in the city, timely distribution of the materials is still a problem resulting in the use of black bags for storage of infectious waste. The strongest dependence and the link that raises questions of the viability of the system is the MoH dependence on PAHO to supply sharp boxes. While it is recognized that systems cannot exist in a vacuum and need to interact with its external environment in order to find ways to deal with uncertainties, the level of recursion here is not clear. As a result public health-care facilities (excluding the GPH) are not necessarily independent and therefore will not be able to adapt to changes occurring around. The viability at the highest level (sector level for environmentally sound waste management system) is dependent on the viability at the facilities level; however, the facilities depend on an external source to provide the basic equipment for waste separation, thereby introducing uncertainties that cannot be controlled by the external source (PAHO).

Collection and Disposal

Health-care facilities depend on the waste collectors to remove waste on schedule and for effective provision of services. The generators under the polluter pays principle have the responsibility to ensure that the waste is disposed in an environmentally sound way and under the duty of care principle to prevent harm to human health and environment. This is also supported by the WHO (1999) where generators are responsible for obtaining the necessary authorization for off-site transport and disposal. The regulating authority also has a key role to approve the process, including the waste collector. However, there is no such process in place in Guyana even though the Environmental Protection (Hazardous Waste) Regulation 2000 outlines the procedure and process. Therefore, once the waste leaves the premises, generators are no longer responsible given the change in ownership. The chain of custody process ensures that the generators maintain the responsibility for waste until final disposal.

While there is daily collection of waste from public hospitals, the collection from private hospitals occurs 2-3 times per week. WHO (1999) recommends in tropical climate, off-site removal of waste within 24 hrs during the hot season and 48 hrs in the wet season. The absence of a regulated system and standards (for storage and collection) removes this

[51] The duty of care principle according to WHO (1999) states that "*any person handling or managing hazardous substances or related equipment is ethically responsible for using the utmost care in that task*"

responsibility by facilities. The general notion-material is waste and does not require any special attention by those responsible at the facilities level also limit the level of commitment. The standards applied in the case of Lund, is the daily removal of waste (Holm 2008; Walin 2008) and in Malmö cold a storage facility in place to store infectious waste at temperature of 8ºC (stipulated by the regulations) since collection occurs 3 times per week (Bengtsson 2008). On the other hand, private facilities in Guyana find it costly for daily collection and may pose an issue. Further, the municipality will be required to expended additional resources for the collection of waste. Additionally, the initiative taken by the GPH to establish its own autoclave will mean that municipality will no longer be required to collect waste from this facility. As a result, the municipality may loose a definite source of income but can address this through an increase in frequency of collection from the private hospitals.

Disposal methods applied at the moment are open dumping in the landfill, opening burning and incineration. Emissions released directly into the atmosphere from burning affect the surrounding population since these facilities and the location of the burnt boxes or incinerators, are up wind of residences. Further, burning of such waste is known to emit toxic pollutants such as dioxins, furans as well as heavy metals (lead, mercury) either directly in the air or from burying of the ash (Emmanuel, Hrdinka, Gluszyński, Ryder, McKeon, Berkemaier, Gauthier 2004). Addressing the issue (infectious and hazardous waste) at source will minimize the impacts downstream at the point of disposal. Literature available on the treatment of health-care waste does not support incineration and landfilling as suitable disposal methods. In fact, these options are least preferred according to the waste hierarchy. For a country such as Guyana, and given the dispersion of health-care facilities, disposal of health-care waste must be managed in order to reduce the environment and health effects. It has been inferred from the interviews with sector agencies that the primary factor in the selection of disposal methods relates to cost. While this is a real consideration for a developing country, it places the population in a compromising situation since the potential environmental effects from methods used in practice are not usually considered. Environmentally sound methods for disposal will reduce the environmental impacts and the potential feedback on public health. Alternative technology such as autoclaving is highly recommended (Emmanuel *et al.* 2004) instead of the rudimentary methods currently applied. The Georgetown Public Hospital has taken the approach install an autoclave, shredder and compactor system a welcome sign, given that it's the largest hospital in the country. However, the autoclave system only targets waste from this facility and health centres under its responsibility. Waste from other facilities will still require disposal. Unless the method(s) for disposal is clear or national treatment facility is available; facilities will continue to generate waste without taking precaution.

Burying health-care waste, in particular at the Mandela disposal site poses a serious threat to the surrounding environment and increases the impact to the nearby water bodies. Large volume of infectious waste deposited daily and the infectious and hazardous characteristics further increases the risk in this area. For many private hospitals, infectious waste is collected for final disposal at least 48 hours after generation[52]. The added residence time, tropical climate and other sources of pathogens at the disposal site can further increase the infectious nature of the waste. Decomposition of the organic matter in the waste pit produces noxious fumes, carbon dioxide, methane and leachate. Contamination of the water bodies can occur

[52] WHO recommends a standard residence time for storage of health-care waste in tropical climate. It is recommended that health-care waste should not be stored for more than 24 hours in the hot dry season and 48 hours in the rainy season from the point of generation to collection for treatment or disposal. Cold storage is required beyond 48 hours (WHO 1999).

through percolation of leachate into the ground water systems[53] and through surface runoff. In the dry season the average depth of the water table along the coast of Guyana is recorded as 71.5 cm and in the wet season 40.3 cm (PAHO/WHO 2004). Burying of small pockets of health-care waste in the outlying regions without considering environmentally sound measures places a wider population at risk through contamination of environment. Artesian water, a main source of potable water for the coastal population, is recharged by rain water permeating through the white sandy region. Burial of waste in this region places this source of potable water at great risk (PAHO/WHO 2004).

The fundamental principle of ESM is to treat and /or dispose of the waste as close to the source as possible in order to minimize the impacts. On-site treatment not only contains the infectious and hazardous materials but is also convenient and reduces the risks related to transportation (WHO 1999). Outlying health-care facilities are smaller and widely spread across the country. On-site treatment and disposal can be costly, requires high level of technical staff and constant monitoring by authorities to address the issues related to infectious waste management. On the other hand, a regional system can also be considered suitable and more cost effective (WHO 1999). As in the case of Region 3, the West Demerara Regional Hospital serves as a central point for incineration of sharp waste from the district hospital and health centres in the area. Given the adverse environmental effects resulting from incineration, this method should no consider viable. Therefore alternative methods such as autoclaving, microwave, or disinfection to normalize infectious waste are safer options, rendering the waste 'normal' for disposal by landfilling or entombing (WHO 1999; Emmanuel *et al.* 2004). Costs related to technology and the necessary infrastructure for operation, environmental and health effects of the methods, availability of land, institutional capacity, monitoring and operation and regulation are factors that must be considered when selecting the most viable option.

If the autoclave system in the Georgetown Public Hospital (GPH) is to be used to treat waste from other facilities, several issues must be considered. This centralized approach by the GPH will require a network of routes from each facility and necessary infrastructure to avoid direct handling of waste. Authorizing the transportation system for hazardous and infectious waste needs to be factored in the planning process also. While having such a centralized system can be beneficial and cost effective, the proposed location for the autoclave system maybe next to a major roadway. Thus, there is possibility of traffic encumbrances during the operational phase. Consideration should be given to the quantities of infectious and hazardous waste transported and whether there will be need for storage (if there is daily collection and treatment there will be no need for transfer stations) (WHO 1999). An important factor is that the GPH will be operating as a private enterprise to treat waste. The question will arise as to whether this is its primary function. To that end, the hospital taking the responsibility for waste from other facilities raises issues related to liability. At this time, the establishment of the autoclave system is mainly for the hospital use (Rachpaul 2008). Therefore, the infrastructure in place will serve only this purpose.

[53] The bags are dumped without sealing or securing and packing together increases the pressure thus it is easier for the liquid material to escape. Additionally single bags are used that increases the probability of rupture and as a result hazardous materials have direct contact with the environment.

6 Challenges, Functions and the Responsibilities

The following chapter identifies the challenges encountered while implementing initiatives to address the issues related to health-care waste. It further elaborates the functions and responsibilities of involved agencies using the structure of VSM and examines the roles of government to reduce the environment and human health effects.

Effective separation at source, proper packaging and handling of waste, separate storage and possible treatment on site to eliminate risks and environmentally sound disposal methods are all components that will optimize the management of health-care waste at the operational level. The lack of any part will affect the later stages in the waste chain and increase the risk for the transmission of pathogens and contamination of the environment. The reduction of waste quantity and toxicity is a significant measurable outcome. Therefore, improving the management of health-care waste, in the wider context of the system, will lead to protection of environment and human health thus contributing towards the overall objective of improve living standards as outlined in section 4.1.

6.1 Challenges

The challenges vary along the waste chain in relation to the roles and responsibilities of the involved agencies. Challenges were found at the policy or national level, institutional level for the responsible agencies and at the operational level of the generators. This section only serves to summarize the issues that were presented chapter 4.

Policy /National Level

In the absence of a policy framework and strategic direction to address health-care waste, the National Oversight Committee established by the Ministry of Health attempted to bring together representatives from the key agencies to work towards addressing the issue of health-care waste. The function of this committee however has been hindered by infrequent meetings, inertia related to its responsibilities and availability of members for meetings. A key constraint faced by many institutions in Guyana is the lack of technical persons. The relatively small number of technical persons is thinly spread and having a number of responsibilities affects their level of commitment to the committees and little priority given to another agency resulting in delayed output. Secondly, technical committees in most cases lack high level management; the representatives are usually lower level (at times junior) staff with little or no decision-making capacity. The function and implementation of activities by the committee and commitment of the key agencies represented are thus further delayed.

Institutional Level

At the national level, the authority responsible for primary health-care addresses waste issues given the emphasis on heath and safety from poor management of waste at the operational level. The authority responsible for waste management focuses on collection and disposal and lacks the requisite legislation for monitoring and enforcement. Several initiatives have been undertaken by a number of agencies to address issues related to health-care waste. As outlined in section 4.4.4 the Municipal Solid Waste Management Department is undertaking an assessment of the current situation and inventory regarding hazardous and health-care waste with the intention to identify feasible alternatives – a similar study conducted by the Ministry of Health in 2004 for health-care waste. Moreover, the EPA is currently undertaking an inventory of hazardous waste from priority sectors country wide of which health-care waste is a part. Furthermore, the IDB funded autoclave projected for the Georgetown Public Hospital

to treat its waste is currently in process and a notable exception here is whether the service will be extended to private hospitals.

The EPA has the responsibility for the management of hazardous waste and in accordance with the legislation an authorization is required for the generation, treatment, storage, transport and disposal of such waste. Health-care facilities must be licensed by the Ministry of Health (MoH). However, each regulation stipulates a different agency or department to address some aspect related to health-care waste. On one hand the EP Hazardous Waste Management Regulation 2000 stipulates disposal in a hazardous waste landfill while the recent regulation – the Health Facilities Licensing Regulations 2008 stipulates the disposal in accordance with the requirements of the Municipal Solid Waste Management Department. This Department has no bona fide status to develop guidelines and standards for hazardous waste as this responsibility rests with the EPA.

The provision of equipment for basic waste separation for public facilities depends on external such as PAHO and USAID. GSIP provides the initial equipment such as covered bins, bin liners (bags) to public facilities after conducting training sessions. However, the RDCs and MoH are required to budget for the provision of such equipment thereafter. PAHO has undertaken to supply the Ministry of Health with sharp boxes for the next 20 years. The MoH through the West Demerara Regional Hospital distributes sharp boxes to the hospitals and centres in Region 3. Clearly this level of dependence has a bearing on the effectiveness of source separation and a successful waste management programme.

The Guyana Safer Injection Project ends in 2009 but the mechanism to transfer its responsibilities and continuance of the activities is still unclear. There is a disconnection between the activities and responsibilities of GSIP and the MoH (Lewis 2008). The operational guideline developed as part of this project is still to be approved before finalization. While the guideline is intended to guide health-care workers of the required procedures when dealing with waste and to develop a waste management plan, it is still voluntary and has no legal basis. It does not outline responsibilities for monitoring and follow up. Further, these guidelines are not yet extended to private hospitals. In general the initiatives undertaken (as outlined in section 4.4.4) apply only to public facilities but managing the private facilities still remains a challenge.

Operational Level

The general lack of information on waste quantity, type and cost (for waste management) creates a gap in the system. Hospitals contract the collection and disposal of waste to private operators and the municipality. In the absence of records regarding the quantity of waste generated and the level of segregation, the amount paid for waste disposal cannot be fully grasped and understood. Information related to waste accounting is missing in most hospitals. Only the Georgetown Public Hospital Corporation has some level of information regarding a budget for waste (PAHO/WHO 2004).

The level of awareness in health-care facilities continues to be a challenge. There is a general lack of awareness of the environmental issues resulting from poor waste management practices. Environmental issues are not considered as important or necessary in most facilities. The level of separation and information regarding waste separation and handling still remains an issue even though training has been conducted by GSIP. The MoH intention to strengthen the lower level facilities (health posts and health centres) denotes that there will be an increase in the services to the population thus increasing the amount of waste generated. There is a need to put systems in place to manage waste and to mandate source separation and segregation in order to reduce the toxicity and quantity of waste and minimize the issues

downstream of the waste chain with disposal. Unless steps are taken to change the behaviour, these facilities will continue dispose of health-care waste using current practices and resulting in continual emission into the environment.

The inconsistent use of colour coded bags pose as a challenge for the waste collectors. Black bags used for storing infectious waste require labels to provide handlers with the requisite information pertaining to content. However, many health-care facilities do not adhere to this. Additionally, facilities, in particular private facilities seek ways to reduce cost by not purchasing the required bags or sharp boxes.

6.2 System Functions and Responsibilities

To prevent antagonism, it is necessary for the national agencies to collaborate and encourage involvement of all actors. A separate institution as proposed by many at the national/institutional level to manage health-care waste is not necessary since it may take years to fully develop and require resources to build institutions (Sterner 2003) however building on existing infrastructure allows for easy transformation.

The viable system model used to structure the health-care waste management system along its core functions identified the responsible agencies and the need to optimize or strengthen the functional capacity of these institutions to manage health-care waste. The EPA was identified as the main actor since it is integrally involved in all five system components and is the driver in the system for policy development. The Ministry of Health and the Ministry of Local Government were identified, as well as, in coordination with the EPA provides the basis for strategic development. The policy and plans developed by the national agencies are implemented through the control and monitoring functions of the municipalities, regional administrations, the corresponding department in the Ministry of Health (Environmental Health Unit) and the Environmental Management Division of the EPA. Table 5-1 highlights the functional areas of the viable system model, the corresponding institutions in the current health-care waste management system in Guyana and the outcome of using VSM to identify the roles of institutions. The EPA, municipality and the regional administration coordinate the operation of the hospitals and health centres and the collection and disposal of waste.

Table 5-1Outlines the VSM functional areas and the corresponding responsible agencies in the management of health-care waste in Guyana

VSM functional areas	Responsibilities in the current health-care waste management system	Using VSM to identify responsible agencies for an Environmentally sound Health-care waste management system
System 5 – Policy & Norms	Unclear in the current system	EPA as the driver
System 4 – Strategic development	Unclear in the current system	EPA & MoH
System 3 & 3* - Control (optimize) & Auditing (monitoring)	Unclear in the current system	Municipality, Regional Administration, MoH & EPA through the Licensing process
System 2 - Coordination	Municipality, MoH and Regional Administration	Municipality, Regional Administration & EPA through the Licensing process
System 1- Operation[al]	Generators, Collectors & Disposal	Generators, Collectors, Disposal & EPA through the Licensing process

6.3 The Roles of Government[54] in health-care waste management system

Sustainability in the management of health-care waste in the context of Guyana will be best achieved through interventions by the national agencies. As such, it is necessary for this actor to set the goals and priorities and to facilitate collaboration among the other actors in the pursuit of an environmentally sound and sustainable system for health-care waste management. Environmental policy forms the basis for governmental intervention in managing adverse environment and health effects. The policy stipulates that the government will prioritize issues affecting public health. Constituents of health-care waste are infectious and hazardous and have serious effects on human health and environment if not managed and contained. To that end, it is crucial that the management of health care waste is a priority. Additionally, it is necessary to strengthen the coordination of the existing infrastructure to address these issues. Therefore, through systems thinking it has been recognized that the central actor in health-care waste management is the EPA.

Government has a key role in mandating, initiating and facilitating improvements in the health-care waste management system. Each role requires different level of intervention that can be achieved through a national position. Policy literature (sections 2.2.1 and 2.2.1.1) recognizes the need for government to define clear goals and objectives for reduction of waste at source and measures to be taken to improve waste management. This policy direction provides the framework for the achievement of the policy objectives through various policy instruments. Therefore, it is urgent for the EPA as the main actor to intervene, through collaboration with the various actors, to set the context or a strategy to reduce the adverse human health and environmental impacts from health-care waste.

Mandating Changes

The results of the current inventory (refer to section 4.4.4) can be used as the basis for policy development. The literature in this research identified elements of sustainable policy that should be included, in particular, the waste minimization and the waste hierarchy. Incorporation of these elements can direct a desired outcome by mandating behavioral change. The policy should also define other interventions such as the use of incentives and the extent of its use. Further and most fundamental to support the mandatory instruments is the provision of information. Information creates awareness though the increase in knowledge; this in turn changes behaviour that eventually leads to implementing measures to improve waste management.

The implementation of efficient source reduction requires a shift in the behaviour at the generators level. Mandatory standards are the easiest at this stage to address the environmental issues related to health-care waste management. It is easier for the EPA to start with the implementation of the Environmental Protection (Hazardous Waste Management) Regulations 2000. The structure exists within this institution to permit any new operation related to health-care, thus, it is important for the EPA to develop mechanism to regulate the existing public and private health-care facilities[55]. It is also necessary to clearly classify waste and develop standards for separation, handling, and storage etc. Authorization is required at all stages; operation of health-care facilities, generation of infectious and hazardous waste, transportation, treatment and disposal. The Ministry of Health needs to utilize the existing

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[54] For the purpose of this thesis, government according to Sterner (2003:13) is used to mean a *"series of public-sector bodies with distinct structures, motivations and modes of operation at different levels"*.

[55] These facilities were in place before the establishment of the EPA, thus, after the enactment of its legislation, the EPA was expected to develop a mechanism to regulate all existing facilities.

tools of legislation to regulate the health-care facilities. Therefore closer collaboration in the licensing process between the EPA and the Ministry is vital to address the issues in the sector allowing for fairness and equity in waste management for private and public facilities. Further, mandatory standards provide the base towards achieving a level of standard as emulated in the cases of Lund and Malmö.

Initiating Changes

The EPA can create incentives as a way of rewarding facilities for efforts made towards environmental improvements. This approach however, only targets hospitals and most beneficial to private hospitals. Public facilities, apart from the Georgetown Public Hospital, receive funding from the central government though the regional administration and the lack of financial control can affect the level and priority placed on waste management. There is a risk that this disparity may hinder the private facilities in pursuing such measures.

Incentives can also be created for private entrepreneurs to intervene to treat health-care waste. Alternative treatment technologies such as mobile autoclaves provide the possibility for the waste treatment at facilities. This option than can address the waste specifically from private hospitals and health centres in outlying areas. It reduces the risk related to transportation and handling and targets a wider area to reduce the infectious and hazardous content. However, cost related to treatment may have an influence on hospitals to seek other possible methods for treatment or other ways of reducing hazardous waste. Maintenance cost is a factor that must be taken into account. But on the other hand, once hospitals are required to treat waste, there will be a market for such technology.

Consideration should be given to interventions by the private disposal companies for the collection of health-care waste. However, this approach requires some caution at the moment and can be applied longer term since there is a need to first establish a functioning normative framework for operation.

Facilitating Changes

Informative instruments influence changes in behavior by increasing awareness and providing knowledge. The EPA can facilitate or stimulate dialogue among the actors through the provision of information to increase awareness of the issues and motivation to change behaviour eventually leading to improve environmental performance. This is most fundamental in the current situation and supports mandatory instruments to improve health-care waste management. While this instrument targets a general level of awareness, it is necessary to also aim at management in the health-care facilities, in particular, managers.

Effective waste management depends on the ability of managers and even top management at the operational level to recognize and understand their role in the process and commitment towards environmental change. The hospitals used as references in this research have been implementing environmental management systems and is well advanced but for Guyana it may not be feasible to implement such system immediately, until standards are in place and health-care facilities have reached the minimum level. However, the principles of EMS can be used as a guide to establish procedures for waste management in health-care facilities, increase awareness, defining clear structure, responsibilities, facilitate information flows and communication. These elements must be addressed so that information can be communicated to the lowest level employees. These employees are often excluded from the process and are usually unskilled workers having minimal yet important responsibilities. In order to change their behavior, management must recognize their role (job) as important and at the same time facilitate training and skills development to motivate these workers to feel a part of the process.

7 Conclusions and Recommendations

7.1 Main Findings

This research tries to examine the situation of health-care waste management using a systems approach, in particular, the application of the hierarchal structure and five functional areas of the viable system model. The model was used only to structure the analysis of the thesis to understand the complexity of the issues in the health-care waste management system (HCWMS) since the five functional areas corresponds to key functions in the HCWMS. The research further examined specific areas at the policy, management and operational levels in the health-care waste management system. This exploration was completed to identify the roles of the relevant agencies and the use of policy to improve waste generated at source and the extent of governmental intervention. Effective source separation to improve the practices at the generator level and necessary mechanisms to effectuate this change were explored in order to improve the current situation in Guyana. The main issues considered were the adverse environmental and health impacts that arise from poor handling and disposal practices, the responsible institutions, initiatives taken and the policy framework. The actors involved in the research included government agencies such as the Environmental Protection Agency, Ministry of Health, Ministry of Local Government & Regional Development, private disposal companies, private and public hospitals and health centres. The research focused on the public sector, mainly governmental actors, in order to understand their role in managing and improving the current situation.

Research questions 1-3 as proposed in section 1.2 were answered in detail in chapters 4 and 5. However, the key findings are summarized as follows:

1. This research supports a fundamental principle in the theory of the viable system - the need to have all five system components in place for the system to function effectively. It further supports the principle of recursion in hierarchal system and the need to define the goal, standard and policy of the system, its purpose and identity for the operational systems. The Environmental Protection Agency has been identified as the main actor in the health-care waste management system using the hierarchal structure and five functional areas of VSM.

2. Health-care waste management has been embedded within the context of environmental management and protection. There is no separate policy for health-care waste and it is not included in the environmental policy. Two regulations are in place to address some element related to the management and disposal of health-care waste: the Environmental Protection (Hazardous Waste Management) Regulation 2000 and the Health Facilities Licensing Regulations 2008. The level of awareness among the governmental actors related to coverage of health-care waste by the legislations is low.

3. The lack of coordination among the responsible agencies is high to the extent that institutions duplicate efforts in managing health-care waste.

4. There is low level of awareness among the actors regarding the risks to environment resulting from poor management of health-care waste. However, actors were aware of the health risks associated with contaminated needles. The Ministry of Health's drive to reduce the number of HIV/AIDS cases in the country led to some level of

awareness among health-care workers of the health risks from poor handling practices. This also led to the separation of needles from other waste.

5. Public hospitals depend on external support to provide basic equipment such as sharp boxes and bin liners for source separation. Source separation in public facilities is affected by timely distribution of sharp boxes and bin liners by the responsible authority in the outlying regions. Cost constrains private hospital to source the required bin liners, thus affecting the level of source separation.

Answering research question 4 as discussed in detail in section 6.3, examined the roles of government in mandating, initiating and facilitating improvements of the existing situation. This research concludes that the key role of government is to mandate changes through mandatory instruments in order to immediately address the situation. Further, in support of its mandatory function, government needs to facilitate dialogue among the actors and provide information to increase awareness towards behavioral changes.

Using the cases of hospitals in Lund and Malmö helped to understand the organization of a fully functioning waste management system. This approach identified the gaps in the Guyanese system; refer to Appendix 8 for summary of the organization of both systems. It recognized the need for mandatory measures to regulate the waste generators. Most importantly the case justified the need for policy intervention to improve the generation at source. Policy is not only important in providing clear direction for waste management through source reduction but to reduce harm to environment and human health. For this to be effective institutions need to change their way of thinking. The current structure for waste management does not allow for it to be sustained in the longer term according to the principles of the viable system model unless the five system components (functional areas) are in place.

This research further identified the organization of the waste system, in the context of a developing country can be bureaucratic for public facilities. The parent facility has the control of out-patient operation centres and limits its autonomy, which restrict its functions and decision-making. The key factor for a functional system, according to the principles of VSM, is for the operational systems to have some level of autonomy to execute its functions. The high external dependence also raises questions for the sustainability of the system. These issues must be addressed for effective waste management and sustainability in the longer term. Further it is evident from this research that long term planning for environmental management is necessary. In the author's experience the approach has been more reactive towards environmental issues and quite often only the legislation is in place without any goal or objective to address key issues as part of the overall planning.

The viability of the health-care waste management system in Guyana becomes questionable given the lack of clarity in key functional areas and high dependence on external support. It is evident from this research that the current practices will not lead to an environmentally sound health-care waste management system. Continuing along the same trajectory purports a risk of an increase in environment and health impacts. Moving off this path involves either a change in the structure of the system to adapt to the current situation or there is a complete shift in paradigm in the management of health-care waste.

7.2 Recommendations

Environmental issues are highly complex and finding the right solution requires the involvement of a number of actors. Since health-care waste is a component of environmental

management and protection, addressing these issues requires a holistic approach. Policy can provide this basis. The policy development process for health-care waste requires the collaboration of a number of actors. The following key recommendations are aimed at improving the situation regarding health-care waste in Guyana:

1. **Increase awareness at the national and operation level in the HCWM system**. It is necessary to facilitate the dialogue among the actors and to provide information to increase the level of awareness. This is fundamental to changing behaviour at all levels. In order for the waste management systems in the hospitals and health-centres to function effectively, information must be provided. The information must include the policy direction of the facility for managing waste through separation to minimize waste generated at source, waste definitions and classifications, procedures for sorting and segregation, labeling and reporting etc. The involvement of the EPA at this level will facilitate the transference of that information through its licenses and other means. A critical factor is to ensure that the information is transferred so that the receiver can understand. Understanding the information and responsibility for its implementation are important elements for the viability of the waste management system. Clearly defined policies and norms provide the cohesive forces for the viability system, in particular, for hospitals and health-centres to function at the operational level.

2. **Policy Development.** The EPA must recognize the important role it has in the management of health-care waste and to take the responsibility to catalyze the policy development process, not only to improve health-care waste management but environmental protection in general. This is necessary to stimulate collaboration of the institutional agencies. There is an urgent need to develop heath-care waste policy with clear objectives and targets building on the hazardous waste inventory conducted by the EPA.

3. **Enforcement of the Legislations**. In order to regulate the activities at the operational level in the HCWMS and immediately arrest the situation, implementing the EP Hazardous Waste Regulation 2000 should be of paramount priority by the EPA. Further, closer collaboration with the Ministry of Health through the Environmental Health Unit is deemed necessary to regulate and monitor public and private facilities.

4. **Development of Standards and Guidelines**. There is an urgent need for the regulatory agencies to establish standards for emission and disposal, procedures and guidelines for waste segregation, labeling, handling, storage and collection of waste. The EPA, National Bureau of Standards and the Ministry of Health through the National Oversight Committee should undertake the development of such guidelines or the amendment of the proposed operational guideline to include these areas (inclusive of responsibilities for monitoring). Once finalized, it (the guidelines) should be incorporated into the permitting or licensing process of the Ministry of Health and EPA for it to be legally binding. Overall there is clear need to define and classify the waste streams as there is enough evidence existing to develop a detail waste classification system for the waste generated from health-care facilities.

5. **Private Sector Involvement**. The private sector's role in the HCWM system at this stage involves the provision of services for the treatment of waste. Alternative treatment technologies can be explored, in particular, the use of mobile autoclave for each region. There is need to provide incentives for entrepreneurs to stimulate interest and facilitate investing in this area. This approach will stimulate a shift in disposal

practices from burning and burying waste to more environmentally sound disposal methods.

6. **Operation Level Management**. Improvements at the operational level can only be achieved if it is regulated by the responsible agencies (EPA and MoH). The need to enable management of the facilities to implement measures to address health-care waste requires stronger push from these agencies. Specific measures that can be implemented at the operational level of the system are as follows:

    a. Increase awareness at management level of the health and environmental effects of the current practices (refer to recommendation 1).

    b. Incorporate environmental considerations and waste management into the standard operating procedures. Waste segregation for efficient source separation, labeling, securing bags, secondary containment where necessary should also be included in the procedure. A policy for environmental management and waste reduction through source separation should be in place for all facilities.

    c. Mandate the use of the colour coded system, particularly for private facilities.

    d. Health and Safety Officers should be employed at all hospitals and define responsibilities to include environmental considerations and waste management. This responsibility should be transferred to the head nurse or medex for health centres.

    e. Training and awareness for health-care workers including lower level unskilled workers should be conducted periodically by management.

    f. Hospitals should undertake waste accounting - inventory of all waste types and quantities and monitor waste generation patterns across departments and wards if possible. Further, separate records of cost associated with waste collection and disposal should be kept and develop reporting mechanism with the regulatory agencies.

    g. Shift away from open burning and incineration by increasing awareness of the human health and environmental effects of such rudimentary practices and investing in alternative treatment technologies.

7. **Suggestion for further research.** To fully grasp the complexity that exists in the management of health-care waste in a developing country, the possibility of using the viable system model to plot or model the system to undertake an in-depth analysis should be explored.

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Personal Communication

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Nelsson, A. (May 2008). Responsible for risk waste - Lund University Hospital

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Svensson, H. (July 2008). Miljösektionen Malmo University Hospital

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Urlin, H. (June 2008). Director (ag.) Mayor and City Council Municipal Solid Waste Management Department

Wallin L. (July 2008). Info.sekr Lunds Renhållningsverk

_____ (June 2008). Person on Duty Queenstown Health Centre
_____ (June 2008). Person in Duty Festival City Health Centre
_____ (June 2008) Nurse NE La Penitance Health Centre

Abbreviations

EHO	Environmental Health Officer
EHU	Environmental Health Unit
EPA	Environmental Protection Agency
ESM	Environmentally Sound Management
GM	Georgetown Municipality
GPH	Georgetown Public Hospital
GSIP	Guyana Safer Injection Project
HCWM	Health-care Waste Management
HCF	Health-care Facilities
IDB	Inter-American Development Bank
MoH	Ministry of Health
MoLG&RD	Ministry of Local Government & Regional Development
MSWMD	Municipal Solid Waste Management Department
PAHO	Pan American Health Organization
RHO	Regional Health Officer
RDC	Regional Democratic Council
USAID	United Stated Agency for International Development
WHO	World Health Organization
WB	World Bank

Definitions

Clinical Waste : Defined in accordance with the EP Hazardous Waste Regulation 2000 as "(i) any part of the human body including tissues and bodily fluids, but excluding fluids, extracted teeth, air, nail clipping and the like that are not infections; (ii) any part of the carcass of an animal infected with a communicable disease; (iii) non-anatomical waste infected with communicable disease; or (iv) any waste that is generated in the diagnostic, treatment or immunization of human beings or animals and related activities that include research or autopsies;".

Duty of Care Principle: "any person handling or managing hazardous substances or related equipment is ethically responsible for using the utmost care in that task" (WHO 1999).

Environmentally Sound Management: "a scheme for ensuring that wastes and use and scrap materials are managed in a manner that will save natural resources, and protect human health and the environment against adverse effects that may result from such wastes and materials" (OECD 2007).

Government:: according to Sterner (2003:13) is used to mean a "series of public-sector bodies with distinct structures, motivations and modes of operation at different levels".

Health-care waste: "the total waste stream from a health care facility that includes both potential infectious waste and non-infectious waste materials" (WHO 2005).

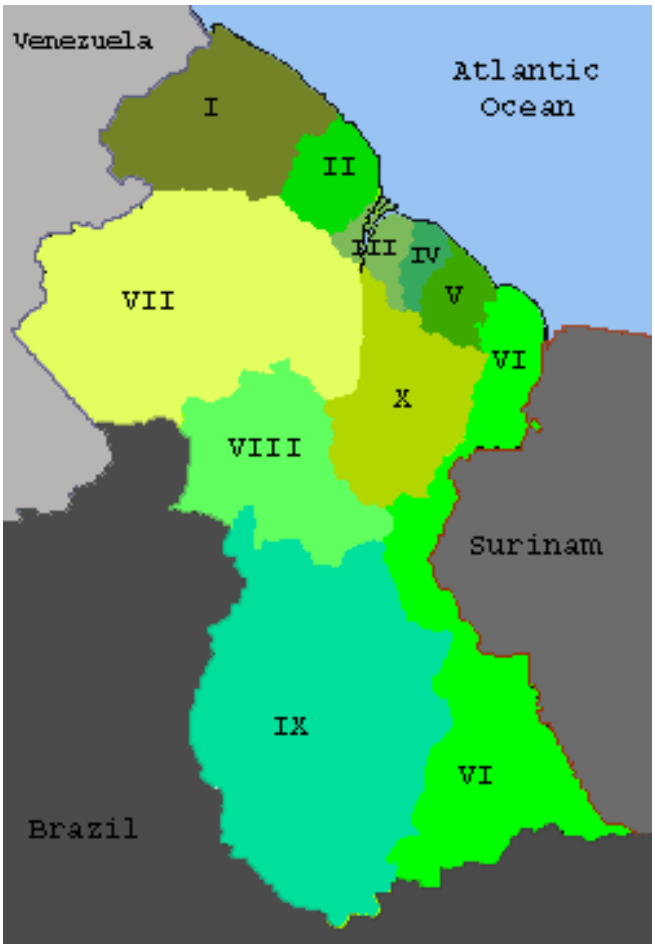
Medical Waste: Defined in accordance with the EP Hazardous Waste Regulation 2000 as *"any waste that is generated in the diagnostic, treatment or immunization of human beings"*.

Polluter pays principle: "The polluter should bear the cost of preventing and controlling pollution to ensure an acceptable environmental state" (OECD, 2000:123).

Precautionary Principle: "The lack of scientific certainty shall not be used as a reason for postponing measures to prevent environmental degradation" (Carter, 2001:6).

Waste Minimization: "preventing and/or reducing the generation of waste at source, improving the quality of waste generated such as reducing hazard and encouraging re-use, recycling and recovery" (OECD 2004).

Appendix 1 Map Showing the 10 Administrative Regions in Guyana



www.mnh.si.edu/biodiversity/bdg/images/regions.gi

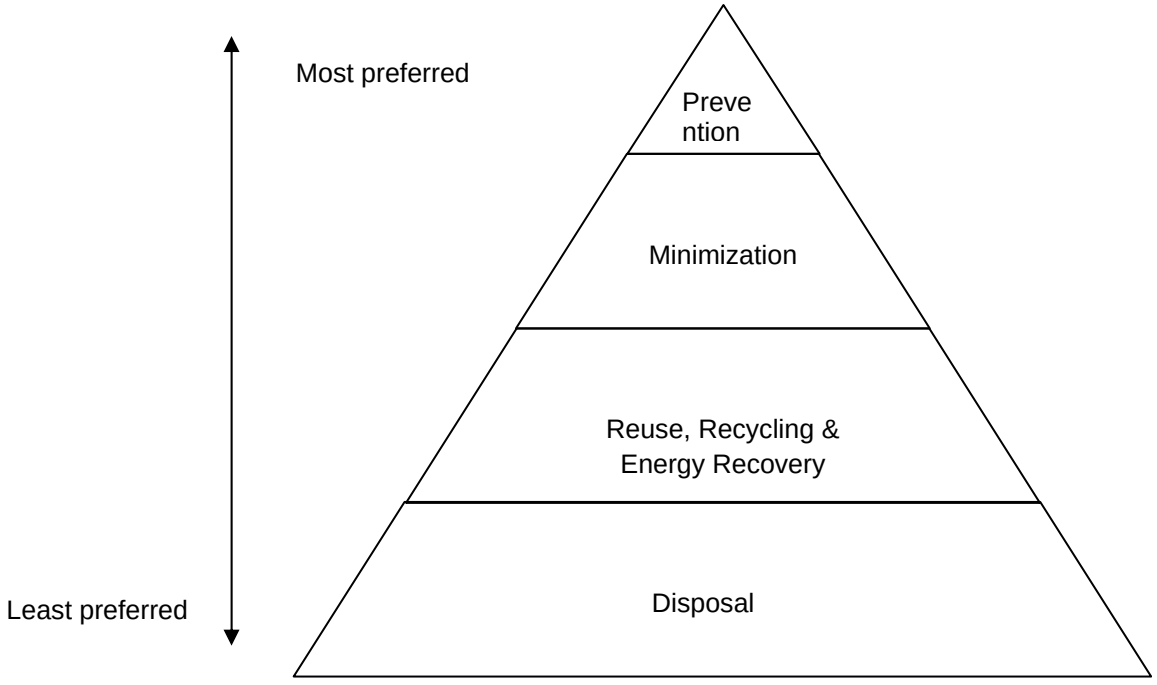
Legend	
Region	**Name**
I	Barima-Waini
II	Pomeroon – Supernaam
III	Essequibo Islands West Demerara
IV	Demerara – Mahaica
V	Mahaica – Berbice
VI	East Berbice-Corentyne
VII	Cuyuni-Mazaruni
VIII	Potaro-Siparuni
IX	Upper Takutu Upper Essequibo
X	Upper Demerara-

Appendix 2 List of persons interviewed during the study period

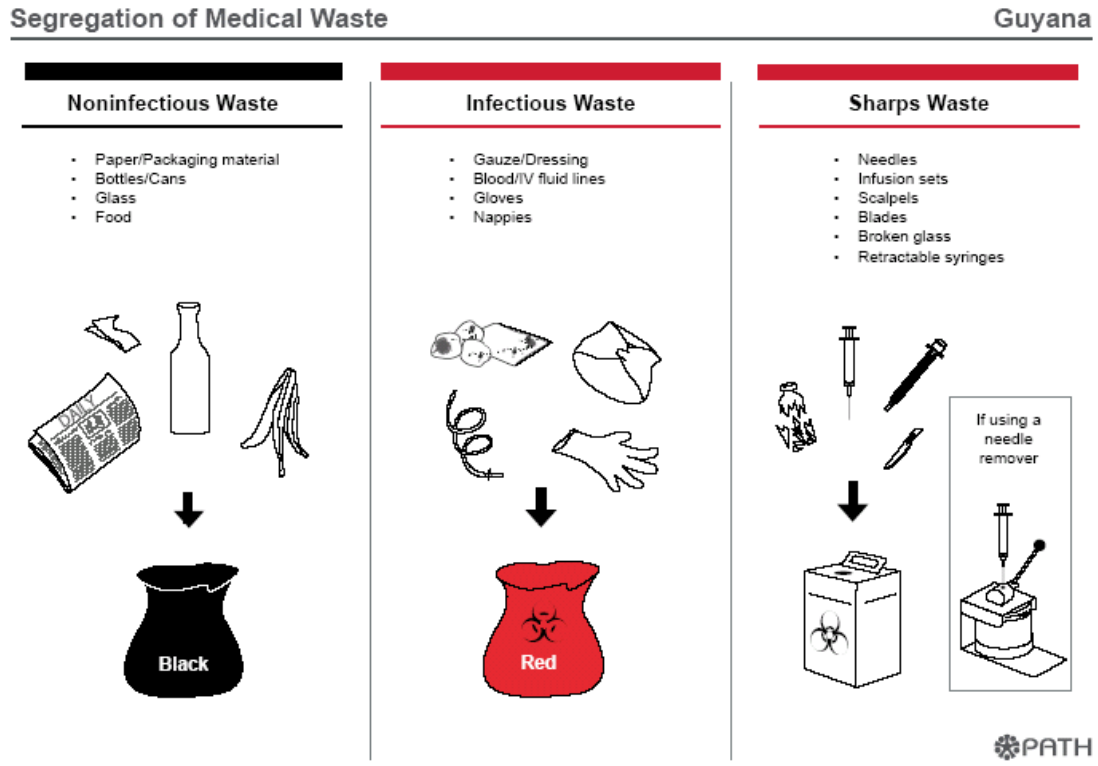
#	Name	Designation	Contact Details	Interview Type	Date
1	Petra Holm	Responsible for EMS implementation Waste collection and storage Responsible for risk waste	Lund University Hospital	Face-to-face	May 27, 2008
2	Daniel Blomqvist				
3	Annelie Nelsson				
4	Lena Wallin	Info.sekr	Lunds Renhållningsverk	Electronic mail	Received response July 29, 2008
			Guyana		
			Sector Agencies		
5	Dr. Ashok Sookdeo	Director	Environmental Health Unit, Ministry of Health	Face-to-face	June 6, 2008
6	Dr. Teofilo Monterio	Health and Environmental Advisor	Pan American Health Organisation Brickdam, Georgetown	Face-to-face	June 6, 2008
7	Mr. Hubert Urlin	Director (ag.)	Mayor and City Council Municipal Solid Waste Management Department	Face-to-face	June 10, 2008
8	Ms. Abbigail Liverpool	Technical coordinator/ Waste Management Advisor	Guyana Safer Injection Project	Face-to-face	June 13, 2008
9	Ms Audrey Anderson	Chief of Party		Face-to-face	June 13, 2008
10	Mr. Hance Thompson	Senior Environmental Officer	Environmental Protection Agency	Face-to-face	June 17,2008
11	Mr. Rufus Lewis	Env./Waste Management Consultant	Guyana Citizens Initiative	Face-to-face	June 17, 2008
12	Mr. Ishri Ratan	Deputy Director (ag.)	Mayor and City Council Municipal Solid Waste Management Department/ Landfill section	Face-to-face	June 24, 2008
			Private Disposal Companies		
13	Mr. Everel Franklin	Managing Director	Franklin Singh Disposal Service, Georgetown	Telephone	June 9, 2008
14	Mr. Kalishwar Pooran	Manager	Pooran Bros. Disposal Company, Region 3	Telephone	June 19, 2008
			Hospitals		
15	Ms. Patricia Blair	Admin Personnel	Medical Arts Centre, Georgetown	Face-to-face	June 17, 2008
16	Ms. Shellan Isaacs	Nurse Aide/Operational Health &Safety	St. Joseph Mercy Hospital, Georgetown	Face-to-face	June 18, 2008
17	Mr. Walter Narine	Quality Control Health & Safety Manager	Woodlands Hospital, Georgetown	Face-to-face	June 18, 2008
18	Ms. Viadwatty	Matron	Georgetown Medical	Face-to-face	

	Hinds		Centre Inc.(Prasad hospital) Thomas St. Georgetown		
19	Mr. Dylon Rachpaul	Assistant Occupational Health & Safety Officer	Georgetown Public Hospital Corporation	Face-to-face	June 18, 2008
20	Mr. Andrew Arthur	Coordinator for Sanitation and Janitorial Services		Face-to-face	June 18, 2008
21	Dr. Ravi Persaud Ms. Savitri Jefers	Director Assistant to the Director	Leonora Cottage Hospital (District) Region 3	Telephone Face-to-face	June 24, 2008
22	Dr. Singh	Medial Superintendent Matron Mortuary personnel	West Demerara Public Hospital, Region 3	Face-to-face	June 24, 2008
23	Ms. Romona Merd				
24	Mr. Jodhan				
Health Centres					
25	Nurse on Duty	Nurse	Campbellville Health Centre Georgetown	Telephone	June 17, 2008
26	Ms. Sharon Chase	Nurse	Kitty Health Centre Georgetown	Telephone	June 17, 2008
27	Decline to provide name	Person on duty	Queenstown Health Centre	Telephone	June 23, 2008
28	Decline to provide name	Person on duty	Festival City Health Centre	Telephone	June 23, 2008
29	Requests confidentiality	Nurse	NE La Penitance Health Centre	Telephone	June 23, 2008
30	Mrs. Sandra Ganga	Medex	De-Kendren Health Centre Region 3	Face-to-face	June 19 2008
31	Ms. Linda Johnson	Health Visitor	Parika Health Centre	Telephone	June 20, 2008
32	Ms. Griffith	Midwife	Goed Intent Health Centre	Telephone	June 23, 2008
33	Ms. Vanessa Dabadin	Community Health Worker	Windsor Forest Health Centre	Telephone	June 23, 2008
34	Ms. Hemwanttie Ali	Midwife	Canal Number 1 Health Centre	Telephone	June 23, 2008
Malmö					
35	Hanna Svensson	Miljösektionen	Malmo University Hospital	Face-to-face	July 21, 2008
36	Lasse Bengtsson	Miljösamordare			

Appendix 3 : The Waste Hierarchy



Appendix 4 Categories of waste segregation



Source : GSIP 2008

Appendix 5 Burnt Boxes used at Health-centres

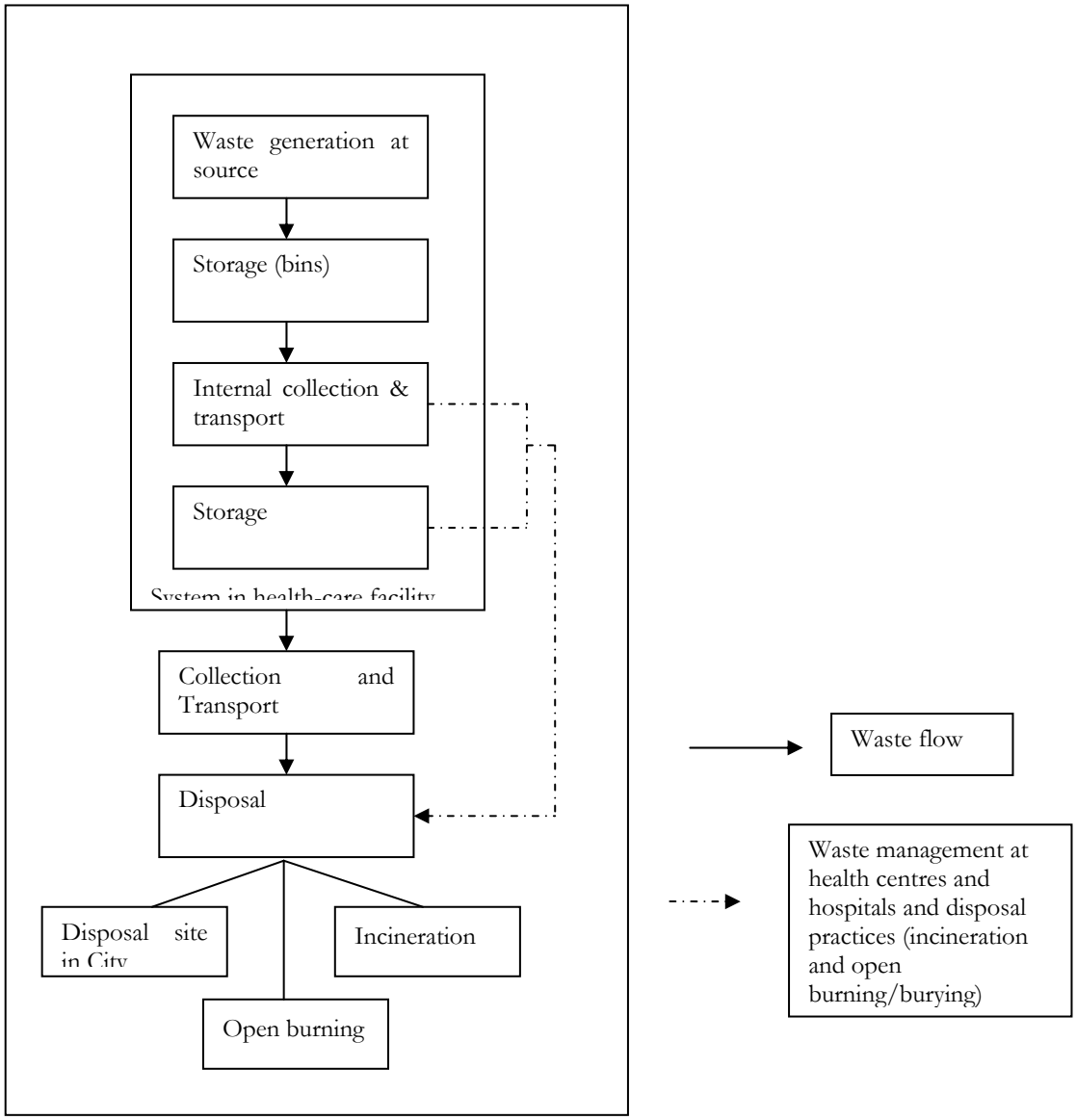
Source : GSIP 2008

Appendix 6 Incinerators used at the West Demerara Regional Hospital

Newly constructed De Montfort incinerator used for incineration of sharp waste at the West Demerara Regional Hospital

Existing furnace used for incineration of infectious waste at the West Demerara Regional Hospital

Appendix 7 Health-care waste management system in Guyana and current disposal practices



Appendix 8 Summary: System organization for HCFs in Sweden and Guyana

Health-care Waste Management System Components	**Sweden**	**Guyana**	
	Lund and Malmö	**Hospitals**	**Health-centres**
Regulation	SOSFS (2005:26) stipulates definition, responsibility, procedure for handling, labeling, storage, collection, pre-treatment, transport routes, and disposal.	EP Hazardous Waste Management Regulations 2000 defines health-care waste only but lack of awareness in the operation system. Health Facilities Licensing Regulations 2008 stipulates standard operating procedures for facility in the provision of health-care and addresses health-care waste from safety perspective to reduce in-house contamination. Specifies storage of waste and disposal method but not in accordance with the EPA. Does not establish transportation routes. Stipulates treatment before disposal	
Environment Section as part of organization structure	Yes	No	No
Environmental considerations integrated into procedures	Yes	No	No
Environmental considerations regulated by permit	Yes	Only private hospitals permitted, no regulation of environmental considerations	Health centres are not permitted
Definition and Classification	Definition as per regulation, detailed categories and classification system	Definition exists in legislation but categories are not defined.	
Written Procedures	Written procedures in place	Standard operating procedures does not include waste management	No procedures in place
Sorting	Detailed sorting into many different waste fractions by fully trained staff.	Limited sorting	
	Waste labeled in accordance with legislation	Legislation does not specify labeling of waste but stipulates labeling of containers for transport	
	Colour coded system used	Colour coded system in place but not effectively used and regulated	
	Containers seal or tightly secure before removal	Bags are not tightly secured before removal.	
Collection & Storage (on-site)	Designated transfer stations onsite for storage	Only the GPH has designated transfer station. No cold storage in private hospitals	No transfer stations Waste fractions stored together No need for cold
	Waste fractions store separately		
	Cold storage for waste beyond 48		

	hrs. Waste not removed if discrepancy with label.	(removal of waste 2/3 times per week) Labeling limited to improvised sharp containers only.	storage.
Transportation & Handling	Designated transport routes for waste.	No special routes to transport waste	
	Transport by trolleys and carts	Use trolleys and carts	Removed by hands
	Further packaging of risk waste to prevent leakage and contamination when handling.	No secondary containment in most hospitals, except one private hospital but limited to needles	No secondary containment
	Materials such as paper, cardboard, metal, plastic, glass, packaging, transported for recycling.	No detail separation for general waste, no recycling	
Disposal	Risk waste is incinerated.	Dispose at dump site, incineration	Open burning, incineration