The development and institutionalisation of an integrated health care waste information system

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The development and institutionalisation of an integrated health care waste information system

by

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To the Doctoral Degree Board
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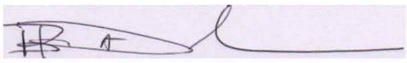
Cape Town, South Africa

I Brian Alphonso Delcarme declare that

The development and institutionalisation of an integrated health care waste information system

is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

Signed:  Date: 24/06/2012

To GOD be the glory

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List of Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
ANT	Actor-Network Theory
CCT	City of Cape Town
Ce-I	Centre for e-Innovation
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEA&DP	Department of Environmental Affairs and Development Planning
DEAT	Department of Environmental Affairs and Tourism
DoH	Department of Health
DoT	Department of Transport
DWAF	Department of Water Affairs and Forestry
HCW	Health Care Waste
HCWIS	Health Care Waste Information System
HCWM	Heath Care Waste Management
HIS	Health Information System
HISP	Health Information Systems Project
HIV	Human Immuno-Deficiency Virus
ICT	Information and Communications Technology
IHCWIS	Integrated Health Care Waste Information System
IPWIS	Integrated Pollutant and Waste Information System
IPWM	Integrated Pollution and Waste Management
IS	Information Systems
ISD	Information Systems Development
ISWM	Integrated Solid Waste Management

NWMS	National Waste Management Strategy
NWMSI	National Waste Management Strategy Implementation
OPP	Obligatory Passage Point
PRTR	Pollutant Release Transfer Register
SITA	State Information Agency
WCPG	Western Cape Provincial Government
WHO	World Health Organisation
WIS	Waste Information System
WMIS	Waste Management Information System

Abstract

Waste management generally in South Africa is poorly defined and practised, and the inadequate management of health care waste (HCW) has been recognised by the South African government as a significant environmental and public health risk. The literature revealed that an integrated health care waste information system (IHCWIS) serves as an important intervention to address the issue of poor health care waste management (HCWM). The overall key research question which this research asked was: ***"How does an IHCWIS develop and become institutionalised among health care waste generators?"***

The aim of the research was to gather empirical data to understand how the development and institutionalisation of an IHCWIS contributes to effective HCWM. This led to the use Actor Network Theory (ANT) as the underpinning theory and the paradigm underlying this research was interpretive with the assumptions of a subjective ontology and an interpretive epistemology. A qualitative descriptive case study research design was used to collect empirical data. The data was analysed (using qualitative content analysis) at three levels namely: Sociology of translation, interpretation of the case and the application of an IHCWIS. The analysis revealed that successful translation through all moments, as defined in ANT, led to the establishment of a stable network of interested actors aligned around the use of an IHCWIS. Factors emerging as important to complementing the sociology of translation and facilitate institutionalisation were effective user participation, dedicated information officers, informatics competence and systems integration. Systems performance and a decision making approach ensured that an IHCWIS could now be used to make decisions to address the problems associated with poor HCWM.

Chapter 1

Introduction

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Chapter 1

Introduction

1.0 Introduction

This chapter introduces the main research question and the analytical approach (detailed discussions on these two aspects are presented in Chapter 3 of this thesis) to develop propositions about the development and institutionalisation of an integrated health care waste information system (IHCWIS) as an intervention to mitigate the problems associated with health care waste management (HCWM).

The chapter is divided into four sections. Section one introduces the thesis topic, rationale for the study and the need to gather empirical information related to the complex networks involved in the development and institutionalisation of a health care waste information system. It also introduces the primary research questions. The second section explains the aim of the study and the objectives it seeks to achieve. Section three puts forward the significance of the research and its key contributions to information systems and health care waste management. The fourth and final section presents the structure of the thesis which contains a brief overview of all the chapters.

1.1 Thesis Topic and Rationale

Before discussing the thesis topic and rationale a structural framework (Figure 1.1 below), illustrating the flow of the arguments and discussions contained in this section, is presented.

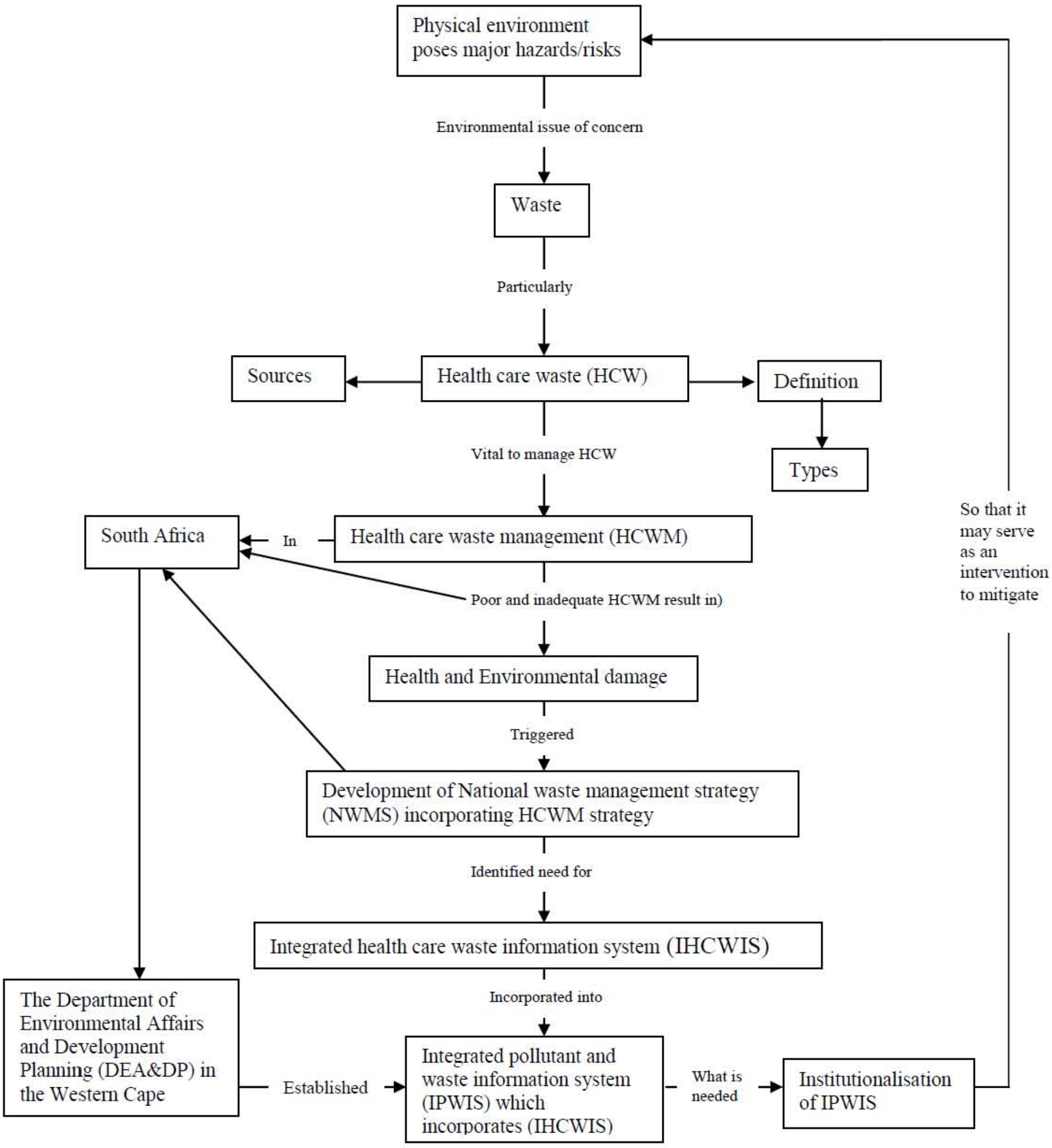

Figure 1.1: The argument structure for problem statement

The environment in which we live greatly affects our lives in many ways. The household, workplace, outdoor and transportation environment pose major risks to health from issues such as poor air quality to the hazards we face as a result of climate change (WHO, 2002). There is no doubt that environmental issues play a significant role in human development, health and disease (Brundtland, 1999), and a recent environmental issue that is causing a great deal of concern and needs urgent attention is that of waste and in particular, health care waste (HCW). Dijkema *et al.*, (2000:634) describe waste in the following manner:

> `Waste' commonly has a negative connotation: one thinks of garbage, rubbish, or maybe even dangerous or toxic material. Waste is a substance that one would like to dispose of, and one is prepared to pay some fee for the service. Apart from household garbage, there are many substances and objects that are considered to be waste, particularly in the process industry and manufacturing business. A substance, however, is a waste only when it is experienced as or labelled as waste. A producer, for example, may consider unwanted by-products `prompt scrap' or `production waste', whilst others regard these as a potential resource. Waste is a subjective concept, or rather a qualification of a particular substance or object, which does not vanish after disposal. The qualification, however, may change: what is considered waste today can be a resource in the future. A more strategic notion, therefore, is that a substance or object is qualified as waste when it is not used to its full potential

The health care industry generates, through products and services, harmful waste (known as HCW) which adversely affects human and environmental health. In the South Africa context, it is estimated that approximately 42 200 tons of HCW were generated in 2007 (Purnell, 2009; Otto & Associates, 2008). HCW is defined as the by-product of health care and comprises all waste generated by health care establishments including waste from minor sources such as home dialysis and insulin injections (Kaiser *et al.*, 2001). HCW contains infectious waste, toxic chemicals and heavy metals, and may contain substances that are genotoxic or radioactive. This type of waste covers a diverse range of materials, and can be divided into infectious, pathological, sharps, pharmaceutical and genotoxic waste (Kaiser *et al.*, 2001;

Johannessen *et al.*, 2000). According to Bendjoudi *et al.* (2009), the sources of HCW results from the treatment, diagnosis, or immunization of humans and/or animals at hospitals, veterinary and health-related research facilities, and medical laboratories. HCW constitutes a larger portion of general infectious waste and is potentially dangerous since it may contain pathogenic agents (Abdulla *et al.*, 2008).

It is now commonly acknowledged that certain categories of HCW are among the most hazardous and potentially dangerous of all waste arising in communities (HCW is considered the second most hazardous waste after radioactive waste) and has been identified as one of the major problems that negatively impact both human health and the environment (Sawalem *et al.,* 2009). It is not only the HCW itself but also the mismanagement thereof which puts the environment, patients, health care workers and the community at risk either via direct or indirect contact (Nemathaga, *et al.*, 2008; WHO *et al.*, 2005). It therefore becomes of great importance to manage HCW in a manner to avoid health risks and damage to flora, fauna, and the environment (Yong *et al.,* 2009). The management of HCW is an important factor in environmental hygiene and needs to be integrated with environmental planning (Oke, 2008). HCWM continues to present an array of challenges and issues which requires a research-led and sustainable integrated approach (Mbongwe *et al.,* 2008). Approximately 5% of all Human Immuno-Deficiency Virus (HIV) infections are due to poor HCWM (Crabb, 2003; and WHO, 1999).

The reuse of syringes by the general public represents one of the greatest public health problems in the developing world related to HCW (WHO, 2000). Illegal dumping, HIV, Acquired Immune Deficiency syndrome (AIDS) and occupational health and safety have become burning issues in HCWM in South Africa (Department of Environmental Affairs and Tourism, 2003). Approximately 50% of the South African biomedical waste (synonymous to HCW) stream is unaccounted for mainly due to improper separation or illegal dumping (MacLean *et al.*, 2007). The poor management of HCW results in many other incidents of illegal dumping and storage of such waste. Prophecy (2009) reported the following incidents:

> 'Manenberg, Cape Town, 2008: waste dumped in an area close to where children play;
> Ibika, Eastern Cape, 2008: waste illegally stored in warehouses;
> Springfield, Gauteng, February 2009: used needles, bloodied bandages and body parts found;
> Barkly West, Northern Cape, February 2009: waste dumped in the veld; and
> Tongaat, KwaZulu-Natal, June 2009: waste dumped at a beach parking lot.'

News24 (2009a;2009b;2009c;2009d) also reported that, during November and December 2009, the Environmental Management Inspectorate uncovered another 20 tons of HCW, buried at an unused Harmony Gold mine outside Welkom. A farm owner also reported that HCW was buried on his farm without his knowledge. 300 tons of highly infectious raw HCW has also been unearthed in the back yard of a brick factory in Welkom, Free State. Officials in Durban discovered HCW, including anatomical waste dated November 17, 2009 which by law should have long since been destroyed. The regulatory services in the Department of Environmental Affairs revealed that they found another two sites of buried HCW in the Welkom area in the Free State; (1) the Jonkerus Farm, 25 km outside the town, and (2) the Welkom Showgrounds. The HCW buried at the site included sharps, pharmaceuticals, vials, syringes, drips, dirty bandages and general medical waste.

This poor management of HCW causes serious disease in health-care personnel, waste workers, patients and the general public (WHO, 2003; Kaiser *et al*., 2001). All individuals exposed to HCW are potentially at risk of injury and/or disease, including those who generate and handle such waste (Prüss *et al*., 1999). The main source of illness from infectious waste occurs through injuries with used needles (sharps), which can cause hepatitis and HIV. Worldwide, an estimated 10 to 20 million infections of Hepatitis B and C and HIV occur annually from the reuse of discarded syringe needles without prior sterilisation (Kane *et al*., 1999). Sharps are considered one of the most dangerous categories of waste, and injuries occur as a result of waste not being packed safely, not collected in safety boxes or where these have been overfilled (United Nations Environment Programme and World Health Organisation, 2005). If HCW is dumped on un-controlled sites or in other areas which can be accessed by the public, the public and in particular children can come in contact with infective material. Waste recyclers or scavengers, on landfills or waste dumps, may come into contact with infectious waste (thereby providing pathways of infection) if the wastes have been disposed of without prior treatment. Contact with toxic chemicals, contained in used disinfectants, may cause accidents when they are accessible to the public.

In addition to the above health risks HCW can also contaminate the environment, such as the water or the air (for instance during waste treatment and disposal), and so indirectly impact on health. This type of contamination could result in the release of resistant microorganisms into the environment. When wastes are disposed of in a pit which is not lined, the groundwater may become contaminated. As the same groundwater may be used as a resource for drinking water, wastes may indirectly impact on health via the water. If waste is burned or incinerated in an incinerator which does not have an emission control (which is the case with the majority of incinerators in developing countries), the air may become contaminated by a large number of pollutants and cause serious illness in people who inhale this air.

When considering a waste treatment or disposal method, it is important to consider all of the associated impacts on the environment. In fact, waste management treatment options (e.g., incinerators, burial pits) should protect health-care workers and the community and minimize indirect impacts from environmental exposures to health care waste. Where such impacts can, in practice, not be eliminated with immediate effect, feasible options with the lowest overall impact need to be selected, but additional efforts are required to find the best long-term solutions. Environmentally-friendly, safe and affordable options may not currently be available for every situation, and the risks of health impacts from environmental exposures should be weighed against the risks of accidental infection from poorly managed sharps or reuse of unsterilised syringes. For example, a treatment option such as a small-scale incinerator which emits pollutants, such as soot, chromium, and carbon dioxide may be used in certain situations (e.g., low-density populated areas) where the overall health benefits from preventing infections from used syringes are likely to outweigh the risks from exposure to toxic pollutants in the air (Mantel *et al.*, 2007; Kermode *et al.*, 2005; WHO, 2005; Rushbrook & Zhgondi 2004; Birchard, 2002; Prüss *et al.*, 1999).

Despite international guidance, waste management generally in South Africa is poorly defined and practised, and the inadequate management of HCW has been recognised by the South African government as a significant environmental and public health risk (Godfrey, 2008; Department of Environmental Affairs and Tourism, 2000; Mabudafhasi, 2000). In Kwazulu Natal, for example, approximately 45% of HCW generated could not be accounted for, demonstrating a general lack of adequate capacity to properly manage HCW (Oke, 2008). Contributing factors to poor HCWM in South Africa are the lack of capacity and awareness; lack of political will; and limited financial resources, particularly at the provincial health care level. While some health care waste facilities manage infective waste in an acceptable manner, almost none have acceptable procedures and management systems in place. The lack of capacity in South Africa, to deal with the management and disposal of large amounts of HCW generated, results in this waste being dumped in residential areas (Leonard, 2003).

The current situation of poor HCWM in South Africa can only significantly be addressed by developing a medium and long-term national strategy that is an integral feature of the health care facilities. This strategy should reflect the integrated effort that is necessary to set-up safe and environmentally sound health care waste management practices. Many governments in developing countries lack resources in the health sector and this tends to affect negatively the way HCW is managed. Under these adverse circumstances the development of a strategy must take into account the given constraints and opportunities, appropriate allocation of resources, clear formulation of objectives, practical indicators of achievement and a well structured timeframe (United Nations Environment Programme and World Health Organisation, 2005).

South Africa too, in keeping in line with global changes, is in a process of transformation and has committed itself to develop, implement and maintain an integrated pollution and waste management system aimed at sustainable development and a measurable improvement in the quality of life. This transformation resulted in the development of the national waste management strategy (NWMS), which includes a health care waste information system, and the integrated pollution and waste management (IPWM) policy. The IPWM policy sets out the vision, principles, strategic goals and objectives for integrated pollution and waste management in South Africa and the NWMS. Together with its action plans it forms the basis for translating the goals and objectives into practice.

The possible impact of HCW on public health and the environment has received much attention. As the demand for more healthcare facilities increases so does the need for waste generation from these facilities. This situation requires an organised system of HCWM to curb public health risks as well as occupational hazards among healthcare workers as a result of poor waste management (Mbongwe, *et al.,* 2008). One such organised system is that of an (IHCWIS) which will act as an important intervention to prevent health problems associated with exposure to health care waste (Moatshe, 1999).

According to the South African Department of Environmental Affairs and Development Planning (DEA&DP) (2006), accurate and consistent information about the waste cycle in the Western Cape is limited and the information database that does exist is inconsistent and not regularly updated. The absence of a functional waste information system in the Western Cape Province was identified as a critical area of concern.

DEA&DP embarked on a separate project to establish a fully functional IHCWIS. The project culminated in the establishment of an Integrated Pollution and Waste Information System (IPWIS) which incorporates IHCWIS (DEA&DP, 2006; Chetty, 2002). The development and institutionalisation of an IHCWIS becomes crucial to mitigating health care waste exposure, improving environmental related disease estimates, and allowing comparability of results. This in turn improves environmental health surveillance necessary for reducing high mortality and morbidity rates associated with the exposure to hazardous health care waste. Furthermore, an IHCWIS plays a major role in environmental decision-making in that it facilitates the management and use of HCW related data and information. Active engagement with an IHCWIS creates a support network of resources and expertise that can be utilised to plan, apply and evaluate actions that will prevent and control HCW related diseases and illnesses. However, the effectiveness of an IHCWIS can only be determined once it is institutionalised. While different stakeholders have a variety of purposes for collecting and using health care waste information, their needs frequently overlap, thus creating the need for the institutionalisation of an integrated health care waste information system.

The institutionalisation process is critical for the success of an innovation because it is during institutionalisation that the organization fully uses the innovation and comes to terms with the changes introduced by such innovation. This process of institutionalisation is a post implementation process that entails stabilising its processes to such a degree that its associated practices become part of everyday life and the resulting changes are mastered (Silva & Backhouse, 2003; Kumar *et al.*, 2002). Various stakeholders and networks are involved during the institutionalisation (post implementation) process, but the human social process is seldom addressed during the development (pre implementation) phase and does not have much in common with the conventional practice of engineering (Rifkin, 2003). The practice of engineering (physical aspects of information systems falls within the discipline of computer engineering) is mainly interested in the product, i.e., the physical system while the human social process refers to what happens during and after the implementation of such a system. Therefore, the development and institutionalisation of an IHCWIS requires an advanced understanding of (not only the physical system) but the systematic implementation and application of information systems, and information technology, to environmental public health practices and research. The public health sector has been slow to move into the information age and significant applications of information technology have yet to be implemented (Lewin Group Inc., 2001; Yasnoff *et al.*, 2001). Although the public health sector has been working on improving its organisation, workforce and infrastructure to create a more coherent IHCWIS, considerable progress is still needed to institutionalise such a system. The overall key research question now being asked is: ***"How does an IHCWIS develop and become institutionalised among health care waste generators?"***

Following from the key research question the sub questions arising are:

1. ***Having conceptualised an IHCWIS what processes are followed in the development of an IHCWIS?***
2. ***How does an IHCWIS manifest and become institutionalised among stakeholders? and when it is institutionalised,***
3. ***How can an IHCWIS contribute to effective and efficient HCWM decisions?***

The institutionalisation of an IHCWIS requires a multi-sectoral approach because of the complex network of various actors/stakeholders involved in the whole process of health care waste management. These complexities result from, apart from technologies, the possible combinations of options or alternatives for HCWM. Actor-Network Theory (ANT) can be used to describe in detail and in a coherent way, how large heterogeneous networks of aligned interest are built (Latour, 1987). Models of the institutionalisation process do exist but fail to clearly explain the formulation of policy during the implementation phase of an innovation (Menter, 2001). There is also a lack of empirical studies that investigate the dynamics of the process where technology and practice evolve together (Aanestad, 2003). Research is therefore needed to gather empirical information related to the complex networks involved in the development and institutionalisation of an IHCWIS.

1.2 Aims and Objectives

The aim of the research is to gather empirical data to understand how the development and institutionalisation of an IHCWIS contributes to effective HCWM among health care waste generators in the Western Cape, South Africa. The theoretical framework that will guide and clarify the focus of the research is ANT. A more detailed discussion of ANT will follow in Chapter 3 of the thesis. However, it must be stated that this research does not aim to develop generalizations about or a theoretical analysis of ANT, but seeks to use ANT to describe, in a detail and coherent way, how large heterogeneous networks of aligned interest are built and institutionalised, concerning an IHCWIS.

The research objectives of this study are to:

1. Provide a detailed description of processes used in developing an IHCWIS.
2. Establish how an IHCWIS is finalised and implemented.
3. Identify the factors that enhance and facilitate the stabilisation and institutionalisation of an IHCWIS.
4. Identify the factors that contribute to effective and efficient management of HCW, through the use of an IHCWIS
5. Explain how an IHCWIS can be used to effectively address the problem of poor HCWM

1.3 Significance and Contribution of the Research

Current academic literature is relatively void of empirical studies that propose a unifying conceptual framework for information systems development and institutionalisation within HCWM. The framework developed through this study could be used to operationalise and realise the information system goals of HCWM in all provinces of South Africa, and countries beyond with similar structures. Research on information systems development and institutionalisation has mainly been conducted in private, profit making organizations rather than non-profit public institutions. The study will bring to light the social issues in HCWM, complex relations that will transpire, and the potential, conceptual and organizational tensions in the information systems development and institutionalisation process. The analysis of complex networks involved in the development and institutionalisation of an IHCWIS will provide several new perspectives and enhance our understanding of the specific problems encountered in the implementation of health related information systems. The study will generate new knowledge and make valuable contributions to the fields of information systems and environmental management. As mentioned previously, this research aims to gather empirical information related to the complex networks involved in the development and institutionalisation of an IHCWIS among health care waste generators. It is envisaged, by interpreting such information, to contribute towards the success of such systems for the prevention of related diseases, injuries and illegal dumping. Although ANT has recently been employed quite widely within information systems research, its application in waste management and public health is relatively new and unexplored. Applying ANT to the analysis of complex networks involved in the definition and institutionalization of an IHCWIS within HCWM will provide several new perspectives and enhance our understanding of the specific problems encountered in the implementation of health related information systems.

1.4 Structure of the Thesis

Chapter 1: Introduction. This chapter provided information which allowed for the formulation of the statement of the problem of poor health care waste management and the need for the institutionalisation of an integrated health care waste information system (the problem under study).

Chapter 2: Literature review: This chapter presents a comprehensive picture of the state of knowledge of health care waste management and stimulates conceptual insights for the institutionalisation of an integrated health care waste information system. The chapter also focuses on the literature related to the primary research questions generated, discusses the development of interventions for poor health care waste management, and articulates how the institutionalisation of an information system could assist in solving this problem. The purpose of the chapter is to show the path of prior research, identify gaps in research, and design the framework for the analysis of the results of the research. The chapter contains six sections. The research focuses on health care waste management in South Africa and section one provides the background to waste management and evolution of an IHCWIS and in particular, the IPWIS. Section two specifically focuses on health care waste management needs and practices while Section three discusses the development of integrated information systems. Section four explains the role of information systems within health care waste management and Section five discusses institutionalisation as a process. Section six concludes the chapter, links this research to previous research, and introduces Chapter 3.

Chapter 3: Research Methodology. This chapter provides a detailed discussion on the methodological issues, tools and techniques used in the process of researching the development and institutionalisation of an IHCWIS. Chapter 3 is divided into eight sections. Section one describes the choice of an appropriate research strategy and Section two examines the underpinning theory. Section three details the ontology and epistemology of the research approach with section four exploring the development of the research questions. Section five explains and describes the research design focusing on a qualitative case study as the method used to provide an in-depth exploration and description of the perspectives, practices and behaviour of the actors in their natural setting. Section six explains data collection methods, handling and analysis. Sections seven and eight address the academic rigour and ethical issues, respectively.

Chapter 4: Organisational Case and Fieldwork. This chapter provides the background and detailed explanation of the Western Cape Department of Environmental Affairs and Development Planning which house and uses an IHCWIS (in the form of IPWIS, the case) as an important management tool to meet the strategic objective of information management as set out in the integrated pollution and waste management policy and the national waste management strategy. This is followed by descriptions of the various sub-cases DEAD&P (Sub-case 1); the Centre for e-Innovation (Ce-I) (Sub-case 2) which provides information management services to DEAD&P; the State Information Technology Agency (SITA) (Sub-case 3) which provide information technology services and support to DEA&DP and Municipalities (Sub-case 4) to which the health care facilities belong. The chapter ends off with an explanation of how the fieldwork for this research was conducted.

Chapter 5 presents the analysis of the data obtained using ANT (sociology of translation) as a lens through which we studied the development and institutionalisation of an IHCWIS. The analysis was done at three levels. The first level of analysis was done using ANT as a lens to uncover the construction, growth and stability of IPWIS as a network. The second level of analysis was done on the interpretation of the case findings to explain how IPWIS *(which incorporated an IHCWIS)* gained acceptance as normal custom practice and became institutionalised. The third level analysis was done on the application of IPWIS for effective and efficient waste management decision making.

Chapter 6 concludes the research and is divided into 5 sections. Section 1 provides an overview of the research and how each chapter individually contributed to the thesis. Section 2 addresses the research questions and Section 3 assesses the theoretical and practical contributions made by this research by employing Klein and Myers's (1999) set of principles which can be used for evaluate the conduction of interpretive field studies in information systems. Section 4 evaluates the contribution made using Whetten's (1989) criteria of what constitutes a theoretical contribution. Section 5 finalises the research with a discussion on the research limitations, recommendations and prospects for further research.

Chapter 2

Literature Review

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Chapter 2

Literature Review

2.0 Introduction

A literature review focuses on what has been researched leading to what is known and creates a firm foundation for advancing knowledge and is crucial for any academic research work including in the information systems (IS) field (Webster and Watson, 2002). This chapter presents a comprehensive picture of the state of knowledge of health care waste (HCW), health care waste management (HCWM) and the development and institutionalisation of an IS for HCW. The chapter stimulates conceptual insights for the development and institutionalisation of an integrated health care waste information system as an intervention to address the problem of poor health care waste management. In doing so, the chapter discusses the development of interventions for poor health care waste management and articulates how the institutionalisation of an information system could assist in solving this problem. The purpose of the chapter is to show the path of prior research, identify gaps in research, link the research question to prior research and devise (the literature yields the initial concepts and constructs) the framework for the analysis of the results of the research.

The chapter contains eight sections. Section one describes the state of knowledge on waste management and its approaches (what is known, researched on, and what is not) while Section two specifically focuses on HCWM needs and practices. Section three discusses the development and importance of participation of information systems, in general, and Section four highlights the state of knowledge of information systems within the delivery of health care. Section 5 discusses the state of knowledge, what is known and researched on waste management information systems to identify gaps, while section six focus on the characteristics of a HCWIS. Section seven focuses on institutionalisation. Section eight concludes the chapter, links this research to previous research, and introduces Chapter 3.

2.1 Waste Management

It is of vital importance that waste be managed in such a way that it represents the best value for the environment so that the environmental impact from waste may be reduced (The Danish Government, 2004). The environmentally acceptable management of waste has now become a global challenge due to limited resources, an exponentially increasing population, rapid urbanization, worldwide industrialization, and, inadequate financial resources, management, technical skills within municipalities and government authorities (Hazra and Goel, 2009).

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) (2010), describes waste management as a basic requirement of ecologically sustainable development and involves the monitoring, collection, transport, processing and disposal of waste materials. The primary goal of effective waste management, it says, is prevention, followed by reuse and recycling and appropriate disposal. Effective waste management strategies assist in minimising or avoiding adverse impacts on the environment and human health, while allowing economic development and improvement in the quality of life. The aims of waste management are to:

- conserve resources of water, energy, raw materials and nutrients
- control pollution of land, air, water and sediment
- enhance business performance and maintain corporate social responsibility
- improve occupational health and safety

The approach to waste management is derived from the solid waste hierarchy framework (Figure 2.1) of eco design; avoidance (prevention); minimisation; reuse, recycle; energy recovery; treatment; disposal and remediation.

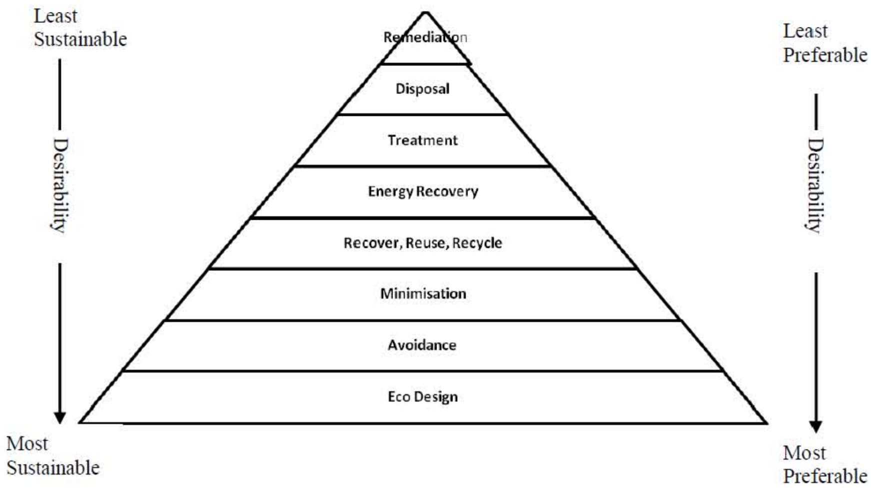

Figure 2.1: Waste hierarchy *(Source: Adapted from Department of Environmental Affairs, 2010; Zeng et al., 2010)*

Eco Design: Eco-design refers to design of products with special consideration for the environmental impacts of such products during its entire lifecycle, and can reduce the stress on solid waste treatment or disposal. Products are designed with the goal of using fewer chemicals, increased energy efficiency, and reduced ecological footprint (Zeng *et al.,* 2010).

Waste Avoidance/Prevention: Waste prevention covers a variety of different options such as stopping the production of certain goods, substitution for one product by another, or extending the utilization phase for items. Waste prevention involves many different players (e.g. beyond waste management and the successful implementation of a measure for private households, food retailing or advertising industry) and the prevention of waste requires accurate advance planning and should include a detailed analysis of the potential impacts and barriers. (Salhofer *et al.,* 2008). In preventing waste, waste and other related health and environmental problems are avoided from the outset and in doing so there is a move towards the concept of zero-waste generation. If waste generation cannot be prevented then waste needs to be reduced or minimised (KESAB, undated; Whangarei District Council, 2007).

Waste Minimisation: Waste minimisation can be viewed as a method of managing existing resources and technology in order to maximise the efficiency of available resource use. The aim of minimisation is to reduce the production of waste through education and improved production processes rather than aiming to increase technology to improve treatment of waste. In spite of growing awareness about the need to reduce waste, waste generation rates have continued to rise in line with growth in our standard of living (Wastenet, undated). Minimisation means lessening waste generation and involves redesigning packaging to use less materials and cutting out unnecessary packaging, looking into using materials more efficiently, implementing new processes and technology, and replacing disposal products with reusable and durable ones where practical (KESAB, undated; Whangarei District Council, 2007).

Reuse, Recycle, Recover: Reuse entails reusing a product in its original form for its intended or different purpose. When reuse can no longer be carried out then waste should be recycled. This means, reprocessing of waste materials into similar products or secondary raw materials for the production of new products. Energy recovery can be a viable option after reduction, reuse and recycling have been fully explored and generally is the final step in the exploitation of maximum benefits from waste.

Energy Recovery: Recovering energy involves the incineration of waste and the recovery of the latent heat energy of the materials. The heat energy can then be converted into power to be used commercially or domestically.

Waste Treatment: Treatment occurs when waste is subjected to any physical, biological or chemical process to change its volume or characteristics so that it could be disposed of without any detrimental effects to health or the environment.

Waste Disposal: Disposal refers to the final deposit of waste on land set aside for this purpose (KESAB, undated; Whangarei District Council, 2007).

Remediation: Waste remediation is a process involving the removal of harmful contaminants (decontamination) or pollution from waste for the benefit of human health and the environment. There are several different ways to handle waste remediation. Sometimes the waste is directly removed from the site using highly specialized remediation equipment. In this case, the waste is packaged properly and transferred somewhere such as a landfill (Bryksa, undated).

Van de Klundert and Anschütz (2001) explain that the solid waste hierarchy framework is a tool used to rank waste management options according to their environmental benefits. This hierarchy considers products from their 'cradle' to their 'grave' and is closely linked to production and consumption processes. Waste policies based on the hierarchy seek to maximise the recovery options and to minimise disposal through open dumping, controlled disposal and land-filling. Once possibilities for recovery have been exhausted, policies based on the hierarchy favour safe disposal, limiting negative impact on the environment and natural resources as much as possible. However, the hierarchy needs to be applied with certain flexibility taking the appropriateness of the solution into account. For example, in the case of HCW recycling may not be the right solution and other solutions like incineration may be more appropriate.

Van de Klundert and Anschütz (2001) further explain that a more systematic way of thinking and looking at waste management is found in an approach called integrated sustainable waste management (ISWM). The waste management hierarchy is also a cornerstone of the ISWM approach. An ISWM approach recognises three important dimensions in waste management: (1) stakeholders, (2) waste system elements and (3) sustainability aspects. The ISWM insight is that most waste management problems have to do with something other – or more – than money and equipment. For example, some problems have to do with the attitude and behaviour of citizens, waste management staff, private enterprises and waste pickers while other problems are caused or made more serious by factors related to managerial (in)capacities, the institutional framework, the environment, or the social or cultural context. ISWM contains six aspects as illustrated in Figure 2.2 below.

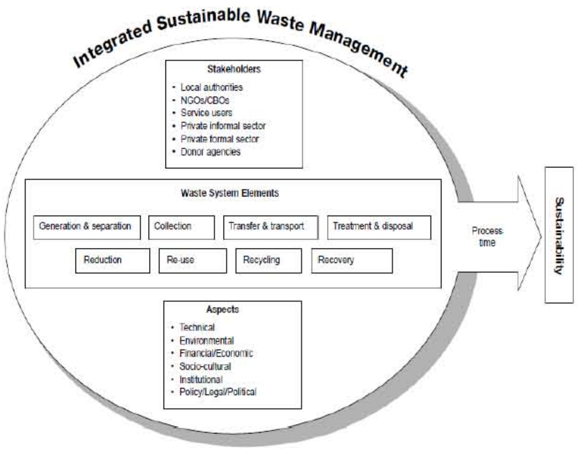

Figure 2.2: Integrated sustainable waste management (*Source: Van de Klundert and Anschütz, 2001*)

The six aspects will now be explained according to Van de Klundert and Anschütz (2001).

1. **Technical and performance** aspects concern the observable practical implementation and maintenance of all of the waste elements: what equipment and facilities are in use or planned; how they are designed; what they are designed to do; whether they work in practice; and how clean the environment is on a consistent basis.

2. **Environmental** aspects focus on the effects of waste management on land, water and air; on the need for conservation of non-renewable resources; pollution control and public health concerns.

3. **Financial-economic** aspects pertain to budgeting and cost accounting within the waste management system and in relation to the local, regional, national and international economy. Some specific issues are: privatisation; cost recovery and cost reduction; the impact of environmental services on economic activities; the commodities marketplace and how the recycling infrastructures connect to it; efficiency of municipal solid waste management systems; macroeconomic dimensions of resource use and conservation; and income generation.

4. **Socio-cultural** aspects include the influence of culture on waste generation and management in the household and in businesses and institutions; the community and its involvement in waste management; the relations between groups and communities.

5. **Institutional** aspects relate to the political and social structures which control and implement waste management: the distribution of functions and responsibilities; the organisational structures, procedures and methods implicated; the available institutional capacities; and the actors such as the private sector who could become involved. Planning is often considered the principal activity in relation with institutional and organisational aspects.

6. **Political/legal** aspects address the boundary conditions in which the waste management system exists: setting goals and priorities; determination of roles and

jurisdiction; the existing or planned legal and regulatory framework; and the basic decision making processes.

Despite the guideline of the solid waste hierarchy framework and the ISWM approach, ineffective and inefficient waste management is still one of the most pressing environmental problems facing many cities in the developing world and not many people are aware of the sizeable contribution waste makes to environmental pollution (Coker *et al*., 2009).

Waste is a result of inadequate thinking, and the traditional approaches to waste management are outmoded customs which have resulted in an unsustainable society. The traditional reductionist approach to waste management is unsustainable as it lacks flexibility and long term thinking. A move to a more sustainable society requires greater sophistication to manage waste (Seadon, 2010). An appropriate waste management system is essential to control the serious problem of the transmission of infectious diseases resulting from poor waste management (Miyazaki and Une, 2005).

The management of waste should also happen at health care facilities because health services may generate large quantity of wastes and by-products that need to be handled safely and disposed of properly (WHO, 2005c). With the rising awareness of the environmental implications of waste disposal, the management and disposal of HCW are gaining more and more attention by the scientific community and by general society (Diaz *et al.,* 2005a). HCWM at primary health care facilities needs more attention and should be better understood (Phengxay *et al.,* 2005). HCWM will now be addressed.

2.2 Health care waste management (HCWM)

Health care is vital for our life and health, but the waste generated from delivering health care represents a real problem (in that it can be hazardous, toxic and even lethal because of their high potential for diseases transmission) and of special concern is the effective management of HCW, a process that helps to ensure proper hospital hygiene and safety of health care workers and communities (Mastorakis *et al.,* 2011; Pasupathi, *et al.,* 2011). Proper management of HCW is therefore a crucial issue for maintaining human health and the environment (Nema *et al.,* 2011). The management of HCW has created another dimension of environmental as well as public health problems and the ineffective management of solid waste leads to negative environmental impacts (Rijal and Deshpande, 2007). Poor HCWM pose a huge risk , contributes to environmental degradation and the indiscriminate disposal waste from hospitals, nursing homes and pathological laboratories has given rise to the following environmental concerns (Sreejith, 2008):

- Spread of infection and disease through vectors (fly, mosquito, insects etc.) which affect the in -house as well as surrounding population.
- Spread of infection through contact/injury among medical/non-medical personnel and sweepers/rag pickers, especially from the sharps (needles, blades etc.).
- Spread of infection through unauthorised recycling of disposable items such as hypodermic needles, tubes, blades, bottles etc.
- Reaction due to use of discarded medicines.
- Toxic emissions from defective/inefficient incinerators.
- Indiscriminate disposal of incinerator ash / residues.

HCWM could be considered as a sub-system of the total healthcare or waste management systems with the objective of preventing the spread of infections to individual workers and the community at large (Brent *et al.,* 2007). Although HCW is an unavoidable outcome of health care, the effective waste management by hospitals, clinics and health care units reduce risks of infection of their staff, waste collection workers, disposal operators and community and finally it protects the environment (Mentzelou, *et al.,* 2009).

The World Bank (2003) defines health care waste management as a:

> process to help ensure proper hospital hygiene and safety of health care workers and communities. It includes planning and procurement, construction, staff training and behaviour, proper disposal methods inside and outside the hospital…The stages in HCWM are: production of waste within a hospital ward, segregation of waste, ward storage, onsite transportation and treatment, onsite central storage, offsite transportation, treatment and final disposal.

A systematic review of the literature by Harhay *et al*. (2009) revealed that substantial public health challenges due to health care waste exist in numerous major cities and urbanizing regions of Africa, Asia and the Middle East and that several major public health threats are attributable to failed HCWM. Not only is waste increasing in quantity, the situation is exacerbated by improper disposal methods, insufficient physical resources, and a paucity of research on interventions to improve HCWM

HCWM is of crucial importance to both public health and the environment, but safety to health and the environment becomes an overriding concern when developing a

HCWM plan (Verma *et al.,* 2008). WHO (2000) is of the opinion that it is the responsibility of governments to establish frameworks for the safe management of HCW and to ensure that health care facilities manage waste safely. It is becoming evident that as healthcare facilities fulfil their commitment to provide safe healthcare services and to heal the sick, the aspect of managing health care waste is often neglected (Mbongwe *et al.,* 2008).

HCW only represents a small amount of total waste generated but the management thereof is considered an important issue (Cheng *et al.,* 2009) magnified by a lack of training, awareness, financial resources to support solutions and a strategy that is based on integrated waste management options (Abdulla *et al.,* 2008). An organised health care waste management system, if legislatively grounded, will enforce implementation of good management practices which are judged as the most effective measure that can be undertaken in order to protect citizens' health and promote environmental welfare (Kontogianni *et al.,* 2008). In addition a study by Bendjoudi *et al.* (2009) reveal a lack of an assigned staff member to manage and coordinate waste management activities at health facility level. The management of HCW is normally governed by the activities of largely untrained and uneducated waste handlers from poorly educated backgrounds and there is need for sustained cooperation among all key actors in implementing a safe and reliable health care waste management strategy, not only in legislation and policy formation but also particularly in its monitoring and enforcement (Coker *et al.,* 2009).

It is typical to assign health care waste handling to poorly educated workers who perform all activities without proper protection, training and guidance (Sawalem *et* *al.,* 2009). Together with this is the issue that the majority of doctors, nurses, and housekeepers possess unsatisfactory knowledge and exhibit inadequate practices associated with healthcare waste management (Mostafa, *et al.,* 2009).

A number of research studies have been conducted on the pollution aspects of general waste, but waste generated at health care facilities has not attracted the same level of attention, especially in developing countries (Oweis *et al.*, 2005). The drawback in developing countries is that there is no comprehensive effort to understand how this type of waste is managed at health care facilities (Bdour *et al.*, 2007). Pandit *et al.* (2005) reports that proper hospital waste management was not being practiced and that doctors lack knowledge about waste management which affects the safe practice of waste management and recommends that a vigorous training programme be implemented for doctors and supportive staff to adopt an effective waste management practices. Furthermore, personnel at health care facilities have unsatisfactory knowledge of and employ inadequate HCWM practices (Mostafa *et al.*, 2009). However, in contradiction, studies by Yadavannavar *et al.* (2010) and Reshmi *et al.* (2011) revealed that the awareness (awareness on waste management being conducted in the hospital was 100%) and proper practice of HCWM was very satisfactory. Shafee *et al.* (2010) found that nurses had better knowledge and attitude, and also practiced HCWM better than the housekeeping and technical staff who lacked the required knowledge. The occupational therapy technicians, laboratory and housekeeping staff had comparatively less understanding of HCWM and this mainly due to the fact that nursing professionals had an edge over the other staff regarding awareness of waste management, which can be attributed to their accountability and commitment in ward management. (Reshmi *et al.,* 2011).

HCWM is perceived as both a public health management issue (the impact of HCW on humans) and an environmental (the impact of HCW on the ecology/environment) issue and therein lies its problem, because this multiple perspective may lead to gaps in vision and understanding (WHO, 2005a). Kaiser et al. (2001:205&207) explain that

> 'it is difficult to categorize health care professionals who work with environmental issues. Some concentrate all of their time on environmental health issues, and some juggle other responsibilities such as housekeeping and safety... The link between health care waste and pollution is not readily apparent. The issue is highly complex and sometimes controversial.
> It includes a web of relationships and decisions encompassing product suppliers, health care workers, and hospital waste treatment choices... Optimizing solutions to environmental issues in the health care industry requires holistic approaches that incorporate not only health care facilities but also the supply chain and end-of-life disposal strategies. This means understanding environmental outputs and inputs and identifying opportunities to provide better service and quality care in a cleaner, greener way.'

Consequently, scientists and public authorities around the world are realizing that human actions have to be responsible regarding not only the social and economic matters, but also the environment issues, regarding the people and environmental issues, proper HCWM will avoid negative long-term health effects (Bulucea, *et al.,* 2008). The human element is as important as technology in waste management and poor compliance with HCW management by a small percentage of staff probably explains the difficulty in managing HCW because even a small proportion of badly managed waste can potentially be dangerous (Ramokatel and Basu, 2009).

Despite the attention given to HCWM its understanding is still insufficient and often the management of HCW is neglected (Longe & Williams, 2006). Coker *et al*. (2009)

conclude that HCWM is beset by many challenges because there has been a scarcity of data on the quantities and nature of the waste generated. Such baseline data are of utmost importance for meaningful planning of waste management procedures. They recommend that consideration be given to environmentally and economically sustainable technological options which can be well operated and maintained (this implies IS).

The management of HCW continues to be a major challenge, particularly, in most healthcare facilities and although, significant steps have been taken on matters related to the safe handling and disposal of HCW, improper management practice remain evident (Hossain *et al.,* 2011). The need for proper HCWM is gaining recognition slowly due to the substantial disease burdens associated with poor practices but the practices, capacities and policies associated with HCWM is inadequate and requires intensification (Ananth *et al*., 2010). These HCWM practices will now be discussed.

HCWM Practices

Current HCWM practices relate to the controlled manner in which HCW is collected, transported, handled, stored, treated, recycled, and disposed. Even though HCWM practices may differ among waste generators, they all have approximately the same problematic areas during the various stages of waste management (Tsakona *et al.*, 2007) and in spite of significant progress being made, current HCWM practices still need modification and improvement (Alagöz and Kocasoy, 2008).

Effective HCWM programs are multisectoral and require cooperation between all levels of implementation (Abd El-Salam, 2010) and no single practice serves as a solution to the problems of managing HCW, so a number of practices are used in combination and with each practice having its own weaknesses and strengths (Nemathaga *et al*., 2008). In the United Kingdom, for example, the complexity of legislation has meant that systems for the management of HCW have evolved over time to meet the regulatory requirements, but there has been little emphasis on waste minimisation and implementation of best practice (Woolridge *et al.*, 2008).

There is also no single HCWM method that completely eliminates all risks to public health and the environment. HCWM practices generally all have the same components such as illustrated in Figure 2.3.

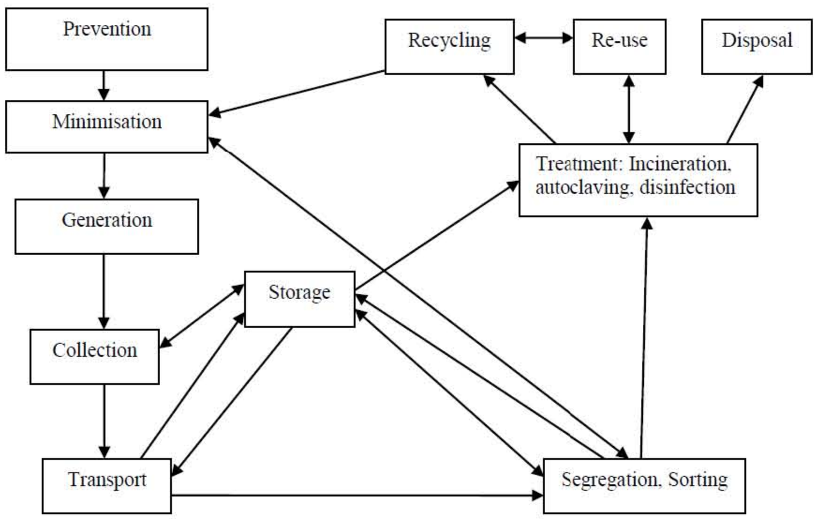

Figure 2.3: General components of health care waste management practices (*Source: Adapted from Nemathaga et al., 2008; and Molefe et al.,2006)*

The practice is briefly as follows (WHO, 2005b): HCW prevention refers to preventing waste from the outset and includes modification of purchasing procedures, control of inventory, and less toxic materials discarded in the wastes. HCW minimization is the prevention of waste production and/or its reduction. It involves strategies, changes in management and behavioural change. In order to avoid accumulation of the waste, it must be collected on a regular basis and transported to a central storage area within the health care facility before being treated or removed. HCW are temporarily stored before being treated / disposed of on-site or transported off-site. Segregation reduces the quantity of wastes which are hazardous and therefore require special attention and treatment. Off-site transportation is required when hazardous HCW is treated outside the health care facility. Treatment modifies the characteristics of the waste. Treatment of waste mainly aims at rendering direct exposure to the wastes as less dangerous to humans, to recover recyclable materials, and to protect the environment. Finally, disposal refers to the final placement of treated waste on the land, using a sanitary landfill or any other environmentally acceptable method of final storage appropriate to the local conditions.

An effective and efficient program for HCWM serves as a critical component for infection control and consequently plays an important role in the quality of care and the occupational health of staff (Diaz *et al.,* 2003). Segregation of waste is often a major problem when there is no specific system in place. This is mainly due to the complex nature of the type of waste and the fact that health care facilities are open 24 hours a day. The end result is that the handling of waste is often assigned to unaware and uninformed staff (Shaner-McRae *et al.,* 2007; Bdour *et al.*, 2007; Patil and Shekdar, 2001).

A good example of health care waste management practice which could serve as best practice is when a facility (as in the case of the Vivekananda Polyclinic located in Lucknow, India) displays a commitment to the environment; compliance with relevant legislation and rules; segregation of HCW into colour-coded bags; use of appropriate technologies for treatment and disposal; that the process of collection, segregation, transportation, treatment, and disposal of waste is done by skilled personnel who are well-versed in managing the HCW generated, and the practice considers regulatory requirements, operating concerns, occupational hazards, and environmental impacts (Gupta *et al.,* 2009). According to Johannessen *et al.* (2000), HCW should be segregated at the point of generation, into reusable, non-reusable, hazardous and non hazardous components. This should be followed by the institution of a sharps management system and waste reduction. Lastly, secure methods of waste collection and transportation, and installing safe treatment and disposal mechanisms should be provided.

Effective HCWM can reduce health risks, save money and protect the environment (Alumuneef and Memish, 2003) and can be achieved only by the use of enforced codes of practice and guidelines for all aspects of the handling, storage, transport and disposal of HCW (Bdour *et al.,* 2007). The provision and enforcement of codes of practice to health care facilities, and the enactment of legislation does not necessarily make HCWM more effective and efficient. Effective and efficient HCWM can be achieved by involving all local bodies and strategies engaged in waste management (including the supply chain and end-of-life disposal) and ensuring that they follow the principles of effective management (Kaiser *et al.,* 2001; Patil and Shekdar, 2001).

Eberle *et al*. (2009) conclude that the primary objective of HCWM is to protect health workers and facility staff, the community, and the environment. The supply chain considerations for HCWM are complex, as they are for any supply chain and that many external factors (e.g. training, commitment, equipment, etc.) could influence how a health facility handles its HCW. The first step would be to determine whether any national HCWM policies are in place. Then the volume of waste to be managed, transportation limitations, and geographic constraints that may impact how a health facility manages its waste should be considered. Finally, health facility and district HCWM policies should be tailored to both facility needs and HCW categories. HCWM practice itself has hazards attached to it (See the following Figure 2.4) and thus becomes important that the process involved be properly documented.

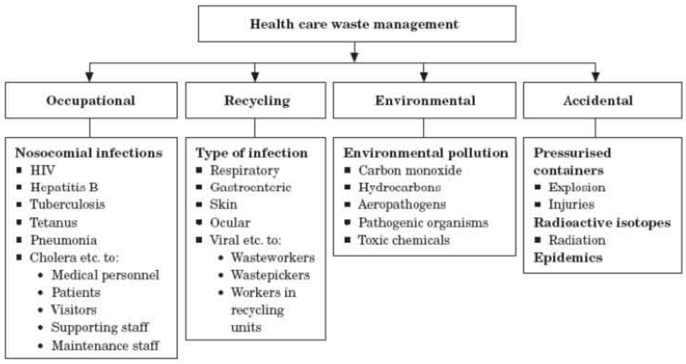

Figure 2.4: Hazards associated with health care waste management (*Source: Patil and Shekdar, 2001*)

Categories

Occupational: Infections which may occur when exposed to HCW in delivering health care to persons.

Recycling: Infections which may occur when exposed to HCW waste during the recycling process

Environmental: Release of various pollutants

Accidental: Various accidents which may arise when handling HCW

Abd El-Salam (2010) conclude that the inadequacies in the current hospital waste management practices are mainly related to ineffective segregation at the source, inappropriate collection methods, unsafe storage of waste, insufficient financial and human resources for proper management, and poor control of waste disposal, lack of appropriate protective equipment, lack of training and clear lines of responsibilities between the departments involved in hospital waste management. Some professionals reason that the waste management problems at district hospitals in developing countries are usually caused by lack of information rather than by financial or technical difficulties (Halbwachs, 1994 in Verma *et al.*, 2008). Furthermore, establishing a database, information and statistics on HCWM practices, provides suggestions and information which aid policy development and improved management (Bdour *et al.,* 2007). HCWM should go further than compiling data, enforcement of regulations, and acquisition of better equipment. It should be supported through appropriate education, training, and the commitment of the healthcare staff and management and healthcare managers within an effective policy and legislative framework (Gupta *et al*., 2009).

HCWM 'also needs better organization, adequate facilities and strict surveillance with recordkeeping…care for medical hazardous waste should be evidence-based, and compared with the data obtained by laboratory research and population studies, advanced treatment and control methods' (Marinković *et al.,* 2008:1055).

Waste management practices can be documented successfully by utilising a range of techniques from business and systems analysis methods because this approach takes into account a range of factors that affect the generation and management of each of the types of waste. This is particularly relevant in a HCW setting where a range of waste streams are generated and some streams fall within different regulatory regimes (Woolridge *et al.,* 2008).

We have discussed HCWM and practices in a broader context but what is the situation in South Africa? Our attention now turns to HCWM within the South African context.

HCWM in South Africa

HCWM, from a South African perspective, was identified as one of the issues of priority in the national waste management strategy (NWMS) that requires immediate attention and was included in the implementation project of the NWMS so that the approach used to address the issues in HCW may serve as a model for addressing other priority waste streams in the future (Molefe *et al.,* 2006).

Historically in South Africa, the proper management of health care waste has been neglected. This was mainly due to a lack of awareness and capacity within health care institutions (Liebenberg, 2003). During the last decade increased environmental awareness in South Africa has focused on the potential impact that HCW has on human health as well as the environment, but a lack of awareness and capacity within health care facilities often results in the neglect of healthy and environmentally sound HCWM practises. The backlog in the provision of suitable treatment facilities and sustainable HCWM systems, are still to be addressed (Government of Gauteng Province, 2004). There is often mismanagement of HCW and the management practices available are not accomplishing the tasks adequately and a major policy implementation gap exists between the national government and the hospitals (Nemathaga *et al*., 2008). A study in the iLembe District public clinics (South Africa) concluded that the management of HCW is of great concern and there is a need to develop a HCWM intervention strategy to be implemented consistently and universally (Gabela, 2007).

Nationally, HCWM falls within the portfolios of the Department of Health (DoH), DEAT, DWAF and the Department of Transport (DoT) (See Table 2.1).

Table 2.1: Key Departments and Responsibilities

1. Internal Stakeholder	Department of Environmental Affairs and Tourism (DEAT) • Implementation of the NWMS • Facilitate waste management strategies
2. External Stakeholder	Department of Water Affairs and Forestry (DWAF) • Water resource management Department of Health (DoH) • Key stakeholder for HCW and to a lesser extent the waste information system. • Regulates the health care industry • Enforce implementation of HCW management strategies • Dissemination of information Department of Transport and Public Work • Set standards for collection and transport of health care waste Department of Trade and Industry (DTI) • Develop and implement economic instruments for health care waste management Department of Labour • Shared responsibility for health and safety Department of Provincial and Local Government • Manages certain clinics where health care waste is generated Provincial Departments of Health • Implement various health care waste outputs • Responsible for health care waste generated by facilities under their jurisdiction Local Government • Implement various health care waste outputs • Implement components of health care waste and recycling Forums (Committee for Environmental Coordination, MINMEC, MINTECH, Working group 2, National Recycling, and the HCW Management Interest Group) • Need to be actively informed and involved NWMSI Funding Organisation (DANIDA)
	NWMSI Project Steering committee NWMSI Project Management Group Technical Advisory Committee

Source: Adapted from DEAT 2004

All of these departments are responsible for the development of strategies and overall guidelines but only the provincial departments of the DoH and DEAT are responsible for its implementation.

The DEAT develop guidelines for the safe management of health care waste, but the monitoring of health care waste and related diseases is the responsibility of the various health departments. The DEAT maintains that the acceptable procedures, as stated in the 'codes of practice for the management of infectious waste and radioactive waste' and minimum requirement documents, are not being implemented correctly within health care facilities (DEAT, 2000). The opinion of the DEAT is that the segregated approach where a single department is given responsibility over specific aspects with no coordination with other government departments causes major problems and in future needs to be based on a holistic approach that extends over the entire waste cycle (DEAT, 2004).

The NWMS action plan makes provision for the clear designation of responsibilities, multi-sectoral workshops, discussion forums, and the circulation of comprehensive reports to interested parties. The expectation is that communication between the various departments will function in this manner and within different working groups. The DEAT has been given the responsibility of ensuring coordination between all spheres of government. DEAT, as the lead agent for waste management, in conjunction with other national departments should develop norms and standards for the management of health care waste (Department of Health, 2003).

Waste management is also practiced using an integrated approach which places pressure on authorities to change the way in which they practice waste management. Authorities therefore need updated and reliable data on the quantity and the quality of the waste generated in order to establish an integrated solid waste management system (Papachristou *et al*., 2009). This approach relies on the active participation of relevant stakeholders and involves the planning of waste management activities by developing integrated waste management plans (Department of Environment and Development Planning, 2006). An integrated approach requires comprehensive data on present and anticipated waste situations and detailed information needs to be collected on all the institutions, currently responsible at any level of the solid waste management chain to identify their role or mandate, institutional framework, human resources and sources for financing their activities (United Nations Environment Programme, 2009).

Limited reliable information is available on the quantities and characteristics of the various types of wastes that are generated in healthcare facilities. Thus, sound management of these wastes, particularly in developing countries, often is problematic (Diaz *et al.,* 2008). Information systems provide a mechanism for obtaining accurate waste balance information through submission of data by waste facilities, municipal waste service providers and the private sector, as well as vertical integration of national and provincial information systems (Department of Environmental Affairs, 2010).

The development and application of telematics has led to more automated systems of environmental control. Telematics provides new capabilities such as access to databases of distributed spatial information, and the processing of primary data and results at any distance from the rapidly transmitted information (Triantafyllou *et al.,* 2006). Databases and information systems play an increasing role in large scientific research projects (scientifically, health care waste management falls within the ambit of environmental science) and there is a growing stake in understanding how to design/develop a useful information system and in broadening our understanding of what constitutes the scientific work involved in building these systems (Baker and Stocks, 2007).

Information systems for environmental management consist of formalised steps to gather and capture information (relevant for environmental planning and management processes) about various environmental issues, as well as fixed procedures to retrieve this information (Mugerezi, 2002). The potential usefulness of different kinds of information systems for environmental management is well recognised but despite these potential benefits, concerns have been raised with the environmental literature that information systems are not always used or that they do not provide the desired outcomes and there is no body of empirical work on the topic for environmental application (Díez and McIntosh, 2009). Research agencies and environmental managers have been paying attention to improving the way technical information is used because environmental challenges are complex and do not respond well to simple solutions. Therefore, scientist, communities and policy makers are seeking collaborative approaches that utilise multiple perspectives and sources of information, but developing an information management system cannot take place in isolation of the broader social context (Allen and Kilvington, 1999). Our focus therefore shifts to information systems development.

2.3 Information Systems Development in the Public Sector

Information technology has become a vitally important part in the successful functioning of both private and public sector organizations and some organizations have further recognized information as a key corporate asset and strategic resource. However, there is a scarcity of literature on how information management practices should be organized in government ministries especially within the health sector (Lau *et al*., 2005). Cordella and Lannacci (2010) state that much public sector information systems literature draws on private sector frameworks, for example, the e-Government literature has mainly drawn on private sector, managerial models that essentially conceive of technology as an enabler, thus downplaying the role played by the organisational context where public sector ICTs are embedded. They contend that ICT developments in the public sector should pay more attention to the complexity that is associated with their implementation, rather than focusing on best practices and universal strategies to prescribe how to successfully implement e-Government programmes. Governments across the world made massive investment directed for the design, implementation, and management of information systems in public agencies. An increasing number of governments have now established a record of adopting national strategies for the adoption of e-government solutions and although we are witnessing the beginning of a growth of studies on the benefits of the use of IS in the public sector interaction with citizens and companies, research on the topic area is still largely dominated by approaches that focus on the diffusion and adoption of e-government services from a supply-side perspective (Andersen *et al.,* 2011). Earlier research by Heeks and Bailur (2007) revealed that e-government research is in a poor state and falls between the stools of theory and of practice. It does not add to the body of theory nor does it significantly help to improve practice because no link exist between theory and practice because there was neither theory nor any particular practical value.

The public sector is an important consumer of information technology, primarily because many public functions are essentially information processing tasks. Despite a growing literature on the effects of the spread of information technology is limited evidence regarding the extent to which its relation to productivity and organization in the public sphere (Garicano and Heaton, 2010). Shin *et al.* (2006) identified the following as problems in public information system design and development process:

- Significant operational gaps exist between different players in the development consortia. The consortia comprise service provider groups, government, equipment provider groups, network groups, and user groups.
- Trajectories of the public networks commonly show a top-down approach. Built from the top down, network projects leave general users out of the design process, only welcoming them upon completion of the project with only end-state completed technology.
- Developmental processes feature infrastructure-oriented development.
- Public network projects have been driven by a technology-push approach instead of a technology-pull approach.

The growth of information technology plays an important role in development and most companies realised the advantages thereof. One of the projects of information technology is that of information systems development (ISD) which can help to simplify many things and offer the best facilities for publics (Nayan and Badioze, 2009). Effective systems development is key to developing responsive strategies in the new digital economy and, in a rapidly changing business and technological environment, the ability to develop and deploy new systems is an important capability that can differentiate organizations (Patnayakuni and Ruppel, 2010). Malmsjö (2006) explains that an information system is a system where the units or components are information processes or information entities involved in information processes. Information systems development (ISD) could also be considered as the analysis, design and implementation of useful information technology systems (Avison and Fitzgerald, 2003).

Information systems development has moved from "how to build a data system" to "how to build an information system that works" to what is now emerging as "how to build a community" – a community with diverse voices and processes organized to identify, address, and respond to the technical, social, and organizational issues arising in the ongoing process of information system design (Baker and Stocks, 2007). Information systems are today connected to almost every single activity that humans in the world engage in. The efficiency but also complexity of information systems and applications has during the last decades increased dramatically. A widely spread usage of information technology by people in general has lead to a situation where many different types of user groups should be able to use the same information system.

Patnayakuni and Ruppel (2010) point out that the process of developing systems and improving the outcomes in organizations has historically been primarily viewed from an engineering perspective. To improve the systems delivery capabilities of organizations it is necessary to recognize that the development process is embedded in the social and technical environment of the organization. The socio-technical approach provides an integrated view of the organizational work context in which work processes and information technology can be examined. They go further to say that information technology and work design can complement each other to provide positive outcomes. In the context of the systems development process, the usefulness of the socio-technical approach is illustrated with initial empirical support for the premise that work design characteristics influence process capabilities and performance.

However, many ISD initiatives fail to deliver desired benefits mainly because of social and organizational factors and not merely technical failures (Luna-Reyes *et al.*, 2005). Non-technical considerations, such as management and communication structures, are as important as technical decisions in system development (Baker and Stocks, 2007). Systems development processes are seen in a negative light due to failed projects, often at large costs, and performance issues that continue to plague information systems (IS) managers. Performance issues related to systems development become even more important due to increased organizational dependence on information systems for mission-critical activities and the magnitude of potential losses associated with poor systems quality (Patnayakuni *et al.*, 2006). There is a significant body of evidence that many IS implementation projects end in failure. This failure rate for major systems appears to linger around 70% (Drummond, 2005).

Technological innovation research informs us that there are two important levels that need to be considered when designing information systems: (1) the macro level that focuses on the industry and the firm as the innovation bearing milieu; and (2) the micro level which looks at individual innovation and identifies factors that lead to successful development and use (Faraj *et al*., 2004). Xiangnan *et al*. (2008) found that five critical success factors including project objective and bound, top management support, project plan and monitoring, project user involvement, project communications would have significant impacts on the performance of the information system development projects and that success is gained by controlling theses critical success factors.

Both researchers and practitioners alike recommend that participation of the target users in the design and development of the information system enhances the likelihood of success of a health care information system because assigning or talking to qualified health practitioners may ultimately determine the failure or success of the system (Saleem *et al.,* 2006). User participation is generally considered an important aspect of information systems development and a leading factor in systems success (Mattia and Weistroffer, 2008).

Wang *et al.,* (2011) explain that numerous studies have highlighted the importance of user participation but participation literature mainly focuses on user review, user-influence, and user-hands-on activities for systems design and implementation. They conclude that user advocacy, a potential behaviour for securing buy-in among stakeholders and often overlooked in IS literature, is positively related to project performance and that the roles of users in system development should not be limited

to the design and implementation aspects but also as a selling agent to other stakeholders. The ability to develop information systems, however, depends crucially upon our understanding of human behaviour (users) in relation to systems and upon being able to identify not only differences (that may explain system failures, for example) but also similarities and stereotypes (Maceviciute and Wilson, 2010).
Successful ISD relies on the relationship between IS developer skills and final project outcomes (Tesch *et al.,* 2009). Research findings by Sheu and Kim (2009) reveal a correlation between the success of ISD and user readiness. User readiness is in the midst of other kinds of readiness such as process readiness, data readiness, organizational and cultural readiness, so it is pivotal to the success of ISD.

'Three elements are essential in the use of information technology in health care: organization, individual and information systems' (Lammintakanen *et al.,* 2010:324). A study in a health care setting revealed that the use of information systems seemed to be quite uncoordinated at operational level and therefore suggested, among others, that future research is needed on how nurse managers participate in electronic ISD and implementation processes as well as on the competencies of nurse managers to use and manage the use of electronic information systems (Lammintakanen *et al.,* 2010).

An IHCWIS could be considered either as a health information system, a waste information system or both. The role of information systems within health care will therefore be addressed next.

2.4 Health Information Systems

'An effective health information system is an important instrument to plan and monitor health interventions and facilitate overall surveillance of the health situation in a population' (De Costa *et al.,* 2008). Health information systems are concerned with the development and application of information and communication technology-based methods for acquisition, representation, processing, presentation, communication and management of data, information and knowledge for medicine, health care and prevention and its evaluation with the ultimate aim of improving the quality of care and patient health in a cost-efficient way (Koch & Hägglund, 2009).

Information communication technology is paving the way for the health care information age and health care information systems are now expected to support goals of increased efficiency and effectiveness (Klecun-Dabrowska, 2003).

One successful health information systems initiative to support goals of increased efficiency and effectiveness was the Health Information Systems Project (HISP). HISP was developed to address the fragmentation of health services and challenge of standardization. This was done by creating a hierarchy of standards (core set of essential health data) to allow flexibility, build local capacity and satisfy local management needs (Jacucci, *et al.,* 2006).

During the apartheid era in South Africa, health services were fragmented into 17 different services resulting in extreme inequity between populations and racial groups in health services provision and health status. The health information reporting systems and the data standards used were equally fragmented and incompatible. In order to measure and monitor the extent to which equity was achieved, and to pinpoint areas where more resources and efforts were needed, a standardized system for collecting health data from the whole country and covering all population groups was seen as a necessity. What became the HISP project started in 1994 as a small collaborative research project with the aim of providing health care workers with basic information to deliver better health services to the local population and at the same time address the problem of HIS fragmentation (Braa *et al.*, 2007).

The effective implementation of information technology is a crucial component for the delivery of effective services (Chiasson *et al*, 2007). However, the use of health information technology is a relatively new phenomenon for the support of communication processes and information access, thereby posing a formidable challenge for its development, application and utilization (Dykes *et al*., 2007).

Despite the availability of ICT, the healthcare sector has lagged woefully behind other sectors to adopt information technology (Goldsmith *et al.,* 2003). Health care, one of the slowest-adopting industries, is ranked with mining as one of the most technophobic industries. This, together with the reluctance of doctors and hospitals to use information technology more widely, is killing thousands of people (The Economist, 2005).

Implementation of information systems in hospitals has generally been slow and disappointing, with limited use being made of the sociology of hospital organisations which defines hospitals as systems in their own right (Tjora and Scambler, 2009).

Information systems, with the rapid changes information technology, and easier to use technology have become an integral component of an organisation's strategy. So much so that all sectors of industry, commerce and government are fundamentally dependent on their information systems and would quickly cease to function effectively in the absence of such systems (Peppard & Ward, 2004). Information technology is being woven into the fabric of health care delivery, thus providing enormous opportunities for population health improvement and addressing global health challenges. When appropriately applied and implemented, population health technologies may greatly enhance existing health intervention models (Eng, 2004).

Breslow and Stone (2005:70) conclude that:

> Like all major transformations, there will be significant changes in how the healthcare industry functions and physicians will need to learn new skills and adapt to new expectations and accountability. Despite the current lack of momentum, these changes will sweep through healthcare rapidly once the potential benefits become clear. Technology innovations will play a major role in this transformation, creating new opportunities for advancing quality of care and improving overall operating efficiency.

The success of health care information systems implementation in achieving its goals remains a lingering concern because the implementation of information systems are faced with barriers of non-use, inaccuracy of information, user incapacity for evaluating quality of information, service unavailability on-line, and disapproval by health care professionals (Saleem *et al.*, 2006; Kouri *et al.,* 2005). Many have expressed scepticism and disappointment on the returns from investments in information systems, and the outcome of many information technology projects reveals that they fail to meet the pre-specified project objectives of scope, time and budget (Kutsch & Hall, 2005; Gupta & Capen, 1996). Emerging public health technologies, including information and communication technologies are currently fragmented, under-recognized and lack critical mass or infrastructure (Eng *et al.*, 2004).

De Costa *et al.* (2008:103-105) experienced (when investigating a comprehensive map-based health management information system in the province of Madhya Pradesh, India) the following constraints with that health information system: (1) Limitations within the map-based information system itself, (2) Institutional limitations within the health system that restrict optimal use and (3) the appropriateness of the information system.

(1) Limitations within the map-based health information system itself: These limitations include absence of health service utilization data, the inability of the system to generate reports in the format desired by higher levels of administration, the need to develop it to demonstrate epidemiological applications relative user unfriendliness, a need for more detailed program-specific indicators, and the absence of the system on a common computer network.

(2) Institutional limitations within the health system that restrict optimal use: These limitations include lack of reliable and complete data, computerized updating has been non-uniform due to the lack of computerized networking between different levels of the health system and the absence of a centralized coordinating entity, varying levels of computer literacy among field functionaries, erratic electricity supply and the lack of real autonomy to lower level institutions resulting in the health information not being used locally in an innovative way.

(3) The appropriateness of the health information system: This refers to the fact that improvement in the information interface might not necessarily result in improvements in information utilization within the system. The health information system was useful largely to health managers who already value information but is not as yet being used optimally by the health system as a whole.

They conclude that uptake by the system is critical to exploit the potential of this and other similar systems. Institutional and structural constraints significantly influence systemic uptake and need to be factored into overall efforts made to develop such interfaces.

The literature reviewed (above) indicates that health information systems are biased towards patient care, electronics needed for treatment and the keeping of records highlighting the gap between HCWM and an IHCWIS.

Given that IHCWIS is both a health and waste management issue, the literature on waste management information system will now be reviewed.

2.5 Waste Management Information Systems (WMIS)

Information systems play a critical role in the planning and operation of waste management services because several activities in waste management are empirical and do not follow a set of theoretical principles; and quantity and composition of waste vary substantially as a function of time as well as among types of generators. Therefore data acquisition and analysis become the principle steps for describing the operation and performance of waste management systems. Those responsible for waste management, especially in economically developing countries do not pay attention to the use and importance of information management and therefore the evaluation, performance and effectiveness of the waste management system is limited (Diaz *et al.*, 2005(b)). Data and information is but one tool to be used in improving the way waste is managed but developing a WMIS is about facilitating the improved management of waste by providing timely, reliable information to the relevant role-players as a means to support and inform so that waste management challenges (ranging from strategic waste management issues at national government to basic operational challenges at local level) are met (Godfrey, 2008).

Information on the generation of waste through to its ultimate re-use or disposal is critical to the management of waste and minimising its impact on the environment. This type of information should enable the tracking of waste from generation through to its ultimate state to ensure that it is not inappropriately handled or disposed of, such that it causes pollution. Such information would also be invaluable to assist in planning and implementing appropriate waste management strategies, co-ordinating efficient minimisation, re-use and recycling initiatives and managing the monitoring of compliance and enforcement (Purnell, 2009).

The decision on an appropriate HCWM program is dependent on data relating to generation sources and types of waste and a lack of such data makes it difficult to plan an efficient management system (Alagöz and Kocasoy, 2007). Thomas (2004) further explains that information is essential to plan for sustainable and integrated waste management and that there is a pressing need for good, reliable, and detailed local information and data on waste in order for local authorities to plan realistically to meet specific targets. In other words, to make informed decisions, strategy planners need to be able to evaluate options, and to do this they need to understand and meet local information, data and analyses needs, as well as assess how realistic the relative options are in meeting their objectives.

The development of a health care waste information system (HCWIS) is that process which takes place between the need for a system and the actual completion of that system. The literature is relatively void of data and information regarding this process in the field of environmental management and by implication, health care waste management (an environmental management issue). Díez and Mcintosch (2009:588-589) write:

> The potential use of different kinds of information systems for environmental management is well recognised. Within the environmental field, it has been argued that different types of information systems including integrated assessment models, geographical information systems and decision support systems are well suited to informing environmental management and policy… However, concerns have been raised about the translation of this potential into actual use and benefit to policy and planning organisations and outcomes. … There is no body of empirical work on the topic for environmental application. Arguing for a better understanding for the use and usefulness is equivalent to arguing for a better understanding of the ways in which information is acquired, manipulated and used by individuals and groups within organisations, and should be a fundamental influence on the process of developing information systems.

The lack of literature on health care waste information systems highlights the need for research on the development and institutionalisation of an IHCWIS.

However, the development of an information system should, when implemented, lead to its institutionalisation. The stage in the implementation of an information system when the users have appropriated the benefits from the system, based on the incorporation of the various functions in their daily work (practices), is referred to as institutionalisation (Azad and Faraj, 2009). Before we discuss institutionalisation it will be apt to first explain the characteristics of a HCWIS.

2.6 The Characteristics of a Health Care Waste Information System

Health information systems (HIS) are designed to inform policy, public health intervention and enhance the effectiveness and efficient functioning of a health care facility (Goater *et al*., 2011). Health Care Waste Information Systems (HCWIS) is an environmental information system structured around what people see in the environment, and how they collaborate to deal with environmental problems. They shape scientific inquiry, legal argument, and how citizens participate in governance. They are systems designed to produce new truths, new social relationships, new forms of political decision-making and, ultimately, a renewed environment (Kim, 2004). There is insufficient planning for health care waste management because of the lack in information and systems which supports the decision making process. The decision-making process is hampered sometimes because of the lack of information and the absence of an information system (Katpatal *et al*., 2010). Health care waste managers make rational decisions through the coordination of environmental information and data management. The results assess the environmental vulnerability around HCW and its impact on the environment (El-Gafy *et al*., 2011).

The special characteristics of a HCWIS which differentiates it from HIS is that it provides intended users with information to: perform spatial analysis, measure and report on environmental indicators, and effect behaviour change. Each of these will be discussed in turn.

Spatial Analysis: Spatial analysis solves environmental problems (Katpatal *et al.*,2010). Environmental data are separated into predetermined classes for a better and smarter characterization of the state of pollution, with the measured values transformed and presented in maps (Kraft *et al.,* 2004). Risk and vulnerability to health care waste -related hazards will vary in both space and time (Parsons *et al.*, 2010). The existence of a large number of sensors for monitoring the environment, with inherent differences in spatial and temporal resolutions and formats, makes it necessary to have a sophisticated computer tool to manage this large volume of heterogeneous data and prepare them for assimilation into models (Jacob *et al.*, 2003). One such sophisticated tool applicable to health care waste is a spatial decision support systems (SDSS) based on the use of geographic information system (GIS) technology. GIS provides an important source of tools and techniques using geographic or spatial data. SDSS is an interactive, computer-based system designed to help a user or group of users achieve a more effective decision-making process while solving a semi-structured spatial decision problem (Katpatal *et al.*, 2010).

Measuring and reporting environmental sustainability indicators: For urban areas that face environmental problems, indicators point a way to a better future. Indicators are becoming increasingly important as a means of communicating health care waste information to decision-makers and the public in a straightforward and easy-to-follow manner. A HCWIS needs to cover a wide range of thematic areas in order to adequately imprint the present situation and future trends regarding the management thereof (Moussiopoulos *et al*., 2010). These areas are determined by (1) driving force and pressure indicators which describe processes or activities that have a positive or a negative impact on environmental sustainability (e.g. health care waste pollution), (2) State and impact indicators which describe the current situation (e.g. relationship between health care waste pollution and resulting environmental degradation or outbreak of diseases), and (3) response indicators which describe reactions and actions aimed at moving towards environmental sustainability (e.g. effective health care waste management) (United Nations, 2007).

Effect user behaviour change: There is growing interest within the IS design community to develop innovative information systems that change user behaviour. The HCWIS should provide instant feedback on problems involving the micro (individual beliefs and actions) and macro (organizational sustainability programs and their economic and environmental outcomes).This, in turn, may lead to joint investment in health care waste pollution reducing programs enabled by information systems (Mellville, 2010).

2.7 Institutionalisation

Institutionalisation does not only refer to the internalisation of practices but also the implementation of the information system ((Kostova and Roth, 2002). Once developed, institutionalised practices then become part of the institutional context of an organization and serve to legitimize other practices (Berland *et al*., 2009).

Institutionalisation is a process wherein changes are mastered; technology stabilized; new competencies around technology and redefined processes are developed; and complementary structure and norms evolve. The institutionalisation of an information system entails stabilizing its processes to such a degree that its associated practices are accepted, become routine and incorporated into the system's culture and its ''day-to-day'' operations. (Lozano, 2006; Silva and Backhouse, 2003; Kumar *et al.,* 2002).

This means that institutionalisation occurs when an information system is no longer seen as an innovation but a habitual way of life. After institutionalisation the information system becomes less of an effort to manage thereby allowing managers to concentrate on and devote their creative energies to their primary functions. The institutionalisation of an information system is possible only if it is sustained and legitimated by organizational actors and individuals (Humes and Reinhard, 2007).

Kumar *et al.,* (2002) state that institutionalisation is a post implementation process, meaning that it does not consider or include the conceptualisation and development facets. This, however, is a narrow view because it considers institutionalisation as an event instead of a process. The event of institutionalisation takes place after the actors have been mobilised into accepting the information system. According to Will (2008) institutionalization begins with the adoption of a practice that reflects a strategy and occurs when a problem is identified that current practices and institutions are incapable of addressing. This means the process of institutionalisation should start at the very beginning when the need for a system has been identified.

Institutionalized processes become absorbed and integrated into the organizations with the ideas being accepted and acted upon to become normal and routine in the organization because of its legitimacy (Kimaro & Nhampossa, 2005). Colyvas & Powell (2006) are of the opinion that institutionalization is the outcome of the self-reinforcing feedback dynamics of heightened legitimacy and deeper taken-for-grantedness. Thus, institutionalization produces a practical form of legitimacy in which statuses are formalized, boundaries redefined, access to resources reinterpreted, and even the nature of resources reconstrued. Taken-for-grantedness entails the creation of routines and the classification of identities and discoveries and focuses on organizational routines, roles, and categories. But in this context institutionalization occurs through the collated embedding of practices, meanings, expectations, and values.

Institutionalization of an information system includes creating roles, responsibilities, structures, and budgets to ensure that it becomes part of the existing organizational routines. When introducing an information system, there is a need to adhere to a new kind of culture that goes with the system, such as new ways of reporting, collecting, processing, analyzing, and using data. Thus, institutionalization implies designing new work activities so that they become a routine way of doing things for most people in the organization (Kimaro & Nhampossa, 2005).

Institutionalisation is not systematic or linear (Dambrin *et al.,* 2007) but becomes eminently dynamic instead of static and includes agency, as well as social structures and takes place at the macro-social and micro-social levels (Machado-da-Silva et al, 2005). The total time frame from initiation to institutionalization is lengthy making institutionalization a long-term goal (Aypay and Kalayci, 2008). During this time change does not always substantially modify the daily activity of organisational actors and is either slowly implemented or rejected by actors, or ceremonially accepted, depending on the element of the management control system under consideration and institutionalisation is completed only if ideals, discourses and techniques are coherent (Dambrin *et al.,* 2007). A highly institutionalized practice is not unchangeable over time (Dambrin *et al.,* 2007) but an institutionalized practice remains in a provisional and dynamic state of equilibrium: the higher the degree of institutionalization, the lesser the chances that it will be sharply changed (Machado-da-Silva et al, 2005).

Webber (2006) concludes that leadership involvement is the most important critical success factor which strongly and significantly correlates with institutionalization of an information system. Factors such as adoption, adaptation, government support, ICT Infrastructure, organizational structure and culture, and transparency in information sharing also contribute to the success of institutionalization. The major critical failure factors that frustrate institutionalization are lack of funds, user resistance to change and lack of MIS policy/strategy guidelines. Silva and Backhouse (2003) argue that the exercise of power is required to institutionalize a system, particularly if the system is resisted, and, once in place, it becomes a source of power. Regulatory pressure, which involves coercive legal mandates, is also considered as a critical contributing factor for institutionalisation (Darnall *et al.*, 2008). For example; mining and mineral companies have adopted environmental management practices which helped them to minimize their impacts on the environment in order to respond to increasing environmental regulations, (Nikolaou & Evangelinos, 2010). Recognizing and acknowledging these success factors, means determining other critical contributing success factors for institutionalisation especially in a case where technology and practice evolve together.

2.8 Chapter Conclusion

Waste management should be managed in such a way that it does not affect the people or the environment. This environmentally acceptable management of waste has now become a global challenge. The approach to waste management is derived from the solid waste hierarchy, a tool used to rank waste management options according to their environmental benefits. The waste management hierarchy is also a cornerstone of the integrated sustainable waste management (ISWM) approach. An ISWM approach recognises three important dimensions in waste management: (1) stakeholders, (2) waste system elements and (3) sustainability aspects. A number of research studies have been conducted on the pollution aspects of general waste, but waste (health care waste) generated at health care facilities has not attracted the same level of attention,

Health care waste generation and the poor management thereof pose a threat to the health and well being of the population and the environment. South Africa recognised and addressed this threat by developing sound policies, procedures and a health care waste information system to face the challenges of this threat. The risks associated with healthcare waste and its management has gained attention across the world in various events, local and international forums and summits. The need for proper healthcare waste management has been gaining recognition slowly due to the substantial disease burdens associated with poor practices, including exposure to infectious agents and toxic substances. Despite the magnitude of the problem, practices, capacities and policies in many countries in dealing with healthcare waste disposal, especially developing nations, is inadequate and requires intensification (Ananth, *et al.,* 2010).

Information systems play a critical role in the planning and operation of waste management services but not enough attention is given to the use and importance of information management. More focus and emphasis have been placed on the general waste information system than on the health care waste information system per se. Reasons for this are unknown and therefore open to speculation. Further empirical research is needed to determine those reasons. A health care waste information system is a possible solution to prevent health problems associated with exposure to health care waste, but its effectiveness and efficiency is dependent on whether the system was developed (designed) comprehensively and properly institutionalised.

‘Considering the process of designing information systems, one consequence is that the user of an information system must be involved in designing that system, otherwise a data system will be developed’ (Malmsjo, 2006:881). It must be said that health care waste information systems development is a complex activity that calls for a challenging discipline of design thinking. The literature mentions the need and actual manifestation of an IHCWIS but the processes involved in establishing such a system are relatively unknown other than stakeholder involvement in determining the need for an information system. Information systems development starts far down the line with a focus on data and data processing concerns, thereby ignoring fundamental issues normally associated with interpretive forms of enquiry (Rose, 2002). Some of these fundamental issues are illustrated in Figure 2.5. below.

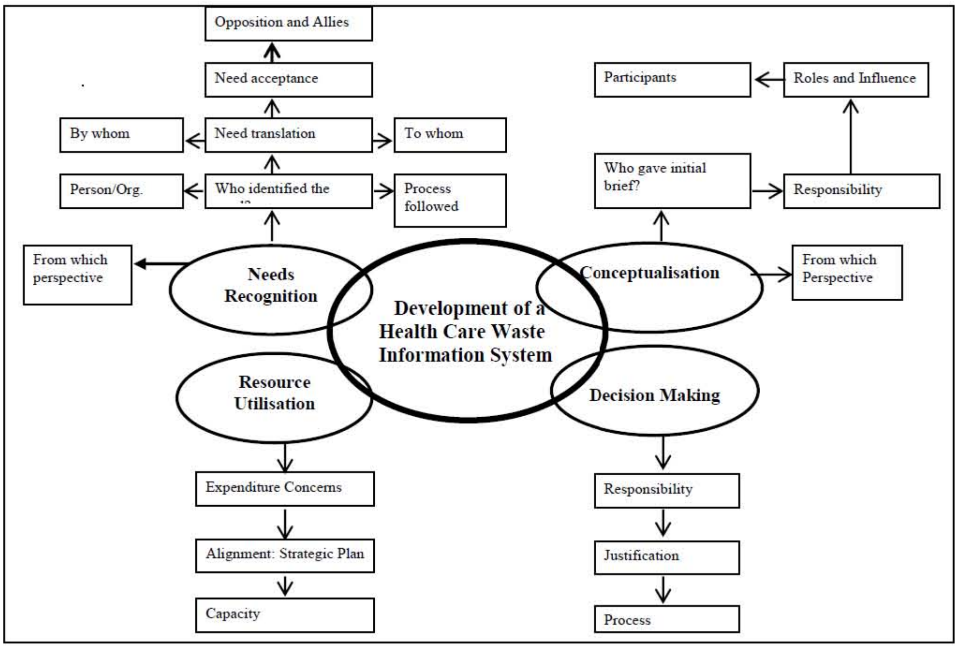

Figure 2.5: Issues involved in health care waste information systems development

Institutionalisation should not merely be seen as a post implementation process but rather than an all encompassing process which includes the processes and interaction which occur during the development (pre-design) and design phases. This will ensure that all stakeholders and potential users are involved from the outset, a recipe for success and effectiveness. The development and institutionalisation of a health care waste information system poses questions such as "How was the health care waste information system developed and designed in South Africa?" and "What factors are critical to the success of institutionalisation of such a system?" These questions could not be answered in this literature review and further research is needed on this.

Most information systems fail due to a lack of emphasis in dealing with complex organisational factors and the balance between technical, strategic and organisational analysis must be redressed (Wainwright & Waring, 2004). Greater emphasis needs to be placed on developing the domain of organisational analysis to better understand implementation issues concerned with structure, social and historical context, power, politics and culture.

Future research should, among other things, examine the detailed nature and scope of user advocacy regarding aspects of when, where and how to serve as a voice for the information system development project.

Future research should continue to explore the behaviors that underlie these worldviews and the UPAs that emerge, focusing upon the social relationships and the methods that can be used to influence participation's effectiveness (Mattia and Weistroffer, 2008).

It should be noted that currently, an IHCWIS is not yet an integral part of waste management practices in general. It is for this reason that we ask the question 'how can an integrated health care waste information system be incorporated into waste management practices?' Before embarking on research to find answers to these questions, one needs to discuss the methodological issues, tools and techniques used in the process of research. The next chapter, Chapter 3: Research Methodology, provides this discussion.

Chapter 3

Research Methodology

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Chapter 3

Research Methodology

3.0 Introduction

The nature of the problem under investigation, need for the research, research goal and aim, were discussed in Chapter 1. Chapter 2 presented the literature review including the primary research questions generated. The purpose of Chapter 3 is to provide a detailed discussion on the methodological issues, tools and techniques used in the process of researching the development and institutionalisation of IPWIS.

Chapter 3 is divided into nine sections. Section 1 argues the choice of an appropriate research strategy and Section 2 details the ontology and epistemology of the research approach. Section 3 examines the underpinning theory with Section 4 exploring health care waste management as a heterogeneous network. Section 5 describes and illustrates the development of the research questions. Section 6 explains the research design focussing on a qualitative case study as the method used to provide an in-depth exploration and description of the perspectives, practices and behaviour of the actors in their natural setting. Section 7 describes data collection methods, handling and Section 8, the data analysis. Sections 8 and 9 address academic rigour and ethical issues, respectively.

3.1 Choice of an Appropriate Research Strategy

There are three primary strategies for conducting research namely, (1) compile information on some topic, (2) solve a problem for which no known or apparent solution exists and (3) look with "new eyes" at existing knowledge to find better solutions for a problem that has been previously solved (Olivier, 2009). It is rare for research to be carried out from "scratch" without building on prior work on the same or similar problem. This prior work is based upon existing theory, previous research, beliefs and experiences of others including you own insights (Potter, 2002). The critique aimed at the status of social research in society resulted in extensions of particular discourses into terrains such as the relationship between theory, methodology and method (May, 2002). Different research studies attempt to answer different types of research problems or research questions and end up employing different combinations of methods and procedures (Babbie and Mouton, 2001). Decisions about what approach to adopt in order to tackle the problem under study, what specific data to obtain and from where and how (Thomas, 2004), all culminate in a plan called the *research strategy*. However, 'few enquiries develop exactly according to the original plan, but without such a plan few enquiries would develop at all. It is therefore better to have an emergent plan with a strong logic than no plan at all. It is also better to have one emerging in a good argument and design logic...' (Henning *et al*., 2004: 142).

The following diagram (Figure 3.1) summarises and illustrates the framework on the choice of the appropriate research strategy/plan utilised in an attempt to answer the research question posed by this study. This framework will now be briefly explained.

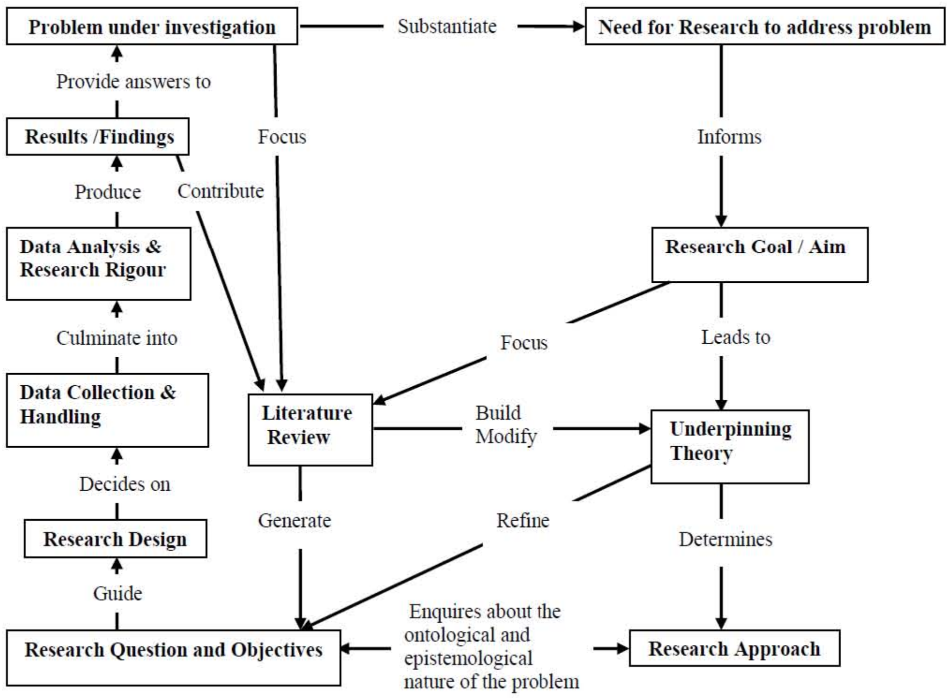

Figure: 3.1 The research framework

Poor health care waste management is the problem under investigation and in addressing it, substantiated the need to research the understanding of the development and institutionalisation of an integrated health care waste information system (IHCWIS). The need for research, to address the poor health care waste management, informed the goal/aim of the research which is to gather empirical data to understand how the development and institutionalisation of an IHCWIS contributes to effective health care waste management. This led us to use an underpinning theory to respond appropriately to understanding how the development and institutionalisation of an IHCWIS contributes to effective health care waste management (HCWM). The processes of developing information infrastructures themselves can be viewed from the perspective of Actor-Network Theory (ANT) (De Man, 2007). ANT was used as the underpinning theory and the paradigm underlying this research is interpretive with the assumptions of a subjective ontology and an interpretive epistemology. The underpinning theory determined the research approach which eventually led to the development of the appropriate research questions and objectives.

The research questions (1) *Having conceptualised an IHCWIS what processes are followed in the development of an IHCWIS?* (2) *How does an IHCWIS manifest and become institutionalised among stakeholders? and when it is institutionalised,* (3) *How can an IHCWIS contribute to effective and efficient HCWM decisions?* guided the research design and provided the rationale for conducting a qualitative case study with a goal to answer the "what" question and to develop pertinent propositions to solve the "how" question (Kothari *et al.,* 2007). The purpose of the research design is to ask 'what type of evidence is needed to answer the question in a convincing way' (De Vaus, 2001:9) and by doing so, allows us to decide on a specific method to collect and handle the data needed for analyses. Primary data was generated by conducting semi-structured face-to- face interviews (using an interview schedule as a guide) with government officials, health care waste generators, health care waste contractors and information systems project managers. Secondary data was collected by reviewing and critiquing relevant literature such as peer reviewed articles, minutes, reports and legislation relating to how an IHCWIS was developed and how it might become institutionalised. Data collection eventually culminates in analysis, which in turn, produces the relevant evidence to answer the research question and thus provides us with possible solutions to the problem under investigation.

The methodological issues (explained above), tools and techniques used in the process of researching the development and institutionalisation of an IHCWIS will now be discussed in detail. As mentioned before, the problem under investigation, the need for research to address the problem, and the research goal and aim were already discussed in Chapters 1 & 2 and will not be repeated here in Chapter 3. We will now, therefore, start with the research approach.

3.2 Research Approach

3.2.1 Philosophical perspectives: Ontology, Epistemology and Paradigms

Research activity is epitomised by, amongst others, two other concepts: epistemology and ontology (Resca, 2009). The way we view reality and being is called ontology and linked to the ontological issues is the epistemology (the view of how one acquires knowledge) about the grounds of knowledge, in other words, "how did we come to know it?" (DePoy and Gitlin, 1998; Roode, 1993). Our ontological assumptions inform the epistemological assumptions (Mack, 2010) because ontology has a complex relationship to epistemology in that it requires knowledge about what is and if knowledge is described as justified belief then ontology devolve to the realm of evidence, manner and methods by which one adjudicates evidence to form belief and thus epistemology (Poli and Obrst, 2010). Together ontology and epistemology make up a paradigm (Mack, 2010).

Ontology: Ontology is the starting point which will likely lead to a theoretical framework because it is concerned with what we mean when we say something exists

(Mack, 2010). Researchers are constantly faced with ontological issues of "what is reality?" and whether the reality is external to the individual, an objective nature or the product of an individual (DePoy and Gitlin, 1998). Ontology by studying being of what exists and of what is think-able determines what types of entities constitute reality. Ontology questions the real nature of entities, how do they come into being and why (Resca, 2009).

Apart from the above traditional philosophical aspects of ontology there is also the computer science and information perspective. Computer science perceives ontology as asking the same philosophical questions, but views it as the technology where the intention is to create engineering models of reality, artefacts used by software to fill software with human level semantics. Ontology provides tools for clarified and reconstructed sciences to classify and organise the results of science from that which science discovers as reality (Poli and Obrst, 2010). From an information systems perspective, ontology may be constructed to enable sharing and support specification. Ontology is therefore viewed as a formal explicit specification of a shared conceptualisation, providing a shared and common understanding of a domain that can be communicated across people and application systems (Gruber, 1993).

The ontology for this research is concerned with how actants structure reality through interaction. The actants, for the purpose of this discussion, are the human actors who need to interact with an IHCWIS and their social reality is not a given but the outcome of the interaction with the system. This assumes a subjective reality.

Epistemology: Epistemology studies the assumptions about knowledge and attempts to answer the basic question of what distinguishes true (adequate) knowledge from false (inadequate) knowledge. The assumptions are not only on the grounds of knowledge, about how one might begin to understand the world and communicate this as knowledge to fellow human beings, but also humans' capacity to use knowledge in an intelligent way (Heylighen,1993; Roode,1993). In other words, epistemology studies what we mean when we say we know something (Mack, 2010).

Knowledge is not only created by what we observe but also by our beliefs, intentions, meaning making, values and reasoning (Henning et al., 2004). Epistemology also questions how reality can be known, the relationship between the knower and what is known, the characteristics, principles, and assumptions that guide the process of knowing, the achievement of findings, and the possibility of that process being shared and repeated by others in order to assess the quality of the research and the reliability of those findings (Vasilachis de Gialdino, 2011).

Some theorists share an epistemological viewpoint 'based on the fundamental assumption that it is not possible to separate the outside world from an individual's ideas and perception of that world. 'Knowledge is based on how the individual perceives experiences and how he or she understands his or her world' (DePoy and Gitlin, 1998:27). Hevner et al., (2004:98) are of the opinion that 'philosophical debates on how to conduct research in information systems lie in the epistemology of the research with the underlying assumption being that of the natural sciences, i.e., somewhere the truth exists and somehow that truth can be extracted, explicated and codified'. Epistemology, by referring to how we know what we know, concentrates on how knowledge can be acquired on the entities being examined. This means that epistemology has to do with methods: theories, concepts, rules and the procedures applied within a discipline in order to derive at knowledge (Resca, 2009).

The fundamental nature of the social world, for the human actors in this research, is at the level of their subjective experiences with an IHCWIS. In other words, their reality is constructed through the work that needs to be done in reporting to an IHCWIS; the nature of relations that are formed through this interaction; the possibilities for multiplicity and dynamic adaptation (Goguen, 1999); and the perplexity and uncertainty they bring along, hence an interpretive epistemology.

Paradigms: Information systems research is dominated by three paradigms, viz., positivism, interpretivism and criticalism. Positivism is considered to be an objective and hard investigative stance concerned with the discovery of universal laws that can be used to predict human activity, and the physical and technological world (Guo and Sheffield, 2008). Positivism has been characterized as usually embracing the doctrines of a value-neutral empiricism, and a unity of the scientific method for the natural and social sciences (Hirschheim, 1985). Webber (2004) argues that nobody takes such a strong positivist stance anymore, and post-positivist philosophies have come to terms with the value-laden nature of science and fallibility.

Concerning interpretivism, Thorne *et al*., (2004:) argue that:

> Interpretive description offers the qualitative health researcher an opportunity to work outside of the disciplinary confines of the more traditional methodological approaches and create a design logic that is consistent with the aims of an investigation of clinical health and illness

> phenomena…interpretivism provides a grounding for the conceptual linkages that become apparent when one attempts to locate the particular within the general, the state within the process, and the subjectivity of experience within the commonly understood and objectively recognized conventions that contemporary health care contexts represent.

The critical paradigm focuses on uncovering illusions so that people will be empowered to change their world by themselves. It assumes that the material world is one of structured contradictions and/or exploitation which can only be objectively known by removing tacit ideological biases (Smith, 2006).

Burrell and Morgan (1979) introduced a typology of four research paradigms (see Figure 3.2) for the analysis of social and organizational theory when they identified fundamentally various assumptions concerning the nature of social science and the nature of society.

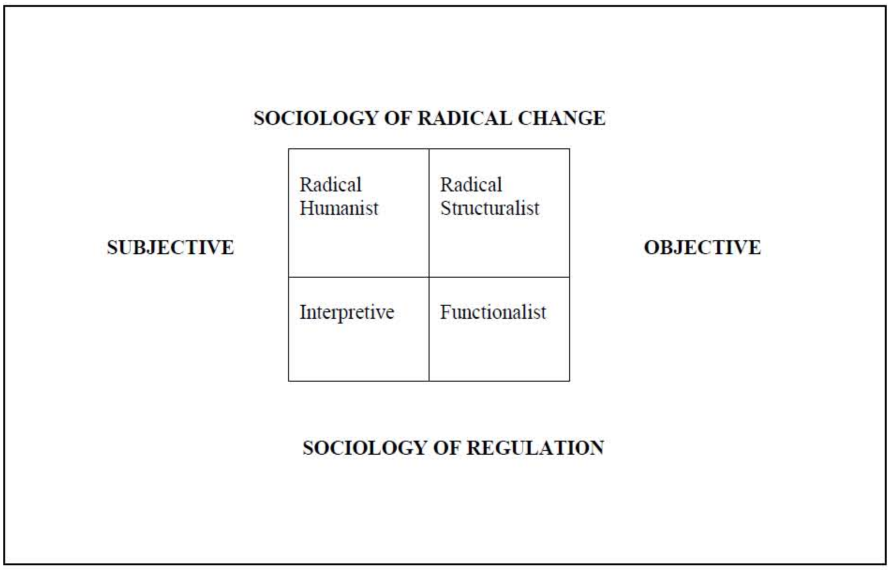

Figure 3.2: **Four paradigms for the analysis of social theory** ***(Source: Burrell and Morgan, 1979)***

These four distinct paradigms are functionalism, interpretivism, radical structuralism, and radical humanism and can be used for the analysis of a range of social theories. The paradigms further depict four sets of basic assumptions, with each set identifying a quite separate social-scientific reality. The paradigms are mutually exclusive and view the world in a particular way based upon the different meta-theoretical assumptions regarding the nature of science and society (Burrell and Morgan, 1979).

Kakkuuri-Knuuttila (2008) argues that the contrast between nominalist and realist is surprising, confusing and flawed. Mainly, because nominalists believe that the only existing things are particulars with their similarities and difficulties, and historically the realist view leads to a positivist philosophy. In spite of Kakkuuri-Knuuttila's (2008) criticism one should view Burrell and Morgan's framework as providing a different research perspectives in IS research, which is still being dominated and underpinned by a positivist philosophy (Mingers, 2004). There is not inconsiderable empirical evidence to indicate that the field of IS continues to be dominated by the positivist paradigm but this state of affairs remains despite attention being paid to the range of research methods available to IS researchers as early as the 1980s (Galliers, 2011). The typology of the four research paradigms is not a matter of 'are these the right categories, or who fits in each' but rather 'are these differences that make a difference' (Deetz, 1996:191). Fitzgerald and Howcroft (1998) contend that the debate between 'hard' (positivist) and 'soft' (interpretive) research approaches cannot be resolved. They therefore conclude that it would be more appropriate to recast the debate at a macro level in order to accommodate different research agenda and recognise the strengths within each tradition.

Thorne *et al.,* (2004:5) state that interpretivism obtains its rigour and legitimacy through the following philosophical underpinnings as described by Lincoln and Gupta (1985):

> 1) There are multiple constructed realities that can be studied only holistically. Thus, reality is complex, contextual, constructed, and ultimately subjective.
> 2) The inquirer and the "object" of inquiry interact to influence one another; indeed, the knower and known are inseparable.
> 3) No a *priori* theory could possibly encompass the multiple realities that are likely to be encountered; rather, theory must emerge or be grounded in the data.

In the context of information systems development, Hussain and Taylor (2007) explain that the assumption within the functionalist paradigm is that information systems needs and requirements already exist and therefore stakeholder views are not required because the one reality is the same for everyone. However, within the social relativist (interpretive), information systems and needs are socially constructed and there is a need to understand social systems from the participants' perspective. Radical structuralism, on the other hand, is based on the principle of class struggle between management and worker implication for information systems development (ISD). Lastly, the humanist paradigm focuses on radical change and emancipation. Information systems requirements, within this paradigm, are constructed by a process of mutual agreement which involves sense-making, discussion and achievement of shared meaning. The information system developer is now required to act from within and create an information systems environment which is free from social constraints.

This research is driven by an interpretive paradigm because of; (1) the interest in understanding the complex processes involved when health care waste information systems are developed and institutionalised; and (2) the strength and power of the interpretivist approach lies in its ability to address the complexity and meaning of situations (Black, 2006).

These underpinnings correspond with the following Klein and Myers' (1999) seven principles for the conduct and evaluation of interpretive field research in information systems:

1. The Fundamental Principle of the Hermeneutic Circle: Understanding a complex whole from preconceptions about the meanings of its parts and their interrelationships
2. The Principle of Contextualization: There is an inevitable difference in understanding between the interpreter and the author of a text.
3. The Principle of Interaction Between the Researchers and the Subjects: Requires the researcher to place him or her and the subjects into a historical perspective.
4. The Principle of Abstraction and Generalization: Requires relating the idiographic details revealed by the data interpretation through the application of principles one and two to theoretical, general concepts that describe the nature of human understanding and social action.
5. The Principle of Dialogical Reasoning: Requires sensitivity to possible contradictions between the theoretical preconceptions guiding the research design and actual findings
6. The Principle of Multiple Interpretations: requires the researcher to examine the influences that the social context has upon the actions under study by

seeking out and documenting multiple viewpoints along with the reasons for them.

7. The Principle of Suspicion: Requires sensitivity to possible “biases” and systematic “distortions” in the narratives collected from the participants.

The above suggested principles provide an important stimulus for the advancement of interpretive research approaches and while not all of the principles may apply in every situation, their systematic consideration is likely to improve the quality of interpretive field research in information systems. There is thus a need to stimulate further debate concerning whether and how the quality of interpretive research can be assessed (Klein and Myers, 1999). In conducting the field research this study followed and applied these principles in order to evaluate and justify the research contributions. See Chapter 6 for a detailed discussion.

One should recognize that interpretative elements are influential and present in all types of research and should be seen as assets rather than a cross to bear (Gummesson, 2003). Chiasson e*t al.,*(2007) explains:

> Information systems are equivocal artefacts that different users, in different settings, must make sense of in different ways in order to adopt the technology into their practices. If researchers assume that users all react similarly, and that their reactions are normative and rational, important aspects of the social, psychological, and organizational processes through which IT are developed and used, will be overlooked. As the IS field developed, a greater appreciation of the interpretive nature of IS phenomena, and the need for research approaches that would be sensitive to these processes, also developed. In the process, IS researchers have drawn research methods and approaches from a broad range of disciplinary bases. For example, experimental and quantitative methods have been drawn from psychology (as they are in MI), whereas qualitative and intensive field study methods are drawn from

> anthropology, sociology, and the humanities. The result is a diverse set of methods that IS researchers may draw on to examine research phenomena from different ontological, epistemological, and methodological perspectives. In particular, in-depth field study and interpretive research methods have gained legitimacy and use in the IS field.

An interpretive approach accepts human experiences as a valuable source of knowledge and its methodology provides the opportunity for expression of the complexity and depth of those experiences (Mackey, 2005). Users of information systems need to make sense of an information system in different ways in order to adopt the system into their daily practices. Researchers therefore cannot assume that all users will react and interact in the same normal and rational way. To do so is to overlook the important aspects of the processes through which IT was developed and used. As the technology develops, a greater appreciation of the interpretive nature of IS phenomena develops giving interpretive research methods legitimacy and use. The use of an interpretive framework deepens the understanding of how human and contextual factors affect, among others, system use and adoption (Chiasson, 2006). This interpretive lens leads to the choice of ANT as an underpinning theory.

3.3 Underpinning Theory

It should be mentioned that ANT is not the only theory which focus on institutionalisation process. Institutional theory and ANT do have some 'semblance' in terms of overarching research theme and both focus – albeit in different ways – on institutionalization processes (Georg *et al.,* 2009). These theories will now be discussed.

3.3.1 Institutional Theory

Institutional theory deals mainly with inter-organizational processes and assumes that forces shaping an organization and its behaviour are largely external to the organization (Kondra and Hurst, 2009). Institutional theory seeks to examine why organizations are homogenous with often little differentiation between organizations in the same organizational field and focuses on organizational response to institutional forces (Weech-Maldonado *et al.*, 2012). The objective of institutional theory as "a science of rules and their consequences" is precisely the production of propositions, generalizations and conjectures about the dynamics of choices, decisions and behaviour. Institutional theorists are challenged to rethink foundational issues of: What are we trying to accomplish? Do we really understand the complexity of the issues involved? What are we really after? (Aligica and Boettke, 2011). New institutional theory conceives of institutions as social models embedded in people's patterns of action, in other words, institutions are organised and established courses of action. Institution represents a social order or pattern that has attained a certain state or property and institutionalisation signifies the process of such attainment (Miscione, 2007).

In this study we choose not to use institutional theory as a lens because (1) institutionalisation could be considered a less widespread variant of institutional theory (Miranda and Kim, 2006), (2) the theory adopts mainly traditional aspect like isomorphism with the organisation as the level of analysis (Svejvig, 2010), and (3) there is a danger that the theory has been stretched beyond its core purpose to understand how organisation structures and processes acquire meaning and continuity beyond their technical goals (Suddaby, 2010).

We choose ANT because (1) the way actors come together in the process of developing and institutionalizing an IHCWIS has to be understood as a convergence between different actors and their interests. ANT is best suited to capture the process where structures between different actors take form (Ihlström, *et al.,* 2009) and (2) ANT theorizes about how people together with their technologies comprise social networks and the ways in which they are connected with and through their technologies (Lamb, 2006). ANT will now be discussed.

3.3.2 ANT

Although ANT has become an increasingly influential theoretical framework (Roberts, 2012) it has not escaped criticism. Despite its popularity, ANT is considered a controversial approach in that it appears to promote a sociological perspective that lacks substantive political critique (Alcadipani and Hassard, 2010). Criticism also surrounds the fact that actors can be equally people, objects and organizations and this tends to be highly deterministic in terms of network constraints leaving no space for actors' reflexivity and resistance, and the structure of power seems to be fully determined (Bellotti, 2011). ANT, in its original form, cannot account for how networks persist over time and space other than at the behest of some 'focal actor'(Brooks *et al.,* 2008).

Walsham (1997) delivers the following four criticism against ANT: (1) ANT provides limited analysis of social structure in that it addresses the local and contingent but pays little attention to the broader social structures which influences the local, (2) It takes an amoral stance on political issues because it neglects issues of political bias and morality, (3) ANT assumes a symmetric position by not rigidly separating or making adequate distinction between human form non-human actors, and (4) ANT faces problems of description in trying to identify and follow all the heterogeneous associations between all actors in the network.

Greenhalgh and Stones (2010) refers to ANT as having a "flat ontology" with no pre-existing layers such as structure and agency. Using ANT as an ontological foundation to inform research is restrictive and limiting. ANT has become a method of a data collection and analysis for interpretive studies rather than an ontology that inform information systems research (Cordella and Shaikh, 2006).

In ANT becoming a method results in it being used as Law (2008) states, an **approach** rather than a **theory**. Law (2008) furthermore claims ANT is not theory because it lacks explanatory power and is descriptive in nature. He continues to say that theories usually try to explain why something happens, but actor-network theory is descriptive rather than foundational in explanatory terms. If this is right, then general criticisms or defences of "the approach" are likely to mistranslate its epistemic and practical import.

This notion of ANT not being theory is challenged by Gregor, (2002) who argues that theory can be considered on many different dimensions and its categorisation depends on the primary purpose that the theory under consideration is to serve. It is appropriate to classify theories in IS (in terms of the purpose the theory serves) in terms of knowledge building and on which knowledge is expected to be used. It is therefore expected that IS research should have relevance and application to individuals, organisations and society.

Gregor (2006) states that theory in IS is of various types as follows:

- Analysis and description. Such theory provides a description of the phenomena of interest, analysis of relationships among those constructs, the degree of generalizability in constructs and relationships and the boundaries within which relationships and observations hold.
- Explanation. This type of theory provides an explanation of how, why and when things happened, relying on varying views of causality and methods for argumentation. This explanation will usually be intended to promote greater understanding or insights by others into the phenomena of interest.
- Prediction. This theory type states what will happen in the future if certain pre-conditions hold. The degree of certainty in the prediction is expected to be only approximate or probabilistic in IS.
- Prescription. A special case of prediction exists where the theory provides a description of the method or structure or both for the construction of an artefact.

ANT, given the above different types of theory, can be classified as descriptive theory.

Despite the criticisms and limitations, ANT is used as a theory because it is conceptually useful in helping to appreciate the complexity of reality and the investigation of technology implementations in health care settings. Health care services research, and in particular the evaluation of complex information technology systems within health care facilities, may benefit from being informed by ANT perspectives (Cresswell *et al.,* 2010). Overall ANT is considered as having a potentially wide area of application and being a promising theoretical vehicle for development informatics research (Stanforth, 2006). ANT is of value because it provides a unique approach to accessing and defining previously ignored non-human entities and their influences (Luoma-aho and Paloviita, 2010).

ANT is rooted in the interdisciplinary field of science and technology studies (Bergquist et al., 2008) and is also known as the sociology of scientific knowledge, the sociology of science and technology, the sociology of translations and the sociology of associations (Lockie, 2007). ANT emerged out of the social studies of science and technology and progressed from the works of Michael Callon, Bruno Latour and John Law in which society is viewed as heterogeneous elements of people, technology and objects (Scott and Wagner, 2003; Hanseth *et al.,* 2004; Lowe, 2000). The interrelationships among these are theorised as networks of human and non-human actors, hence the term Actor-Network Theory. ANT describes how particular networks of technical and non-technical elements become established, and how this process is simultaneously an establishment of knowledge.

ANT is used as the theoretical framework for conceptualising the development and institutionalisation of the IHCWIS. One approach to better understand issues, as they relate to information systems implementation and institutionalisation, is to apply the actor-network theory (ANT) framework because ANT provides a particular set of understandings of social and material phenomena (Fox, 2005) by describing the various networks and allies involved in the creation and commissioning of science (Comber *et al*., 2003). 'ANT is good at describing a fine-grained relationship between technology and people and being a conceptual tool describing how technology stabilises in organizations' (Ellingsen and Obstfelder, 2007:106). ANT is relevant to this study because it, as Lockie (2007:786) puts it, 'offers different perspectives on the relationship between humans and the different perspectives they bring to bear on the relationships between humans and the environments with which they interact'. ANT is especially relevant since it takes technology seriously, gives due attention to nuances in design and use, as well as the role of different technological devices (Ranerup, 2006). ANT has enjoyed increasing interest among information systems scholars, who have seized on ANTs foregrounding of technology, process-oriented perspective, and attention to divergent interests as a compelling foundation for the analysis of information technology initiatives (Ramiller, 2007:197). 'In information systems research, we often hear of calls for new theoretical perspectives to enhance our understanding of IS phenomena. ANT rates high on a list of those useful theories' (Lee and Oh, 2006). ANT can be used as an analytical tool for environmental questions and an analytical approach to understand science in action (Burgess *et al*., 2000 in Morris, 2004).

ANT is not concerned with scientific discoveries but with how truth is constructed from statements made by researchers and scholars (Comber *et al.,* 2003). Callon (2001) explains that:

> . …ANT, also known as the sociology of translation, is not just another attempt to show the artificial or dialectical nature of these classical oppositions. On the contrary, its purpose is to show how they are constructed and to provide tools for analyzing that process. One of the core assumptions of ANT is that what the social sciences usually call 'society' is an ongoing achievement. ANT is an attempt to provide analytical tools for explaining the very process by which society is constantly reconfigured. What distinguishes it from other constructivist approaches is its explanation of society in the making, in which science and technology play a key part.

While initially employed to the phenomena of science ANT has now also been applied to the IS domain. A recent collection of case studies of information systems strategy formation uses ANT as its dominant organizing theme (Mutch, 2002) because, as Ciborra *et al.,* (2000) argue that ANT has recently been imported into the information-systems field as an interesting way to understand the influences and the "actions" performed by technology.

There are various theories which describe the socio-technical aspects of information and communication technology but ANT is one of the few that provide a framework where the technology is acknowledged on the same level as other actors (Aanestad, 2003) and 'offers advantages over other IS research methodologies, particularly in situations where 'political' considerations are important' (Tatnall and Gilding, 1999:963). Doolin and Lowe (2002) suggested that ANT provides a particularly fruitful approach for critical research on information systems, and more broadly the integration of ICT in organisational life. By not tolerating the great divides in the sciences ANT is put in a position to explain on a theoretical level the role of sciences in its construction and evolution (Callon, 2001). ANT, as a useful theoretical lens for understanding socio-political phenomena, could provide added explanatory power over existing theories (Sarker, *et al.* 2006). ANT strongly emphasises empirical inquiry and is well suited to the generation of detailed empirical knowledge, about information systems, which is local and contextual (Doolin and Lowe, 2002). ANT describes how particular networks of technical and non-technical elements become established, and how this process is simultaneously an establishment of knowledge. Callon (2001:62) writes:

> ANT makes no theoretical or methodological distinction between the social and the natural and puts forward three basic theoretical propositions. First, it must be accepted that nonhuman species, ecosystem processes, and technologies make a material difference to social affairs. Second, the sorts of categorizations that are traditionally used to describe the social (categorizations such as gender, occupation, place, ethnicity, etc.) have no intrinsic explanatory power. Instead, the formation, stabilization, and transformation of groups are phenomena that themselves need to be explained. Third, the task of social science is not to deconstruct or debunk the so-called ''grand narratives'' of modernity and thus to explain away scientific knowledge, for example, as a mere set of ''social constructions'' no different to any other knowledge claim. Rather, it is to explore how new procedures, techniques, concepts, and institutions are used to pull the social together in whatever (unstable) form the social scientist might find it.

'There have been few attempts to take the use of ANT ideas outside the realm of the IS academic and use them actively as a basis for action' (Lewis and Townson, 2004:4). Even though ANT has been developed within the social studies of technology and science it has slowly gained more attention also among environmental and rural researchers (Kaljonen, 2006). ANT is of particular concern to scholars interested in uncovering how science and technology projects are actually accomplished (Ramiller, 2007) and increasingly popular as a powerful tool to help overcome the current poor understanding of the information technology (IT) artefact (Hanseth *et al*., 2004).

Selman and Wragg (1999:329) state that:

> ANT uncovers the way in which a 'particular' technology and scientific models gains acceptance as 'normal' custom and practice and how as a result of successive agreements and decisions, actors become committed to a conventional wisdom or enduring mindset which others must accept if they want to join mainstream practice.

The term ANT is usually used to denote an emerging set of ideas about networks of association, in which groups of heterogeneous allies (by virtue of the strengths of aligned interest) create black-boxes that eventually become the facts of everyday life. ANT is based on the principles of (1) agnosticism (the demand for analytical impartiality towards all actors), (2) generalised symmetry (technical and non-technical actors should be treated the same by means of an abstract and neutral vocabulary), and (3) free association (the abandonment of all *a piori* distinctions between technical and non-technical actors). ANT is not about traced networks but about the network tracing activity (Law, 1992; Latour, 1987; Callon, 1986).

Latour (1987) explains that there is not a net and an actor laying down the net but there is an actor whose definition of the world outlines, traces, delineates, limit, describes, shadows forth, inscrolls, files, lists, records, marks, or tags a trajectory that is called a network. No net exists independently of the very act of tracing it, and no tracing is done by an actor exterior to the net. A network is not a thing, but the recorded movement of a thing. The question ANT addresses has now changed. It is not longer whether a net is a representation or a thing, a part of society or part of discourse or part of nature, but what moves and how this movement is recorded.

The two concepts of ANT which are of relevance to this research are that of (1) inscription and (2) translation. Inscription refers to the way technical artefacts embody patterns of use and how future patterns of use are involved in the development of a technology while translation refers to the design of that technology (Monteiro, 2000 in Ciborra *et al.,* 2000). Monteiro further explains that interests may be translated into specific "needs,"(e.g., the need for effective health care waste management) and these specific needs are further translated into more general and unified needs (e.g., the development of a health care waste information system) so that these needs might be translated into one and the same solution, e.g. the integrated pollutant and waste information system (IPWIS *incorporating an IHCWIS*) which is the case under study. When the solution (IPWIS) is running, it could be adopted by the users by translating the system into the context of their specific work tasks and situations (institutionalisation of IPWIS). In such a translation, or design process, the designer works out a scenario (reporting structure). This scenario is inscribed into the system. The inscription includes programs of action for the users, and it defines roles to be played by users and the system. In doing so implicit or explicit assumptions are made about what competencies are required by the users as well as the system.

Interactions between actors are the primary building blocks of actor-networks and their manifestations are also called translations. The translation process underlines the existence of a cluster of links that bind the innovation with all those who use it (Alcouffe *et al.*, 2008). An actor or initiating entity of an idea or concepts enrols others, through a process of translation, in order to realise that idea. The actor who enrols others together with those who are enrolled form the actor network (Franks and

McGloin, 2007) and it is only when the process of translation is complete that the network becomes stabilised (Morris, 2004). Translation can be both violent and forceful, or mutually consensual, but it can also be more subtle and complicated thereby changing the enrolled actors in that they now become displaced, redefined and transformed (Callon, 1986). The process, also called sociology of translation, involves four phases namely: (1) problematization; (2) interressement; (3) enrolment and (4) mobilisation.

Problematization is the first moment of translation and occurs, according to Heeks and Stanforth (2007:166), when 'one focal set of actors seeks to define problems of other actors in their own (focal actors) terms and suggests that the solution to those problems is an 'obligatory passage point' (a path from problem via single solution to goal) of the focal actors' proposed programme of activities'. An obligatory passage point (OPP) is a 'place' where other actors are forced to pass through in order to proceed (Whitely, 1999). Examples of an OPP could be mechanisms such as legislation, contracts, technical devices or informal social norms that have to be passed by all the actors in order to satisfy the interests that have been attributed to them by the key actor.

Problematization can also be viewed as the key actors' efforts to convince others to subscribe to their own view by showing that they have the correct solution. It is during this phase that the key actors identify other actors that have goals and interests consistent with their own (Callon *et al.,* 1986). Whitely (1999) further states that it is not enough simply to have a solution to problems other actors may be aware of. They must be shown that it is in their interests to pass through an 'obligatory passage point'. They must be persuaded to define their problem and even their own identity in such a way that the proposed system is the obvious solution to their problem.

The potential advantages and disadvantages in the function of an OPP is illustrated in Table 3.1 below.

Table 3.1: Potential advantages and disadvantages of the OPP in an actor network

	Strong	**Weak**
Advantage	Controls the network Perpetuates network existence Maintains interaction with participating actors	Distributed responsibility Greater circulation
Disadvantage	Network success inextricably linked to the success of the OPP	Competing channels between actors circumvent resource control and responsibility for success Competing OPP can fracture a functioning network

Source: Martin, 2000

When the key actor identifies the nature of the problem, develops the solution, defines identities and roles, and establishes an obligatory passage point they then become indispensable to the network. This enables the key actor to position itself as an indispensable resource for the solution of the problem defined (Allcoufe *et al.,* 2008; Ramiler, 2007; Mähring, 2004).

'A strong obligatory point of passage exercises control over resources and is able to claim responsibility for the success of the network' (Law and Callon, 1992 in Martin, 2000:719). Martin (2000:719) goes further to state that:

> As a connective and controlling feature, the presence and function of an obligatory point of passage varies from network to network yet plays an important role in alignment and durability. Co-location of the obligatory point of passage with a centre of calculation, where control over resources coincides with the management and analysis of multiple data sources, may result in an especially strong actor network depending on the nature of constituent actors' interactions. In assessing the contribution of the obligatory point of passage to the nature of an actor network, the strength and nature of interactions among individual actors must be taken into account.

Interressement, the second moment of translation, refers to a series of processes that attempt to impose the identities and roles on others (Callon, 1986). It is also viewed as an alignment of interest and a matter of identifying possible ways in which such variety of interest could be used to benefit a project. If the focal actor is able to identify sufficient other actors of similar interests then a stable network may be formed (Franks and McGloin, 2007). The main focus of interessement is convincing actors that the interests as defined by the key actor for them are, in fact, consistent with what their own interests should be (Sarker *et al.,* 2006). The key actor does not necessarily strive to create an alliance with identical interests; rather, the intent is to have allies with interests that are aligned with (i.e., in harmony with*)* those of the key actor. The process of interessement often involves negotiations among the actors

Sarker *et al.,* (2006:55) explain interessement as a process which involves:

> Convincing other heterogeneous actors that the interests defined by a focal actor for them are, in fact, consistent with what their own interests *should be.* Moreover, incentives are created for actors such that they are willing to take a detour from their earlier charted paths and pass through the OPP defined by the focal actor. It is important to note that the focal actor does not necessarily strive to create an alliance with *identical* interests; rather, the intent is to have allies with interests that are *aligned with (i.e., in harmony with)* those of the focal actor. The

> process of interessement often involves *negotiations* among the actors; however, the actors do not always participate in such negotiations themselves. *Speakers* or *representatives* may negotiate on their behalf. For example, an IT vendor can speak on behalf of an application system. It is not guaranteed, however, that actors will necessarily abide by the agreements signed off by their representatives. In many cases, actors fail to act as promised by their representatives. This phenomenon is referred to as *betrayal* …

Enrolment, the third moment of translation, is a process of persuasion and control which creates, and maintains, actor-networks (Allen, 2004). Enrolment could also be described a process through which actors attempt to enlist the interest or action of another so that their own desired performance can take place (Hitchings, 2003). This is mainly done through the construction of agencies of alliances and coalitions to reach agreement on the ends which they desire to pursue (Lowe, 2000). "Successful networks of aligned interests are created through the enrolment of a sufficient body of allies, and the translation of their interests so that they are willing to participate in particular ways of thinking and acting which maintain the network (Walsham, 1997)". "Actor-networks are the consequence of an alignment of otherwise diverse interests. Alignment is dependent upon the enrolment of different actors into the network" (McLoughlin, 1999). Generally, enrolment is viewed as the creation of alliance networks with the aim of building an agreement among the stakeholders concerning their interests (Alcouffe *et al.,* 2008). In spite of this, enrolment could also lead to the possibility of less harmonious relations, as actors struggle and compete to ensure their own performance (Power, 2005) or when the focal actor uses a process of coercion to impose its will on others and these others yield to the persuasion (Singleton and Michael, 1993 in Tatnall and Lepa, 2003).

The final moment of translation is that of mobilisation. Mobilisation occurs as the proposed solution gains wider acceptance (Tatnall and Lepa, 2003) and refers to how the enrolling agencies control the enrolled agencies or ensure that representations of interests remain fixed (Lowe, 2000). The key actors seek to ensure that the specific representatives of the other actors come to be accepted as representative of those actors, resulting in them being accepted as the main voice that speaks on behalf of all actors in the network (Heeks and Stanforth, 2007). Mobilisation of actors occurs, when fact, technology, or solution gains wider acceptance thereby stabilizing the network, albeit temporarily (Hardy and Williams, 2008).

3.3.3 A Heterogeneous Network

The heterogeneous network lies at the heart of ANT and is a way of suggesting that society, organisations, agents and machines are all effects generated in patterned networks of diverse materials (Law, 1992). The concept of network is used in the context of describing shifting alliances of actors and entities, these in turn are often converted into inscriptions such as computer programs (Callon, 1986). A network is produced when an act is linked to its influencing factors. For example, writing a document using a word processor involves many factors that influence how we write this document - our earlier experience using it, the functionality of the word-processor, and so forth. Business is not carried out in a total vacuum but rather under the influence of a wide range of surrounding factors. All of these factors are related or connected to how we act in writing the document (Monteiro, 2000 in Ciborra *et al.*, 2000). The creation and maintenance of coextensive networks of human and non-human elements is dependent on the interaction between people, organisations, software, computer and communications hardware and infrastructure (Walsham, 1997). The nature of interactions between humans and objects are the building blocks of networks within and beyond organisations (Latour, 1992 and Law, 1992 in Martin, 2000). Using an actor-network approach all factors, both human and non-human that influence the institutionalisation of an IHCWIS, are seen as actors and the combination of all of these constitute a network. It is a feature of actor-network theory that the extent of a network is determined by actors that are able to make their presence individually felt. One needs to focus on this process of social integration of science and technology, and document how scientific and technological products as well as the roles of social actors both come to be re-defined in the process (Maares, 2004; Tatnall & Lepa, 2003; Lehenkari, 2000.

The main focus of ANT is on process with the process of network formation being central. ANT seeks to identify the processes responsible for producing the results of, among others, scientific activities instead of only results and accuracy of results (Comber *et al.*, 2003). The main purposes of ANT are to demonstrate how actors and the network are constructed and provide analytical tools for explaining the process by which society is constantly reconfigured (Callon, 2001). There is also a need to document how scientific and technological products as well as the roles of actors both become re-defined in the process, in order to understand the role of science and technology in society (Marres, 2004). In information systems research, ANT interprets and describes the sociological phenomena surrounding the use and creation of information systems. However, the use of ANT ideas is seldom used as a basis for action outside the realm of information systems academia (Lewis and Townson, 2004) hence the need to apply it in the field of health care waste management.

ANT can be very helpful when one wants to theoretically represent and explore networks and associations (of roles, routines and artefacts) that are underpinning the situated practices (Azad and Faraj, 2009). ANT frames controversial events, presenting them as a hub to study the negotiations associated with moving from one state to another, and, through its particular treatment of both technological and human agency, helps us better understand the implications that can be drawn from developments (Scott and Wagner, 2003).

> In respect of the future use of ANT, it can be argued that despite its status as an 'unconventional' and thus perhaps peripheral approach in social science… amongst other things it has provided us with new perspectives on sociological method, notably through analysis of deconstruction and representation, reflexivity and 'otherness', managerial power and organizational technologies, and the ontological status of theories. As we increasingly confront the role of contemporary technologies in novel 'virtual' spatio-temporal configurations, and as our interactions with technological systems increasingly define our modes of existence, ANT can potentially offer new and meaningful ways of representing the associated processes and practices' (McLean and Hassard, 2004:516).

According to Couldry (2008), ANT seeks to explain social order not through an essentialised notion of 'the social' but through the networks of connections between human agents, technologies and objects. Entities (whether human or non-human) within those networks acquire power through the number, extensiveness and stability of the connections routed through them, and through nothing else. If the connections are successful then it acquires the force of 'nature': and becomes 'black-boxed'. ANT is therefore perfectly placed to generate theory and propositions about the development and institutionalisation of an integrated health care waste information system for effective and efficient waste management.

Fagan (2002: 2&17) is of the opinion that there is very little theoretical analysis done in the sociology of the environment and that recent studies in this field fail to address waste at all. A sociology of waste is therefore urgently needed in order to understand the relationship between social change and environmental change. The author goes further to say that 'a network analysis framework offers one way of bringing the best interpretive sociology to bear if interactive effects are investigated for the meaning held by the actors engaged in them… A major challenge for social theory at this particular moment in history of the governance of waste, when powerful corporate actors who produce and dispose of waste are strengthening their role, is to ensure that the discourse of all players are heard, that all the nodes in the networks are uncovered…'. Fagan's paper attempts to understand the position and role of the various actors involved in waste governance in Ireland and argues for the critical importance of 'glocal' (hybridity of the global and the local) action around waste management in developing a sociology of waste. A major argument of the article is that we need to take a grounded globalisation approach to build insights into networks of waste and networked political processes of waste governance. Fagan (2002) provides an explanation and discussion on the theories of social networking and actor-network in the context of waste management.

Institutionalisation is a very complex process where human and non-human (objects) which interact with one another to form heterogeneous networks. Actors become the carriers of institutional meanings by instilling actions into organizations through the interpretation of external and internal factors and institutionalisation presupposes the examination of interplay between actions, meanings and actors (Machado-da-Silva *et al.,* 2005). More research is therefore needed:

- To identify the most important technical and non-technical actors that form the network associated with the definition and institutionalisation of an integrated waste information system.
- To establish how these actors are recruited, the relationships between them, their interests, how those interests are aligned, what values they hold, and the existing/potential roles they play.
- To describe the explicit anticipations (scenarios) of use held by the various actors.
- To identify critical success factors for institutionalisation in a case where technology and practice evolve together.

3.4 Research Questions

According to Roode (1993) a problem or issue is usually expressed as a question that enquires about the ontological, phenomenological, epistemological and normative nature of the problem at hand and the researcher would deliberately pose different questions to explore different aspects of the problem or situation at hand. He goes further and argues that the researcher does not accept the assumptions associated to one question and defy the assumptions of all other questions but merely enquires about different facets of the problem and how to obtain as much as possible information about it.

The different research paradigms and the accompanying assumptions should be used deliberately from different perspectives (process-based) in order to appreciate the uniqueness of each problem situation. A process-based framework guides the researcher in formulating the research questions. Figure 3.3 below illustrates the process-based framework used to formulate the research questions for this study and the generic questions one asks when exploring different aspects of the problem situation.

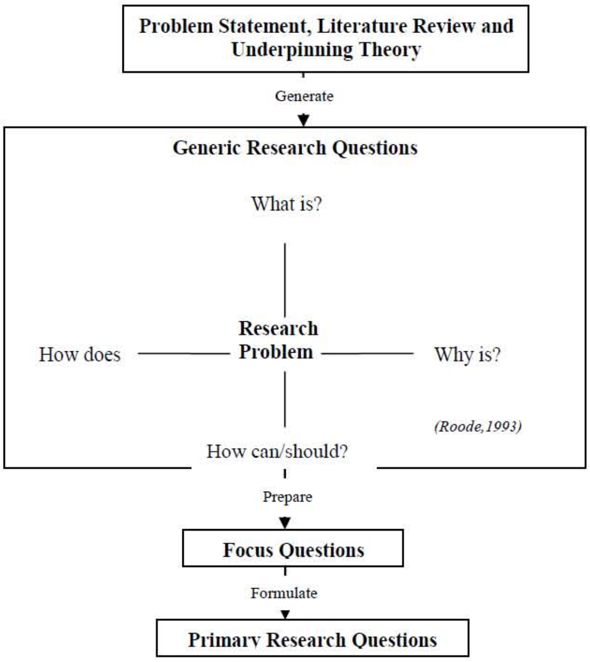

Figure 3.3: Process based research approach in formulating research questions

3.4.1 Generic Questions

The generic questions one asks when exploring different aspects of the problem situation are: What is?, Why is?, How does?, and How should?

What is?

With this question the fundamental nature or essence of the research problem is first explored. The question aims at exposing the structure of the problem or the meaning of the underlying concepts or ideas.

The fundamental nature of the research problem asks the following:

- *What processes were used in developing integrated health care waste information system (IHCWIS)?*
- *What process was used to decide which actors are accepted and/or rejected?*
- *What perplexities did the actors bring along?*
- *What processes were used to impose the defined roles on the actors?*
- *What scenarios of use do these actors anticipate?*
- *What barriers threatened the stability of the relationship within the network?*
- *What factors were considered to enhance/facilitate the stabilisation of the network?*
- *What are the indicators that the IHCWIS has become a part of everyday life?*
- *What factors contribute to the effective and efficient management of HCW?*

How Does?

In answering this question the phenomenon or problem is directly observed and described as it manifests itself in reality. We thus ask the following:

How was the role of actors defined?

How was the IHCWIS finalised?

How were the key actors established?

How do key actors remain just that (key actors)?

How were the most important technical and non-technical actors identified and recruited?

How were the interests of actors aligned?

How were these interests accommodated/simplified?

How was the network mobilised?

How was the legitimacy of actors established?

How was the hierarchy of position and importance established?

How was the relationship between everyone involved established?

3.4.2 Focus Questions

A number of focus questions have been developed to address the generic research questions outlined above, they are:

1. What processes were used in developing an IHCWIS?

The purpose of this question is to provide a detailed description of the entire process of health care waste information systems development.

2. How was the IHCWIS finalised?

This question identifies the most important technical and non-technical actors that form the network associated with the development and institutionalisation of a health care waste information system. It also establishes how these actors were recruited, the relationships between them, their interest, how those interests were aligned, what value they held, and the existing/potential roles they played.

3. What factors were considered to enhance and facilitate the stabilisation of an IHCWIS?

The purpose is to illustrate and discuss the process of admitting actors into a single collective and how this could contribute towards the success of an integrated waste information system.

4. How can an integrated information system be used for effective and efficient HCWM?

This question focuses on the application of an IHCWIS and will identify the key issues which need to be addressed in order for the system to be used for effective and efficient HCWM.

These focus questions position us to formulate the primary research question.

3.4.3 Primary Research Questions

The primary research questions raised in Chapter 2 will now be revisited and put into perspective of the research strategy.

The overall key research question raised is "*How does an IHCWIS develop and become institutionalised among health care waste generators?*"

The research specifically asks:

> ***(1) Having conceptualised an IHCWIS what processes are followed in the development of an IHCWIS?***
>
> ***(2) How does an IHCWIS manifest and become institutionalised among stakeholders? and when it is institutionalised,***
>
> **(3) *How can an IHCWIS contribute to effective and efficient HCWM decisions?***

The above research questions are formulated in practical terms for the following reasons: (1) health care waste management is an issue of practice and therefore an applied discipline, as is information systems, (2) the development and institutionalisation of an integrated health care waste information system is seen as an practical intervention to address the problem of poor health care waste management, and (3) IS is an applied discipline and Actor-network theory, as a useful theoretical lens for understanding socio-political phenomena, provides added explanatory power over existing theories thereby denoting applied research.

The reason for formulating the research questions into practical terms is because practicality indicates relevance. According to Mellville (2010) IS scholarship is sorely needed to overturn half-truths, contribute to the body of knowledge about environmental sustainability, and develop a well-founded discourse on IS for environmental sustainability that leads to improvement of the natural environment.

IS no longer models itself on the research disciplines found in the natural and social sciences, but instead charts a course for its future development by modeling itself on the research disciplines found in the professions (Lee, 2010). Klein and Rowe (2008) recognise that the "professionally qualified doctoral student" has a different type of knowledge that may give her/him some advantages over other students, including greater symbolic capital and part of their practical experience constitutes a specific type of "applicative" knowledge that should be considered as different from but of equal value to theory, which has been the mainstay of academic education.

Watson et al., (2010) have this to say:

" currently, many organizations have an opportunity to tackle sustainable development while improving productivity, reducing costs, and enhancing profitability. Their poor environmental practices result in many forms of waste; unused resources, energy inefficiency, noise, friction, and emissions are all waste products that subtract from economic efficiency. Such poor environmental practices, we argue, could be improved by Green IS initiatives. It is our responsibility, as IS scholars, to dedicate some of our research efforts to better understand (in terms of description, explanation, and prediction) the role of IS in tackling environmental sustainability"

The need for relevance in all IS research is epitomised by research into IS practices. The relevance gap between academic research and practice is a topic of discussions in all fields (Kuechler and Vaishnavi, 2011) and there is no doubt that the issue of relevance is an important one to resolve (Straub and Ang, 2011). Research questions in IS therefore need to exhibit relevance and persistence (Rosemann and Vessey, 2008). The research is grounded in relevance and practice and as discussed above has implications for theory in IS. There is merit to the argument that theory for explaining and predicting, when used for practical purposes, need not strive for the exacting rigor and perfection that pure research strives for; the legitimacy of the approach of delivering research that is efficacious (i.e., 'good enough') for solving the practical problem at hand has been demonstrated (Lee, 2010).

IS as a discipline has shifted from a fragmented adhocracy to a polycentric state, which is particularly appropriate to an applied discipline (Taylor et al., 2010). Studies adopting a practice perspective in examining work practices should address issues related to the practical relevance of research. Practice based studies are uniquely positioned to serve both the practitioner and research communities and provide outcomes that are relevant to practice and research (Vashits et al., 2011). IS research should focus on problems found in organisational practice. These organisational contexts and practices have the potential to reveal a wealth of richness and relevance that provide context for information, systems and theory that would go far beyond what we have accomplished so far (Davison, 2010). By proposing that IS researchers conduct applicability checks (relevance) with practitioners they thereby produce or use theory focussed research (Rosemann and Vessey, 2008).

As they stand the research questions nevertheless imply a theoretical contribution, for example, the overall key research question implies a descriptive and explanatory theoretical contribution. The theoretical contribution implied by this thesis is discussed in Chapter 6.

Table 3.2 below illustrates how the research questions were used to formulate the interview questions used in this research.

Table 3.2 Interview questions derived from the process based research approach

Research Question 1: ***Having conceptualised the IPWIS, what processes were followed to develop such an information system?***			
Objectives	**Focus Questions**	**Generic Research Questions**	**Interview Questions**
		How were the most important technical and non-technical actors identified and recruited?	How did you or your organisation become involved with developing the IPWIS? Who else participated in developing the IPWIS?
		How was the role of actors defined?	What roles do those who participated, hold or play? How was the value of these roles and influences determined? What interest do these actors hold?
		What processes were used to impose the defined roles on the actors?	Did DEA&DP have a role in mind for those who participated? If Yes, what was done so that those who participated accept this role?
		What process was used to decide which actors are accepted and/or rejected	How did you decide who to include in developing IPWIS How did you decide who to exclude in developing IPWIS
		How were the key actors established?	How did you become the main organisation to spearhead the IPWIS?
		How do key actors remain just that?	Why are you still spearheading IWIS?
Establish how IPWIS was finalised and implemented	How was the health care waste information system finalised?		
Describe how a due process approach could contribute towards the success of IPWIS		What perplexities did the actors bring along? And How were these accommodated/simplified?	Did those who participated in developing IPWIS have any concerns? If Yes, how were these concerns addressed/handled Did you experience any problems with those who participated? If Yes, how were these handled/addressed?
		What consultation processes were followed?	How did consultation occur with those who participated?
		How was the legitimacy of actors established?	What made you to accept those who participated?
		How was the hierarchy of position and importance established?	How did you know who was an important or useful participant?
		How was the relationship between everyone involved established?	How did you manage to establish a working relationship among the participants?

Research Question 2: ***Now that the IPWIS has been developed, how does it manifest and become institutionalised among health care waste generators in the Western Cape?***			
Objectives	**Focus Questions**	**Generic Research Questions**	**Interview Questions**
Identify the factors that enhance and facilitate the stabilisation of an IPWIS	What factors were considered to enhance and facilitate the stabilisation of the health care waste information system?	How did everyone agree on the health care waste information system as a solution?	Who considered IPWIS to be a solution to the problem of health care waste? How did they come to consider this as a solution? How was the IPWIS as a solution, accepted? What made them agree on IPWIS being a solution?
		How was the network mobilised?	How will interaction between the participants be determined? How will interaction between the participants and IPWIS occur? What barriers threatened the stability of this interaction? What will encourage interaction?
		What factors were considered to enhance/facilitate the stabilisation of the network?	In your opinion, what factors will facilitate the reporting to the IPWIS? What factors will hinder reporting to the IPWIS? What are the difficulties experienced when reporting to an information system?
		Is the IPWIS still negotiable?	Can IPWIS still be changed/modified? If Yes, how? If No, why not?
Research Question 3: ***How will an IHCWIS contribute to effective and efficient management of HCW?***			
Explain how an IHCWIS can be used to effectively address the problem of poor HCWM	How can an integrated information system be used for effective and efficient HCWM?	*What factors contribute to the effective and efficient management of HCW?*	What aspects will make it easy for you to report to the System? What needs to be in place in order for you to make IPWIS part of your daily function? And what will make it difficult to send information? Are there any other concerns that you have

3.5 Research Design

The nature of enquiry for the research study is descriptive in that it seeks to understand and describe a clear picture of how waste information systems are developed and institutionalised.

A qualitative descriptive case study research design was used to obtain more information about the development and institutionalization of health care waste information systems. A case study approach was used to gain an in-depth exploration and description of the perspectives, practices and behaviour of the actors in their natural setting. Descriptive research gains more information about characteristics within a particular field with the purpose of providing a picture of situations as they naturally happen (Burns and Grove, 2011).

Qualitative Research

In the past positivism was regarded as the main view of science and one had to use external standards against which observations could be quantitatively measured in order to be objective and unbiased. This type of quantitative method does not allow one to explore underlying reasons for, or insight into, people's actions (Olivier, 2009). Qualitative research will allow us to do that. In qualitative research the emphasis is on the quality of entities, processes, meanings and on seeking how social experience is constructed (Denzin and Lincoln, 2000).

Qualitative research is not without its critics who often see it as a relatively minor methodology that could only be contemplated at the early or exploratory stages of a study (Silverman 2000). Be that as it may, the distinction between the qualitative and quantitative paradigm lies in the quest for understanding and in-depth inquiry. Qualitative studies usually aim for depth rather than quantity of understanding (Henning *et al.,* 2004). Qualitative research is based on the premise that gaining knowledge is impossible without describing the experiences as it is lived and defined by the actors themselves. It has been described as holistic in that it is concerned with humans and their environment in all complexities (Polit and Hungler, 1991).

Case Study Methodology

'Case research has commanded respect in the information systems (IS) discipline for at least a decade...it is clear that current research standards have evolved and are more demanding of case researchers than they were in the early 1980s' (Dube and Pare, 2003:597 and 629). Case studies are empirical enquiries used when the researcher has no or little control over events and when the focus is to understand complex social phenomena within real life situations. It can be used for a variety of issues and when the research questions of "how" and "why" are asked. Apart from understanding, case studies also add to extending experiences and increasing conviction about a subject (Anfara & Mertz, 2006; Gray, 2004; Creswell, 2003; Yin, 2004).

In spite of its fruitful applications case research is typically criticized on the basis of four issues: lack of objectivity, methodological rigour, and external validity and most importantly, generalisation (Stuart *et al*., 2002; Hellibrand *et al*., 2001). These criticisms have been rejected as poorly founded and made in the midst of methodological conflict where the drawbacks of case study were not being attacked, rather the immaturity of sociology as a discipline was being displayed (Hamel *et al.,* 1993).

It must be acknowledged that these are positivist criteria but the use of reliability and validity, which are common in quantitative research, is now being reconsidered in the qualitative research paradigm (Golafshani, 2003). Reliability and validity remain appropriate concepts for attaining rigor in qualitative research and qualitative researchers should reclaim responsibility for reliability and validity (Morse *et al.*, 2002). As previously mentioned Klein and Myers' (1999) seven principles for the conduct and evaluation of interpretive field research in information systems provide the interpretivist criteria for reliability and validity.

Bashir et al. (2008), state that validity in qualitative research refers to the extent to which the data is plausible, credible and trustworthy and that validity and reliability (in qualitative terms) remain appropriate concepts for attaining rigor in qualitative research. Qualitative researchers will therefore have to implement verification strategies, integral and self-correcting, during the conduct of inquiry itself to ensure the attainment of rigor using strategies inherent within each qualitative design.

Guba and Lincoln (2005) list the following as an alternative to positivist criteria:

Positivist	Interpretivist
internal validity	credibility
external validity	transferability
reliability	dependability
objectivity	confirmability

Case studies, through their observational richness, provide a means of refutation of, or extensions to, existing concepts and should therefore not be seen as a methodology appropriate only for understanding and for the preliminary stages of theory development.

The following common misunderstandings exist about case-study research (Flyvbjerg, 2006):

1. General theoretical knowledge (context-independent) is more valuable than concrete, practical (context-dependent) knowledge.
2. One cannot generalize from a single case therefore, the single-case study cannot contribute to scientific development.
3. The case study is most useful for generating hypotheses, whereas other methods are more suitable for hypotheses testing and theory building.
4. The case study contains a bias toward verification, that is, a tendency to confirm the researcher's preconceived notions.
5. It is often difficult to summarise and develop general propositions and theories on the basis of specific case studies.

The problems of summarising case studies concern the case study process and not case outcome. These problems of summarising are due, more often, to the properties of the reality studied rather than to the case as a research method. It is not desirable to summarise and generalise case studies. Good case studies should be read as narratives in their entirety. Valuable contributions in the IS field are lost, because IS researchers fail to make these types of generalisations (Byrne and Sahay, 2005).

Barbour (2008) argues that case study methodology has been rigidly applied and has failed to take account of its potential flexibility. One should not agonise as to whether a study is a real case study or not but rather question the purpose of the research and whether a case design might help to interrogate the data. Researchers should not be bogged down with unfruitful debates, but instead should think carefully about what case studies will help them achieve in the context of the research. Barbour's (2008) arguments stem from the fact that case studies should also be seen as a qualitative sampling method and locating case studies within qualitative sampling allows us to gain an understanding of their potential and how we might harness this most effectively.

Halinen and Törnroos (2005) explain that case studies pose many challenges for researchers studying networks and distinguish the following four challenges:

- The problem of network boundaries. What forms the case network and what belongs to its context are fundamental questions to be answered in any case study project.
- The problem of complexity formed by structure and embeddedness creates important problems for a researcher. It is not simple to describe a network, with all its actors and all the characteristics of the links between them.
- The problem of time. Networks are changing in relation to the value that they create and the problems that they aim at solving over time.
- The problem of case comparisons. This is particularly relevant to case studies that aim to generate theory.

3.6 Study Site

It must be noted that the development of a waste information system is a national initiative and involves all nine provinces of South Africa. However, only two provinces Gauteng (Gauteng Health Care Waste Information System) and KwaZulu-

Natal (KwaZulu-Natal Waste Information System) are currently using waste information systems. The Gauteng Health Care Waste Information System has minimal management information and does not fit the user requirements of the Western Cape, and the KwaZulu-Natal Waste Information System is not available for use (Chetty and Vally, 2004).

The Western Cape also embarked on developing an IHCWIS namely the Integrated Pollutant Waste Information Systems (IPWIS) (The case) which is housed by the DEA&DP and developed by the C-e and SITA. It is for this purpose that these organisations were selected as the case study sites.

3.7 Data Collection

3.7.1 Primary Data

Primary data that was used to derive answers to the research and focus questions was obtained through semi-structured face-to-face and telephonic interviews. Interview schedules (Appendices A1 and A2) were used as the data collection tool during the interview. The interview schedule contained open-ended guiding questions based on the research and focus questions as previously shown in Table 3.1. Semi-structured interviews explore a topic or issue in great breadth , meaning that detailed information will be obtained to gain deeper insights into what one wants to find out (Denzin & Lincoln, 2000; McMurray *et al.*, 2004).

Structured questionnaires (Appendix B1) were also used to generate primary data and were administered to health care waste managers at the various health care facilities. The questionnaires obtained data used to answer focus questions 3 and 4. Evaluation questionnaires administered by DEA&DP (AppendixB2) were also analysed. Questionnaires are important data gathering tools and one of the most widely used primary data gathering techniques (Gray, 2004). The structured questionnaire contained both open-ended and closed questions which were formulated around the research question and focus questions 3 and 4. The questionnaire was piloted on a small group of respondents and modified accordingly. The interview records and questionnaires were labelled with unique identifiers.

3.7.2 Secondary Data

The search and selection of appropriate and significant literature is outlined in Figure 3.4.

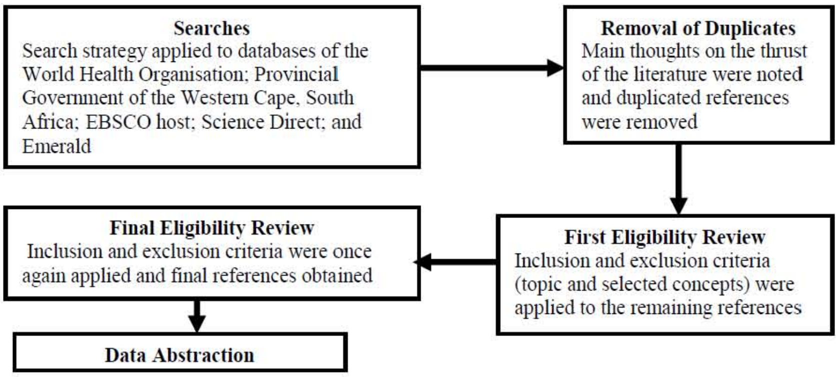

Figure 3.4: Search and Selection process (*Source: Adapted from Revere et al., 2007*)

Secondary data (the literature was used to support analysis beyond what was required for Chapter 2) was obtained by reviewing and critiquing literature that coincided with the research, focus and generic questions, and that was relevant to the concepts of health care waste; waste management; information systems; and institutionalisation. The websites of the World Health Organisation and the Provincial Government of the Western Cape, South Africa, were accessed for publications that cover health care waste; information systems; and waste management.

Peer reviewed articles were extracted (using the same concepts) from the EBSCO host and Science Direct and Emerald databases. The easy and improved access to electronic libraries and journals yielded many articles but brought its own problems in that there was less time to track the growing numbers of conferences, journals and reports (Uren *et al.*, 2006).
The literature, therefore, was selected using specific inclusion and exclusion criteria.

Selected references (used in Chapter 2 and during analysis) had to meet the following inclusion criteria:

1. present a perspective of the development and institutionalisation of information systems;
2. provide a detailed description of waste management.
3. provide an overview of health care waste and health care waste management;
4. had to be peer reviewed (excluding official government and legal documents);
5. offer a perspective on the challenges facing health care waste management;
6. need to support the researcher's arguments;

7. provide practical examples of information, communication and technology application related to health care waste management
8. focus on the concepts and variables contained in the research question and purpose of the study.

The following references were excluded:

1. Non-peer reviewed references except for government documents such as minutes of meetings, legislation, guides and workshop reports.
2. References that focused on institutionalisation in relation to facilities, e.g., admissions to mental institutions;
3. References focussing purely on the technical aspects of treatment and disposal of HCW.

3.8 Sampling

It becomes necessary to select a sample on the basis of knowledge of a population, its elements and the purpose of the study. This type of sampling is known as purposive or judgemental sampling, a non-probability sampling method where respondents are selected on the basis of which ones will be most useful or provide the most useful information (Babbie, 2004).

Purposive sampling was used in this study and the participants (See Table 3.3: Unit of analysis) were selected on the basis of who can provide the most useful information regarding the development and institutionalisation of an integrated health care waste information system. This type of sampling Flyvberg (2006) refers to as information oriented selection and its purpose to maximise the utility of information from small samples and single cases. Here cases are selected on the basis of expectation about their information content.

The unit of analysis (the element from which information was collected), the criteria for selection as well as the data collection methods used are illustrated in Table 3.3.

Table 3.3: The unit of analysis

Primary Unit of Analysis	Sub-Unit of Analysis	Code	Total	Criteria for Selection	Data Collection Method
DEA&P	Deputy Director	KA	2	They acted as project managers for the development of IPWIS.	Face-to-Face interviews
	Information Officer: Technical Support	SD	1	Responsible for systems application, business analysis, system administration and networking	Face-to-Face interviews
	Environmental Officer	KA	1	Receives information from role players and responsible for the back office	Face-to-Face interviews
Centre for E-innovation	Application Development Manager	SD	1	Served as Project Manager and developed the applications for IPWIS.	Face-to-Face interviews
State Information Technology Agency	Senior Manager Professional Services	SD	1	Served as Project Manager and responsible for the functional specification design of IPWIS	Face-to-Face interviews
Municipalities	Health Care Facility Managers	HCF	17	In charge of the health care facilities that generate medical waste. They are responsible for the operations of the facility	Structured questionnaires
	Manager Information Systems	MIS	2	Responsible for collating and disseminating information. Also attended IPWIS training workshops	Telephonic interviews
	Waste Managers	WM	6	Responsible for managing all types of waste. Attended IPWIS training workshops	Telephonic interviews
	Training worksop attendees (Environmental Health Practitioners, Supervisors, Technicians and Environmental officers		21	Involved with waste management at their respective municipalities. Attended IPWIS training workshops	Analysis of the raw data obtained from the workshop evaluation questionnaires. Workshop organisers administered the evaluation questionnaires but never analysed it.
Waste Companies	Operations manager	SP	1	Contracted to remove, store, transport and dispose of health care waste	Face-to-Face interviews

3.9 Data Analysis

There are numerous approaches for analysing qualitative data but one such method, qualitative content analysis, is extremely well-suited to analysing the multifaceted, sensitive phenomena characteristic (Elo & Kyngäs, 2008) of, in this case, an IHCWIS. The data obtained during this research was analysed using qualitative content analysis to uncover and understand the latent meaning that are hidden in the text. Content analysis is a scientific process in which one systematically collects and analyzes the makeup and exchange of, among others, auditory communication to identify messages relevant to a defined or evolving theoretical framework, recode the messages into a quantifiable form using explicit and objective processes, and analyze the messages to draw conclusions that further yield the understanding of theory (Holdford, 2008).

The strength of content analysis is that it is unobtrusive, non-reactive and does not disturb the research surroundings in any way when the researcher attempts to discover intended and received meanings (Marshall & Rossman, 2006; Pole & Lampard, 2002). Qualitative content analysis has the capacity to explore questions unanswerable by more quantitative methods (Holdford, 2008). The advantage of qualitative content analysis is that large volumes of textual data and different textual sources can be dealt with and used in corroborating evidence (Elo & Kyngäs, 2008).

The content of the data obtained during this research was analysed (a detailed explanation of the levels of analysis and the content analysis process followed are found in Chapter 5) beginning with the research question and the preliminary concepts of health care waste; waste management; information systems; and institutionalisation. Coding, to capture and signal what is going on in the data, was done by hand. The data obtained was broken down into smaller units to reveal their characteristic elements and structure (Gray, 2004). The outcome of the analysis is concepts or categories describing the phenomenon. Usually the purpose of those concepts or categories is to build up a model, conceptual system, conceptual map or categories (Elo & Kyngäs, 2008).

Patterns in the data were observed, and organised into conceptual frameworks. Data abstraction resumed in order to explore and challenge the developed conceptualisations. Data abstraction and data interpretation continued until further observations yielded redundant, minimal, or no new information to further challenge or elaborate the conceptual framework (Russel and Gregory, 2003). The aim was to attain a condensed and broad description of the development and institutionalisation of health care waste information systems.

Once analysed, all qualitative data was summarized in diagrams, flow charts, narrative text, matrices and tables.

3.10 Research Rigour

Qualitative researchers describe validity in terms of (1) rigour, (2) credibility,
(3) trustworthiness, and (4) believability. Numerous articles and books focus on validity but there are variations in how rigour and validity are addressed in specific designs (Russel and Gregory, 2003).

The following applied to this research:

(1) Rigour: Concepts were operationally defined from the outset and appropriate data collection instruments (in the form of questionnaires and interview schedules) were developed. The data obtained from the questionnaires and interviews was interrogated to establish if the findings made sense and, to uncover meaning. Triangulation was analysed with different data sources of information used by ways of examining evidence (Appendix C). The evidence was used to build a coherent justification for themes.

(2) Credibility: Member checking was done by providing a sample of respondents with a copy of their transcribed responses to verify accuracy, assure that the respondents were not misinterpreted, and for additional comments which they may have (See Appendices D1 and D2 for examples). Providing credibility checks is important for the trustworthiness of the findings (Elliot *et al.,* 1999). Both negative and discrepant information (e.g. where members did not interrogate the analysis presented to them for comment) are reflected in the thesis.

(3) Trustworthiness: Respondents were sampled on the basis of which ones would be most useful, and best suited to provide the most useful information. All notes and text were documented and were open to inspection/review. The generalization of the results is discussed in Chapter 6 of this thesis.

(4) Believability: The data was thoroughly analysed (using content analysis) to enhance believability. A discussion of the analysis, accuracy and preciseness of the data is found in Chapter 5 of this thesis.

3.11 Ethical Issues

Ethics approval was granted by the Commerce Faculty Ethics in Research Committee of the University of Cape Town (Appendix E)

Permission to conduct research at health care facilities was granted by the City of Cape Town (Appendix F1) and the Provincial Government of the Western Cape (Appendix F2).

Informed consent: The nature, objectives and benefits of the study were explained to potential respondents. Only once this was done were the respondents asked to participate in the research. The potential respondents were informed that they had the right not to participate and could exit the research at any time. Persons who refused to participate were thanked and ensured that their non-participation would not be held against them. Respondents were informed that they had the right not to answer all the questions or specific questions and leave the interview or questionnaire at any time without being victimised (Appendix G).

Anonymity and confidentiality were upheld. No names or identifying information appear in the thesis. The names and identifying information is only be known to the researcher and kept for validity and reliability purposes. Sensitive government information does not appear in the thesis.

In conclusion, this chapter delved into the research methodology. It described in detail the research approach, underpinning theory, how the questions were formulated and the methods used to obtain the empirical evidence. The next chapter, Chapter 4: Organisational Case Study will deal with the Integrated Pollutant and Waste Information System (IPWIS) as the case and related sub-cases from which the empirical evidence was obtained.

Chapter 4

Organisational Case Study

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Chapter 4

Organisational Case Study

4.0 Introduction

This chapter provides the background and detailed description of the Western Cape Department of Environmental Affairs and Development Planning (DEA&DP) which uses an integrated pollutant and waste information system (IPWIS (incorporating an integrated health care waste information system (IHCWIS)) as an important management tool to meet the strategic objective of information management as set out in the integrated pollution and waste management policy and the national waste management strategy. The chapter firstly provides the background to waste management in South Africa. Secondly the chapter describes the DEA&DP (Sub-case1)which houses IPWIS (The case); thirdly, the chapter describes the Centre for e-Innovation (Ce-I) (Sub-case 2) which provides information management services to DEA&DP; fourthly, the State Information Technology Agency (SITA) (Sub-case 3) which provide information technology services and support to DEA&DP is described and finally the Municipalities to which the health care facilities (waste generators belong) (Sub-case 4) are described.

4.1 Background: Waste Management in South Africa

Waste is a major environmental threat resulting in crammed landfills which in turn contaminate the soil and streams, and pollute the air (Bekin *et al.,* 2006). South Africa committed itself through its Constitution (Act 108 of 1996) (RSA, 1996), the White Paper on Integrated Pollution and Waste Management (IPWM), and the National Waste Management Strategy (NWMS), to develop, implement and maintain an integrated pollution and waste management system aimed at sustainable development and a measurable improvement in the quality of life. Historically, waste management in South Africa was not afforded the priority it warranted and it was only in 1998 that the Integrated Pollution and Waste Management process identified waste as a key issue. Subsequently the Departments of Water Affairs and Forestry (DWAF) and Environmental Affairs and Tourism (DEAT) undertook the development of a NWMS (DEAT, 2000; RSA, 2000). The NWMS has been developed with priority action plans for the following key elements of the strategy (RSA, 2000):

- Integrated waste management planning;
- Waste information system;
- General waste collection, minimisation, recycling, treatment and disposal; and
- Capacity building, education, awareness and communication.

The development of the NWMS occurred through a consultation process of four phases (Department of Environmental Affairs, 2011):

1. The Inception Phase wherein consultation on project objectives and planning were done.
2. The Situation / Baseline Phase where information was gathered on the status quo regarding waste management in South Africa.
3. The Strategy Formulation phase which looked at developing a broad range of strategic options and scenarios from key issues identified in the Situation Analysis Phase.

4. The last phase focused on the development of action plans to implement strategic priority initiatives. Seven action plans (among which was the development of a Waste Information System) were developed.

Table 4.1: Strategic objectives of the NWMS

Existing Waste Management Approach	**Strategic Objectives for Integrated Waste Management**
Limited focus on control mechanisms	Focus on sustainable environmental Protection
Inadequate waste collection services	Adequate waste collection services for all
Adverse effect on the environment and public health	Sustainable protection of the environment and public health
Fragmented approach with single media focus	Consolidated multimedia approach
Conflict of interests	Transparency in conflict resolution
Insufficient information	***Integrated Waste Information System***
Inadequate environmental planning	Holistic integrated environmental planning and capabilities
Inadequate R&D programmes	Focused investigations that take cognisance of cross-cutting implications
Fragmented regulatory approach	Integrated regulatory approach
Regulations inadequately enforced	Enforcement facilitated
Full waste management costs not realised	Polluter Pays Principle and total cost Realised accounting

Source: Moatshe, 1999

The key elements, in broad terms, of the existing waste management approach as practised in South Africa during 1997/98 compared to the proposed future situation after implementation of the strategic objectives of the NWMS, are summarised in the above Table 4.1. The strategic objectives represent an overall approach for the whole of waste management and include the aspect of health care waste management. This must be seen as an encouraging endeavour to transform from a 'silo' approach to that of a more integrated and comprehensive approach for waste (including health care waste) management. One outcome of the rigorous waste management transformation process was that conditions have changed from a fragmented and *ad hoc* waste system to that of a coherent and integrated management system.

The National Environmental Management Act (NEMA) (Act 107 of 1998) (RSA. 1998), makes provision for the formulation of sectoral policy and legislation including those for waste management. The IPWM is a policy that sets out the vision, principles, strategic goals and objectives for integrated pollution and waste management in South Africa and the NWMS and its action plans form the basis for translating the goals and objectives of waste management into practice (Macozoma, 2001).

A Waste Management Bill, drafted in 2002, 'operationalises' the NWMS and action plans, and is considered to be one of the guiding documents for implementation of, and compliance with international requirements. Confusion surrounded the status of this draft in that it is still considered a restricted internal DEAT document, but the document is already in the public domain to which various parties also have access. It was not clear, at 2002, when the draft would be finalised, as it needed to be revised, adopted by government and then gazetted. The draft bill has now been passed as an Act and signed off on 10 March 2009 as the National Environmental Management: Waste Act, 2008, Act 59 of 2008 (RSA, 2008). The passing of this Act has major implications for IPWIS because the regulations which compels waste generators to register with and report to IPWIS was not developed under this Act. A discussion of these implications appears in Chapter 5.

The National Waste Management Strategy Implementation Project (NWMSI), a direct follow-up of the NWMS, was established and focused on the implementation of selected components of waste management, namely, Health Care Waste, Recycling and a Waste Information System (DEAT, 2004).

The objectives set by the NWMSI were:

1. Developmental:

- Reduced generation and environmental impact of all forms of waste so that uncontrolled and uncoordinated waste management no longer adversely affects the socio-economic development of South Africa, the health of its people, and the quality of its environmental resources.

2. Intermediate (among others):

- Improved health care waste management: Sustainable and integrated health care waste management established within the framework of NWMS covering the full waste stream for all generators of health care waste from areas with varying population densities and degrees of accessibility.

- Establishment of a waste information system: A waste information system has been established in DEAT with management software in place. Minimum reporting requirements have been established for provincial and local levels.

The minimum reporting structures and information flows have been developed through a waste information system (WIS). The four significant elements of such a WIS are: information reporting, data collection, verification/quality assurance, and data processing and information dissemination. The short term focus (1999-2004) within the NWMS focussed on gathering information specifically required by all priority initiatives and which was readily available in the public and private sectors.
In the longer term following aspects will be addressed:

- Establish effective and efficient information systems,
- Strengthen and build capacity of government to collect, analyse and use relevant information and knowledge,
- Disseminate information in an accessible format,
- Develop a register of pollutant points and diffuse sources for pollutant releases,
- Develop a register of all waste handlers, and
- Register all waste disposal sites.

The implication is that the establishment of a health care waste information system now becomes dependent on the development and progress of a national waste information system.

Purnell (2009) informs us that the need for a national South African WIS was recognised in 1999 but only developed and piloted for implementation in 2006. The reasons for the WIS were to register waste generators and to record waste generated and disposed of per classification. The WIS was developed in such a way that it could be expanded in future to add the registration and reporting of the waste management actions. The WIS was initially implemented in two provinces, namely Mpumalanga and the Eastern Cape and 3 municipalities in these cases (Mbombela Local Municipality, Buffalo City Municipality and Nelson Mandela Metropolitan Municipality) as a pilot project. A comprehensive Pilot Project Review was undertaken which identified issues and shortcomings. The project was subsequently rolled out to KwaZulu Natal, North West Province and Free State in 2007/08. Gauteng and Western Province were in the process of developing their own provincial WIS. Currently only 133 waste management facilities are registered with the WIS, and although most initially reported regularly, reporting has diminished during 2007-2008 due to registration and reporting being voluntary. Registration and reporting will only become compulsory through the finalisation, promulgation and implementation of the Waste Information Regulations. Currently the WIS does not meet the requirement of the Waste Act in the following respects- the recording, collection, management and analyses of data and information of quantities of waste: stored, transported, treated, transformed, reduced, reused, recycled or recovered. The WIS does however, allow for the registration of licensed waste management activities and enables the recording, collection, management and analysis of data and information on the quantity and type of waste.

Table 4.2 below depicts the milestones for the development and implementation of the South African National WIS (DEAT, 2008).

Table 4.2: Milestones for the development and implementation of the South African National Waste Information System

Year	Milestones
1999	Develop the national waste management strategy (NWMS) Establish the WIS as priority initiative Develop action plan for the WIS initiative
2000	Develop an integrated pollution and waste management strategy (IP&WM) with information management as one of its goals
2001	Declare waste information and monitoring systems
2004	National waste information strategy implementation (NWMSI) Waste information system is established and in use
2005	WIS needs analysis, status quo analysis and framework Pilot WIS
2006	WIS manuals, implementation guidelines and verification methods Waste Management Bill and draft WIS regulations
2007	WIS roll out
2008	WIS roll out
2009	Waste information dissemination and state of waste report

Source: Adapted from DEAT, 2008

The Western Cape Provincial Government (WCPG) took a decision to alternatively, develop its own ***Integrated Pollutant and Waste Information System*** (IPWIS) as a vehicle to interact with the national WIS. This decision was taken because, in spite of the NWMS setting objectives and timeframes, stipulated deliverables were not met

(Chetty, 2002). The relationship between IPWIS, health care waste and the national WIS is illustrated in Figure 4.1.

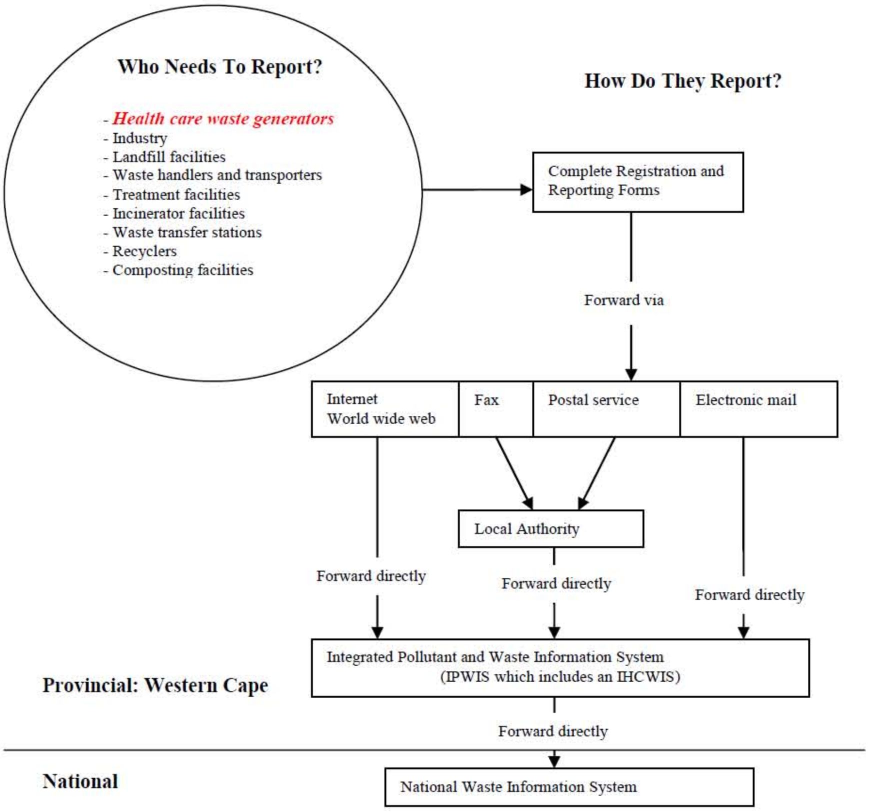

Figure 4.1: Framework for reporting to the Integrated Pollutant and Waste Information System (*Source: Adapted from Department of Environmental Affairs and Development Planning, 2006*)

IPWIS is a combination of the Pollutant Release and Transfer Register (PRTR) (a register kept for the purpose of controlling chemicals and its releases) and the waste (which includes health care waste) information system. It is envisaged that this IPWIS will regulate the pollutants and waste cycle, and provide accessible information to interested parties in order to support effective pollution and waste management. The purpose of IPWIS is to (DEA&DP, 2006):

- Enable municipalities, business and industry to report on the quantity of waste generated, stored, transported and disposed
- Provide the general public access to information from the system and to lodge complaints on suspected waste and pollution transgressions
- Track health care waste from generation to disposal
- Assist with pollution management, policy planning, compliance monitoring, enforcement, reporting and decision making.

Figure 4.1 illustrates that health care waste generators, transporters, treatment and disposal facilities need to report to IPWIS. ***This demonstrates that IPWIS encompasses an IHCWIS, which is the focus of this study.*** The WCPG legislated the participation and interaction with the IPWIS by gazetting the Western Cape Health Care Waste Management Bill, 2006 (which has now become the Western Cape Health Care Waste Management Act, 2006). This legislation compels the health care waste generator, treater, transporter, processor or disposer to:

- register with IPWIS
- keep written or electronic records
- make these records available to the public
- submit all the information to the IPWIS.

Those who need to report (See Figure 4.1) have to register with the IPWIS on a prescribed form (Appendix 1) and report annually to the system (Figure 4.1). How IPWIS is to be implemented so that it may contribute to effective health care waste management among health care waste generators is another aspect that requires further research. Purnell (2009:43) recommends among others that 'capacity to operate and maintain the SA WIS must be developed and maintained at provincial and national levels, so that the significant increase in registration and reporting resulting from the Waste Information Regulations will be accommodated. What follows now is a discussion of the case and the various sub-cases.

4.2 The Case: IPWIS (incorporating IHCWIS)

Having discussed IPWIS (IPWIS will also be discussed later under the activities of the Department of Environmental Affairs and Development Planning (DEA&DP)) we now focus our attention to the various sub-cases which cut across an influenced the development of IPWIS. The case context is that IPWIS is housed in and managed by the DEA&DP (sub-case1). The Centre for e-Innovation (Ce-I) (Sub-case2) provides information management services to DEAD&P. The State Information Technology Agency (SITA) (Sub-case 3) provides information technology services and support to both the DEA&DP and Municipalities to which the health care waste generators belong (Sub-case 4).

4.3 Sub-case 1: The Department of Environmental Affairs and Development Planning (DEA&DP)

Organisational Structure

The DEA&DP, consisting of various chief directorates, directorates and sub-directorates with their own components, is led by a head of department who reports directly to the minister. See organisational chart in Figure 4.2 below.

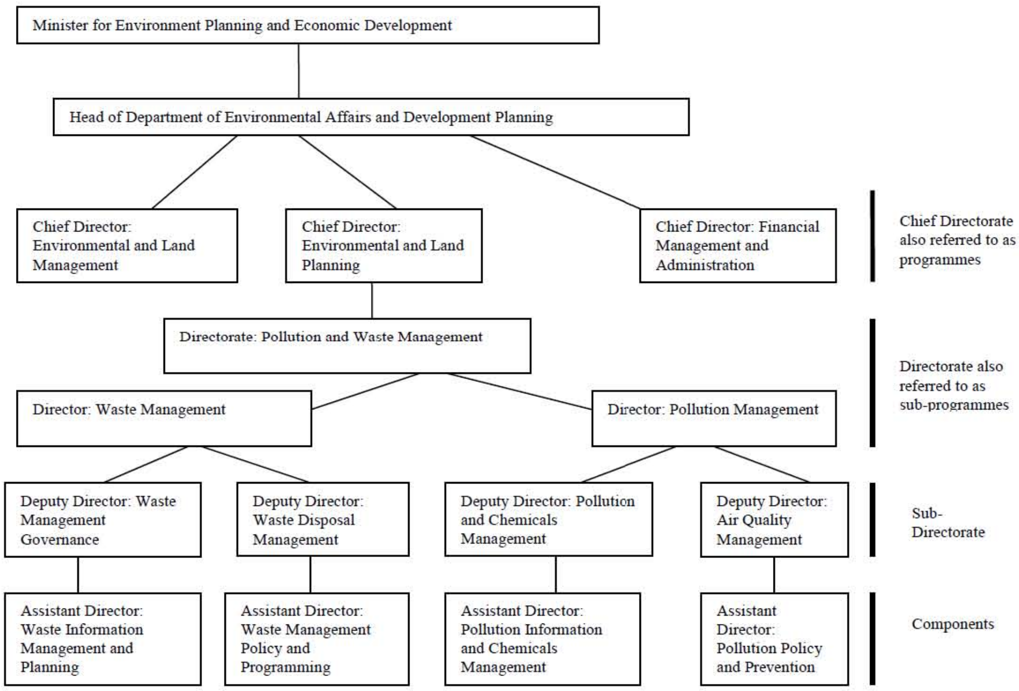

Figure 4.2: Organogram of the Western Cape Department of Environmental Affairs and Development Planning (*Source: Adapted from DEA&DP, 2007*)

Aims and Objectives

- The aim of the DEA&DP is to foster human well being. This is done by promoting equitable access to natural resources, facilitating economic development and ensuring environmental integrity towards sustainable development (DEA&DP, 2007).

The main focus of the DEA&DP is on:

- Sustainable environmental management
- Integrated sustainable human settlements

- Integrated development planning
- Ensuring equal access and sustainable use of natural resources.

Activities

The DEA&DP identified the development of a functional IPWIS as an important tool to effectively manage pollution and waste. It was envisaged that IPWIS would facilitate and support the development of projects, co-operative management and policy mechanisms and guidelines to ensure integrated management of pollutants and all forms of waste. IPWIS was also developed in order to achieve the goal of the Policy on Integrated Pollutant and Waste Management which is to:

> promote information management with respect to integrated pollution and waste management by developing and maintaining databases and information management systems that provide accessible information to interested and affected parties that will support effective integrated pollution and waste management via informed decision making.

During 2006 the DEA&DP set the following key measurable objectives to achieve its aim:

- Mainstream the sustainable development paradigm in environmental planning and management
- Develop systems, processes and measures to support service delivery
- Promote environmental integrity and the progressive realization of environmental rights
- Undertake spatial planning that promotes and guides sustainable development

- Provide integrated and holistic environmental management to improve the quality of life of all people in the Western Cape
- Develop intervention strategies to facilitate equitable access to and participation in the environmental economy.

The need for IPWIS was further motivated by the following problems in the Western Cape:

- Limited consistent and accurate information regarding the waste cycle
- Lack of legislation, human resources, finances, knowledge and infrastructure to support data collection and reporting
- Inconsistent information sets or databases which are not regularly updated, incomplete and not representative
- Limited use and application of information.

The main aim of IPWIS was to provide accurate and complete information on potentially harmful pollutants, waste types and quantities, waste management services providers and waste disposal facilities. The development of IPWIS was completed, with the exception of the management information systems module, and structured for both internal and external users. IPWIS was launched in June 2006 and has already informed important strategic decision making and interventions in environmental management. The quality assurance of IPWIS was carried out in accordance with ISO 9126 standard. Capacity building of the sub-programme's staff and stakeholders was employed to ensure the optimum use and effective administration of the system.

DEA&DP developed the Health Care Waste Management Bill of 2006, now called the Western Cape Health Care Waste Management Act, 2006, in order to (among others) legislate the registration of health care waste generators and the reporting of relevant information. The Health Care Waste Management Bill was certified as a Bill by the legal services of the Department of the Premier of the Western Cape and published for public comment which were received by 28 February 2007, the end of the commenting period. The Bill was then submitted to the Provincial Cabinet for approval. The detailed development of the said legislation is illustrated in Table 4.3.

Table 4.3 Development of the Health Care Waste Legislation

2002	2004	2005	Oct 2005 – Nov 2006	2007
Drafted Health Care Waste Regulations Identified relevant stakeholders First round interactive workshops to introduce the discussion document and identify key areas to be addressed by legislation.	In-principle approval, by provincial cabinet, for drafting the Bill Obtained buy-in from the provincial department of health Develop training manual in collaboration with the provincial department of health Held 4 training manual workshops Draft Bill published for comment	Second round workshops to introduce the published Health Care Waste Management Bill to all stakeholders Obtain input and comments on draft Established special reference group Third round workshops to introduce a regulations discussion document Obtained inputs and comments on the document	Costing Legal review Certification of draft Bill Introduce Bill at provincial cabinet Published as Bill, 07 December Publish Bill for comments	Received comments by the extended period of 28 February Considered comments and proposed changes Finalise regulations Bill approved as an Act Submit regulations for approval

Source: Adapted from Hanekom, 2008

As part of the initial data capturing requirements of IPWIS, the Environmental and Land Planning programme, through its different directorates, sub-directorates and components, audited 250 pre-selected waste disposal facilities with the aim of characterizing waste. This initiative improved the quality, quantity and accuracy of collated and compiled information on waste management in the Western Cape.

Constraints

The widespread deployment of IPWIS and capacity building initiatives were hampered by poor IT network infrastructure, computer network instability, high computer network traffic, problematic servers, system errors and the slow response in finding adequate solutions to network and other ICT related problems (Chetty, 2008). Other problems were experienced in appointing suitable and skilled human resources to fill vacant posts and it became difficult to retain the staff when those posts were filled. Table 4.4 illustrates the human resource profile for 2008.

Table 4.4: Directorate Pollution and Waste Management Staff Profile (Up To August 2009)

Post	Number of Posts	Post Status
Directorate: Pollution and Waste Management		
Director	1	Filled
Personal Assistant	1	Filled
Senior Administrative Clerk	1	Filled
Sub-Directorate: Waste Management Governance		
Deputy Director	1	Filled
Administrative Officer	1	Filled
Senior Administrative Clerk	1	Filled
Sub-Directorate: Waste Disposal Management		
Deputy Director	1	Vacant
Administrative Officer	1	Vacant
Senior Administrative Clerk	1	Vacant
Components		
Waste Information Management and Planning		
Assistant Director	1	Vacant
Principle Environmental Officer	3	3 Vacant
Senior Environmental Officer	2	2 Vacant
Environmental Officer	3	Filled(Contract)
Data Capturer	1	Filled (Contract)
Temporary Interns	1	Filled
Waste Management Policy and Programmes		
Assistant Director	1	Filled
Principle Environmental Officer	2	2 Vacant
Senior Environmental Officer	2	1 Vacant; 1 Filled
Environmental Officer	3	1 Vacant; 1 Filled; 1 Contract
Temporary Interns	1	Filled
Waste Disposal Specialised Services		
Assistant Director	1	Vacant
Environmental Officer	5	4 Vacant; 1 Filled (Contract)
Waste Disposal Regulatory Services		
Assistant Director	1	Vacant
Environmental Officer	3	Vacant

The filling of vacant posts was further delayed by the development of generic job descriptions. Vacant posts resulted in heavy workloads for existing staff which placed them under tremendous pressure. The Directorate: Pollution and Waste Management's current state (as at 2011) is not ideally operationally effective because its components and staff are fairly new. The work currently being conducted is that of gathering information in reaction to its responsibilities.

4.4 Sub Case 2: Centre for e-Innovation (Ce-I)

The Western Cape information technology and e-government units merged in April 2004 to form the Center for e-Innovation. The Centre's purpose is to improve the quality and efficiency of government service delivery and increase public participation by driving ICT within the Western Cape Provincial Government. In general the Ce-I has four major roles:

1. Provide and support basic ICT infrastructure
2. Provide and support applications that improve efficiency
3. Provide and support applications that enable government to deliver better services
4. Build an inclusive information society.

The Economic Governance and Administration Division (EGA) of Ce-I provides ICT services and support to DEA&DP including driving its e-government strategy. EGA set the following objectives as part of the IPWIS project:

- Develop and maintain databases and information management systems which are effective in tracking waste from generation to disposal

- Provide decision makers with a framework for assessing compliance and criteria for permits
- Facilitate capacity building and training of users
- Develop a system that would enable successful registration of all pollutant releases and transfers of waste generators and disposal facilities
- Ensure that the necessary ICT service is delivered in accordance with systems and application specification as indicated in the user requirement specifications and functional specification design.

EGA also served as project manager for the development of IPWIS. Its project management roles and responsibilities were:

- Production of required goods
- Taking responsibility for overall progress, use of resources and initiating corrective action where necessary
- Reporting to a steering group in an agreed standard
- All project planning, management, monitoring and management including outsourced agents
- Ensuring that government standards are adhered to
- Raising formal issues
- Identifying scope change and obtaining approval
- Submitting project closure report.

4.5 Sub Case 3: The State Information Technology Agency (SITA)

SITA provides IT services and application development to government departments in relation to economies of scale. SITA was mainly responsible for the functional specification design of IPWIS with emphasis on what the system is to do rather than how it is to be implemented (SITA, 2004). The functional specification design of IPWIS described the business requirements from an information architecture perspective and also served as a guide to solution providers to define or match the technical application design depending on whether the intention was to build or buy the final system.

Some of SITA's duties with respect to the development of IPWIS were (WCPG, 2001):

- Establish and maintain an IT/IS and related service rendering capabilities
- Avail the IT/IS and related services in a cost-efficient manner
- Provide data processing services
- Provide technology and information systems training
- Provide application software development and maintenance services
- Promote the effective utilisation of information technology
- Provide technical, functional, business research and development advice and support
- Undertake acquisition and procurement management
- Any other service as mutually agreed between the WCPG and SITA.

4.6 Sub Case 4: Municipalities

In collaboration with the Department of Provincial and Local Government, municipal health services are considered the responsibility of district and metropolitan municipalities and defined as basic environmental health services which municipalities render in accordance with Constitution of South Africa (Department of Health, 2004). According to regulation R.123 of the Health Professions Act, 1974, the scope of environmental practice, regarding waste management, includes:

- Ensuring proper refuse collection, storage and disposal
- Ensuring proper liquid waste management including sewerage and industrial effluents
- Ensuring the proper storage, treatment, collection, transportation, handling and disposal of health care waste and hazardous waste
- Sampling and analysis of any waste or product (sewage), refuse or 'other wastes. Investigations and inspections of any activity relating to the waste stream or any product resulting there from
- Advocacy on appropriate sanitation
- Control of the handling and disposal of diseased animal tissue
- Ensuring safe usage of treated sewerage sludge and the health safety of reclaimed waste
- Ensuring waste management including auditing of waste management systems and ensuring the "cradle to grave" approach is adhered to.

(*The next section draws extensively from the City of Cape Town's Integrated Solid Waste Management Plan* (City of Cape Town Solid Waste Directorate, 2004)). The City of Cape Town in response to the relevant national and provincial legislation developed its own medical waste policy (which took effect in March 2002) and initiated the development of an Integrated Waste Management Plan (IWMP).

The main aims for the IWMP are to:

- increase waste minimization by promoting the prevention, reduction, reuse and recycling of waste
- ensure that the Solid Waste By-Law is drafted for enforcement
- optimize airspace at landfills by adopting strategies to steadily reduce the amount of waste which is disposed of at landfills
- improve the levels of service in certain areas of the City such that adequate and equitable waste collection services become available to everyone in the CCT
- develop Waste Management Strategies and programmes, which recognize the specific waste management demands and needs reflected by the various community members and society sectors
- determine the waste management demands and needs as reflected by the various community members and society sectors (including industry, commerce, schools, formal and informal residential developments, etc.).
- ensure an integrated approach to all waste management projects is adopted so as to prevent adverse social and environmental impacts, identify and develop a plan for future waste management needs and requirements that provide an outlook for short-, medium- and long-term planning and strategies
- optimise infrastructural and financial requirements so as to ensure that waste management costs are minimised by optimising the efficiency of the waste management system aimed at a "full cost accounting" system to assess waste management costs
- ensure that adequate capacity is made available for the City and long-term political support is given to meet the targets set within the IWMP

- present the IWMP to the public and all stakeholders and thereby ensure that they have a voice in development of the waste management systems and strategies chosen
- ensure that the institutional, legal and financial frameworks proposed, are accepted for practical implementation.

According to the City of Cape Town the National Integrated Waste Management Bill requires that municipalities collect data for the national waste information system. Local government, through DEA&DP, is as at 2011, at an advanced stage in developing a waste information system (WIS) for the City of Cape Town and indeed all other municipalities of the Western Cape. Local government will be required to submit information on an annual basis. At present the Waste Department of the City of Cape Town has no comprehensive database or overarching integrated management information system in place to produce reliable data and management information. Decisions and policies in the past have often been made without being guided and informed by a proper knowledge-based system. It is against the background described above that the Waste Department has decided to proceed with the acquisition of a WIS that best meets its future planning and management requirements and to promote review of the effectiveness of the new strategies flowing out of the IWMP. The acquisition of the WIS will be undertaken through a separate procurement process. The requirements of the Project Team contracted to assist the City in developing its IWMP, is to assist in preparing the Terms of Reference for the WIS procurement. The WIS is to include weighbridge software and will ideally interface with the City's new SAP information and business solution (which has the facility to include a waste module).

The elements of the WIS considered to be necessary for the City's requirements include the following:

- The system must serve as an effective design, operating, planning and financial management tool for the Waste Department
- The system must be able to be easily interrogated and should provide meaningful management information of such a value to enable effective decision-making
- The system must interface effectively with the City's SAP information and business solution
- The system must be able to effectively provide the data required by DEA&DP for the maintenance of their Provincial and National WIS systems
- Development of the WIS software must ensure that all the data and information required by the Waste Department can be easily accessed and output in a format that suits the current systems used by the management staff
- Data verification and quality control systems are to be incorporated
- The system must be able to accept weighbridge data and perform the required analyses, include a Geographic Information System (GIS) component, optimise collection areas, include staff information, details of plant, depots and waste departments facilities, and record existing information required for the management of waste reduction, collection and disposal
- The system must be designed to report on the progress and effectiveness of the strategies adopted in terms of the IWMP
- The system should be linked to a Quality Management System

- The Waste Department may consider following the lead taken by the City's Water Department in seeking accreditation to an internationally recognised Quality Management System such as ISO 9001:2000.

This chapter provided a broad overview of the case and sub-cases and how they relate to the problem under study. The next chapter, Chapter 5: Results and Discussion, presents and discusses the findings of this research.

Chapter 5

Results and Discussion

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Chapter 5

Results and Discussion

5.0 Introduction

Chapter 4 described the case study while Chapter 3 explained the field work done to collect the data. This Chapter presents the analysis of that data to investigate the development and integrated use of a health care waste information system. This was done by conceptualizing the translation and inscriptions necessary to facilitate the development, institutionalization and eventual application of the integrated pollutant and waste information system (IPWIS) *(incorporating an integrated health care waste information system (IHCWIS))* as a consequence of the dynamic alignment of actors and artefacts. The rationale behind this is to draw out conclusions and recommendations regarding the development and institutionalization of information systems for effective and efficient management of health care waste. Qualitative content analysis was used as an approach for analyzing and interpreting the narrative data. Chapter 5 brings together key issues and insights presented in the rationale of the study (Chapter 1) and review of the relevant literature (Chapter 2). These issues and insights were, in turn, used to develop the framework for and levels of analysis as depicted in Figure 5.1.

The Chapter is divided into five sections namely, framework for analysis; analysis process; levels of analysis; chapter conclusions; and recommendations. These will now be discussed.

5.1 Framework for Analysis

As shown in Figure 5.1 below, the need for IPWIS *(incorporating IHCWIS)* arose to address, among others, the issue of inadequate management of health care waste. This, in turn, shaped the process of network formation/establishment and stabilization.

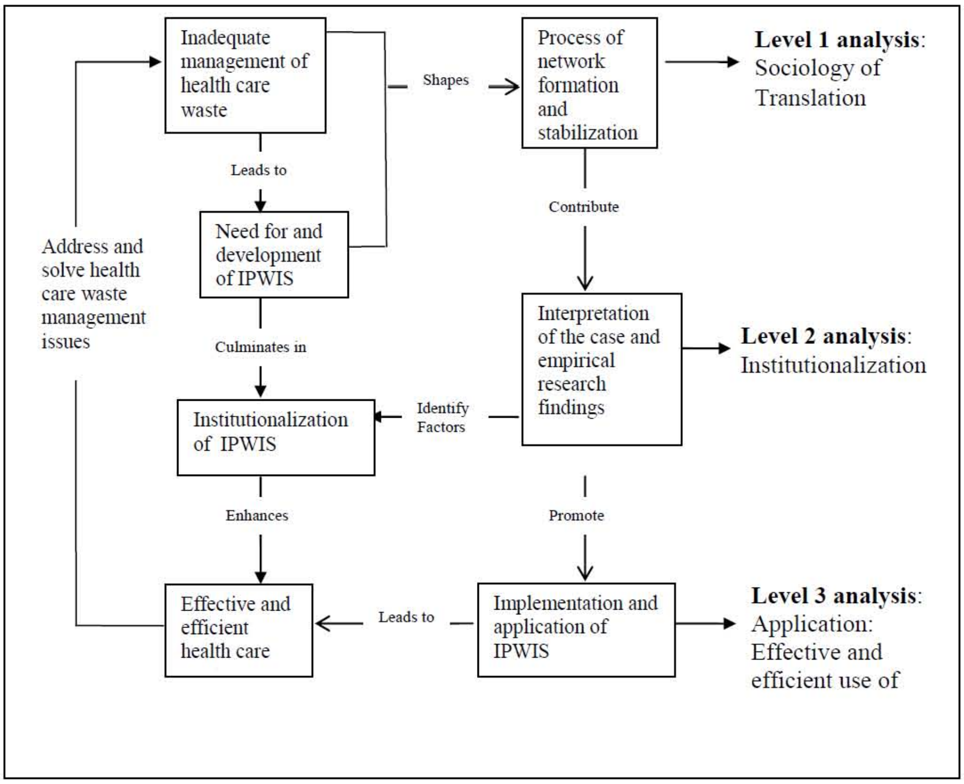

Figure 5.1: Conceptual model for analysis

The establishment of the network contributes towards its institutionalization but does not ensure it. We therefore had to interpret the case and the empirical findings to uncover factors which will lead to institutionalization (IPWIS *(incorporating IHCWIS)* is not institutionalised yet).

An institutionalized network promotes, but does not imply, the implementation and application of IPWIS and therefore we had to identify factors which will lead to the effective and efficient management of health care waste (HCW) (currently interaction with IPWIS *(incorporating IHCWIS)* is voluntary). We will now describe the process used to analyze the data.

5.2 Analysis Process

Before we start discussing the analysis process, one must bear in mind that the data from the interviews and questionnaires were analyzed through three lenses; (1) sociology of translation, (2) institutionalization and (3) application (effective and efficient use). The same data were subjected to these three kinds of analysis, respectively. Qualitative content analysis was used to analyse the data obtained and both inductive (themes were derived directly from the text) and deductive (information systems, health care waste and waste management literature) methods were applied (Zamani *et al.,* 2007). Combining inductive and deductive methods have been widely used in research and considered as the most realistic form of analysis which uses theory and literature to drive the framework (Patton, 2002 in Zamani *et* *al.,* 2007). Different themes emerged during the analysis and these will be discussed later.

The analysis followed a process described by Graneheim and Lundman (2004) and Taylor-Powell and Renner (2003) and is depicted in Figure 5.2 below.

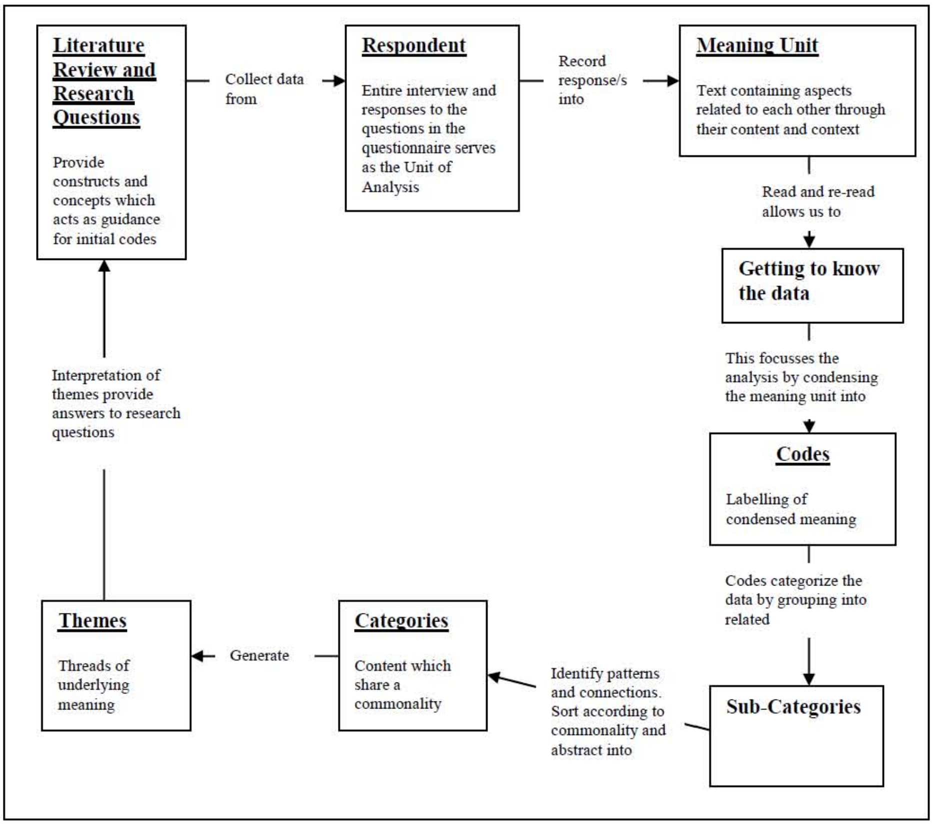

Figure 5.2: Content analysis process ***(Source: Adapted from Taylor-Powell and Renner, 2003;and Graneheim and Lundma, 2004)***

We start the process with the research question and the pursuit of answers. We concentrate on the research question because it enables us to read the text for a specific purpose thereby permitting us to move more expeditiously from sampling relevant text to answering given questions. This pursuit of answers to the research question not only grounds the content analysis empirically but also protects us from getting lost in mere abstractions or self catering generalization (Krippendorff, 2005).

The variables contained in the research questions together with the objectives also provide the initial underlying concepts and constructs. The definition of the concepts and constructs contained in the research questions were derived from the theory and previous literature from the development and institutionalisation of health care waste information systems. This approach is what Hsieh and Shannon (2005) refer to as 'directed content analysis'.

Data was collected from respondents and recorded (transcribed verbatim), culminating into meaning units. The element from which data was collected was discussed in Chapter3: 112-114 and will not be repeated here.

In getting to know the data, we listened over and over again to the recordings of the interviews with the various actors, and read and re-read the responses generated through the questionnaires, This was mainly done to separate the quality data from non-quality data. Quality data in this context refers to data which can be used to generate information which in turn provide possible answers to the research questions. To focus the analysis we reverted to the research questions and objectives set in Chapters 1, 2 and 3. By getting to know the data we also condensed the meaning unit into codes.

The codes allowed us to group the data into sub-categories which was used to identify patterns and connections. These were sorted, according to commonality and abstract, to become categories. The categories generated the necessary themes for discussion and interpretation.

Table 5.1 provides an example of the analysis process we have just described.

Table 5.1: Dedicated information officers: Example of categories and themes

Question: What will make it difficult for you to report to the System?							
Construct	**Respondent (Unit of analysis)**	**Respondent Code**	**Meaning Unit**	**Condensed Meaning Unit**	**Code**	**Categories**	**Theme**
Difficulty in reporting to the System	Information manager	MIS01	I think the main problem with that is to get information from the ground to the System. That is, who is going to take the information from the ground to the System. That is the main part of the thing. Because it means we must have somebody who is responsible for the System or responsible for capturing all the data.	Collecting information from the ground Responsible person	Responsible person to collect and capture data	Information officer	Dedicated information officer
	Waste manager	WM03	As I say, I think that, due to the fact that we don't have a lot of admin personnel that we can utilize to populate the system and to report to the system. That's gonna be challenging to S, to actually get that up and running smoothly and get accurate and trustworthy information put onto the system.	Insufficient administrative personnel Challenge: collecting accurate and trustworthy information	Administrative person	Information officer	Dedicated information officer

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5.3 Levels of Analysis

This section discusses the contribution and experiences of the actors within the case study. The analysis was done at three levels as depicted in the previous Figure 5.1 (page 146) and the following Table 5.2 below.

Table 5.2: Levels of analysis

Level		**Description**
Level 1	ANT: Sociology of Translation	Using ANT as a lens to uncover the establishment/construction, growth and stability of IPWIS *(incorporating IHCWIS)*
Level 2	Interpretation of the Case	Using the analysis of the case study findings to explain how IPWIS *(incorporating IHCWIS)* gains acceptance as normal custom and practice (institutionalisation)
Level 3	Application of IPWIS	The use of IPWIS *(incorporating IHCWIS)* for effective and efficient health care waste management decision making in the Western Cape

The first level of analysis was done using ANT (sociology of translation) as a lens to uncover the construction, growth and stability of IPWIS *(incorporating IHCWIS)* as a network. The second level of analysis was done on the interpretation of the results of case findings in order to investigate how IPWIS *(incorporating IHCWIS)* gained acceptance as normal custom practice and could become institutionalized. The third level analysis focused on the implementation and application of IPWIS *(incorporating IHCWIS)* for effective and efficient health care waste management decision making.

Level one analysis was thus done using the sociology of translation (Callon, 1986) in order to understand the complex issues involved with network establishment and stabilization. It is envisaged that the need for and development of IPWIS *(incorporating IHCWIS)* will eventually culminate in the network being institutionalized. However, the sociology of translation analysis allows us to make judgements about the construction and establishment of the network but not about the growth and institutionalization thereof. An established network does not guarantee that institutionalization will occur. If institutionalization does not occur then the established network will simply become weak and decline. A level two analysis was thus performed to investigate how IPWIS *(incorporating IHCWIS)* becomes institutionalized. An institutionalized network means that IPWIS *(incorporating IHCWIS)* gains acceptance as normal custom practice, but it does not necessarily signify or guarantee that it will be used for effective and efficient management of health care waste. We therefore conducted a level three analysis to determine the effective and efficient use of the network for decision making in order to address and solve the issue of poor health care waste management.

ANT does not prescribe detailed guidelines on how to analyze or construct the descriptions of actor-networks and how to explain innovation outcomes using these descriptions (Latour, 1995). It is envisaged that these three levels of analysis will address this shortcoming. The three levels of analysis will now be discussed in detail.

5.3.1 Level 1 Analysis : IPWIS, Sociology of Translation

Drawing on the qualitative data (responses) generated from various actors during interviews and administering written questionnaires, we trace and examine how their interests are aligned through translation and inscription leading to a stabilized network. The focal point of ANT analysis is to examine the process of translation where actors align with each other to form an actor-network (Callon, 1986). The four moments of translation; problematisation, interessement, enrolment and mobilization, (as discussed in Chapter 3) provided the basis for analyzing and interpreting the data. Before the four moments of translation are used in our first analysis, the various actors that were identified will be introduced.

The actors: The actors (Figure 5.3 below) involved with the actor network of IPWIS *(incorporating IHCWIS)* consist of both human and non-human actors. Their roles and interests will be discussed later in this section.

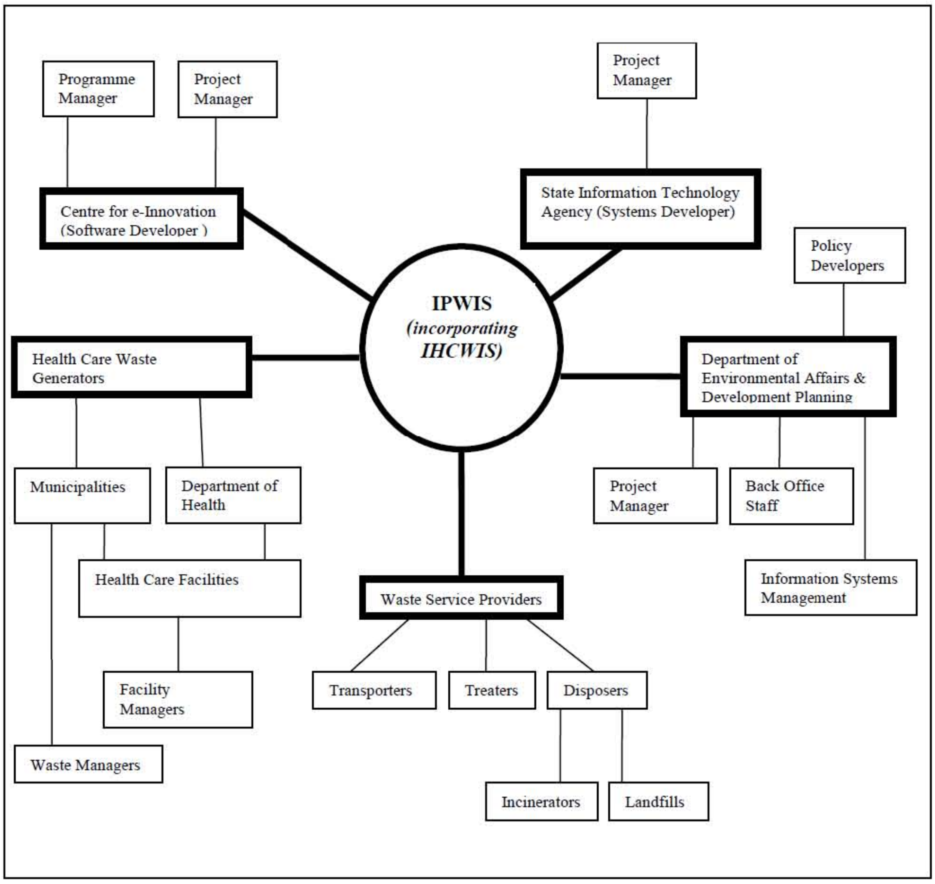

Figure 5.3 Human and non-human actors involved with the development and institutionalization of IPWIS *(incorporating IHCWIS)*

Human actors have direct and tangible interests, for example, the interest of the Deputy Director would be to solve and prevent problems of illegal dumping of health care waste. These interests could be measured by the reduction in illegal dumping incidents. The functionality of IPWIS *(incorporating IHCWIS)* is of such a nature that health care waste can be traced from generator to disposal. The non-human actors, on the other hand, have their interest inscribed in the purpose they serve, for example, the interests of the approval and promulgations process is to operationalise legislation.

The legislation, Health Care Waste Management Act will only become effective once the regulations have been passed. Once this happens everyone engaging with the process of waste management will be compelled to interact with IPWIS *(incorporating IHCWIS)*.

Problematisation

Problematisation is the first moment of translation and it is here where the key actor attempts to convince other actors to subscribe to their own view by demonstrating that it has the correct solution to the issue that they face. During problematisation the key actor defines the problem in its own terms, identifies other relevant actors, highlights how the problem affects them and then outlines strategies for addressing it (Sarker *et al*., 2006).

We will now discuss where the need for IPWIS *(incorporating IHCWIS)* originated and how it was recognized as a possible solution, how DEA&DP established itself as the key actor, who the other actors are, their roles and interest. The need and appreciation for IPWIS *(incorporating IHCWIS)*, as a possible solution to effectively and efficiently manage health care waste, arose from a health, legislative and benefit perspectives (See Figure 5.4 below).

The need from a Health Perspective: According to Titus (1998), four separate cases of illegal dumping of health care waste were reported and occurred within the period 26 October 1998 to 26 November 1998.

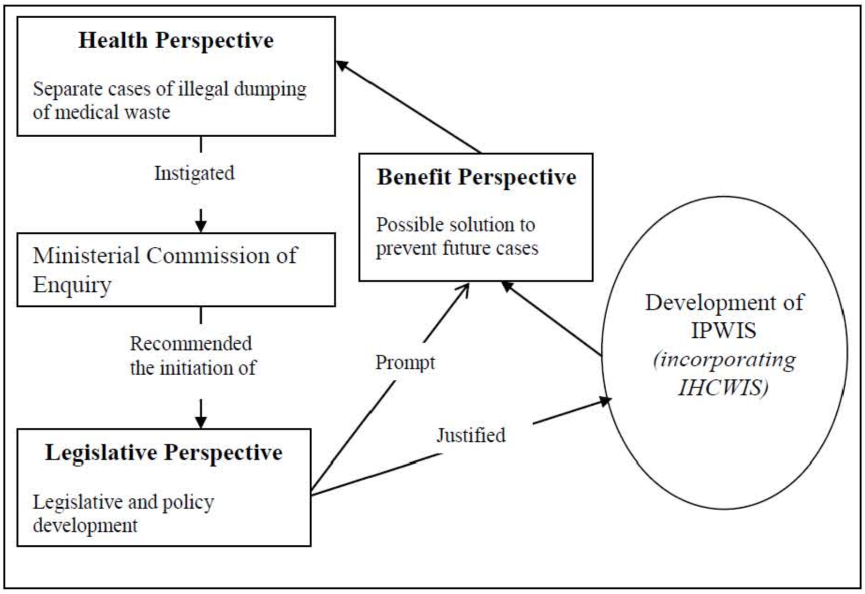

Figure 5.4 Need and appreciation for IPWIS *(incorporating IHCWIS)*

The first case was reported on 26 October 1998 when the South African Police Services called for assistance with the handling of health care waste discovered on a large vacant land in Tafelsig, Mitchell's Plain, Cape Town. Approximately 200 children were exposed to the health care waste. The second case occurred on 09

November 1998 when health care waste was found in a refuse bin in Grassy Park, Cape Town. No persons were exposed to this waste.

The third case arose when the Emergency Medical Services (EMS) were called out to investigate health care waste found on a municipal dumping site in Uitsig, Elsies River, Cape Town. Six children were exposed to this waste. The fourth case was reported when the EMS were called to investigate the dumping of health care waste on the corner of AZ Berman and 10th Avenues, Mitchell's Plain, Cape Town.

The emergence of these cases resulted in the Minister of Health and Welfare: Western Cape setting up a task team to conduct a ministerial commission of inquiry into the health care waste dumping in Mitchell's Plain. The task team recommended, among others, the following:

- New provincial legislation regarding health care waste be drawn up by the Department of Health and Social Services in Collaboration with the Department of Environmental Affairs and Tourism (DEAT)
- Compulsory registration of health care waste generators at Local Authorities (LAs)
- Mechanisms/Procedures agreements for the removal of health care waste by local authorities
- LAs should coordinate, monitor and evaluate storing, transporting and disposal of health care waste within their jurisdiction
- Implementation of a compulsory training programme for all health care waste generators in the Western Cape.

The need from a Legislative perspective: The Constitution of the Republic of South Africa, (Act 108 of 1996), states that the people of South Africa have the right to an environment that is not detrimental to human health, and imposes a duty on the State to promulgate legislation and to implement policies to ensure that this right is upheld. Steps taken to date to ensure this environmental right include: the publication of the Environmental Management Policy for South Africa (1998); the preparation of the Draft White Paper on Integrated Pollution and Waste Management (1998); the National Water Act (1998); as well as the promulgation of the National Environmental Management Act (1998). A further step was the development of the National Waste Management Strategy (NWMS) for South Africa (Moatshe, 1999). The NWMS makes provision for the establishment of a waste information system. The Constitution places the responsibility on Provinces to promote integrated waste management by means of the NWMS, and DEAT prioritized health care waste in terms of this strategy.

The need for a solution to poor waste management perspective: The events of illegal dumping of health care waste became a stimulus for the development of IPWIS *(incorporating IHCWIS)* as a solution to the problem of poor health care waste management. The need for IPWIS *(incorporating IHCWIS)* was recognized as a possible solution to poor health care waste management was well received and accepted for reasons stated in the responses (See Table 5.3 below) which were extracted from questionnaires distributed and obtained from health care facilities (HCF). The selected responses indicate how IPWIS *(incorporating IHCWIS)* will provide perceived benefits which could assist with the planning and effectiveness of health care waste management, creating awareness, integration, participation, accountability, record keeping and the prevention of problems associated with health care waste. IPWIS *(incorporating IHCWIS)*, by means of integration, will also promote the creation of uniformity among health care waste generators which in turn will lead to better health care waste management.

Table 5.3: Why the need for IPWIS *(incorporating IHCWIS)* (The code assigned to the unit of analysis, health care facilities, is HCF)

Theme	Sample Quotations	Respondents
Planning	- To have data (base-line) and continuous updated to plan budgets, manpower utilization and - ...planning for future	HCF01; HCF10;
Effectiveness	- Been in Austria in 1996 and saw how well organized waste management is overseas - It would lead to better control of medical waste... - Monthly we generate waste information, sent it in, but we do not know if we need to improve on our system - Proper management of work and pollution - ...for better management of Waste Disposal - ...able to identify different Waste Information Systems	HCF03; HCF05; HCF07; HCF09; HCF10; HCF11; HCF14; HCF15
Awareness	- Become aware of environmental health hazards - ...to encourage reporting - ...and education	HCF06;
Integration	- Integrate services provided to health facilities - For uniformity... - Uniformity for monitoring purposes - Uniformity in Health practices - For uniformity in all Health Sectors in the Province...	HCF06; HCF10;HCF11; HCF13;HCF14
Participation	- Can participate in policies drawn up - It is a matter that includes all health facilities	HCF06; HCF08;
Accountability	- ...and accountability reasons - ... know whether people adhere to the rules or policy of the Health Care Waste System	HCF11; HCF17
Record Keeping	- ...and how accurate data on how much waste is generated annually... - ...referral purposes - It is the only way that information can be collected and collated, to provide an estimate of how much waste is generated - ... and keeping of records	HCF05; HCF11;HCF12; HCF13
Prevention	- ...work out actions to prevent pollution - Disease due to waste in our area - ...monitor Infection Control measures - Cleaner communities - To prevent medico (medical) legal hazards	HCF01; HCF07; HCF09; HCF15; HCF16

These responses of perceived benefits of effective health care waste management were also shared by waste managers. The benefits that IPWIS *(incorporating*

IHCWIS) hold for waste managers are (See Table 5.4 below): (1) Engagement: DEA&DP can now engage and work together with municipalities; (2) Finding solutions to challenges facing municipalities and deciding on the way forward; (3) Tool to manage waste; and (4) Recording and updating information.

Table 5.4 Benefits that IPWIS *(incorporating IHCWIS)* hold for waste managers

Theme	Selected Responses	Respondent
Engagement	"Because I think it's a requirement from IPWIS to record and I think it's for engagement from the Provincial side to, amongst Municipalities and so on" "but I think if you can send it down to Province then they can actually respond much quicker"	WM01; WM02
Finding solutions	"I think it is really about working together and finding solutions because at the end of the day this is going to happen" "and then afterwards I think it's about getting solutions and how to deal and tackle and to get to grip with challenges within Municipalities" "and the better the record-keeping is, the better you can make decisions in the future"	WM01; WM03
Waste management tool	"and to me, this is an ideal tool that could be utilized by the Municipality and by Government to look at the Waste scenario in South Africa and to manage it better with the information on hand" "we do need to have accurate reported information that we can, at a later stage that we can access to use in any calculation of a tariff and a tariff structure" "We are actually dealing with Licensing issues at the EDM and all the other District Municipalities. So, we're gonna use this system as from then on"	WM03; WM05
Updating records	"there was no such system in place that you can report anything down" "I can just think that the more record-keeping you have and the better the record-keeping is" "Every-time there is an update, then you must report it" "Well, to keep your record, you know, it's no good having statistics and it's not upgraded. If the system is everywhere, then if everybody loads, you know, then the information will be accessible for everybody. …because I get also monthly statistics of all the recycling that we do… and that I can also upgrade every month or every quarter"	WM02; WM03; WM04; WM06

The benefits for some municipalities would not only be restricted to health care waste but also effective in other areas such as air quality management. This was clearly articulated by respondent WM01 (WM is the code assigned to the unit of analysis, waste manager) who is responsible for waste management:

> Because I think Province is on the right track with IPWIS. I'm referring to Pollutant and Waste Information Systems here in Western Cape. So I think the Municipalities around here in Western Cape, I think it's going to contemplate preventing pollution and provide air quality management as well in the Province.

Key Actor: The Department of Health (DoH) initially took the lead in investigating the illegal dumping but it was the environmental departments, DEAT and DEA&DP, who were responsible for developing the legislation which ultimately led to the actual development of IPWIS *(incorporating IHCWIS)*. By doing so, DEA&DP established itself as the key actor. DEA&DP now had to pursue other actors to join in their defined network of IPWIS *(incorporating IHCWIS)*. It must be mentioned briefly that currently (as at 2011) it is not compulsory for health care waste generators to register with and report to IPWIS *(incorporating IHCWIS)*. The reason for this is that the regulations under the Health Care Waste Management Act are still in the process of being approved and subsequently promulgated. This will be discussed later in this Chapter 5 under the Section: The obligatory passage point (OPP).

We will now discuss the roles and interest of the other actors. The DEA&DP, Centre for e-Innovation and the State Information Technology Agency were discussed in detail in Chapter 4 and will only be briefly repeated here. The DEA&DP is responsible for fostering human wellbeing through the practices of sustainable environmental management, integrated human settlements, integrated development planning and ensuring equal access and sustainable use of natural resources. The Centre for e-Innovation and the State Information Technology Agency provide technical and project management support to DEA&DP.

Health care facilities are responsible for generating the bulk of health care waste in the Western Cape. The waste generators consist of the department of health and municipalities under which all health care facilities resort. The health care facilities are managed by a facility manager who is ultimately responsible for all health care waste. According to the City of Cape Town's policy on HCW disposal, all health care facilities managers must maintain up-to-date written records of medical waste removed from the premises and acquire from the disposer written notification that the HCW has been disposed of. On receipt of such notification, it has to be indicated on the written record that the HCW has been thus disposed of. These records must be kept for a period of one year after the removal of the HCW from the clinic premises. Other non-health care facilities are managed by waste managers. In some smaller municipalities the waste manager is also responsible for managing health care waste at the health care facilities.

Health care facilities see themselves playing a specific role within the network of IPWIS *(incorporating IHCWIS)*. Except for one respondent who considered their role to be small the other health care facilities foresaw themselves in the roles of monitoring HCW, ensuring compliance with relevant legislation, information management, information dissemination, interaction with others, and implementing waste management policy (See Table 5.5 below).

These roles are aligned to and correspond with DEA&DP's aim of identifying the development of a functional IPWIS *(incorporating IHCWIS)* as an important tool to effectively manage pollution and waste. It was therefore not necessary for DEA&DP, as the key actor, to vigorously impose roles on the health care facilities.

Table 5.5 Perceived roles of health care facilities

Theme	Sample Quotations	Respondents
Small	- small	HFC01
Monitoring	- Monitoring	HCF02;
Compliance	- Complying with provincial guidelines - Maintain a safe and healthy waste management	HCF05;HCF14
Information Management	- Collection, collating of data - Provide stats/reports	HCF04; HCF11; HCF16
Dissemination	- ... and dispatching it - Be on a mailing system; - To inform the provincial-wide health care waste information system	HCF04; HCF06; HCF17
Interaction	- interact via district managers - Be part of the health care waste system	HCF04; HCF07; HCF08;
Implementation	- Health education at clinics - Implement system at health facility level	HCF09; HCF10

Health care facilities are also aware of the imposing role that the key actor has in determining their roles within the network. The reactions to this determination of roles and how it should be determined were extracted from the questionnaires and captured in the Table 5.6.

Table 5.6 Determination of roles for health care facilities

Theme	Sample Quotations	Respondents
Consultation	- Consultation	HCF02
Needs analysis	- ...and stipulating what is needed - awareness and training of what's needed - By needs analysis -...screening process - To find out if there's a need if yes, how can it be implemented or monitored	HCF02; HCF04; HCF06; HCF11; HCF16
Participation	- Participation in the decision making process; workshops... - Should be involved in policy-making by attending workshops	HCF04; HCF14
Adherence	- We will await instructions as to our role - Via policies & guidelines - by management - Whatever decision taken; What's best for us - Through the city health and provincial health departments.	HCF05; HCF07; HCF08; HCF09; HCF10

There are various ways in which DEA&DP, as the key actor, could impose identified roles on the health care facilities but the health care facilities' belief is that they should not be coerced into accepting identified roles, but that their roles be determined through a needs analysis, consultation, participatory workshops and adherence to instructions via the managers, policy and guidelines. The health care facilities not only acknowledge that the key actor could assign roles to them but their reaction to this, by implication, spell out a possible method/approach for enrolment.

The role of service providers (i.e., health care waste collectors, transporters, treatment and disposal facilities) is to keep records of the health care waste and forward this information to IPWIS *(incorporating IHCWIS)*. This role was imposed by DEA&DP on the service providers. The service providers feel that they have much more to contribute than just merely submitting information to IPWIS *(incorporating IHCWIS)*. One service provider is of the opinion that they can make a positive contribution to ensure a healthy environment. During the interview Respondent SP01 (SP is the code assigned to the unit of analysis, service provider), the service provider, gave a clear picture of its roles and contributions. The respondent saw its role as much more than merely representing their organisations; and its contribution as maintaining a healthy environment. This is supported by the following extract from the interview conducted with Respondent SP01:

> I would say actively taking part in discussions or suggesting ideas, taking notes and feeding back to my own company possible ideas that were mentioned or raised. You are just another number partaking in a discussion without knowing that we could say something or do something. I think we want to be seen as an environmentally responsible company, making a positive contribution to maintain a healthy environment. By participating we firmly believe that we can play a very active role and as such it's important to get going on.

Despite this, the service provider felt that the contribution and value was somewhat restricted by the workshop method used to engage other actors. This aspect will be discussed in detail later when the focus will be on enrolment of actors. The linkage between the role and responsibilities of service providers and various forms of government is illustrated in Table 5.7

Table 5.7: Roles and responsibilities with respect to the waste information system

Sphere	Role	Responsibility
DEAT	National custodian of the waste information system	Collect data from provinces, verify, collate and disseminate national information. Maintenance, updates & expansion to the waste information system.
DEA&DP	Provincial custodian of the information system	Collect, verify and submit provincial information to DEAT
Local Authorities (Municipalities)	Providers of data to the waste information system. Support to Provincial Authorities	Provide accurate, reliable and timeous data to provinces. Assess that all reporting facilities within municipal area are registered and reporting
Service Providers	Providers of data to waste information system	Provide accurate, reliable and timeous data to provinces

These roles and responsibilities ensure that the responsibility of data collection lies with the most appropriate level of government, thereby facilitating linkages with other waste management processes. This is also to ensure that municipalities are empowered through access to information for their particular area (DEAT, 2004).

Tables 5.8 below summarises the value and interest of the human and non-human actors.

Table 5.8 Interests of human actors involved with the development and institutionalisation of IPWIS*(incorporating IHCWIS)*

Actor: Human	Value	Interest
Deputy Director	- Project manager	- Solve health care waste problems - Achieve goals of DEA&DP
Information Officer: Technical Support	- Responsible for systems application, business analysis, system administration and networking	- Maintenance and support
Environmental Officer	- Receives information from role players and responsible for the back office	- Execute departmental duties - Achieve goals of DEA&DP
Application Development Manager	- Developed the applications	- Serve DEA&DP
Senior Manager Professional Services	- Project Manager - Responsible for the functional specification design	- Serve DEA&DP
Health Care Facility Managers	- Involved with waste management at their respective municipalities	- Prevent illegal dumping of health care waste
Environmental Health Practitioners	- Involved with waste management at their respective municipalities	- Adequate waste management
Technicians	Involved with waste management at their respective municipalities	- Adequate waste management
Waste Managers	- Responsible for managing all waste	- Adequate waste management
Manager Information System	- Collect, collate and disseminate information	- Information management
Actor: Non Human	**Value**	**Interest**
Department of Environmental Affairs and Development Planning (DEA&DP)	- House's IPWIS *(incorporating IHCWIS)* - Serve as Key Actor	-Development and enforcement of waste management legislation - Fully functional IPWIS*(incorporating IHCWIS)* - Effective and efficient health care waste management
Centre for e-Innovation	- Project Manager - Develop information technology applications - Systems Development (user requirements)	- Serve DEA&DP
State Information Technology Agency	- Project Manager - Responsible for functional specification design	- Serve DEA&DP
Municipalities	- Develop and implement waste management systems - Manages waste	- Effective and efficient health care waste management
Registration and Reporting process	- Provide vehicle for communication	- Link stakeholders with key actor
Health Care Waste Act and Regulations	- Compels actors to interact with IPWIS*(incorporating IHCWIS)*	- Citizen health and safety
FRNS Consulting	- Quality assurance	- Quality
Health care waste generators	- Generate information required by IPWIS *(incorporating IHCWIS)*	- Manage waste
Service Providers	- Direct link with waste generators - Collect information from waste generators	- Manage waste - Secure and retain services
Approval & promulgation process	- Provide legal direction	- Operationalise the Act
Training workshops	- Provide actors with knowledge	- Capacity building

Now that the actors, their interests and roles have been identified we turn our discussion to how DEA&DP made itself indispensable by establishing IPWIS *(incorporating IHCWIS)* as an obilgatory path to solving the problem of poor health care waste management.

The obligatory passage point (OPP): The OPP as mentioned in Chapter 3 (under Section 3.3 Underpinning Theory) consists of IPWIS *(incorporating IHCWIS)* (primary OPP) and the Health Care Waste Management Bill of 2006 which is now called the Western Cape Health Care Waste Management Act, 2006 (secondary OPP). The Department of Environmental Affairs and Development Planning (DEA&DP) became indispensable when it compelled health care waste generators to subscribe to their own conceptions by demonstrating that IPWIS *(incorporating IHCWIS)* (primary OPP), a mandatory standard action, is the right solution to the problems of health care waste management. This was achieved by channelling health care waste generators through a set of unique and well-defined practices, in this case the Health Care Waste Management Bill of 2006 which is now called the Western Cape Health Care Waste Management Act, 2006 (secondary OPP). Section 2 of this Act states that the object of the Act is to promote integrated health care waste management,

thereby—

(a) reducing the risks of health care waste to human health;

(b) preventing the degradation of the environment;

(c) preventing the illegal dumping of health care waste;

(d) promoting sustainable development, and

(e) ensuring responsible management of health care waste in the Province.

The Act serves as a secondary OPP in that according to Section 6 (2) *(j-n)* of the Act:

*(j)*A generator, transporter, treater or disposer of health care risk waste must maintain up-to-date written or electronic records of the health care risk waste that he, she or it generated, treated, transported or disposed of.

(k) A generator, transporter, treater and disposer of health care risk waste must keep the written or electronic records referred to in subsection (2)*(j)* for a period prescribed by the Provincial Minister.

(l) A generator, transporter, treater or disposer of health care risk waste must make these records available to the public, if requested, in terms of the Promotion of Access to Information Act, 2000 (Act 2 of 2000).

(m) A generator, transporter, treater or disposer of health care risk waste must submit all the information contemplated in subsection (2)*(j)* to the Department at a frequency to be prescribed by the Provincial Minister, and the Provincial Minister may stipulate the format and the specific dates for submission of such information.

(n) A generator, transporter, treater or disposer of health care risk waste must, within a prescribed period after the promulgation of this Act, register with the Department by submitting to the Department a duly completed registration form that is available from the Department.

(o) A generator, transporter, treater or disposer of health care risk waste must perform and record internal audits at a frequency to be prescribed by the Provincial Minister, and must make them available to inspectors on request.

DEA&DP developed the Health Care Waste Management Bill of 2006, now called the Western Cape Health Care Waste Management Act, 2006, in order to (among others) legislate the registration of health care waste generators and the reporting of relevant information.

The regulations, under the Western Cape Health Care Waste Management Act, 2006, operationalise the Act and once this occurs the registration and reporting to IPWIS *(incorporating IHCWIS)* becomes mandatory. The establishment of IPWIS *(incorporating IHCWIS)* as the OPP will then be achieved. The process followed in developing and finalizing the OPP is illustrated in Figure 5.5 below.

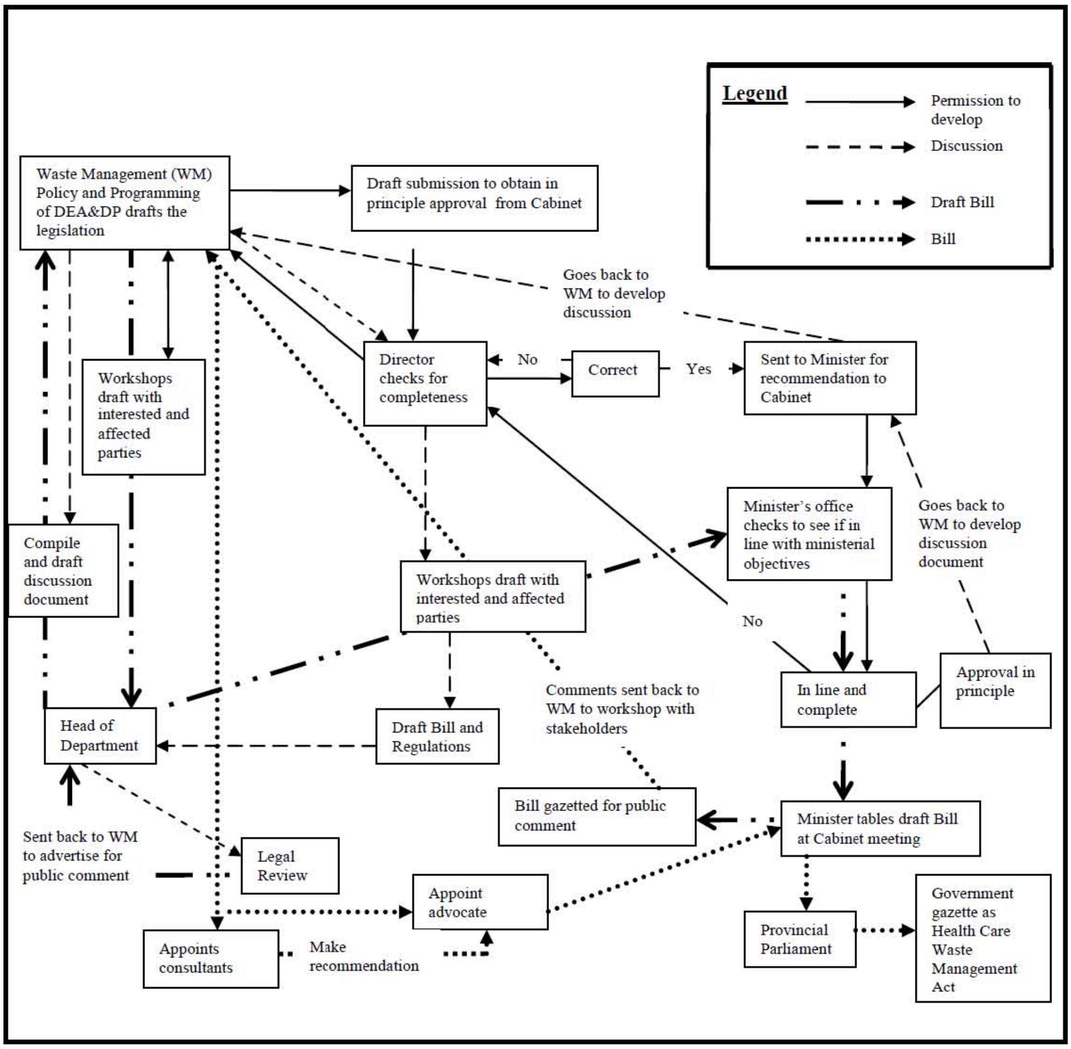

Figure 5.5: Developing and finalizing the OPP

Four workshops were held on 17 and 24 February 2005 and on 1 and 3 March 2005 in the four Health Districts of the Western Cape, viz., West Coast Winelands (Saldanha Bay), Southern Cape Central Karoo (George), Boland-Overberg (Grabouw) and the Cape Metropolitan (Brackenfell). The purpose of the workshops was to introduce the Health Care Waste Management Draft Bill to the public, health care service providers, other government departments and municipalities, as well as to extract comments and concerns about the draft document from the relevant stakeholders. At the end of each workshop a brief summary was given about the Department's thinking on Regulations to support the Bill and to get some idea of what stakeholders would like to see included in such Regulations.

The inputs from these workshops formed the basis of the regulations. The regulations were drafted, forwarded to the relevant legal sections, redrafted until it was finally ready for submission to Cabinet for approval and promulgation. In spite of these efforts, the regulations are yet to be approved by Cabinet (as at 2011). The consequence of this is that the finalisation of IPWIS *(incorporating IHCWIS)* as the OPP is now being delayed and registration with and reporting to IPWIS *(incorporating IHCWIS)* is not mandatory. The actors cannot go through the OPP and everyone, including the key actor, finds themselves in limbo. Regarding the approval of the regulations of the Health Care Waste Management Act respondent KA01, the key actor responsible for IPWIS *(incorporating IHCWIS)* project management, clearly showed his frustration regarding the delay. This was his response during the interview conducted with him:

> It's sitting somewhere in Cabinet. My understanding. The detail around that maybe "E" is the best person to speak to. I do not know what the status of that is. I'm just waiting for them to

> tell me, right, we're ready for them to register and I must indicate to our guys to open the system on the Internet so that people outside of the department can access it.

Another event transpired which further impacted on the OPP, and that is the passing of the National Environmental Management: Waste Act, 2008 on 06 March 2009. According to another key actor, respondent KA02, the passing of the regulations by Cabinet is now further delayed by the passing of this Act. The dilemma now for the health care waste regulations is that it 'speaks' to the Environment and Conservation Act and not to the Waste Act. The reason for this is that the Waste Act was still a draft Bill during the development of the Health Care Waste Management Act.

DEA&DP now have two options: amend the regulations so that it speaks to the Waste Act or follow the entire procedure of developing new health care waste regulations for the Waste Management Act. The latter process could take years. DEA&DP has not yet taken a decision as to their course of action. Irrespective of which course of action will be taken, the OPP will not be finalised for some time and therefore passing through the OPP will not be mandatory and actors do not have to engage with IPWIS *(incorporating IHCWIS)*.

So what effect does this delay have on the rest of the actors in the network? Very little because, in spite of this, actors are still engaging with IPWIS *(incorporating IHCWIS)* mainly because of the threat that unmanaged health care waste poses as well as the acceptance and recognition for the need of IPWIS *(incorporating IHCWIS)*. In spite of some of the actors having little knowledge of IPWIS *(incorporating IHCWIS)* software they are still of the opinion that IPWIS *(incorporating IHCWIS)* as a record keeping system and information data base will assist with future decision making regarding the management of health care waste.

This fact is typified in the following response of respondent WM03, an actor responsible for waste management:

> I know too little of the software, to really tell you how beneficial it would be in the long run for an organization like the Municipality and also for Government to have all this on record. I can just think that the more record-keeping you have and the better the record-keeping is, the better you can make decisions in the future. And to me, this is an ideal tool that could be utilized by the Municipality and by Government to look at the Waste scenario in South Africa and to manage it better with the information on hand because up to now I think that's one of the big problems in Waste Management and that is that the information available is not representative enough and I think is, at many times, totally unreliable.

It is thus not vital that the OPP be finalised (in the legal sense) before subjecting actors to it. The mere acceptance of the idea of the OPP and the perceived benefits that will result from the effective management of health care waste seem to be sufficient. The other fact is that the actors are aware that the OPP will inevitably be finalised and delaying engagement with IPWIS *(incorporating IHCWIS)* means delaying their own processes. Waste managers WM01 and WM03, in their interviews, envisaged that IPWIS *(incorporating IHCWIS)* will make a difference in the way that health care waste is currently managed and thought that engagement with IPWIS *(incorporating IHCWIS)* would result in interactions between local and provincial government. They also thought it necessary to forward information to IPWIS *(incorporating IHCWIS)* and not let it pile up within their own system. They said that accumulating and piling information could result in it becoming unmanageable once you decide to use it. The responses of the waste managers WM01 and WM03 during an interview were:

> What I've learnt is that I think there's a lot of work to be done for Municipalities. I think once IPWIS is running, I think it is indeed going to make a difference because each Municipality is going to provide info to the Province which is the Department of Environmental Affairs and Development Planning. With that respect I think what we in fact should do is that the information that we provide to Province is going to be captured and there's going to be interaction between Municipalities and the Provincial Department of Environmental Affairs.

> One of the ultimate objectives, is to put information into the system on a regular basis and not let it, let the stuff pile up and do it once every second or third month. If you do populate your databases on a regular basis and feed that the system into the databases or your information into the system on a regular bases and not even once a month, I mean, one should actually do that at least once a week or and needed, even once a day. Certain information then that should, by doing that, one should actually, to a certain extent, prevent the problem that you have that you'll find yourself at one specific time that you cannot manage it.

The alignment of the interest of IPWIS *(incorporating IHCWIS)* to the day-to-day management of health care waste makes it possible for actors to naturally engage with each other. This is supported by the response given by one of the respondents responsible for waste management, Respondent WM04, who said during the interview:

> The system is about, when you, in a community, you take the complaints of the community and put it into the system and from there you work out, get various people involved, in order to get maybe a project going, or to get a solution also.

The National Environmental Management: Waste Act not only caused unnecessary delays in the finalisation of the secondary OPP (the primary OPP being IPWIS *(incorporating IHCWIS)* and the secondary the Western Cape Health Care Waste Management Act, 2006) but now also acts as and forms a third OPP. This Act also legislates the development and implementation of a provincial waste information system which must include the information required by the national information system.

The purpose of the Act is to provide for, among others:

- institutional arrangements and planning matters;
- national norms and standards for regulating the management of waste by all spheres of government; to provide for specific waste management measures;
- the licensing and control of waste management activities;
- the national waste information system;
- compliance and enforcement; and to provide for matters connected therewith.

Section 1 of the Act states:

(1) The Minister must establish a national waste information system for the recording, collection, management and analysis of data and information that must include—

(a) data on the quantity and type or classification of waste generated, stored, transported, treated, transformed, reduced, re-used, recycled, recovered and disposed of; and

(b) a register of—

(i) waste management activities that have been licensed;

(ii) the holders of waste management licenses authorized to commence the waste management activities recorded in terms of subparagraph (i); and

(iii) the locations where the licensed waste management activities are or may be conducted.

Section 2 states:

(2) The waste information system may include information on—

(a) the levels and extent of waste management services provided by municipalities:

(b) information on compliance with this Act: and

(c) any other information that is necessary for the purposes of effective

The objective of the national waste information system is to —

(a) store, verify, analyze, evaluate and provide data and information for the protection of the environment and management of waste;

(b) provide information for the development and implementation of any integrated waste management plan required in terms of this Act; and

(c) provide information to organs of state and the public —

(i) for education, awareness raising, research and development purposes;

(ii) for planning, including the prioritization of regulatory, waste minimization and other initiatives;

(iii) for obligations to report in terms of any legislation;

(iv) for public safety management;

(v) on the status of the generation, collection, reduction, re-use, recycling and recovery, transportation, treatment and disposal of waste; and

(vi) the impact of waste on health and the environment.

Furthermore, the Minister may establish a provincial waste information system. A provincial waste information system must at least include the information required by the national information system. The Minister may, by notice in the *Gazette* or in writing, require any person to provide, within a reasonable time or on a regular basis, any data, information, documents, samples or materials to the Minister that are reasonably required for the purposes of the national waste information system.

In summary actors were convinced that IPWIS *(incorporating IHCWIS)* is the solution to adequately manage health care waste by the following factors:

- threat that unmanaged health care waste poses
- acceptance and recognition for the need of IPWIS *(incorporating IHCWIS)*
- perceived benefits that will result for the effective management of health care waste
- OPP will inevitably be finalised
- delaying engagement with IPWIS *(incorporating IHCWIS)* means delaying their own processes.
- value that actors bring to the network and the fact that IPWIS *(incorporating IHCWIS)* assists actors with their own waste management strategy
- alignment of the interests of IPWIS *(incorporating IHCWIS)* to the day-to-day management of health care waste.

This concludes the discussion on the establishment of IPWIS *(incorporating IHCWIS)* as the OPP and we will now focus our attention on the status of IPWIS *(incorporating IHCWIS)*.

Status of IPWIS (incorporating IHCWIS): In spite of the secondary OPP not being finalized yet, IPWIS *(incorporating IHCWIS)* has now been developed and ready for implementation. DEA&DP is planning to first train their staff internally and once that is done deploy IPWIS *(incorporating IHCWIS)* within the department. This means that once the system is deployed all staff will have to work on it, thereby operationalising IPWIS *(incorporating IHCWIS)* and paving the way for provincial wide deployment. When the other actors forward information to IPWIS *(incorporating IHCWIS)* then there will be a trained official at the other end to accept, process and validate it.

During the interview the key respondent responsible for IPWIS *(incorporating IHCWIS)* project management, Respondent KA01, had this to say regarding the status of IPWIS *(incorporating IHCWIS)* and its deployment:

> Ready for deployment we are busy training our officials to actually deploy the system internally. Deployment basically means internally we have to use the system to perform our daily tasks and that means if we investigate a complaint we respond to an incident we'll have to do it through the system. If a particular facility requires a license and which needs to be inspected from a compliance perspective we conduct those operations using IPWIS. Everything will be determined, any data, any correspondence will be done through the system. The problem we are having is we cannot train people all at once. We don't have a venue for the training which is making it a bit complicated because we are working with an existing infrastructure that's work based so what basically happened is that we have trained certain staff but we need to train all staff before we can deploy it internally because once we deploy internally that mean everyone must work on the system.

Notwithstanding these plans, DEA&DP are experiencing infrastructure problems in training all staff. The internal deployment and widespread implementation of IPWIS *(incorporating IHCWIS)* and capacity building initiatives are hampered by problems such as poor network infrastructure, computer network instability, network traffic, problematic servers, system errors and the slow response in finding adequate solutions to network and other ICT related problems. These problems were expressed by Respondent SD01, a systems developer, who said during the interview:

> Well because its (IPWIS) not live yet, its on the outgoing stage now it hasn't affected that much but work has come to a, I would not say standstill, but it has dragged a bit more because out of the original 20, I would say 21 staff we have three four running mainly on it right but the rest of the guys is starting to get back on to it now. We used to be 12, 14, but as you know a lot of the guys left now so we now we having to build up that capacity again. Furthermore I would say it hasn't stalled or halted in any way to be honest with you. My main concern is I would actually like to see how the application holds down say about a thousand users 'cause I have not seen it yet I'm not sure the application can run on a thousand. Understand what I'm trying to say? I have not have, where I can say 250 users on the application at once… It handled the 95 but the network went slow. That's why we addressed the network but now we need to cater to see if the application can handle it. The network should be able to handle about 500 users now at once but the application, I can't be certain about it yet because I did not have that amount of users coming through with the data flow.

The analysis of workshop participation questionnaires (the workshop organisers collected the raw data and the researcher analysed it) revealed the following concerns regarding the usability of IPWIS *(incorporating IHCWIS)* (IPWIS Training Workshop, 2007):

- Upgrade of network and sound system
- Server was off
- Server was interrupted
- Problems experienced with the programme affected session flow
- System errors to be sorted out to ensure that every module can be exercised
- Access to the system needs attention

- Improve and make sure system is up and running effectively
- Computer and network is slow
- Sort out network
- Open telephone line for giving advice when uncertain what to do next on the system

Other problems were experienced in appointing suitable skilled human resources to fill vacant posts and it became difficult to retain the staff when those posts were filled. The filling of vacant posts was further delayed by the development of generic job descriptions. Vacant posts resulted in heavy workloads for existing staff which placed them under tremendous pressure. The Directorate: Pollution and Waste Management's current state is not one of ideal operational effectiveness because its components and staff are fairly new. The work currently being conducted is that of gathering information in reaction to its responsibilities.

In summary, we have discussed where the need for IPWIS *(incorporating IHCWIS)* originated, how it was recognized as a possible solution, how DEA&DP established itself as the key actor, who the other actors are, their roles and interest. We also discussed IPWIS *(incorporating IHCWIS)* and the Acts as OPPs, talked about the current status of IPWIS *(incorporating IHCWIS)* and the problems associated with its deployment and implementation. We will now focus our attention on the alignment of interest and identify possible ways in which such a variety of interests could be used to benefit a project.

Interessement

An act of interessement occurred when the Department of Environmental Affairs and Development Planning identified, defined and stabilised the identities of all those who needed to report to IPWIS *(incorporating IHCWIS)*, and then developed and cemented links between itself and them. The promulgation of the Western Cape Health Care Waste Management Act of 2006 could also be seen as an act of interessement. This is because the Act has, as Lee and Oh (2006) put it, 'a legal binding force, and the potential acceptance of the legal force by various other actors would suggest their confirmation' that IPWIS *(incorporating IHCWIS)*is the OPP addressing the problems of poor health care waste management or realizing the interests of various actors.

The DEA&DP used various information sharing and training workshops to convince other actors to interact with IPWIS *(incorporating IHCWIS)*. The various actors were persuaded that registering with IPWIS *(incorporating IHCWIS)* and reporting on a regular basis would also assist them with managing health care waste within their own municipalities. By doing so DEA&DP started the process of aligning the perceived benefits of IPWIS *(incorporating IHCWIS)* to the waste management practices and strategies of the various municipalities and health care facilities, and also alluded to the fact that their interests are the same as that of IPWIS *(incorporating IHCWIS)*. The perceived benefits of IPWIS *(incorporating IHCWIS)* were recognized and understood, resulting in actors indicating that they would engage with and use IPWIS *(incorporating IHCWIS)* by reporting on a regular basis. The information system managers view IPWIS *(incorporating IHCWIS)* as being beneficial to them in that it can keep them updated and informed of information changes. Engaging with IPWIS *(incorporating IHCWIS)* will also assist them in their application for permits to operate for example, a landfill site. Furthermore, IPWIS *(incorporating IHCWIS)* could inform them of the status of health care waste management, how much wastes are generated and how it is disposed of or minimized. These aspects were communicated by Respondents MIS01 and MIS02, two information systems managers, who revealed the following during their respective interviews:

> Because the information that we need to upload onto the system, change regularly or is changing regularly. The main purpose of the system is to get the updated information so in future, report maybe once a year or once every six months, then there's no use of the system.
>
> It's important that we have to inform them of our activities, well, otherwise how they are going to know how many waste is generated in Cape Town or how many waste is disposed of or how many waste is minimized. So we have to report to them. And it's also important for us to, with regards to our permit for a landfill site and stuff to report to them.

Another interesting benefit which developed was that interacting with IPWIS *(incorporating IHCWIS)* is actually perceived as providing a collective effort for addressing the challenges faced by municipalities. Engaging with IPWIS *(incorporating IHCWIS)* results in engaging with other actors in finding solutions to the issues faced by municipalities. Responses from the various actors provided clear indication that they accept the roles given to them by the key actor and that their interests are catered for. This is supported by their willingness to participate in submitting information to IPWIS *(incorporating IHCWIS)* on a regular basis and is clearly articulated in the response given by one of the waste managers, Respondent WM01, who said during the interview:

> Yes, I think we have that obligation to report to IPWIS and to, but like I say there are many challenges because you know, we have staff shortages around the country as well, so I think within the Waste Management itself, we need to report to IPWIS whether it is daily or quarterly or monthly but we need to record that data. Because I think it's a requirement from IPWIS to record and I think it's for engagement from the Provincial side to, amongst Municipalities and so on. So once we recorded it, I think it is really about working together and finding solutions because at the end of the day this is going to happen and specifically to what Air Quality Management, you get the Air Quality Management Act, for example which takes on a lot of things. And the Environmental Management Act, so I'm talking about NEMA *(referring to the National Environmental Management Act)*. So I think for those purposes and what Municipalities and Waste Manager and Air Quality Managers in the Province should do is report on the finding within each Municipality and then afterwards I think it's about getting solutions and how to deal and tackle and to get to grip with challenges within Municipalities.

In summary, during the interessement moment of translation DEA&DP persuaded other actors to accept its definition of their interest by convincing them that it was consistent with what their own interests should be. DEA&DP alluded to the fact that the various actors were faced with the same challenge of managing health care waste effectively and efficiently. This was done by drawing their attention to the existing problems that they were experiencing and how IPWIS *(incorporating IHCWIS)* was established to face and address these. How these interests were enlisted so that the desired performance of IPWIS *(incorporating IHCWIS)* can take place will now be discussed during the moment of enrolment.

Enrolment

Enrolment is the third moment of translation and viewed as the creation of alliance networks with the aim of building an agreement among the stakeholders concerning their interests (Alcouffe *et al.,* 2008). Enrolment mainly took place via a series of training, information and feedback workshops. In general, each workshop was divided into two work sessions during which participants were grouped into three groups, each with a facilitator (Officer) using a table with pre-determined questions for discussion (See Table 5.9 below for an example).

Table 5.9: Workshop predetermined questions and responses

QUESTIONS	GROUP RESPONSES		
	GROUP 1	GROUP 2	GROUP 3
Are the people designated to be inspectors appropriate And are they sufficiently empowered	No, Insufficient training. Need to be delegated to law enforcement section. Job description must be specified	No, Regulations should deal with qualifications	No, training. Delegation to certain people in disaster management team every local auth should know who does what. Distinguish between inspectors from justice department. Important for inspector to be able to show expertise.
Are municipalities adequately empowered by this legislation?	Yes not sure about capacity. Has SALGA been involved? Has Minister of Local Government been involved? Suggestion: Specify that inspectors can enter without prior notification. Inspections: specify any time or reasonable time.	Yes, but reword section on fines.	Yes and No

The workshops consisted of formal presentations and group work sessions. Different members of the DEA&DP Project Team gave presentations on aspects covered by the

Bill and Regulations while the administrative support personnel rendered general assistance.

Table 5.10: Interest and concerns expressed by actors

Legislation	Health care waste management	Roles and responsibilities	Training
Input on Bill and Regulations Clear idea of comments on Bill Find out about Bill and how to improve systems Understand how Bill will implicate work (functions) especially of municipalities How Bill will be implemented Hope that Bill will require financial provision to be made for hcwm Understanding of Bill and how it will reinforce Health Act How can hospital comply to Bill Means of implementing and enforcing the Bill Clarity on standards of Bill, are they implementable or not. Practical and affordable legislation Health wants simple, practical, affordable, effective and efficient legislation.	How HCW from home-based care will be addressed, especially removal Hope that it will come up with reasonable practices for managing health care waste in rural areas (clinics etc.) Improve medical waste management No expired medicine lying around Community medical waste handling Clinics- what to do with nappies etc (infectious waste) of hiv babies in communities Safe waste system for children No standardize system to handle waste i.t.o disposal- clarity on this Health care and community worker safety to be addressed Standardized procedures for health care workers Don't want to see expired medicine lying around. What do patients do with medicines ones finished with it.	What will the role of Environmental Health Practitioners be in terms of the implementation of the Bill Advise Roles of Environmental Affairs in public Health Roles of generator Control of HCW. Contractors to comply and ensure protection of workers Role of environ affairs in protection of environ health. Clarity on responsibility of generators.	Training for all handlers including general workers Protection and training of health care workers in HCWM Workshops for handlers of waste in hospitals. Environmental Health Programmes- Any in place? To make sure Bill covers protection of health care workers and gives training.

During each workshop participants were requested to list their expectations, interests and concerns. These various interests and concerns revolved around (as shown in

Table 5.10 above) legislation; health care waste management; roles and responsibilities; and training. Members of the Project meetings Team (key actors) assisted with meeting these expectations and addressed the concerns via a series of follow up meetings.

The key actor used workshops as the main strategy for enrolling other actors but this was not acceptable to all actors. This was mainly due to the nature of the workshops and how they were arranged and conducted. Concerns were raised that it appeared that invitations to the workshops were forwarded to actors as a means of getting attendance rather than being purposeful. Being purposeful in this context meant enrolling actors into the newly established network with the purpose of re-defining their roles.

With workshops not being compulsory actors would send representatives for the sake of sending them, irrespective of whether they could make meaningful contributions or not. A more direct approach such as personal meetings would have obtained more meaningful contributions. These were alluded to by Respondent SP01, a service provider, who commented as follows during the interview:

> Workshops are not compulsory, you are not directly questioned, if you wish you can send a participant if you don't know one is going to blink an eye. But if you have a direct appointment with somebody you probably will get better co-operation. So it is direct one-on-one, you get the information, apply whatever needs to be done and you get going. Workshops tend to lose that personal interaction, you are one of the numbers and it's actually very dangerous.

Workshops, as the main form of enrolment, in itself was inadequate to create alliance networks with the aim of building an agreement among the stakeholders. Workshops only attract those who wished to attend or were "forced" to attend (by their employer), thereby losing out on potential meaningful alliances. DEA&DP recognised this shortcoming and envisaged other enrolment strategies such as awareness campaigns, utilization of printed and audio media and going on road shows to publicise IPWIS *(incorporating IHCWIS)* and educate all relevant stakeholders. These were referred to in the following response from the key actor responsible for IPWIS *(incorporating IHCWIS)* project management, Respondent KA01:

> We will campaign around the registration and deployment of the system, requesting industry to register. Part of the registration is a whole media campaign that will educate the people who are in this sector. If you are a medic healthcare waste handler generator, you will have to register. That's basically how we're going to conscientise people that they will have to register. There's nothing else beyond the information that I have looked at. That's basically it. The media campaign will be - like radio, different media, the newspaper, it could also be other things in raising awareness like posters and pamphlets.

During the enrolment phase the key actor should also be aware of the manner in which actors interact with other organisations and who or what determines this interaction. Responses extracted from questionnaires distributed and obtained from health care facilities (See Table 5.11 below) indicate that they interact with other organisations and that their ways of interaction is determined via the same factors i.e. meetings, mail, electronic media, discussion, written media, management structures and service delivery. The key actor could use these as avenues for enrolment.

Other means of enrolment is to make IPWIS *(incorporating IHCWIS)* compatible with the existing information systems used by municipalities. This would avoid duplication and would also give value to the municipality's systems thus providing an environment of inclusiveness.

Table 5.11: How, who and what determines interaction

Theme	**Interaction with other organisations**		
	Theme	**Sample quote**	**Respondent**
Meetings Mail Electronic media Discussion Written media Management Structures Service Delivery	Meetings	"meetings" "feedback meetings" "HDMT mtg -" "Quarterly meetings" "Health committee meetings; community based meetings" "We could have monthly or quarterly meetings" "District meeting for Waste Management"	HCF01; HCF02; HCF04;HCF07; HCF08; HCF10; HCF11; HCF12
	Mail	"mail" "circulars"	HCF01; HCF02; HCF04
	Electronic media	"telephone" "fax" "e-mail"	HCF02; HCF06; HCF07; HCF08
	Discussion	"Sharing best practice" "...where business plan of the city is discussed at top management level"	HCF05
	Written media	"We will have to comply with all protocols of policies" "Through maybe quarterly reports"	HCF09;HCF10; HCF13
	Ways interaction is determined		
	Theme	**Sample quote**	**Respondent**
	Written media	"Policy"	HCF01;
	Service Delivery	"Availability of service of the city" "planning of immunization campaigns" "Depending on who won the tender for removal of waste"	HCF03; HCF05; HCF09;
	Management Structures	"Management" "District management" "Top and middle management" "City Health Director" "Executive director of health" "Management organizes the interaction/meetings"	HCF05; HCF06; HCF07; HCF08; HCF09; HCF10; HCF11; HCF12

A smooth and inclusive enrollment process creates trust and understanding making convincing the actors, to take on their different roles, so much easier. These were put forward by two waste managers, Respondents WM05 and WM06 during their respective interviews:

> …you see what we, we've got a collaborator system running at the District Municipality. So we almost got a similar system but we asked the guys from Province to actually co-ordinate the two or link the two up with each other otherwise it won't help us to, because we're using a other system than Province, you see? So they must look into that.
>
> You see, but what we've asked them with the IPWIS course, because we've got a Groupwise system. If we can just, if they can do it, you know, that it's the same as Groupwise because we've already got a Groupwise system at our place.

In summary, enrolment mainly occurred via IPWIS *(incorporating IHCWIS)* information and training workshops. These seem to be problematic in that they were perceived to be exclusive rather than inclusive. DEA&DP recognised this and proposed other means of enrolment e.g. embarking on a provincial wide roadshow. However, actors were successfully enrolled in that they took on roles and responsibilities as defined by DEA&DP. We will now concentrate on how the actors were mobilised in order to stabilize the network.

Mobilisation

Mobilisation is the final moment of translation where the actors within the network remain loyal to the key actor and start acting as spokespersons for the key actor. Successful enrolment of the other actors and aligning IPWIS *(incorporating IHCWIS)* (See previous discussion on interessement), to the waste management practices and strategies of the various municipalities and health care facilities, created the ideal opportunity for actors to become spokespersons for the key actor. The service providers were now becoming spokespersons for DEA&DP. For example, when they collected the health care waste from the health care facilities they educated the facilities on the importance of record keeping. The following response from a service provider, Respondent SP01, illustrates this point:

> …what I mean by that is we doing health care waste management in the Western Cape, we have started by telling the waste generators, that is hospitals, clinics, maternity wards, private and public, to make absolutely sure of the volumes that they generate. To tell us everything so that we in turn can get that volumes documented, which we are doing, and share that information with them.

Actors will also take action on behalf of the key actor by challenging each other to release information in the pursuit of becoming more environmentally responsible and address the issues of poor health care waste management. The information that needs releasing should contain amounts and types of health care waste generated and transported, types of pollutants, and best practices followed. This became evident when a service provider, Respondent SP01, stated that:

> I will personally challenge them saying "we going to make this information available and I invite them to be seen as an environmentally and responsible by starting to share information. I think I will convince a couple of people... I'm looking at waste generators, waste transporters, other waste management companies and disposal facilities to come to the front and what they get, say what they transport, talk volumes, talk products, look at the pollutants, look at best practices

Level one analysis allowed us to follow the actors through the process of the four moments of translation. If a specific moment of translation is not successful then one has to go back to previous moments. As the moments become successful so does the network grow and network stabilization increase and become established. But it does not get institutionalized yet. An established network only shows establishment and does not signify or guarantee institutionalization. Merely following the actors is just observing them through the moments of translation. Following the actors could be seen as an instrument of analysis to determine if the network is in the process of getting established, grow and become stable. It doesn't reveal anything about institutionalization or the effective and efficient use of the network. By doing so we observed that the moments only move from one to another if the prior moment is successful. In the event that a moment of translation is unsuccessful the process will have to revert back to the previous moment (See Figure 5.6 below).

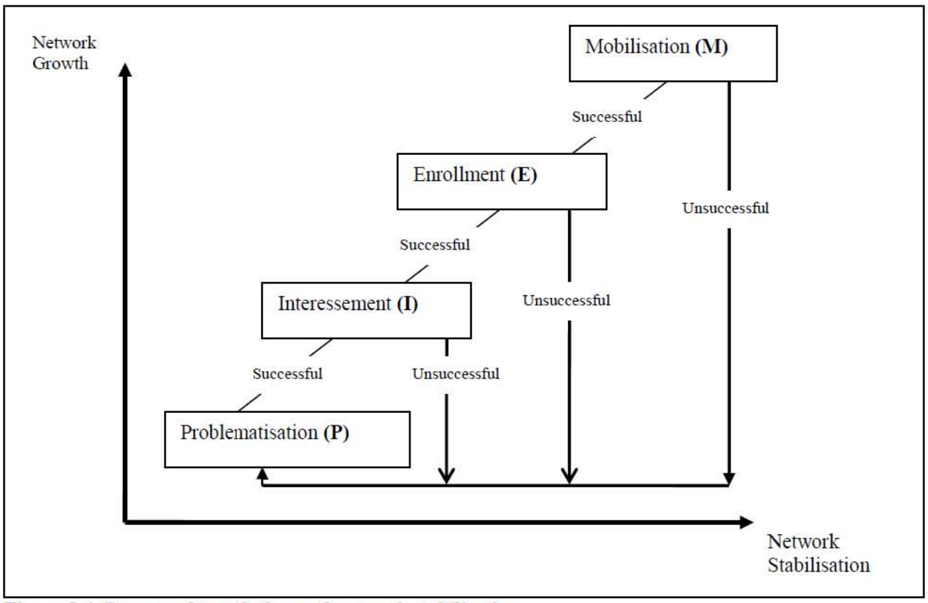

Figure 5.6: Process of translation and network stabilisation

The actors were previously enrolled and mobilised through a series of training workshops where they interacted with IPWIS *(incorporating IHCWIS)*. However, more than a year elapsed without actors engaging with IPWIS *(incorporating IHCWIS)* (due to the OPP not being finalised yet) and some of them had already forgotten how to interact with IPWIS *(incorporating IHCWIS)*. DEA&DP will now have to go back to the interessement and enrolment processes.

It must be reiterated that the process of translation is necessary to enhance and facilitate the establishment and stabilization of IPWIS *(incorporating IHCWIS)*. Successful translation through all moments only showed the establishment of a stable network of interested actors aligned around the use of IPWIS *(incorporating IHCWIS)*. This, however, is not sufficient to ensure its eventual institutionalisation. To investigate this we carried out a second level of analysis.

5.3.2 Level 2 Analysis : Institutionalisation of IPWIS*(incorporating IHCWIS)*

During level one analysis we interpreted data through the lens of the four moments of translation. In level two analysis we use a different lens which focus on factors that could contribute to institutionalization. The institutionalisation of an information system entails stabilising its processes to such a degree that its associated practices become routine. Information systems become institutionalized when they are no longer considered as novelties, but as unnoticed and unremarkable tools (Silva and Backhouse, 2003). Figure 5.7 below illustrates a comprehensive framework for the process of institutionalising an IHCWIS as derived from the level one analysis.

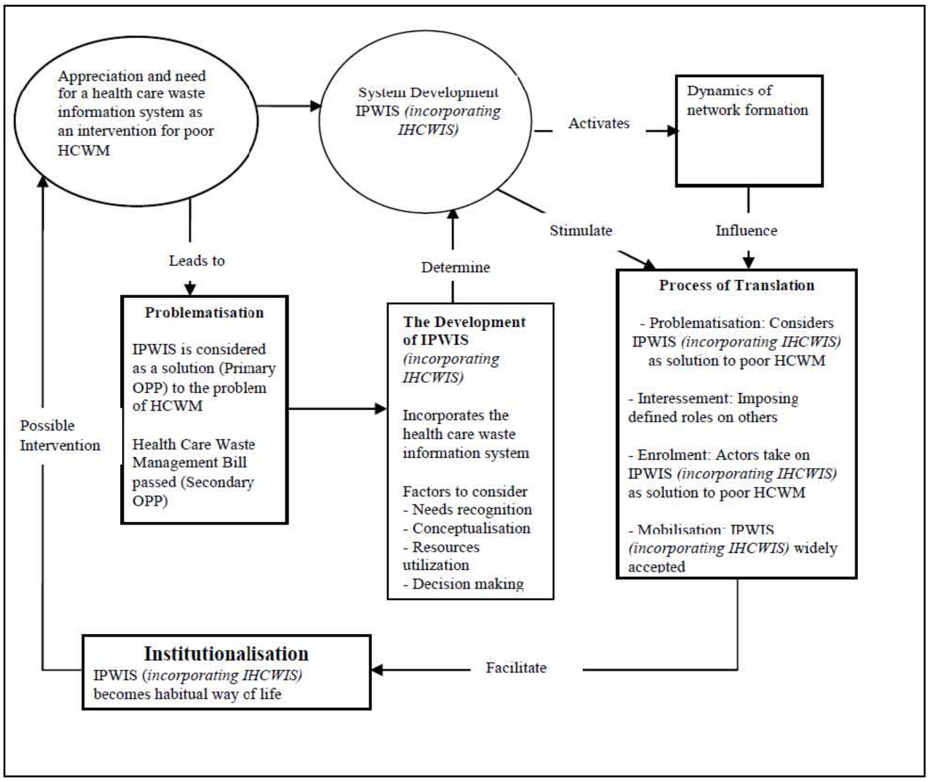

Figure 5.7: Framework for the institutionalisation of IPWIS *(incorporating IHCWIS)*

Level 2 analysis focuses on how IPWIS *(incorporating IHCWIS)* gains acceptance as normal custom and practice and thereby could become institutionalised. Some of the discussions will be specific to IPWIS *(incorporating IHCWIS)* as the primary OPP (It is compulsory, by law, for relevant actors to register with and report IPWIS *(incorporating IHCWIS)* and in this context we refer mainly to hardware and software), but what requires institutionalisation is IPWIS *(incorporating IHCWIS)* as the all encompassing network. When we now discuss IPWIS *(incorporating IHCWIS)* we refer to the all encompassing process including the software and hardware system, all the actors and everything that needs to be done and that is to institutionalized, IPWIS as the network.

The review of the literature (Chapter 2, page 59) revealed that leadership involvement, adoption, adaptation, government support, ICT Infrastructure, organizational structure and culture, and transparency in information sharing are all critical to the success of institutionalisation. Tied to and in addition to this, the following success factors of (**emerged from the level two analysis process (not the literature) and which became factors complementing the sociology of translation and facilitated institutionalisation**): (1) effective user participation during systems development (2) dedicated information officers (assigned to IPWIS *(incorporating IHCWIS)* functions); (3) informatics competencies; and (4) System integration. (See Tables 5.12 and 5.13 for examples on how these factors emerged). These factors will now be discussed in detail.

(1) Effective user participation during IPWIS *(incorporating IHCWIS)* development

According to Avison *et al.* (1998) any IS methodology that relies overly on technical rationality is, by itself, an insufficient foundation for IS development. It should be recognized that needs of computer artefacts, organisations, and individuals must be considered jointly. An IS development exercise should generate robust technical artefacts that support purposeful organisational activity and take into account the needs and freedom of the individual. The failure of health care information systems to realise their full potential could be attributed to failure in user involvement and education (Ball, 2003).

Tarafdar and Vaidya (2006:440) support the idea of information professionals interacting with the organisation and users when they state that:

> information systems professionals should be encouraged to increase their knowledge about current technologies, develop professional affiliations in their specialised fields and increase their understanding of the organisation. Mechanisms and programs should also be instituted to increase the interaction between information systems professionals, line managers and end users, so that there are possibilities for interchange of ideas and transfer of awareness and interest.

An analysis of the interview responses (See Table 5.12 for an example) and relevant literature (See Chapter 2) was done to provide an in-depth understanding of effective user participation in information systems.

Table 5.12: Effective user participation: Example of categories and themes

Theme	Subtheme	Selected Responses	Respondent
Effective Participation	Contribution Feedback Value	I would say actively taking part in discussions or suggesting ideas, taking notes and feeding back to my own company possible ideas that were mentioned or raised. You are just another number partaking in a discussion without knowing that we could say something or do something.	SP01
	Value Contribution Value Feedback	I can't really say it was helpful because we just attended the training. But now we are not engaged with the System. We are not working with the system …the Provincial guys haven't come back to us to tell us about the System, whether it is ready to be used or not	MIS01
	Feedback Contribution	We actually had a meeting during last year some time with the guys of IPWIS and they would like to have our input in the system as well. So I think in conjunction with them or they with us rather, we can have input in the system and give them some feedback and give them recommendations on where they can better the system or make it even more user-friendly or whatever.	MIS02
	Value Contribution	I think in the Municipalities, sit down and try and determine what are the different kinds of information that is required to be put into the system and then determine it from there, according to the frequency of loading of information	WM03
	Feedback	To be updated as a clinic manager and to be on par with new developments	HCF04

By effectively participating in the development of IPWIS *(incorporating IHCWIS)*, users could make meaningful contributions, add value, respond to development issues through providing and receiving feedback. These will now be discussed.

Contribution: Users, by sharing their experiences can make a valuable contribution to the development and institutionalisation of an information system. Some of the actors have vast experiences regarding health care waste management and best practices. This has been highlighted by a service provider, SP01, who sated during an interview that:

> I have years of experience in waste disposal, waste collection, waste management. That is what I do, that is my whole life, it revolves around that. I learnt what other companies do by being there. Coming back to best practices, I feel that we and I have a major contribution to make.

According to Akesson *et al.,* (2007), healthcare delivery via information, communication and technology ICT e.g., telemedicine, is acceptable to patients in many different contexts. However, few studies report the consumers' opinion of the intervention itself. Consumers' experiences of ICT and the factors that influence consumers' satisfaction therefore, need to be incorporated when developing information systems. The experiences of the various actors which have been mobilised into the IPWIS *(incorporating IHCWIS)* network and their needs needed to be incorporated in the design and development phase of IPWIS *(incorporating IHCWIS)*. This incorporation was mainly done through the participation workshops and meetings (as discussed in the level one analysis) where DEA&DP took the concerns and contributions of the actors and incorporated it into the design and development of IPWIS *(incorporating IHCWIS)*. Repsondent MIS02, an information manager, had this to say during an interview:

> We actually had a meeting during last year some time with the guys of IPWIS and they would like to have our input in the system as well. So I think in conjunction with them or they with us rather, we can have input in the system and give them some feedback and give them recommendations on where they can better the system or make it even more user-friendly or whatever.

The contributions that health care facilities can make to IPWIS *(incorporating IHCWIS)* is illustrated through the health care facilities' responses regarding engaging with IPWIS *(incorporating IHCWIS)*, as presented in Table 5.13

Table 5.13: Contribution/s health care facilities can make to IPWIS *(incorporating IHCWIS)*

Theme	Sample Quotations	Respondents
Evaluators	- Comparison between clinics, districts, providers - Ensure correct, validated data is submitted - To put the proper practices in place	HCF01; HCF05; HCF16
Disseminators	- Feedback... - Forward data to respective data collecting points - Give information about what happening in my district and ground level - Provide information	HCF02; HCF04; HCF07;HCF10
Researchers	- Assist with research - Capture relevant data - Written reports from facilities as to the control and management of waste (medical waste)	HCF06; HCF11;
Partcipants/users	- Follow instructions - Team work - To follow set guidelines and policies	HCF06; HCF08; HCF14; HCF16

The health care facilities indicated that they could contribute by fulfilling the roles of evaluators by comparing management practices between themselves and service providers, validating data submitted, serve as disseminators of information, assisting with research and participants in decision making and policy processes.

Users can also contribute by determining the quality of information that needed to be reported to IPWIS *(incorporating IHCWIS)* and the frequency thereof. Respondent WM03, a waste manager, aptly stated during an interview that:

> …in the Municipalities, sit down and try and determine what are the different kinds of information that is required to be put into the system and then determine it from there, according to the frequency of loading of information.

Value: Some actors experienced some difficulties during the IPWIS *(incorporating IHCWIS)* training workshops. Some of the difficulties experienced (as expressed by key actor KA01, a project manager) were that those who attended the training workshops did not value IPWIS *(incorporating IHCWIS) and* generally viewed it as low priority. Even DEA&DP staff did not fully understand the implications of deployment and the functionality offered by IPWIS *(incorporating IHCWIS)*. Another difficulty was that actors themselves did not feel recognised and valued.

Some of those who participated in IPWIS (*incorporating IHCWIS)* training did not engage with the system and this created the perception that the training was of no value or helpful as one of the information managers, MIS01 during the interview stated:

> We just attended the training but now we are not engaged with the System. But the way I look at it, it's gonna be helpful but at the moment we cannot say it is helpful because it is not working.

Apart from engaging with the system some felt that despite their years of experiences they were not recognized and valued as having special/valuable knowledge and skills. In other words they were just seen as "one of the rest" or "just like the other" participants. A service provider, SP01, had this to say during an interview:

> We passed comment but I doubt it very much if it was valued because the people did not necessarily look up at us and said " Oh there's one of the two biggest waste management companies in South Africa; we should actually listen to them". Again I come back to the issue of we were one of the numbers and the value of what we said could be valued by the guy next door as just another comment. So not much value added. I have years of experience in waste disposal, waste collection, waste management...but in a workshop it was difficult. It's not always easy to stand up in front of a crowd and just talk. Crowd a couple of people together, there are other role players that you not sure what everybody's… honestly and again forgive me if I'm paranoid you don't know what the other people's intentions are. Say if I talk and others are just noting down there's a "big boy" talking and we need that information. It's difficult.

The health care facilities placed tremendous value on their contributions because it would assist them with, among others, assisting DEA&DP in rendering IPWIS *(incorporating IHCWIS)* to be functional, comparing themselves to other facilities and will provide them with the opportunity of being custodians of information. The value that actors bring to the network and the fact that IPWIS *(incorporating IHCWIS)* assists actors with their own waste management strategy are more reasons for engaging with and participating in the development of IPWIS *(incorporating IHCWIS)*.

Feedback: For the purpose of this discussion feedback is used in the context of how the key actor responds to the inputs given by the actors and the importance of feedback for healthcare facilities. When actors were granted the opportunity to provide input, they were not provided feedback regarding their inputs as the information manager Respondent MIS02, clearly stated during the interview:

> We had a meeting quite some time ago with the project team of IPWIS where they asked us for some input regarding the system. This unfortunately to my knowledge is where it ended.

DEA&DP did not inform and update the actors regarding the status and readiness of IPWIS *(incorporating IHCWIS)*. Respondent MIS01, an information manager, had this to say during an interview:

> We are not working with the system…the Provincial guys haven't come back to us to tell us about the System, whether it is ready to be used or not.

Table 5.14 Importance of Feedback

Theme (Based on variables contained in the questionnaire administered to health care facilities)	**Selected responses**	**Respondent**
Concerns during participation/ interaction with IPWIS *(incorporating IHCWIS)*	Not getting any feedback of data collected & reasons for collecting it; That it will only be more paper work with no real need; - Only someone's research and thereafter nothing else	HCF04
Awareness of IPWIS *(incorporating IHCWIS)*	Waste management feedback workshop	HCF04
Factors encouraging interaction with IPWIS *(incorporating IHCWIS)*	Regular feedback; Up to date and fast information technology; Feedback meetings and circulars; Good feedback systems and communication	HCF04; HCF07; HCF11
Factors hindering interaction with IPWIS *(incorporating IHCWIS)*	What systems is being put in place to report back; Are this just another administrative task no feedback to us	HCF09
Updating	To be updated as a clinic manager and to be on par with new developments	HCF04

The health care facilities underscored the importance of feedback when they responded (See Table 5.14 above) that feedback was a concern during participation and interaction with IPWIS *(incorporating IHCWIS)*; feedback workshops created awareness of IPWIS *(incorporating IHCWIS)*; and feedback plays a role in encouraging or hindering interaction with IPWIS *(incorporating IHCWIS)*. It was also important to receive feedback so that clinics could be updated and on par with the latest developments.

Importance of effective participation

Researchers and practitioners alike recommend the participation of the target users in the design and development of the information system as an important strategy. User participation needs to be mandatory rather than universal. Unfortunately, the information systems literature offers few guidelines for selecting user representatives to serve on a design team. This lack of guidelines easily results in system designers talking with the wrong users or managers assigning the wrong users to the design team (Saleem *et al.,* 2006).

Although the contributions of the other actors were taken into consideration none of them served on the design team of IPWIS *(incorporating IHCWIS)* as the OPP. The design team consisted of the project manager of DEA&DP, information technology specialists from SITA and Ce-I. Excluding the other actors from the design team basically meant that DEA&DP lost the opportunity to validate their contributions made, and to include social inputs for an in-depth needs analysis on IPWIS *(incorporating IHCWIS)* development. Various actors should be involved as early as the conceptualisation stage of an IHCWIS.

Table 5.15 below presents (responses were extracted from the questionnaires administered to the health care facilities) those who should be involved with the conceptualisation of a provincial wide health care information system.

Table 5.15 Participation regarding information systems conceptualisation

Participation in the process of forming the idea for a provincial wide health care waste information system		
Theme	**Sample Quotations**	**Respondents**
All role players in health care waste management	"All the role players..." "Stakeholders..." "Community" "waste management organization..."	HCF01; HCF02; HCF06; HCF10; HCF12; HCF15
Health care waste generators	"generators..."	HCF01;
Health care workers	"...health workers..." "Integrated health team" "Environmental health officer" "...both nursing, environmental health practitioners, medical officers" "Infection Control Officer"	HCF02; HCF04; HCF06; HCF07; HCF16
Health care waste service providers	"providers removing waste..." "waste people working with waste and pollution..." "Providers of service..." "medical Waste Disposal companies" "...and people will do the collection and processing of waste"	HCF01; HCF02; HCF03; HCF06; HCF12; HCF17
Managers	"...managers..." "... management..." "managers heading local institutions, organizations, i.e. all the heads whose organizations are involved in waste control/disposal" "all different sectors/managers of health care facilities in the..."	HCF01; HCF02; HCF13; HCF14; HCF16
Consumers	"Consumers"	HCF03;
Government	"...government provincial..." "Reps from PAWC-Health department" "City health department" "Provincial and city health" "Provincial government; local government"	HCF03; HCF07; HCF10; HCF11
Politicians and Policy makers	"...as well as politicians-policy maker" "policy task team" "...mayor; councillors..." "Province together with the M.E.C for Health"	HCF04; HFC05; HCF06; HCF08; HCF09; HCF11; HCF14
Information technology	"IT department..."	HCF06;

This denotes all stakeholders who are either directly or indirectly involved with health care waste management. Those who should be involved include managers, health workers, health care waste generators, service providers, politicians and policy makers, local and provincial government, as well as the information technology department. The reasons why they should all be involved (depicted in Table 5.16 below) are because of ownership, inclusiveness, efficiency, and the stakeholders indentified in Table 5.15 have the best knowledge/"know how" of health care waste management.

Table 5.16 Reasons for who should participate in the process of forming the idea for a provincial wide health care waste information system

Sub-theme: Reasons for who should participate in the process of forming the idea for a provincial wide health care waste information system		
Theme	**Sample Quotations**	**Respondents**
Inclusiveness	"To have input from all" "involvement of all needed" "These are all your role players" "Money is definitely involved therefore an MSAT approach must be followed- All stakeholders to be on board" "It will not work if only one party complies" "For well representation of all" "People on a lower level very seldom get involved with forming processes but, are expected to drive it"	HCF01; HCF04; HCF05; HCF16
Efficiency	"For efficiency of programme" "The information will disseminate easily to the facilities on the ground level"	HCF03; HCF13
Represent knowledge	"It is all the role players and decision makers in health in health care waste" "The staff is working in this situation" "They are suppose to serve the people of Cape Town" "They know best about Waste Management...E.H.O's know best how to preserve the environment"	HCF06; HCF07; HCF08; HCF10; HCF12
Ownership	"This will assist with people on the ground to own it"	HCF17

The impacts of the problems of health care waste are severely experienced at operational level and it is those working at that level who will ultimately be expected to drive the process of managing those impacts. Furthermore the information will eventually be disseminated to them. Participating in the design and development of IPWIS *(incorporating IHCWIS)* provides a sense of ownership to the users facilitating everyday interaction with it which in turn enhances the chances of instutionalisation.

Effective participation in IPWIS *(incorporating IHCWIS)* development should be seen as more than just serving on design teams. The other actors, as potential users of IPWIS *(incorporating IHCWIS)*, found it difficult to participate in the IPWIS *(incorporating IHCWIS)* development mainly due to the fact that the training workshops they attended were once-off and did not empower them. These once-off workshops merely introduced the other actors to the functionality of IPWIS *(incorporating IHCWIS)*, i.e., what IPWIS *(incorporating IHCWIS)* can do and how to work with IPWIS *(incorporating IHCWIS)* software. Alter (1996:246) views empowerment as 'giving people the ability to do their work, the right information and the authority they need. Information systems help empower people by providing information, tools and training'. Participation is about empowering users to 'become active partners in the regeneration of communities by contributing and sharing in the decisions that affect their lives' (Standing Conference for Community Development, 2001) and interacting with others to achieve change (Barr & Hashagen, 2000). Lane (2005: 293) argues that 'participation and empowerment, according to this concept of planning, become goals to be attained rather than methods to be used'.

Participation is also seen as a deliberative process aiming to incorporate all relevant interests, produce relevant information for environmental decision making, and achieving public agreement (Primmer & Kyllönen, 2006). Webler & Tuler (2000) introduce into public participation the principles of fairness referring to the opportunity for all interested or affected parties to assume any legitimate role and competence: the ability of the process to reach the best decision possible.

The process of participation incorporates and gives legitimacy to non-technical/scientific persons who enter the decision-making process and inform the decision in a different manner than scientific information. It does not substitute scientific knowledge, but supplements it (Glicken, 2000). Some authors (Buchy & Hoverman, 2000) view participation as an approach where participation is either an ideology (a specific ethos for community development) or a method, that is, a set of guidelines and practices of involving communities or the general public in specific planning activities. Actors were given legitimacy (in the context of participation) through the process of translation, where their roles and interests were incorporated and aligned respectively.

From the aforementioned discussion it is clear that only limited participation in the development of IPWIS *(incorporating IHCWIS)* (as the OPP) took place. The question we now ask is 'Was such participation active and thereby effective?'

Effective participation in IPWIS *(incorporating IHCWIS)* development and institutionalisation, would have occurred if the process included end user empowerment and/or control. This would still have resulted in a strong decision (the end users understand and accept) which is beneficial to the public, environment and relevant developing agency. Attempts were made by DEA&DP to educate and train the other actors, but this was merely aimed at interacting with IPWIS *(incorporating IHCWIS)* and did not result in capacitating the other actors to effectively participate in the design and development of IPWIS *(incorporating IHCWIS)*. Effective participation can only take place if the end users have the capacity to participate. An informed, educated and capacitated end user allows us to move away from, as Friend & Coutts (2005:166) put it, 'we know what's best for you culture'. Then again the 'we know what's best for you culture' is advocated by ANT theory in that the key actor impose roles and needs to convince the other actors that its own interest is the same as their interest (Callon, 1986).

IPWIS as a solution to the problem of health care waste was developed by DEA&DP and it could not capacitate other actors to change this or dictate what IPWIS *(incorporating IHCWIS)* should be or look like. If DEA&DP did this then it would surely have lost its status as the key actor and thereby would have endangered the stabilisation and institutionalisation of the network. Capacitating the users was therefore not a given and even if participation was prescribed by organisational policy and legislation (see previous Figure 5.5:Developing and finalising the OPP), it ultimately would have become the responsibility and task of the developing proponent, in this case DEA&DP, to design and implement the process. Participants in the IPWIS *(incorporating IHCWIS)* workshops were not granted the opportunity to say or do something and felt that they were just there to make up the numbers. During the interview a service provider Respondent SP01had this to say:

> I would say actively taking part in discussions or suggesting ideas, taking notes and feeding back to my own company possible ideas that were mentioned or raised. You are just another number partaking in a discussion without knowing that we could say something or do something.

Effective participation necessitates that the participation process starts early in the development project's conception phase. The users are too often involved at the late stages of a project and the proponents rely mainly on using the informing process as participation by posting notices and waiting for written submissions (Sinclair & Diduck, 2001 in Hunsberger et. al., 2005). Ivey *et al.* (2006) speak of two kinds of capacity: (1) capacity for action, a functional perspective where the focus is on efficiency and effectiveness; and (2) capacity for self-determination, a relation perspective in that everyone is involved with the establishment and achievement of project goals and agendas. Both these types of capacity building are needed if effective participation is to take place. Thus, effective participation is much more than just involvement but a process which ultimately leads to empowerment.

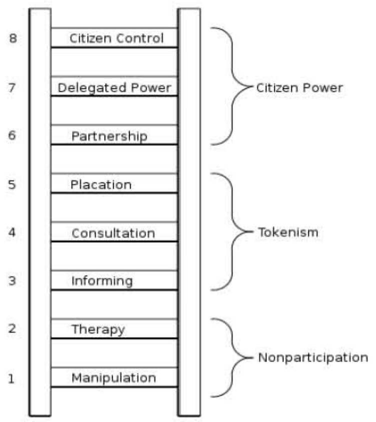

Figure 5.8 Eight Rungs on a Ladder of Citizen Participation (*Source: Arnstein, 1969)*

According to Arnstein's (1969) ladder of citizen participation (Figure 5.8), participation is grouped into non participation, tokenism and citizen power. Public participation can only be reached if there is control, delegated power and partnership. The bottom rungs of the ladder (1) Manipulation and (2) Therapy describe levels of "non-participation" that have been contrived by some to substitute for genuine participation. Their real objective is not to enable people to participate in planning or conducting programs, but to enable powerholders to "educate" or "cure" the participants. The levels of "tokenism" allow the have-nots to hear and to have a voice through (3) Informing and (4) Consultation. Under "tokenism" citizens still lack the power to ensure that their views will be heeded by the powerful. When participation is restricted to these levels, there is no follow-through, no "muscle," hence no assurance of changing the status quo. Rung (5) Placation is simply a higher level tokenism because the ground rules allow have-nots to advise, but retain for the powerholders the continued right to decide. Further up the ladder are levels of citizen power with increasing degrees of decision-making clout. Rung (6) Partnership enables citizens to negotiate and engage in trade-offs with traditional power holders. At the topmost rungs, (7) Delegated Power and (8) Citizen Control, have-not citizens obtain the majority of decision-making seats, or full managerial power.

Tritter and McCallum (2006) critically assessed Arnstein’s (1969) model and founded that applying the model closes of options. Their critique of the model outlines the following shortcomings:

- Arnstein (1969) fail to differentiate between method, category of user outcome and outcome
- Failure to consider process as well as outcome, or the importance of methods and feedback system
- There is no reflection of the different forms of participation desired
- The ladder does not capture the dynamic and evolutionary nature of involvement
- There is no acknowledgement of the fact that some users may not wish to be involved

- User involvement requires that the structure and processes be dynamic and negotiated by users themselves
- The term "citizen" is limiting because there are multiple sources of potential user power
- Little attention is paid to the evaluation of the quality of user involvement

If one considers Arnstein's (1969) ladder and aspects of Tritter and McCallum's (2006) critical assessment, then effective participation in IPWIS *(incorporating IHCWIS)* in the all encompassing network did occur even though it was absent in the development aspect of IPWIS *(incorporating IHCWIS)* as the OPP.

Effective participation is really about a process which results not only in an accepted outcome (the development of IPWIS *(incorporating IHCWIS)* as the OPP) but also in the users being empowered to take control and make decisions regarding the establishment and institutionalisation of IPWIS *(incorporating IHCWIS)* as an all encompassing network. Establishing IPWIS *(incorporating IHCWIS)* through the process of translation included the building of partnerships or alliances and the delegation of power where the enrolled actors could speak and act on behalf of DEA&DP.

According to the International Association for Public Participation (undated) participation stretches over a continuum (see Table 5.17 below) and the level of public impact increases as the process moves forward towards placing ultimate decision making in the hands of the public.

Table 5.17 Public participation spectrum

Increasing level of public impact →				
Inform	**Consult**	**Involve**	**Collaborate**	**Empower**
Provide the public with balanced and objective information to assist them with understanding the problem, alternatives, opportunities and/or solutions	Obtain feedback on analysis, alternatives and/or decisions	Work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered	Partner with the public in each aspect of the decision including the development of alternatives and the identification of preferred solutions	Place the final decision making in the hands of the public

Source: *International Association for Public Participation (IAP2),(undated)*

One could argue that the reasons why participation in information systems development and institutionalisation, in the case of developing IPWIS *(incorporating IHCWIS)*, was often not achieved are:

1. Pivotal to participation is the issue of empowerment, placing power in the hands of (in most cases) ordinary people, and therein lay its dilemma because the power distance between other actors and DEA&DP the proponents of development, are still too big. Those who have the power are not willing to sacrifice it.
2. Participation is entrenched in environmental legislation but the legislation does not prescribe the time period, thus proponents of development are under no legal obligation to allow participation at the early/conceptual phase of a development project. Proponents see participation more as a problem than a solution. Doelle & Sinclair (2006:189 and 190) are of the opinion that:

> Proponents are generally not motivated or encouraged to look at public participation as an opportunity to improve project design and implementation, to gain community acceptance and to ensure the project's long-term viability by making sure it fits with communities' visions for sustainability. The design of projects in isolation from the public happens again and again in project environmental assessment under current legislation in spite of the fact that in the process valuable time and opportunities are lost in understanding public concerns and incorporating their concerns and ideas into project design and implementation. Members of the public are generally not encouraged to participate, and if they do participate, are often seen as a problem to be managed rather than a valuable resource and an interest to be incorporated in project design and implementation.

3. Another issue is that the value and weighting of the public contribution during participation is also difficult to determine and verify. Follow-up and evaluation to measure these contributions (after project completion) seldom occur.
4. Final decisions in most cases are not made during the participation process but in boardrooms and behind closed doors.
5. Time constraints. The process of effective participation is often unpredictable, long and drawn out and this interferes with time schedules and committed resources.
6. Lack of trust. With any development project there is always the case of opposing sides "us" and "them" with each side seeing the other as a threat.

Users have been regarded as a key variable in the successful development of an information system (Barki and Hartwick, 1994). Contrary to the portrayal of weak links, users may be an important resource and a means to protecting sensitive information (Spears and Barki, 2010). Although research findings revealed that user participation is minimally-to-moderately beneficial to ISD (He and King, 2008), a recent industry survey observed that only 34% of IT projects were considered successful. Of the several potential factors contributing to this hard-to-achieve success, user involvement was noted as the most important one (Subramanyam *et al*., 2010). The implementation of an information system may be considered as a political process and the user's acceptance of the new system will play an important role on its success. Before a system is designed and implemented the prospective users must know how it is going to influence on their jobs. This will allow understanding of the thinking behind a strategic information systems plan and in doing so, reduce resistance to change (Lapeidra et al., 2006). There is uncertainty about the exact nature of the relationship between user participation and system outcomes (Lynch & Gregor, 2004) and the research literature has not been conclusive about the value of user participation, although the perception of value has still existed (Terry and Standing, 2004)

Drawing from the gaps and shortcomings identified in Tritter and McCallum (2006), the above discussions and given, according to Heiskari & Lehtola (2009), that that an organized way of involving users in the development process is needed, a conceptual framework (Figure 5.9) is proposed which could be used as a framework that would lead to successful, real and active participation in information systems development for large scale projects such as an IHCWIS.

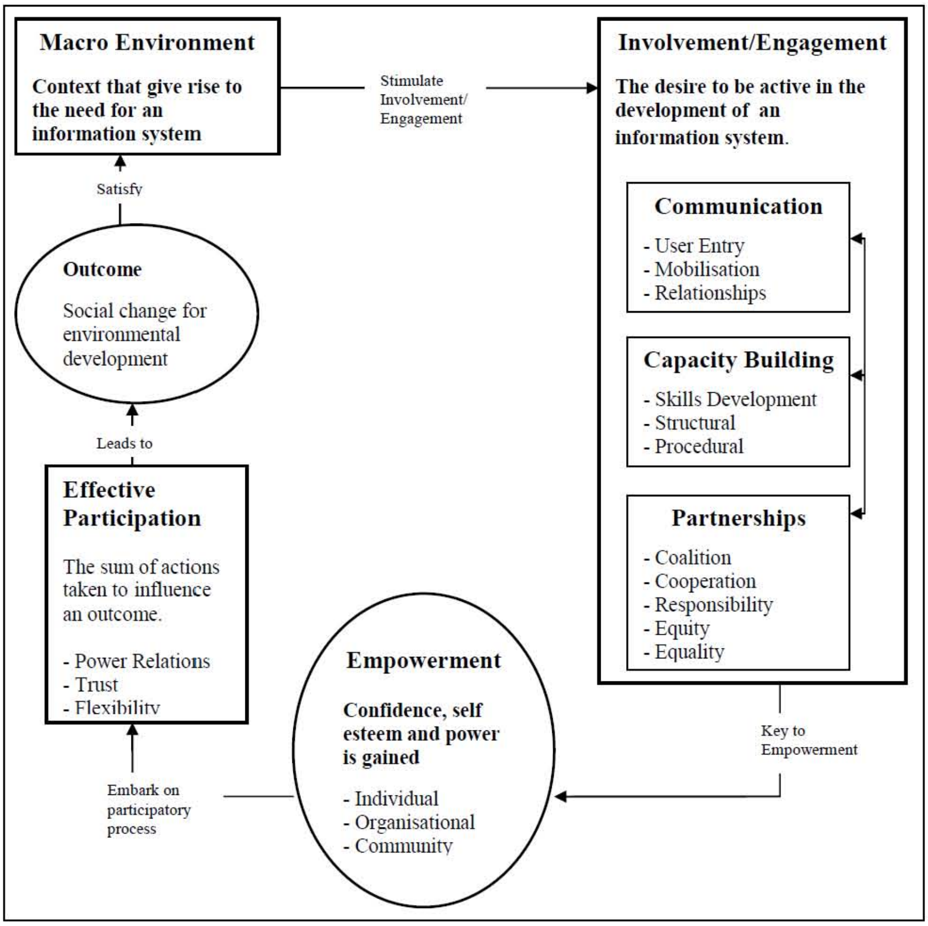

Figure 5.9: Conceptual **framework for effective participation in information systems development** ***(Source: Adapted from Delcarme, 2004)***

Macro Natural Environment: The macro natural environment, which is rapidly degrading (Melville, 2010), represents the context (poor and inadequate HCWM) that gives rise to the need for the development of an information system. The need stimulates the desire to become involved with the development of the information system so that it may be used to solve the issue of poor health care waste management.

Involvement/ Engagement: This is a process where actors express their desire to be active in the development of an information system. It is a collaborative partnership between individuals groups, organisations and professionals to mobilise resources and change relationships (Chapman *et al.*, 2003). It therefore becomes important to apply the principles of communication; capacity building; and partnerships.

- **Communication:** Effective communication with related stakeholders enables project teams to collect early signs of problems and take prompt, effective and appropriate actions at an early stage to effectively solve the problems (Li *et al.,* 2011). Yucel *et al.,* (2012) consider communication (i.e. communication between hospital management, clinicians, and information technology people) as one of the risk factors affecting the successful health information system implementation and performance. Stakeholders have to interact (the process of communication) with a diverse range of people from both technical and non-technical domains, which is where their communication skills and experience with problems come to the fore (Coughlan *et al.,* 2003). One should be clear of the purposes and goals of the engagement effort and the actors you want to engage. One therefore needs to become knowledgeable about the actors in terms of its dynamics, structure, norms and values. Relationships must be established with formal and informal leaders in order to build trust and create the processes for mobilisation.
- **Capacity Building:** We are living in an 'information age' where the key challenge is developing the capacity to mobilise the vast amount of information for the purposes of sustainability which underlines the importance of involving users and focusing on techniques for information system development which encourage capacity building and knowledge sharing

(Stojanovic et al., 2010). Capacity building is based on the premise that people can lead their own change processes in order to become actors and not merely subjects of change. It is unrealistic to expect individuals or groups to make complex decisions and become involved with major projects. Their capacity must be built or enhanced. Capacity building is developmental in nature and involves training, providing resources that strengthen the ability to establish structures and systems, upgrading of skills, developing procedures that enable them to participate and take decisive action.

- **Partnerships:** User partnering activities (partnerships) provide a chance for diverse parties to distinguish the potential problems, conflicts, and develop tactics to ensure cooperation. This creates the opportunity for different stakeholders to recognize potential problems, clarify roles, and develop procedures for cooperation (Liu *et al.,* 2011). Partnerships are characterised by mutual cooperation and responsibility. The main aim of establishing partnerships is to reach a compromise that entail the recognition of self-help activities, respect for the individual and a willingness to cooperate.

Empowerment: A critical element of success relates to empowerment. Participatory design methods for ISD were introduced in the 1970s in collaboration between employees, employers, and researchers as a means to empower system users by letting them take active role in the design of an important part of their work environment (Pilemalm &Timpka, 2008). Empowerment is the process whereby individuals, communities and organisations gain confidence, self-esteem and power to articulate their concerns, take action to address them, participate and negotiate with influence (Centre for Global Development, 2009). Empowered persons are motivated to change problems that they face and mediate the negative effects over things which they have no control. Effective participation can only start once the ability to influence has been reached because empowerment, which is a form of selfactualization, is based on the extent to which participants are able to take control of their organizational and technological futures (Lee & Carroll, 2010). Interactive participation (empowering) is seen as the highest degree of participation since it applies when participants have a voice and influences group decisions (Coulibaly-Lingani et al., 2011).

Effective Participation: Effective Participation refers to the sum of actions taken to influence or attempt to influence an outcome. Participation varies in extent and intensity and considered increasingly intensive as more actors engage with it. It should be viewed as an evolutionary process that starts with planning and ends with operation. The factors that affect participation are:

- **Power relations:** Needed to reduce the power distance between those who have power and those who not. Many authorities fear the loss of control and do not want to release control of actions or interventions. Actors themselves may also compose of factions that contend for power and influence.

  Trust: It is essential to maintain high ethical standards as ethical failures create distrust among actors. Ethical action is the only hope for developing and maintaining trust.

  Flexibility: Actors should be flexible in meeting each other's changing needs. Greater flexibility is strongly associated with greater responsiveness to needs.

  Decision-making: Participation will only be truly effective if actors gain the right and opportunity to participate in actual decision-making. This can only be achieved if the correct approached is used.

Outcome: The outcome of any participatory project should be social change for development in addressing the needs created by the macro environment. It therefore becomes important to evaluate the outcome to determine if it addresses the needs created.

Participation underpins institutionalisation in that it is seen as a possible solution to shortcomings as identified with policy making and implementation, building accountability, and ensuring that public policies reflect societal needs (Gustaffson & Driver, 2005). Furthermore, participation has been recommended as an effective means to establish sound sustainable development practice and encouraging active participation of local communities in development projects. This is done through capacity building and environmental education, which have become major objectives of sound development programmes (Tran 2006:367 and 368). Effective participation therefore underpins institutionalisation as Reid (2000:3) writes:

> '…participation is far more than a requirement. It is a condition for success. Studies have documented that communities that engage their citizens and partners deeply in the work of community development raise more resources, achieve more results, and develop in a more holistic and—ultimately—more beneficial way'.

The implication of potential users not participating effectively (in this case the development of IPWIS *(incorporating IHCWIS)*) is that there will be an information system which few will use. Rosenström & Kyllönen, (2007:296) report that in the Finnish case of developing sustainable development indicators:

> the process was to improve the quality of the outcome and not democratic representation or citizen empowerment…the participants represented mainly those providing expertise to the developing process, rather than those who would have a potential interest in deciding of the indicators or those who would use them…the lack of careful planning led to random choice of participants, usually those who could best contribute to the data and interpretation of the indicators…the process proved technocratic and driven top-down… Communication with the stakeholders was mainly one way, failing in democratic participation and social learning. This

> has led to slight use of the original indicators and a need to change the methods of developing indicators. Hence the objective of the indicators as a tool for political decision-makers and the public was not met... the outcome did not support user needs.

Another consequence is the creation of mistrust. If effective participation does not occur in past endeavours then users might be sceptical towards future ones. The users in general tend to be negative towards big developers and business thus creating a divide between them. Not being effectively part of previous projects would deepen this divide for future projects. Puri and Sahay (2007:133) state that 'participation of people in development programs as well as the design and use of information systems (IS) have been emphasized to enhance effectiveness of development programs and IS projects. The theme of participation becomes increasingly significant in the contemporary scenario where development projects in third world countries are being integrated with information and communication technologies'. Finally the recent violent service delivery uprising in South African municipalities is a clear indication that the environment has become an integral part of politics. So much so that politicians are viewed and judged by their actions towards environmental (sanitation and waste) issues. The consequence of this is that the users may refuse to participate in proposed processes and / or reject a project based upon a politician's attitude towards and handling of the environment.

In summary it could be said that effective participation in the development of IPWIS *(incorporating IHCWIS)* as an OPP was very limited and restricted to contributions made during scheduled workshops. These contributions were deemed to have been incorporated by DEA&DP when developing IPWIS. DEA&DP as the proponent of IPWIS *(incorporating IHCWIS)* took the techno-centric approach (including technology specialists on the design team) and by doing so missed the opportunity of including social aspects. If the focal actor defines the identities and interests of other actors (that are consistent with its own interests) and a process under its control that must occur for all actors to achieve their interests (Tilson and Lyytinen, 2005) then surely this negates the idea of complete empowerment. However, participation in IPWIS *(incorporating IHCWIS)* as an all encompassing network only took place through the process of translation.

(2) Dedicated information officers

Another theme which emerged from the analysis is the need for dedicated information officers. Table 5.18 is an example which illustrates how we arrived at the factor of dedicated information officers.

Table 5.18: Dedicated information officers: Example of categories and themes

Theme	Subtheme	Selected Responses	Respondent
Dedicated information officer	Responsible person to: - collect and capture data - monitor information	"I think the main problem with that is to get information from the ground to the System. That is, who is going to take the information from the ground to the System. That is the main part of the thing. Because it means we must have somebody who is responsible for the System or responsible for capturing all the data." "Always having a responsible person to monitor info needed Extra duty, will add more to monthly or quarterly reports"	MIS01; HCF16
	Administrati ve person	"As I say, I think that, due to the fact that we don't have a lot of admin personnel that we can utilize to populate the system and to report to the system. That's gonna be challenging to S, to actually get that up and running smoothly and get accurate and trustworthy information put onto the system"	WM03
	Trained individuals	Individuals collecting information; Collection and verification of data by trained person; Dispatching data and collect point...Data will end up in a waste paper basket not being used	HCF05

Dedicated information officers in the form of trained, responsible and administrative persons are needed to collect, capture, monitor, analyse and despatch data. A health care facility manager responded that one concern they have when participating in IPWIS *(incorporating IHCWIS)* is that the "data will end up in a waste paper basket not being used"

DEA&DP and the local municipalities are plagued by lack of personnel and/or high turnover of staff. This situation impacts negatively on the stabilization of IPWIS *(incorporating IHCWIS)*.

Table 5.19 Effect of Staff Shortages

Theme	Subtheme	Selected Responses	Respondent
Dedicated information officers (Staff Shortages)	Factors which will hinder providing information to IPWIS *(incorporating IHCWIS)*	Individuals collecting information	HCF05
		Lack of resources and technical support	HCF11
	Factors which encourage becoming part of IPWIS *(incorporating IHCWIS)*	Enough staff	HCF11
	Factors which hinders becoming part of IPWIS *(incorporating IHCWIS)*	Clerk not available to collect data. Reporting lines not in place! Who receives data?	HCF05; HCF11
	Barriers threatening IPWIS *(incorporating IHCWIS)*	No dedicated committee members	HCF08

The health care facility managers reported (Table 5.19 above) that staff shortage was considered as a factor which will hinder the provision of information, encourage and hinder participation; and that the lack of dedicated committee members act as a barrier that threatens IPWIS *(incorporating IHCWIS)*.

The primary duties of health care facility managers centre on the delivery of health care. That means treating ill patients. Waste managers are primarily responsible for operating the various sites. None of them have health care waste information management as a primary function. Health care waste information management is sometimes considered to be secondary and less of a priority. Difficulty is experienced with incorporating health care waste information functions into the general information functions even when it is a primary function, as in the case of information systems managers. These tasks are in most cases secondary functions and there is no guarantee that they will be performed.

Municipalities are facing severe staff shortages and personnel such as waste management technicians are sometimes tasked with uploading information for IPWIS *(incorporating IHCWIS)* purposes.

Respondent MIS02, an information system manager, had this to say during an interview:

> But unfortunately I think most departments within the City – we are also very understaffed so we don't have time to go and sit and work on IPWIS for a day or whatever. So we, in our section, we are only two people at the moment and we have to help our own department first with their needs and provide them with information and service and that's our main function within the department.

Respondent WM01, responsible for waste management, stated during an interview:

> Yes, I think have that obligation to report to IPWIS and to, but like I say there are many challenges because you know, we have staff shortages around the country as well, so I think within the Waste Management itself, we need to report to IPWIS whether it is daily or quarterly or monthly but we need to record that data.

This therefore impacts on institutionalisation in that making IPWIS *(incorporating IHCWIS)* part of the everyday activities is now jeopardised. Dedicated information personnel are thus needed if IPWIS *(incorporating IHCWIS)* is to be made part of the everyday activities.

Another information system manager, Respondent MIS01 remarked during an interview:

> I think our Department or our Section needs a bit of restructuring in terms of our organogram or the staff structure so that we appoint somebody to look, as I've already mentioned, to look after the system because our concern or our Municipalities' very big so there's a lot of information that needs to be uploaded onto the system.

Another waste manager, Respondent WM03 replied:

> As I say, I think that, due to the fact that we don't have a lot of admin personnel that we can utilize to populate the system and to report to the system. That's gonna be challenging to actually get that up and running smoothly and get accurate and trustworthy information put onto the system. Because if you don't do it, you're gonna be lost. The way that our municipality will do it is through one of our technician that we have here that will basically load up the information to the system and then also draw the necessary reports from that. I think in my mind, that is one of the big problems, let's not say it's a problem, it's one of the things where this thing might not be utilized as well as it should be and that is that you need manpower to populate the databases. I mean, if you put in rubbish information, you're gonna get rubbish out. And that's a problem and there should be a way of managing that and monitoring the information that is being fed to system, so that at an early stage the Department should actually pick up that there is something wrong with the information being to the system and then try and rectify it and try and investigate at which local authority this is taking place and then go and maybe assist in getting the right information for the system. And for me that is one of the big things and I think it's gonna be time-consuming for the Municipality to put all the information on the system.

In summary, dedicated information personnel will have IPWIS *(incorporating IHCWIS)* as their primary function which in turn would increase the chances of it becoming part and parcel of the daily activities of health care waste management.

(3) Informatics competencies

Informatics competencies is another factor which emerged during the analysis.
Table 5.20 below provides an example of how we arrived at the factor of informatics competence.

Table 5.20: Informatics competence: Example of categories and themes

Theme	Subtheme	Selected Responses	Respondent
Informatics competence	Competent persons to analyse and interpret data	…I don't think it's a real problem for Municipalities to record the data. But now the problem is how we're going to deal with data once we recorded that data. Once we got the information from the hospitals and from the communities and so on etc, so it's upon what we're going to do with that data after we've recorded it and send it to the Province.	WM01
	Competent persons to manage and monitor information	I think in my mind, that is one of the big problems, let's not say it's a problem, it's one of the things where this thing might not be utilized as well as it should be and that is that you need manpower to populate the databases. I mean, if you put in rubbish information, you're gonna get rubbish out. And that's a problem and there should be a way of managing that and monitoring the information that is being fed to system, so that at an early stage the Department should actually pick up that there is something wrong with the information being fed to the system	WM03

Informatics competencies can best be described as a worker's observable or measurable performance, skill or knowledge related to the systematic application of ICT (O' Carroll, 2009). 'While most attention has been paid to exemplar leaders in the health information technology, less has been focused on the issue of the workforce necessary to sustain the system to achieve their vision' (Hersch, 2006).

The persons involved with data flow are nurses in charge of health care facilities, environmental officers, environmental health officers, technicians and waste managers. None of these cadres have had training or formal education relating to information systems and informatics. At best most of them have been made computer literate. Computer literacy is, however, but one of the areas of informatics competencies.

Sensmeier, (2008) state that informatics competencies are organised around the following four areas:

1. Basic computer competencies
2. Information literacy competencies
3. Information management and informatics competencies
4. Attitude and awareness competencies

Health care providers need the necessary knowledge, skills and resources to communicate and manage information effectively in an electronic environment. However, emphasis is placed on computer literacy instead of informatics literacy and there is also a lack of understanding about informatics knowledge and computer competencies (McNiel *et al.,* 2006).

Trained human resources, among others, have been reported as factors which could hinder reporting to IPWIS *(incorporating IHCWIS)*. These are presented in Table 5.21 below.

Table 5.21: Factors which will hinder reporting to IPWIS*(incorporating IHCWIS)*

Theme	Subtheme	Selected Responses	Respondent
Informatics competence	Factors which will hinder reporting to IPWIS*(incorporating IHCWIS)*	"Collection and verification of data by trained person; Dispatching data and collect point"	HFC05
		"Lack of resources and technical support"	HCF11
		"Lack of training as to how to collect and report the information needed"	HCF13

Health informatics experts argue that those who work in the field of health care need to be introduced to the principles and concepts of informatics and that health informatics should be demystified so that it becomes part and parcel of clinical curricula. ICT is increasingly important to public health practice and public health professionals at all levels should be appropriately skilled in the application of ICT (O'Carroll, 2002).

What we have now discussed is that if dedicated information officers are to be deployed then they must be competent or made competent in informatics. If IPWIS *(incorporating IHCWIS)* is to be institutionalised then the information officers need to be skilled in and have a comprehensive understanding and knowledge of how to perform these functions. Lack of trained human resources, among others, could hinder reporting to IPWIS *(incorporating IHCWIS)* as presented in Table 5.18. In order for actors to be informatics competent they need to have an in-depth understanding of, as Alter (1999:170) puts it, 'the usefulness of the information in the information system'. Alter explains that the information usefulness is determined by the user's knowledge, information quality, accessibility and presentation. Information quality refers to how good the information is based on its accuracy, precision, completeness, timeliness, and source; information accessibility means how easy it is to obtain and manipulate the information regardless of its quality; and information presentation focus on the level of summarization and format for presentation to other users regardless of information quality and accessibility. Trained and dedicated human resources could ensure that reporting to and interacting with IPWIS *(incorporating IHCWIS)* transpires and this would enhance the chances of becoming institutionalised.

(4) Systems Integration

Table 5.22 provides an example of how we arrived at the factor of systems integration.

Table 5.22: Systems integration: Example of categories and themes

Theme	Subtheme	Selected Responses	Respondent
Systems integration	Linking up of system	Yes, you see what we, we've got a collaborator system running at the District Municipality. So we almost got a similar system but we asked the guys from Province to actually co-ordinate the two or link the two up with each other otherwise it won't help us to, because we're using a other system than Province, you see? So they must look into that. ... all the municipalities that I know of in the Southern Cape is actually using the collaborator system.	WM05
	Systems compatibility	I'm not very good, the technical side, but as I say, we've got the e-mail or the Groupwise system. And if that is compatible with that, then it will be easy…but what we've asked them with the IPWIS course, because we've got a Groupwise system. If we can just, if they can do it, you know, that it's the same as Groupwise because we've already got a Groupwise system at our place.	WM06

The need for systems integration, with the purpose of sharing information, has been highlighted during the enrollment phase of translation. Some municipalities have existing regional information systems while others, e.g., City of Cape Town are in the process of developing their own waste information system.

During an interview Respondent MIS02, an information manager, had this to say regarding the integration of systems:

> Solid Waste is still in the process of establishing and documenting their "as is" business processes and information systems are part of that. The next step would be to establish and develop the "to be" processes. Part of this process would be to either develop a waste/management information system or to determine whether the SAP modules available would be able to handle our need. Either of these options should be able to link to IPWIS. Each section within Solid Waste which is responsible for reporting information would capture information directly into this system from which different reports can be drawn.

The integration of IPWIS *(incorporating IHCWIS)* with these existing systems would make it much easier for IPWIS *(incorporating IHCWIS)* to be a part of the daily activities of waste generators. This is highlighted during an interview with Respondent WM05, a waste manager, who said:

> Yes, you see what we, we've got a collaborator system running at the District Municipality. So we almost got a similar system but we asked the guys from Province to actually co-ordinate the two or link the two up with each other otherwise it won't help us to, because we're using a other system than Province, you see? So they must look into that... all the Municipalities that I know of in the Southern Cape is actually using the collaborator system.

Another waste manager, Respondent WM06 replied:

> …but what we've asked them with the IPWIS course, because we've got a Groupwise system. If we can just, if they can do it, you know, that it's the same as Groupwise because we've already got a Groupwise system at our place.

Integrating IPWIS *(incorporating IHCWIS)* with other information systems is possible but must be treated with the utmost care and precaution must be taken to avoid the 'dumping' of unnecessary information onto the server. Alter (1999:111) cautions against systems integration in that:

- there may be a time delay in system one responding to another system
- forcing processes to respond too frequently may make it difficult for each process to gets its work done causing the system to freeze
- there may be difficulty in responding rapidly while also maintaining quality and efficiency
- the systems may be prone to catastrophic failure than less integrated systems

One needs to consider the challenges and constraint faced by the other actors in performing their daily activities. IPWIS *(incorporating IHCWIS)* is deemed to be an add-on and to make it part of their everyday functions means addressing the challenges and alleviating the constraints. Systems integration will result in municipalities saving considerable structural and administrative costs. It will not be expected from them to develop new systems nor duplicate the work (in relation to IPWIS *(incorporating IHCWIS)*) already done. This is clearly presented in the response of Respondent SP01, a service provider, who had this to say during the interview:

> We might now need to spend some money in considerable administration costs. I mean a direct link of having an able body available you need a PC to be made available to that person. You need to get the information from various waste generators, it takes time, phone calls it is following up and a blank document is worth absolutely nothing. So while to start collecting the waste makes you collect it from everybody, make the document work. Don't give a half thing in and then you might as well just leave it. So it's going to take an effort to get that thing together.

In concluding this section on level two analysis it could be argued that IPWIS *(incorporating IHCWIS)* will become sustainable if it is instituonalised in the sense of being integrated into the everyday routine of the user organisation. However, a sustainable IPWIS *(incorporating IHCWIS)* should be flexible enough to allow changes as the user needs change. Moreover, introduction of a new health care waste information system is not only a technical change, but requires the cultivation and institutionalisation of a new kind of culture (Kimaro and Nhampossa, 2005).
An institutionalised network would mean that IPWIS *(incorporating IHCWIS)* would be part and parcel of the daily activities of health care waste managers. It does not necessarily mean that IPWIS *(incorporating IHCWIS)* would be used for effective and efficient decision making. The application of IPWIS *(incorporating IHCWIS)* in this regard necessitates the third level of analysis.

We therefore need to consider both the translation process and the institutionalisation factors as major divers for institutionalisation. The presence of these drivers will promote network growth and stability while the absence thereof will promote network decline and instability (Figure 5.10 below illustrates).

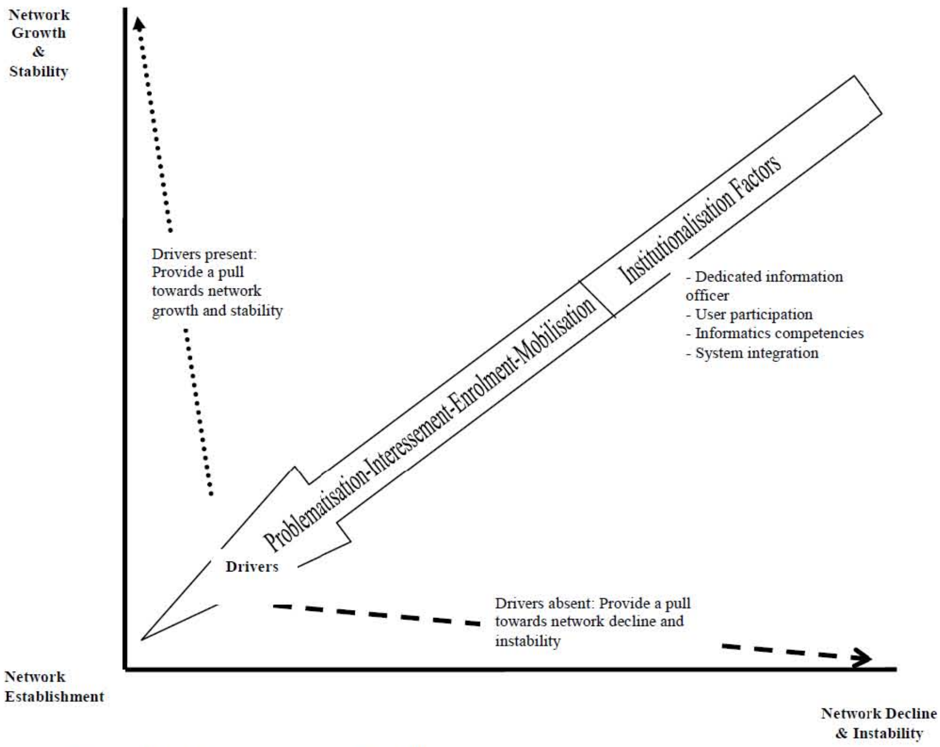

Figure 5.10: Network growth and stability

5.3.3 Level 3 Analysis: Application of IPWIS *(incorporating IHCWIS)*

Level 3 analysis focuses on the effective and efficient application of IPWIS *(incorporating IHCWIS)*. In other words the use of IPWIS *(incorporating IHCWIS)* for effective and efficient pollution and waste management decision making in the Western Cape. The themes which emerged in the third level of analysis were systems performance and decision making (See Tables 5.23 below as an example of how the theme systems performance emerged)

Table 5.23: Systems performance: Example of categories and themes

Theme	Subtheme	Selected Responses	Respondent
Systems performance	System stability	The rest of the Municipalities we will gradually get involved as well. But we first want to get it stabilised where we can say 'ok, the application can take so much people running through the server' because as you know we've been on a test platform where we don't actually know what's gonna happen when we have thousands of people logging in at once. So, it's all test basis for the servers as well as the application.	SD02
	Enhancing the system	We need to make sure – look, basically we don't want a white elephant running out there .So, the first six months is basically trial basis, to see where we must enhance, where we can enhance, right? And then from there, we're gonna start adding everyone to the system.	SD02

(1) System performance

The effective use of information systems is crucial for the delivery of an effective service. Chiassonn *et al.*(2006) state that as the adoption of technology increases so does the challenges of developing, implementing and using health care information technology.

Technological implementation is related to organisational dynamics and effective use of information systems tends to follow a pattern where managers proceed with disjointed periods of intensive implementation rather than with continuous improvement (Legris *et al.,* 2003).

Ramiller (2007:202) concludes that 'an actor network analysis can speak to the scope, diversity and quality of participation in the collective effort to use information technology to improve the conditions of health care practice'. Work practices could be transformed by the introduction of a new technology and the reproduction of work practices with information technology use may be considered as a result of how actors work, represent their work environment, use and represent information technology (Vaast and Walsham, 2005).

The main objective of IPWIS *(incorporating IHCWIS)* is to promote, restore and maintain good health care waste management practice which is not detrimental to human health and the environment. However, this objective is often not achieved due to the poor performance of the health system. Failure is more due to, as WHO (2000) puts it, systematic failings than technical limitations. Service delivery failure, in turn, is mainly due to dysfunctional organisation of the system, even when the needed inputs exist and financial support is adequately and fairly distributed.

IPWIS *(incorporating IHCWIS)* is a continuous and systematic process of collection, analysis, interpretation and dissemination of outcomes specific data which is essential to the planning, implementation and evaluation of waste management practice. IPWIS *(incorporating IHCWIS)* data is primarily used to assess health care waste management status, define health care waste priorities, evaluate programmes, and to identify emerging problems. The core activities of IPWIS *(incorporating IHCWIS)* comprise registration, reporting, confirmation and analysis. Improved public health surveillance can lead to earlier implementation of disease prevention and control measures.

Links between the application and use of IPWIS *(incorporating IHCWIS)* and the development of health care waste management policy needs to be strengthened. It is vital that technical and non-technical human actors work together to create the useful application of IPWIS *(incorporating IHCWIS)*. Saleem *et al.,* (2006) support this argument when stating that despite the critical role that healthcare information systems play in effective and efficient patient care, the success of these systems in achieving these goals remains a lingering concern.

The success of an information system is determined by the dimensions of systems quality, information quality, service quality, use, user satisfaction and net benefits (DeLone and Mclean, 2003). Studies by Al-adaileh (2009) and Sabherwal *et al* (2006) revealed that useful application (system's usefulness or perceived usefulness) is an influential factor that affects the extent to which the system is being used.

Efforts to measure health care waste management practice have taken on various forms and focussed on different aspects of the system of public health practice. Recent efforts suggest that the system of public health practice must be improved to achieve targets of effectiveness (Handler and Turnock, 2001).

The point of health care waste information systems performance is definitely not just to compare countries (sometimes information is merely used for comparison and not for performance aspects) by looking at their position on the table, but to monitor the status of environmental health goals in relation to resources spent. Decision-makers need to quantify the variation in IPWIS *(incorporating IHCWIS)* performance, identify factors that influence it and articulate policies that will achieve better results. In this way the assessment can be a diagnostic tool to evaluate policy reform and facilitate evidence-based decision-making (Wibulpolprasert & Tangcharoensthien, 2001; Murray & Frenk, 2000; Turnock & Handler, 1997).

Table 5.24: Issues affecting performance of IPWIS *(incorporating IHCWIS)*

Factor	Description
Responsiveness	Responding to the needs of effective and efficient health care waste management
Service Provision	Provision of accurate, precise, complete, timely information. The manipulation, summarisation and presentation of information
Resource Generation	Production of dedicated informatics competent human resources, physical resources and knowledge
Stewardship	Defining the vision and direction of environmental policy, through influencing regulation, advocacy and, collecting and using information. It thus involves setting, implementing and monitoring of information systems

Source: Adapted from WHO, 2000; Alter, 1999; Roemer, 1991

How well IPWIS *(incorporating IHCWIS)* performs, in the context of waste management, depends on its responsiveness, service provision, resource generation and stewardship (Table 5.24 above).

To improve system performance one needs to ensure that the factors which affects performance are constantly present. These issues which emerged as important are illustrated in the above Table 5.24 as responsiveness, service provision, resource generation and stewardship.

(2) Decision making approach

It is critical to design information systems that provide incentives and accountability for evidence–based decision making (Stansfield *et al.,* 2006). A useful tool for making decisions is an information system and in this context, information systems is an organizational method of providing past, present and projected information related to internal operations and external intelligence. It supports the planning, control and operation functions of an organization by furnishing uniform information in the proper time frame to assist the decision makers (Asemi *et al.,* 2011). Using IPWIS (incorporating IHCWIS) for decision making is another factor which emerged during level 3 analysis. Table 5.25 below provide an example of how we reached the theme of decision making.

Table 5.25: Decision making: Example of categories and themes

Theme	Subtheme	Selected Responses	Respondent
Decision making	Using disseminated data for developing solutions	I think once that data has been disseminated to Province, once it has been analysed, I think it's for us as Municipalities within the Western Cape is to liaise with Province and perhaps amongst Municipalities itself within the Western Cape and decide and to come up with solutions on how to deal with these problems.	WM01
	Addressing issues	"So it is about sitting together and discuss these issues and getting to grip with these issues and decide what we're going to do and how we're going to tackle it because I think that is lacking within the Municipalities itself" "Yes because from the 9th of September…11th of September I think, we are actually dealing with Licensing issues at the District Municipality and all the other District Municipalities. So, we're gonna use this system as from then on, so we need it to be efficient, you see."	WM01;WM05

Information systems have been successfully used to support decision making for example: Great responsibility was placed on local authorities in the United Kingdom to take a longer term view of the likely impacts of decisions involving the environment. To this end the Environmental Information System for Planners (EISP) developed to demonstrate the value to urban planning of making environmental information more widely accessible. Feedback from local authorities recognised that EISP represented an important step towards faster and improved decision-making (Culshaw *et al*., 2006).

IPWIS *(incorporating IHCWIS)*, as our research revealed, plays a major role in environmental decision-making in that it facilitates the management and use of health care waste related data and information. The district municipalities in the South Cape region will be occupied with licensing issues around health care waste facilities and they need IPWIS *(incorporating IHCWIS)* to be efficient so that they may use it in dealing with these issues. Respondent WM05, a waste manager, had this to say during the interview:

> Yes because from the 9th of September…11th of September I think, we are actually dealing with Licensing issues at the District Municipality and all the other District Municipalities. So, we're gonna use this system as from then on, so we need it to be efficient, you see.

Participation in IPWIS *(incorporating IHCWIS)* creates a support network of resources and expertise which in turn could be used to plan, apply and evaluate actions to prevent and control environmental related diseases. However, the use of IPWIS *(incorporating IHCWIS)* for effective and efficient pollution and waste management decision making in the Western Cape requires an advance understanding of the systematic application of information systems, computer science, and technology.

A typical top-down decision making approach has led to a number of failures, failed to generate community support for policy changes and rarely had the benefit of securing detailed local knowledge (Fraser *et. al.,* 2006). A more decentralised approach is needed because decentralisation of the decision making authority and full and meaningful public involvement offer evidence for a successful decision making process (Kuhn and Ballard, 1998). Projects that are successfully implemented are normally those with activists willing to push the agenda, public officials willing to exercise leadership, researchers able to present authoritative findings, and proponents who effectively mobilised resources and worked to build community coalitions, using persistent but non-adversarial advocacy (Downing *et. al.,* 2005).

Moving away from the top-down approach often means that it becomes apparent that the traditional role of government and local governmental authorities in particular, must change as well (Choguill, 1994).

The majority of environmental management decisions-making processes are guided by multi-stakeholder interests (Hajkowicz, 2008) and a good decision-making framework should integrate technical, economic, political, legal, and ethical decision levels (De Anguita *et. al.,* 2007). The process should also be transparent in that it allows all those who are interested in a decision to understand what is being decided and why (Drew & Nyerges, 2002). The University of Wisconsin (2000) in their decision-making guide mentions five important strategies that should be kept in mind while designing and implementing a decision-making process: start the process early, use an unbiased approach, share information and educate stakeholders, keep discussions focused on interests, and select and implement an appropriate decision-making method.

Stakeholders are required to report to and interact with IPWIS *(incorporating IHCWIS)*. This interaction can only be meaningful if these stakeholders effectively use IPWIS *(incorporating IHCWIS)* to facilitate making decisions about the management of HCW.

5.4 Chapter Conclusion

The data was analysed at three levels namely: Sociology of translation, interpretation of the case and the application of IPWIS *(incorporating IHCWIS)*.

Level 1: Sociology of translation: The analysis revealed that the need and appreciation for IPWIS *(incorporating IHCWIS)*, as a possible solution to effectively and efficiently manage health care waste, arose from both a social and legislative perspective. The value that actors bring and the alignment of the interest of IPWIS *(incorporating IHCWIS)* to the day-to-day management of health care waste, makes it possible for actors to naturally engage with each other. IPWIS *(incorporating IHCWIS)* are experiencing problems associated with its deployment and implementation. The OPP has not been formally finalised yet but this did not prevent actors from passing through it. Enrolment mainly took place via a series of training, information and feedback workshops. Workshops proved to be exclusive (regarding efficient participation) rather than inclusive and enrolment via other means such as one-on- one visits, forum meetings, roadshows and mass media were suggested by DEA&DP. The process of translation is necessary to enhance and facilitate the establishment and stabilization of IPWIS *(incorporating IHCWIS)*. Successful translation through all moments leads the establishment of a stable network of interested actors aligned around the use of IPWIS *(incorporating IHCWIS)*. Successful translation, however is not sufficient to ensure the eventual institutionalisation of IPWIS *(incorporating IHCWIS)*. For instance in this study factors (resulting out of level 2 analysis) such as user participation, dedicated information officers, informatics competence and systems integration would lead to and enhances institutionalisation.

Level 2: Interpretation of the case: In order to go beyond translation to facilitate institutionalisation, several factors emerged as important to complementing the sociology of translation and facilitate institutionalisation. These factors are:

(1) Effective user participation during systems development: Actors were invited to attend various workshops but some were not granted the opportunity to provide input those who were granted the opportunity were not provided with feedback regarding the outcome of the input. Effective participation underpins institutionalisation and should take place throughout, i.e. pre and post institutionalisation. In this case participation only took place during the moments of translation.

(2) Dedicated (assigned to IPWIS *(incorporating IHCWIS)* functions) information officers: It is vital that health care waste generators employ dedicated information officers. These officers sole responsibility will be to interact with IPWIS *(incorporating IHCWIS)*. Lack of such personnel meant that the responsibility now falls on the shoulders of others. The result of this is that it now becomes a secondary function which is often neglected or not carried out correctly.

(3) Informatics competencies: Competent informatics personnel are needed to convert raw data into meaningful information which could later be used for decision making regarding the effective and efficient management of health care waste.

(4) System integration: IPWIS *(incorporating IHCWIS)* need to be integrated with or adapted to information systems which exist at the various health care waste generators.

Level 3: Application of IPWIS: It was found that institutionalisation does not necessarily ensures that the system (IPWIS *(incorporating IHCWIS)*) could now be used to make decision which will address the problem of poor HCWM. IPWIS *(incorporating IHCWIS)* need to perform at its peak without any brittleness. Information need to flow back to the users who in turn could use it for decision making.

Chapter 6

Conclusion

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Chapter 6

Conclusion

6.0 Introduction

The inadequate management of health care waste (HCW) has been recognised by the South African government as a significant environmental and public health risk. As technologies are created, new approaches and strategies, such as the development and implementation of new innovations, must be introduced as emerging priorities. One such innovation is the development of an integrated health care waste information system (IHCWIS) that will act as an important intervention to prevent health problems associated with exposure to health care waste. The development and subsequent institutionalisation of an IHCWIS is crucial to mitigating health care waste exposure, improving environmental related disease estimates, and allowing comparability of results.

This research was undertaken to gather empirical data to understand and describe how the development and institutionalisation of an IHCWIS takes place to contribute to effective health care waste management (HCWM) among health care waste generators in the Western Cape, South Africa. It is to this end that the research was undertaken within the confines of an interpretivist paradigm and a case study strategy.

This Chapter 6 concludes the research and is divided into 5 sections. Section 1 provides an overview of the research and how each chapter individually contributed to the thesis. Section 2 addresses the research questions and Section 3 assesses the theoretical and practical contributions made by this research by employing Klein and Myers's (1999) set of principles for conducting and evaluating interpretive field studies in information systems. Section 4 evaluates the contribution made using Whetten's (1989) criteria of what constitute a theoretical contribution. Section 5 finalises the research with a discussion on the research limitations and prospects for further research.

6.1 Overview of the research

Chapter 1 formulated the statement of the problem of poor HCWM, identified the need for the institutionalisation of the IPWIS as an intervention to the problem and introduced the research questions.

HCW is considered the second most hazardous waste after radioactive waste and causes a great deal of concern which needs urgent attention because the current mismanagement thereof puts the environment and people at risk. In spite of international guidance, waste management generally in South Africa is poorly defined and practised, and the inadequate management of health care waste has been recognised by the South African government as a significant environmental and public health risk. To this end a national waste management strategy (NWMS), which includes an IHCWIS, and the integrated pollution and waste management (IPWM) policy were developed. This resulted in the development and establishment of an integrated pollutant and waste information system (IPWIS). Although efforts are being made to create a more coherent and integrated health care waste information system, considerable progress is still needed to institutionalise such a system. The development and institutionalisation of an integrated health care waste information system (IHCWIS) involves a complex network of various actors/stakeholders who are directly and/or indirectly responsible for health care waste management. This then raised and introduced the following research questions:

1. ***Having conceptualised an IHCWIS what processes were followed to develop such an information system? and given the system is developed,***
2. ***How does an IHCWIS manifest and become institutionalised among health care waste generators in the Western Cape? and when institutionalised,***
3. ***How can an IHCWIS contribute to effective and efficient HCWM decisions?***

Chapter 2 reviewed the literature in 7 distinct areas covered by the research questions: (1) waste management, (2) health care waste management, (3) information systems development and participation, (4) health information systems, (5) waste management information systems, (6) the characteristics of a health care waste information and, (7) the institutionalisation of information systems.

The South African government realised that waste management was a serious problem and needed urgent attention. To address this problem, the national government developed various policies, initiatives and legislation which included the NWMS, National Waste Management Strategy Implementation Project, National Environmental Management Act, and National Environmental Management: Waste Act. The Western Cape government developed the Health Care Waste Management Bill and Western Cape Health Care Waste Management Act. One of the key objectives which came out of these was the development and implementation of an

IHCWIS. To this end the Western Cape government then developed the IPWIS which incorporates an integrated health care waste information system (IHCWIS).

Health care waste, through its hazardous nature and the negative impact it has on people and the environment, was identified as needing urgent attention even though it only represents a small amount of the total waste generated. It was then discovered that the management of health care waste was plagued with ineffectiveness and inefficiencies. This was mainly due to the lack of training, awareness, financial resources to support solutions, comprehensive effort to understand how this type of waste is managed, unsatisfactory knowledge of and inadequate waste management practices. Currently adequate management practices involve the minimization, generation, collection, storage, transportation, segregation, treatment, recycling, reuse and disposal of health care waste. Other factors such as the implementation and institutionalization of an effective information system are often not considered part of HCWM. The poor management of health care waste inevitably results in waste being unaccounted for and illegally dumped.

Information systems have potential benefits for effective health care waste management. The efficiency and complexity of information systems and applications has during the last decades increased dramatically. Wide spread usage of information technology by people in general has lead to a situation where many different types of user groups should be able to use the same information system. However, problems with the development and institutionalization of information system are still found. Information systems development research mostly centers around the implementation phase and relatively few studies focus on pre-implementation and post-implementation phases. Health information systems are biased towards patient care and therefore mainly focus on hospital based information systems. Environmental information systems on the other hand are mainly concerned with corporate performance and focused on the impact of the product on the environment. The literature is relatively void of data and information regarding the application of information systems in the field of environmental management and more specifically, HCWM. This study sought to fulfil this gap.

Institutionalisation occurs when an information system is no longer seen as an innovation, but a habitual way of life. Institutionalisation is often thought of as a post implementation process but this process should start at the beginning of the information systems development phase. In doing so, the institutionalisation of the information system becomes less of an effort to manage thereby allowing managers to concentrate on and devote their creative energies to their primary functions. This study therefore explored the contributing factors for institutionalisation especially in a case where technology and practice evolve together (pre and post).

Chapter 3 discussed the methodological issues, tools and techniques used in the process of research. Different research studies attempt to answer different types of research problems or research questions and employ different combinations of methods and procedures. A research strategy was developed to assist with deciding what approach to adopt in order to tackle the problem under study, what specific data to obtain and from where and how. The underpinning theory for the research was Actor-Network Theory and the paradigm underlying this research was interpretive with the assumptions of an inductive and deductive epistemology and a subjective ontology. This research was driven by an interpretive paradigm because of the interest in understanding the complex social processes involved when health care waste information systems are developed and institutionalised. The strength and power of the interpretivist approach lies in its ability to address the complexity and meaning of situations. The use of an interpretive framework deepens the understanding of how human and contextual factors affect, among others, system use and adoption. Interpretivism accepts human experiences as a valuable source of knowledge and its methodology provides the opportunity for expression of the complexity and depth of those experiences. The ontology for the purpose of this research is that actors structure reality through interaction. The actors have been identified as the human and non-human actors who need to interact with the Integrated Pollutant and Waste Information System (IPWIS) which incorporates an integrated health care waste information system (IHCWIS). The fundamental nature of the social world, for the human actors in this research, is at the level of their subjective experiences with the IPWIS *(incorporating IHCWIS)*. In other words, their reality is constructed through the work that needs to be done in reporting to the IPWIS *(incorporating IHCWIS)*; the nature of relations that are formed through this interaction; the possibilities for multiplicity and dynamic adaptation and the perplexity and uncertainty they bring along.

ANT is used as the theoretical framework for conceptualising the development and institutionalisation of IPWIS*(incorporating IHCWIS)*. One approach to better understand issues as they relate to information systems implementation and institutionalisation, is to apply the actor-network theory (ANT) framework. ANT provides a particular set of understandings of social and material phenomena by describing the various networks and allies involved in the creation and commissioning of science. ANT is good at describing a fine-grained relationship between technology and people and being a conceptual tool describing how technology stabilises in organizations. ANT is especially relevant since it takes technology seriously, gives due attention to nuances in design and use, as well as the role of different technological devices. ANT, as a useful theoretical lens for understanding socio-political phenomena, could provide added explanatory power over existing theories. ANT strongly emphasises empirical inquiry and is well suited to the generation of detailed empirical knowledge, about information systems, which is local and contextual. Even though ANT has been developed within the social studies of technology and science it has slowly gained more attention also among environmental, rural and information systems (IS) researchers. The heterogeneous network lies at the heart of ANT and is a way of suggesting that society, organisations, agents and machines are all effects generated in patterned networks of diverse materials. Using an actor-network approach, all factors (both human and non-human) influencing IPWIS *(incorporating IHCWIS)* institutionalisation are seen as actors, and the combination of all of these in terms of networks. Very little theoretical analysis has been done in the sociology of the environment and recent studies in this field fail to address waste management at all. A sociology of waste management is therefore urgently needed in order to understand the relationship between social change and environmental waste management change.

A research problem or issue is usually expressed as a question that enquires about the ontological, phenomenological, epistemological and normative nature of the problem at hand and the researcher would deliberately pose different questions to explore different aspects of the problem or situation at hand (Roode, 1993). A process-based framework was used to guide the researcher in formulating the research questions. The generic questions asked when exploring different aspects of the problem situation are: What is?, Why is?, How does, and How should? of health care waste information systems development and institutionalisation. These generic questions paved the way for a number of focus questions namely: What processes are used in developing a health care waste information system?, How was the health care waste information system finalised?, What factors are considered to enhance and facilitate the stabilisation of the health care waste information system?, and What are the indicators that IPWIS *(incorporating IHCWIS)* became a part of everyday life? The focus questions raised the primary research questions:

1 ***Having conceptualised an IHCWIS what processes are followed in the development of an IHCWIS?***
2 ***How does an IHCWIS manifest and become institutionalised among stakeholders? and when it is institutionalised,***
3 ***How can an IHCWIS contribute to effective and efficient HCWM decisions?***

The above research questions led to the choice of a research method. A qualitative descriptive research design was used to obtain more information about the development and institutionalization of health care waste information systems. A case study approach was used to gain an in-depth exploration and description of the perspectives, practices and behaviour of the actors in their natural setting. Qualitative studies usually aim for depth, rather than quantity, of understanding and have been described as holistic in that they are concerned with humans and their environment in all complexities.

Primary data that was used to derive answers to the research and focus questions was obtained through semi-structured face-to-face and telephonic interviews. Semi-structured interviews explore a topic or issue in great breadth , meaning that detailed information will be obtained to gain deeper insights into what one wants to find out. An interview schedule was used as the data collection tool during the interview. The interview schedule contained open-ended guiding questions based on the research and focus questions as previously shown. Structured questionnaires were used to generate primary data and were administered to health care waste generators and transporters at the various health care facilities. The structured questionnaire contained both open-ended and closed questions which were also formulated around the research question and focus questions. Secondary data was obtained by reviewing and critiquing existing literature and case documentation that coincided with the research, focus and generic questions, and that was relevant to the concepts of health care waste; waste management; information systems; and institutionalisation.

The data obtained during this research was analysed using qualitative content analysis to uncover and understand the latent meanings that are hidden in the text. The content of the data obtained during this research was analysed beginning with the research question and the preliminary concepts of health care waste; waste management; information systems; and institutionalisation. Coding, to capture and signal what is going on in the data, was done by hand. The data obtained was broken down into smaller units to reveal their characteristic elements and structure. The outcome of the analysis was concepts or categories describing the phenomenon. Usually (during the analysis process) the purpose of those concepts or categories is to build up a model, conceptual system, conceptual map or categories. Patterns in the data were observed, and organised into conceptual frameworks. Data abstraction resumed in order to explore and challenge the developed conceptualisations. Data abstraction and data interpretation continued until further observations yielded redundant, minimal, or no new information to further challenge or elaborate the conceptual framework. The aim was to attain a condensed and broad description of the development and institutionalisation of an IHCWIS. Once analysed, all qualitative data was summarized in diagrams, flow charts, narrative text, matrices and tables.

The following procedures were applied to ensure research rigour: concepts were operationally defined from the outset and appropriate data collection instruments were developed, all notes and text were documented and are open to external inspection/review, triangulation with different data sources of information by ways of examining evidence and member checking was done by providing a sample of respondents with a copy of their responses to verify accuracy. From an ethical perspective: permission to conduct the research was obtained from the University of Cape Town's Faculty of Commerce Ethics in Research Committee and various health care facilities , the nature, objectives and benefits of the study were explained to potential respondents and only then were respondents asked to participate in the research.

Potential respondents were informed that they had the right not to participate and could exit the research at any time. Persons who refused to participate were thanked and ensured that their non-participation would not be held against them. Respondents were informed that they had the right not to answer all the questions or specific questions and leave the interview or questionnaire at any time without being victimised. Anonymity and confidentiality were upheld. No names or identifying information appear in the thesis.

Chapter 4 provided a broad overview of the case and how it relates to the problem under study. IPWIS was identified as the case and the DEA&DP which houses IPWIS, Sub-case 1.The background and detailed description of DEA&DP, which uses IPWIS as an important management tool to meet the strategic objective of information management as set out in the integrated pollution and waste management policy and the NWMS, was given. The Centre for e-Innovation and the State Information Technology Agency, support units to DEA&DP, were identified as Sub-case 2 and Sub-case 3 respectively. Municipalities who render basic health care and environmental health services, such as health care waste management, served as Sub-case 4.

The Western Cape embarked on developing a waste information system (IPWIS*(incorporating IHCWIS)*) which is housed by the DEA&DP and developed by the Centre for e-Innovation and the State Information Technology Agency. It is for this purpose that these organisations were selected as study sites. Purposive sampling was used in this study and the participants were selected on the basis of who can provide the most useful information regarding the development and institutionalisation of an integrated health care waste information system.

Chapter 5 presented the analysis and discussion of the data obtained during the fieldwork. The chapter also brought together key issues and insights presented in the rationale of the study and review of the relevant literature. These issues and insights were, in turn, used to develop the framework for and levels of analysis.

Data from the interviews and questionnaires were analyzed through three lenses; (1) sociology of translation, (2) institutionalization and (3) effective and efficient use of IS. The first level of analysis was done using ANT as a lens to uncover the construction, growth and stability of IPWIS as a network. The second level of analysis was done on the interpretation of the results of case findings in order to investigate how IPWIS gains acceptance as normal custom practice and becomes institutionalized. The third level analysis focused on the implementation and application of IPWIS for effective and efficient health care waste management decision making. The same data were subjected to these three kinds of analysis, respectively. Qualitative content analysis was used to analyse the data obtained and both inductive (categories were derived directly from the text) and deductive (information systems, health care waste and waste management literature) methods were applied.

6.2 Addressing the research questions

Three distinct questions were asked in Chapter 1 in order to unravel the problem of poor health care waste management. These research questions are now revisited in the context of the research results.

What processes are followed in the development of an IHCWIS?

The events of illegal dumping of health care waste became a stimulus for the development of IPWIS *(incorporating IHCWIS)* as a solution to the problem of poor health care waste management. IPWIS *(incorporating IHCWIS)* was designed to provide benefits which could assist with effective health care waste management through the planning of budgets, prevention, monitoring and control of problems associated with health care waste. IPWIS *(incorporating IHCWIS)* was also designed to promote the creation of uniformity among health care waste generators which in turn would lead to better health care waste management. In developing IPWIS *(incorporating IHCWIS)* the value and interests of all those involved were identified and aligned through translation and inscription leading to a stabilized network. The functionality of IPWIS *(incorporating IHCWIS)* is of such a nature that health care waste can be traced, through this network of aligned interests, from generator to disposal. Health care facilities see themselves playing a specific role within the network of IPWIS *(incorporating IHCWIS)*. Health care facilities foresee themselves in the roles of monitoring, providing information, collecting and collating data, and providing reports. These roles are aligned to and correspond with DEA&DP's aim of identifying the development of a functional IPWIS *(incorporating IHCWIS)* as an important tool to effectively manage pollution and waste. The value that actors bring to the network, and the fact that IPWIS *(incorporating IHCWIS)* assists actors with their own waste management strategy, were reasons for engaging with IPWIS *(incorporating IHCWIS)* during the development phase. Thus, the alignment of the interest of IPWIS *(incorporating IHCWIS)* to the day-to-day management of health care waste made it possible for actors to naturally engage with each other.

The process used to develop IPWIS *(incorporating IHCWIS)* was very limited and restricted to contributions made during scheduled workshops. These contributions were deemed to have been incorporated by DEA&DP when developing IPWIS *(incorporating IHCWIS)*. DEA&DP as the proponent of IPWIS took a technical perspective to the development (including technology specialists on the design team) and by doing so missed the opportunity of including social aspects in the design.

The experiences of the various technical actors were mobilised into the IPWIS *(incorporating IHCWIS)* network and their needs needed to be incorporated in the design and development phase of IPWIS *(incorporating IHCWIS)*. Thus, excluding the other non-technical actors from the design team basically meant that DEA&DP lost the opportunity to validate their contributions made, and include social inputs for an in-depth needs analysis on IPWIS *(incorporating IHCWIS)* development. Results of this research indicated that everyone involved with IPWIS *(incorporating IHCWIS)* as a network should have participated in its design. The impacts of the problems of health care waste are severely experienced at operational (user) level and it is these users who will ultimate be expected to drive the process of managing those impacts. Furthermore the information will eventually be disseminated to the users. Participating in the design and development of IPWIS *(incorporating IHCWIS)* would have provided a sense of ownership to the users, facilitating everyday interaction with it which in turn would have enhanced the chances of institutionalization. Participation in IPWIS *(incorporating IHCWIS)* development should be seen as more than just serving on design teams. Potential users of IPWIS *(incorporating IHCWIS)* found it difficult to participate in the IPWIS *(incorporating IHCWIS)* development mainly due to the fact that the training workshops they attended were once-off and did not empower them. These once-off workshops were merely to introduce the other non technical actors to the functionality of IPWIS *(incorporating IHCWIS)*, i.e., what IPWIS *(incorporating IHCWIS)* can do and how to work with IPWIS *(incorporating IHCWIS)* software.

How does an IHCWIS manifest and become institutionalised among stakeholders?

Factors emerging from the level two analysis process, and which became factors complementing the sociology of translation and facilitating institutionalisation, were:
(1) Effective user participation: By effectively participating in the development of IPWIS *(incorporating IHCWIS)*, users could make meaningful contributions, add value, respond to development issues through providing and receiving feedback. Participating in the design and development of IPWIS *(incorporating IHCWIS)* provide a sense of ownership to the users facilitating everyday interaction with it which in turn enhances the chances of instutionalisation. Effective participation in IPWIS (incorporating IHCWIS) in the all encompassing network did occur even though it was absent in the development aspect of IPWIS (incorporating IHCWIS) as the OPP.
(2) Dedicated (assigned to IPWIS *(incorporating IHCWIS)* functions) information officers: DEA&DP and the local municipalities are plagued by lack of personnel and/or high turnover of staff. This situation impacts negatively on the stabilization of IPWIS*(incorporating IHCWIS)*. The primary duties of health care facility managers centre on the delivery of health care. That meant treating ill patients. Waste managers on the other hand are primarily responsible for operating the various waste sites. None of the health care facility managers have health care waste information management

as a primary function. Dedicated information personnel are thus needed if IPWIS *(incorporating IHCWIS) (incorporating IHCWIS)* is to be made part of the everyday activities. Dedicated information personnel will use IPWIS *(incorporating IHCWIS)* as their primary function which in turn would increase the chances of it becoming part and parcel of the daily activities of health care waste management.

(3) Informatics competencies: Informatics competencies can best be described as being competent to organise, store, retrieve, analyse, and optimally use data, information and knowledge to solve relevant problems. The persons involved with data IPWIS*(incorporating IHCWIS)* flow are nurses in charge of health care facilities, environmental officers, environmental health officers, technicians and waste managers. None of these cadres have had training or formal education relating to information systems and informatics. At best most of them have been made computer literate. Computer literacy is, however, but one of the areas of informatics competencies. If dedicated information officers are to be deployed then they must be competent or made competent in informatics. IPWIS*(incorporating IHCWIS)* has not yet reached a stage of institutionalisation (it will only become compulsory to register with and report to IPWIS*(incorporating IHCWIS)* once the regulations under the Health Care Waste Management Act have been passed) but if it is to be institutionalised then the information officers need to be skilled in and have a comprehensive understanding and knowledge of how to perform these functions. Lack of trained human resources, among others, could hinder reporting to IPWIS*(incorporating IHCWIS)*. Trained and dedicated human resources could ensure that reporting to and interacting with IPWIS*(incorporating IHCWIS)* transpires and this would enhance the chances of it becoming institutionalised.

(4) Systems integration: Some municipalities use existing regional waste information systems while others, e.g., City of Cape Town are in the process of developing their own waste information system. The need for systems integration, for the purpose of sharing information, has been highlighted during the enrolment phase of translation. Systems integration will result in municipalities saving considerable structural and administrative costs. It will not be expected from them to develop new systems nor duplicate the work (in relation to IPWIS*(incorporating IHCWIS)*) already done. Integrating IPWIS*(incorporating IHCWIS)* with other information systems is possible but must be treated with the utmost care and precaution must be taken to avoid the 'dumping' of unnecessary information onto the server.

How can an IHCWIS contribute to effective and efficient HCWM decisions?

The main objective of IPWIS*(incorporating IHCWIS)* is to promote, restore and maintain good health care waste management practice which is not detrimental to human health and the environment. IPWIS*(incorporating IHCWIS)* data is primarily used to assess health care waste management status, define health care waste priorities, evaluate programmes, and to identify emerging problems. The core activities of IPWIS*(incorporating IHCWIS)* comprise registration, reporting, confirmation and analysis. Improved public health surveillance can lead to earlier implementation of disease prevention and control measures. Links between the application and use of IPWIS*(incorporating IHCWIS)* and the development of health care waste management policy need to be strengthened. Decision-makers need to quantify the variation in IPWIS*(incorporating IHCWIS)* performance, identify factors that influence it and articulate policies that will achieve better results.

IPWIS*(incorporating IHCWIS)* plays a major role in environmental decision-making in that it facilitates the management and use of health care waste related data and information. Participation in IPWIS*(incorporating IHCWIS)* creates a support network of resources and expertise which in turn could be used to plan, apply and evaluate actions to prevent and control environmental related diseases. However, the use of IPWIS*(incorporating IHCWIS)* for effective and efficient pollution and waste management decision making in the Western Cape requires an advanced understanding of the systematic application of information systems, computer science, and technology. How well IPWIS*(incorporating IHCWIS)* performs, in the context of waste management, depends on its responsiveness, service provision, resource generation and stewardship. Two key issues identified were that of:

(1) System performance: The core activities of IPWIS *(incorporating IHCWIS)* comprise registration, reporting, confirmation and analysis. Decision-makers need to quantify the variation in IPWIS *(incorporating IHCWIS)* performance, identify factors that influence it and articulate policies that will achieve better results. In this way the assessment can be a diagnostic tool to evaluate policy reform and facilitate evidence-based decision-making; and

(2) Effective decision making: IPWIS *(incorporating IHCWIS)*, as our research revealed, plays a major role in environmental decision-making in that it facilitates the management and use of health care waste related data and information. The use of IPWIS *(incorporating IHCWIS)* for effective and efficient HCWM decision making in the Western Cape requires an advance understanding of the systematic application of information systems, computer science, and technology.

In summary the findings were that:

- IPWIS *(incorporating IHCWIS)* addressed the issue of inadequate management of health care waste and by doing so shaped the process of network formation/establishment and stabilization. The establishment of the network contributed towards its institutionalization but did not ensure it. We therefore had to interpret the case and the empirical findings to uncover factors which will lead to institutionalization. These factors were: Effective user participation, dedicated information officers, informatics competency and systems integration were factors which enhances the institutionalization of IPWIS *(incorporating IHCWIS)*.
- An institutionalized network promotes, but does not imply, the implementation and application of IPWIS and therefore we had to identify factors which lead to the effective and efficient management of health care waste. These were identified as systems performance and effective decision making throughout the use of IHCWIS.

The following model (Figure 6.1) formulates the theoretical contribution made by this research.

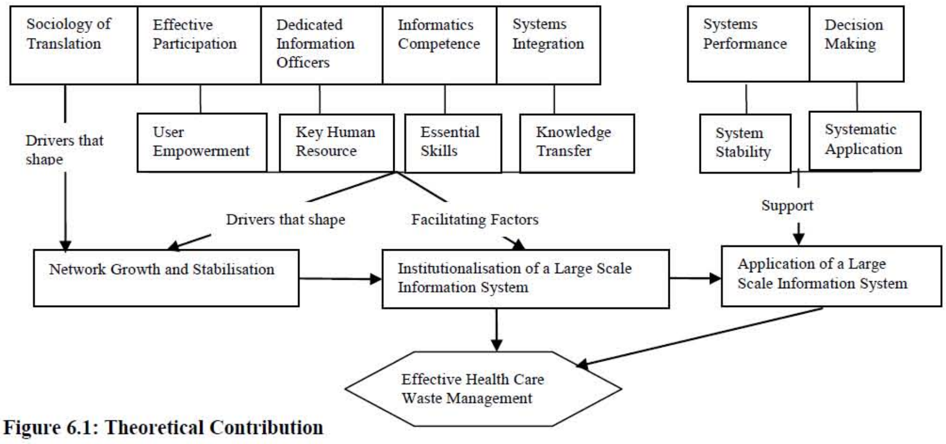

Figure 6.1: Theoretical Contribution

6.3 Evaluation of Research Contributions

Klein and Myers' (1999) set of principles for conducting and evaluating interpretive studies is an effort to advance the legitimacy of studies grounded in an interpretive position (Pozzebon, 2004). These principles assisted with the conduct and evaluation of interpretive research in the field of health care waste management. What follows now is the discussion of each principle in this research.

6.3.1 Evaluation of interpretive research (Klein and Myers, 1999)

The Fundamental Principle of the Hermeneutic Circle: This principle suggests that all human understanding is achieved by iterating between considering the interdependent meaning of parts and the whole that they form. This principle of human understanding is fundamental to all the other principles.

In this research we considered network establishment, information systems development, institutionalisation, and effective and efficient health care waste management to explain the phenomena of poor health care waste management. These factors are related in the sense that the establishment of the network contributes towards its institutionalisation but does not ensure it. Institutionalised network promotes, but does not imply, the implementation and application which lead to the effective and efficient management of health care waste.

The use of ANT accomplished the implementation of this principle by identifying and following the actors through the moments of translation. This facilitated and enhanced the establishment and stabilization of the network as a whole, IPWIS *(incorporating IHCWIS* the use of IPWIS *(incorporating IHCWIS)* for effective and efficient pollution and waste management decision making in the Western Cape requires an advance understanding of the systematic application of information systems, computer science, and technology. It was only when the actors successfully moved through all moments of translation that IPWIS*(incorporating IHCWIS* was established as a stable network of interested actors aligned around the use of IPWIS*(incorporating IHCWIS.*

The Principle of Contextualization: Requires critical reflection of the social and historical background of the research setting, so that the intended audience can see how the current situation under investigation emerged.

The case study approach and using IPWIS *(incorporating IHCWIS* as a case allowed us to take note of the context of poor health care waste management in South Africa. Detailed description of the case and sub-cases were provided and data gathered and analysed from the cases.

HCW is considered the second most hazardous waste after radioactive waste and the mismanagement thereof puts the patient, health care workers and the community at risk, both in terms of health and the environment. The poor management of health-care waste causes serious disease in health-care personnel, waste workers, patients and the general public. It also resulted in many incidents of illegally dumping and storage of such waste. The first cases of illegal dumping occurred as early as October 1998 and recent as December 2009. Research was thus needed to investigate the development and institutionalisation of health care waste information system as an intervention to address the issue of poor health care waste management.

The context of poor health care waste management allowed us to develop research questions and the variables contained in those research questions provided the initial concepts and constructs which later formed the basis for interpretation of the research findings.

The Principle of Interaction Between the Researchers and the Subjects: Requires critical reflection on how the research materials (or "data") were socially constructed through the interaction between the researchers and participants.

Research subjects were selected on the basis of who could, through their experiences knowledge and understanding, provide/share the most useful information regarding the development and institutionalisation of an integrated health care waste information system. Research subjects included: project managers for the development of IPWIS, information officers and technical support responsible for systems application, business analysis, system administration and networking, environmental officers who receive information from role players and responsible for the back office, senior manager responsible for the functional specification design of IPWIS, health care facility managers in charge of the health care facilities that generate health care waste, information systems managers responsible for collating and disseminating information and who attended IPWIS training workshops, waste managers involved with waste management at their respective municipalities.

Interviews were conducted with stakeholders in order to gain first-hand knowledge of the issues associated with health care waste management as well as the development and institutionalisation of IHCWIS as an intervention to address those issues. The researcher being an environmental academic had the necessary background and knowledge to conduct the interviews and analyse the data generated.
Once the data was analysed, it was then sent back to a sample of respondents for verification of correctness, confidentiality and providing an opportunity to supply additional comments.

The Principle of Abstraction and Generalization: Requires relating the idiographic details revealed by the data interpretation through the application of principles one and two to theoretical, general concepts that describe the nature of human understanding and social action.

Poor health care waste management is the problem under investigation and this substantiated the need for research to address it. The need for research to address the poor health care waste management informed the goal/aim of the research which is to gather empirical data to understand how the development and institutionalisation of a waste information system contribute to effective health care waste management. This led us to the underpinning theory for the research which is Actor-Network Theory and the paradigm underlying this research is interpretive with the assumptions of an inductive and deductive epistemology and a subjective ontology.

The underpinning theory determined the research approach which eventually led to the development of the appropriate research questions and objectives. The research questions guided the research design and provided the rationale for conducting a qualitative case study. The purpose of the research design is to ask 'what type of evidence is needed to answer the question in a convincing way' and by doing so, allows us to decide on a specific method to collect and handle the data needed for analyses. Data collection eventually culminated into analysis, which in turn, produced the relevant evidence to answer the research question and thus provides us with possible solution to the problem under investigation in the form of theoretical concepts.

The data was analysed at three levels namely to (1) uncover the establishment / construction, growth and stability of IPWIS, (2) explain how IPWIS gains acceptance as normal custom and practice, and (3) determine the use of IPWIS for effective waste management decision making. In addition to the concepts derived from ANT, different themes emerged during the analysis which reflected factors influencing institutionalisation these being dedicated (assigned to IPWIS *(incorporating IHCWIS* functions) information officers; informatics competencies; system integration; systems performance; and participatory decision making.

The Principle of Dialogical Reasoning: Requires sensitivity to possible contradictions between the theoretical preconceptions guiding the research design and actual findings ("the story which the data tell") with subsequent cycles of revision.

The data from the interviews and questionnaires were analyzed through three lenses; (1) sociology of translation, (2) institutionalization and (3) effective and efficient use. The same data were subjected to these three kinds of analysis, respectively.

Qualitative content analysis was used to analyse the data obtained and both inductive (categories were derived directly from the text) and deductive (information systems, health care waste and waste management literature and ANT) methods were applied. Combining inductive and deductive methods have been widely used in research and considered as the most realistic form of analysis which uses theory and literature to drive the framework.

Two contradictions emerged out of the analysis: (1) the limitations of ANT being a "top down" approach (e.g. all actors which subscribed to the views of the key actor). The results suggest that user participation ("bottom up" approach) underpins institutionalisation; (2) the non finalisation of the OPP provided another contradiction. The moments of translation proceeded without the OPP being finalised. This could occur because interaction with IPWIS was aligned to the primary duties of the actors. These contradictions revealed deeper insights into this phenomenon.

The Principle of Multiple Interpretations: Requires sensitivity to possible differences in interpretations among the participants as are typically expressed in multiple narratives or stories of the same sequence of events under study. Similar to multiple witness accounts even if all tell it as they saw it. To access multiple interpretations, actors were identified varying from information systems managers, waste managers, health care facility managers, service providers, and systems developers.

The first level of analysis was done using ANT as a lens to uncover the construction, growth and stability of IPWIS as a network referring to multiple stakeholder views.

The second level of analysis was done on the interpretation of the results of case findings from multiple sources in order to investigate how IPWIS gains acceptance as normal custom practice and become institutionalized. The third level analysis focused on the implementation and application of IPWIS for effective and efficient health care waste management decision making.

The multiple views of actors were used in the form of direct quotes. These quotes were then applied to support or reject a particular fact or perspective.

The Principle of Suspicion: Requires sensitivity to possible "biases" and systematic "distortions" in the narratives collected from the participants.

In getting to know the data, we listened over and over again to the recordings of the interviews with the various actors. These were then transcribed (verbatim) and, together with the data generated through the questionnaires, read and re-read. This was mainly done to separate the quality data from non-quality data. Quality data in this context refers to data which can be used to generate information which in turn provide possible answers to the research questions. With focusing the analysis we reverted to the research questions and objectives set in Chapters 2 and 3.

Multiple stakeholders at different levels, member checking and triangulation were performed to eliminate the issue of bias/distortion.

6.3.2 Evaluation of the theoretical contributions

In assessing a theoretical contribution Whetten (1989) provide criteria for judging theoretical contributions through the following series of questions:

- What's new? Does the paper make a significant, value added contribution to current thinking?
- So what? Will the theory likely change the practice of organisational science in this area?
- Why so? Are the underlying logic and supporting evidence compelling? Are the author's assumptions explicit?
- Well done? Does the paper reflect seasoned thinking, conveying completeness and thoroughness?
- Done well? Is the study well written? Does it flow logically? Are central ideas easily accessed?
- Why now? Is this topic of contemporary interest to scholars in this area? Will it likely advance current discussion, stimulate new discussion, or revitalise new ideas?
- Who cares? What percentage of academic readers are interested in this topic?

What's new? The development and institutionalisation of information systems is not new but the application thereof in health care waste is. We have captured the experiences and difficulties of the actors which in turn could be used as enabling factors. What is new is that factors have been identified which enhance the chances of institutionalisation, namely: the (1) OPP does not have to be finalised in order for actors to establish and stabilise the network; (2) successful moments of translation, effective user participation, dedicated information officers, informatics competence and systems integration are drivers that promote network establishment and leads to network growth and stability; and (3) In the context of IHCWIS, the system could be used for effective HCWM if the system performs at its peak without any brittleness and if the system is used as a decision making process.

So what? The practical contribution of this research is the detailed insight provided by analysing the case study. This expanded our thinking around how the development and institutionalisation of a health care waste information system could be used for effective and efficient management of such waste. The application of health care information systems could lessen the incidents of illegal dumping and improve health care waste management practices. Furthermore, it will also assist health care waste generator, treater, transporter, processor or disposer to comply with health care waste management legislation by:

- registering with IPWIS
- keeping written or electronic records
- making these records available to the public
- submitting all the information to the IPWIS.

Why so? This research was built on convincing arguments and grounded in reasonable explicit views of human nature and organisational practice. These are discussed in detail in Chapter 5 and the preceding section 6.3.

Well done? Arguments do reflect a broad understanding of health care waste management, and the development and institutionalisation of information systems. The use of three levels of analysis to determine the effective and efficient use of the network for decision making in order to address and solve the issue of poor health care waste management is also an indication that thorough thinking has occurred. Completeness was ensured through the process of starting with the problem under study and then moving to the concepts and constructs in the research question which eventual culmination of possible answers to the research question.

Done well? The central ideas were generated from the phenomena of poor health care waste management and the need for an appropriate intervention. The development and institutionalisation of a health care waste information system was considered as one of such intervention. The logical flow was discussed under principle of abstraction and generalization in section 6.3. The thesis structure also provided a systematic and logical account from the problem statement through to the literature review, research questions, data collection, analysis and interpretation.

Why now? The inclusion of health care waste information systems as part of effective and efficient health care waste management has largely been ignored. Researchers and theorists, when addressing issues relating to health care waste management, only focussed on the practice component i.e the cradle-to-grave approach. External (external to the cradle-to-grave approach) factors which impacts on health care waste management, as identified in this research, were not considered. The problem of illegal and indiscriminate health care waste dumping is still a recent occurrence especially in developing countries such as South Africa.

The topic will be of interest to scholars because according to Jackson and Klobas (2008) most organisations continue to attempt to implement systems which ignore social constructions, attempting to engineer solutions as if organizations and processes were constructed of components or objects which exist outside their social context.

Lloyd-Smith (2009) argues that resources must be available to ensure information access and capacity building initiatives if one wants to achieve sound hazardous waste management. Pan *et al.* (2008) state that more longitudinal field studies on project failures (in the context of information systems implementation) are clearly called for, so that we may have a deeper understanding of the dynamics of project failure in various contexts.

Who cares? The impact of poor health care waste management has dire consequences for the health of people and that of the environment and this topic together with finding possible solutions will keep on attracting scholarship in the field of information systems, environmental management and public health.

6.4 Limitations and prospects for further research

Key limitations have to do with the study site. The study site is placed within the public sector and limited to health care waste generated by public health care facilities. Health care waste generated by private health care facilities were excluded from this study. Secondly, the research did not include the technical design aspects of a health care waste information system and the factors, other than participation, which influences such design. In analysing the data we used content analysis which in itself is limiting. The analysis was mainly limited to the material (content) obtained from the participants.

Further research is needed to develop indicators for effective and efficient health care waste management as well as determining which factors will ensure the tracking and safe disposal of health care waste so that no health care waste go unaccounted.

The research was done at public health care facilities and research is needed to determine if the results of this study is applicable to health care facilities in the private sector or if research private health care facilities will yield different results to that of this study. Research into factors which facilitate the smooth integration of health informatics in the curricula of heath related (e.g. nursing) and environmental management courses is also needed. Prospective health care and waste managers will therefore have an in-depth understanding of information systems and its application to environmental and health problems.

This study provided an identification and description of the factors (effective participation, dedicated information officers, competence, integration) which facilitate the development and institutionalisation of an integrated health care waste information system. More research is needed on these factors to determine the extent to which they affect the quality of an information system and the extent to which the system is used.

6.5 Recommendations

In view of the findings and conclusion of this thesis, the following are recommended to sustain the institutionalisation of a large scale health care waste information system:

- Information systems developers should create collaborative platforms, during the design phase, to serve as a point for information dissemination and knowledge transfer between developers and end users.
- Environmental management and health profession curricula should be tailored to the point where competent professionals are produced to foster the ever increasing use and application of ICT to address environmental and health problems.
- ICT capacity should be accelerated in the environmental management and health fields to compensate for the absence of dedicated information officers in these disciplines.
- Environmental data needs to integrated and linked to health data. This calls for innovative approaches to link overarching health information systems to that of an environmental information system so as to facilitate data flow and knowledge transfer.

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Appendices

Appendix A1: HCW Service Providers: Interview schedules

HCW Service Providers: Interview Schedule: Questions

1. What do you know about the Integrated Pollution and Waste Information System (IPWIS)?

2. Are you aware that everybody, by law, will have to report to IPWIS?

3. How do you expect to be informed about the information system and your responsibility under that system?

4. What interest do (or will) you have in IPWIS?

5. Communication in the past was done by workshops. Do you feel they should do the same this time?

6. Were you informed by the Department of Environmental Affairs and Development Planning of any workshops regarding IPWIS?

7. Were you or your organisation in any way involved with developing (IPWIS)?

8. Do you know of anyone else who participated in developing the Integrated Pollution and Waste Information System?

9. What roles do those who participated, hold or play?

10. How was the value of these roles and influences determined?

11. Did you have a role in mind for those who participated?

12. If Yes, what was done so that those who participated accept this role?

13. Did those who participated in developing have any concerns?

14. If Yes, how were these concerns addressed/handled?

15. Did you experience any problems with those who participated Integrated Pollution and Waste Information System?

16. If Yes, how were these handled/addressed?

17. How did consultation occur with those who participated?

18. What made you to accept those who participated?

19. How did you know who was an important or useful participant?

20. How did you manage to establish a working relationship among the participants?

21. Who considered IPWIS to be a solution to the problem of health care waste?

22. How did they come to consider this as a solution?

23. How was the IPWIS as a solution, accepted?

24. What made them agree on IPWIS being a solution?

25. How will interaction between the participants be determined?

26. How will interaction between the participants and IPWIS occur?

27. What barriers threatened the stability of this interaction?

28. What will encourage interaction?

29. In your opinion, what factors will facilitate the reporting to the IPWIS?

30. What factors will hinder reporting to the IPWIS?

31. Can IPWIS still be changed/modified?

32. If Yes, how?
33. If No, why not?

Appendix A2: Systems Developers: Interview schedules

Systems Developers: Interview Schedule: Questions

What is your position in the organisation?

Were you in any way involved with developing (IPWIS)?

What interest do (or will) you have in IPWIS?

1. Systems Development

From which perspective or within which context was the recognition for a HCWIS initialised?

- Technical?
- Operational?
- Personal?
- Political?
- Environmental?
- Community?

Who recognised the need for a HCWIS?

- Person?
- Organisation?
- Community?
- 1.3 What recognition process was followed?
- 1.4 How was this need disseminated to others?
- To whom?
- By whom?

Was the need accepted?

- How well?
- Who supported this need?
- Who was opposed to the need?

2. Decision Making

Whose responsibility was it?

What was the decision making process?

How were decisions justified?

How were decisions implemented?

3. Conceptualisation

From which perspective or within which context was the recognition for a HCWIS conceptualised?

- Technical?
- Operational?
- Personal?
- Political?
- Environmental?
- Community?

To who was initial brief given?

Whose responsibility was it?

Who were the participants?

What were their roles and influences?

Were there any contractual agreements?

4. Resource Utilisation

Were there any expenditure concerns?

Was expenditure in alignment with the organisational strategic plan?

What capacity exists?

5. Interaction

Communication in the past was done by workshops. Do you feel they should do the same this time?

Do you know of anyone else who participated in developing the Integrated Pollution and Waste Information System?

What roles do those who participated, hold or play?

How was the value of these roles and influences determined?

Did you have a role in mind for those who participated?

If Yes, what was done so that those who participated accept this role?

Did those who participated in developing have any concerns?

If Yes, how were these concerns addressed/handled?

Did you experience any problems with those who participated Integrated Pollution and Waste Information System?

If Yes, how were these handled/addressed?

How did consultation occur with those who participated?

What made you to accept those who participated?

How did you know who was an important or useful participant?

How did you manage to establish a working relationship among the participants?

Who considered IPWIS to be a solution to the problem of health care waste?

How did they come to consider this as a solution?

How was the IPWIS as a solution, accepted?

What made them agree on IPWIS being a solution?

How will interaction between the participants be determined?

How will interaction between the participants and IPWIS occur?

What barriers threatened the stability of this interaction?

What will encourage interaction?

In your opinion, what factors will facilitate the reporting to the IPWIS?

What factors will hinder reporting to the IPWIS?

Can IPWIS still be changed/modified?

If Yes, how?

If No, why not?

Appendix B1: Structured questionnaire for health care waste facilities

REF. NO……………………………..

1. Organisation Information

(You will now be asked questions regarding yourself and the health care waste generated at your facility. Names are for record, validity reliability purposes only. Only the researcher and his supervisor will have access to these names.)

1.1 What is your name?……………………………………………………………….…

1.2 What is the name of your facility?……………………………………………..….

1.3 What is your position at your facility?……………..………………………..

1.4 What type of health care waste does your facility generate? **(*Circle relevant type/s)***

Infectious	Pathological	Sharps	Pharmaceutical	Pressurised Containers	Genotoxic	Chemical	Metals	Radioactive

1.5 How much health care waste in total (kilograms), does your facility generate?………

2. Information Systems Definition

(You will now be asked questions regarding the Integrated Pollution and Waste Information System and your involvement / non- involvement with this system)

2.1 Are you aware of the Integrated Pollution and Waste Information System?

(please circle) **YES** **NO**

2.2 If **YES**, how did you become aware?...
……………………………………………………………………………………………

2.3 If **NO**, how should you be made aware of the Integrated Pollution and Waste Information System?
……………………………………………………………………………………………

……………………………………………………………………………………………

2.4 Are you aware that it will become mandatory for your facility to provide information to the Integrated Pollution and Waste Information System?

(please circle) **YES** **NO**

2.5 If **YES**, how did you become aware?..
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2.6 What factors would encourage your facility in providing information to Integrated Pollution and Waste Information System?

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2.7 What factors would hinder your facility in providing information to the Integrated Pollution and Waste Information System?

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2.8 Were you or your facility involved with the development of the Integrated Pollution and Waste Information System?

(please circle) **YES** **NO**

2.9 Did you or your facility wanted to be involved? (please circle) **YES** **NO**

2.10 If **YES,** Why did you want to be involved?..

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2.11 If **NO,** why not?…………………………………………………………………….

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2.12 Is there a need for a provincial wide health care waste information system?

(please circle) **YES** **NO**

2.13 If **YES**, why do you say there is a need for a provincial wide health care waste information system?

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2.14 If **NO**, why is there not a need for a provincial wide health care waste information system?

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2.15 Who should recognise the need for a provincial wide health care waste information system?

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2.16 What should be in place for you to accept the need for a provincial wide health care waste information system?

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2.17 How should the idea for a provincial wide health care waste information system be formed?

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2.18 Who should participate in the process of forming the idea for a provincial wide health care waste information system?

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2.19 What is the reason/s for the above answer (question 2.18)?

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…………………………………………………………………………………………

2.20 Should there be any contractual agreements between those participating in forming the idea for a health care waste information system ?

(please circle) **YES** **NO**

3. Health Care Waste Information Systems Utilisation

(You will now be asked questions regarding the use a health care waste information system. A Health Care Waste Information System is any system (comprising of people, technology and processes) that collects, processes, stores, analyze and/or disseminate information regarding the generation, handling, storage, transport and / or disposal of health care (medical) waste.)

3.1 Does your facility have a health care waste information system?

(please circle) **YES** **NO**

(If your answer is* YES *then please ONLY answer questions 3.2 to 3.11)

(If your answer is* NO *then ONLY answer questions 3.12 to 3.15)

3.2 How does your health care waste information system operate?

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3.3 How is your health care waste information system funded?

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3.4 What products (outputs) does your health care waste information system produce?

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3.5 What benefits do you reap from your health care waste information system?

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3.6 Which organisational goals is the health care waste information system achieving?

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3.7 Which changes in the organisational structure have occurred as a result of the health care waste information system?

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3.8 Which changes in operational practices have occurred as a result of the health care waste information system?

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3.9 Was expenditure in alignment with the organisational strategic plan?

(please circle) **YES** **NO**

3.10 What capacity exists at your organisation regarding the management of a health care information system?

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(The following questions 3.12 to 3. should only be answered by those whose facilities do not have a health care waste information system)

3.12 Who should fund a health care waste information system?

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3.13 What products (outputs) should the health care waste information system produce?

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3.14 What benefits should be reaped from a health care waste information system?

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3.15 What capacity exists at your facility regarding the management of a health care waste information system?

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4. Interaction

(You will now be asked questions regarding you or your facility as part of a bigger network that interacts with a provincial wide health care waste information system)

4.1 What interests do you or your facility have in a provincial wide health care waste information system?

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…………………………………………………………………………………………………

4.2 How should these interests materialise/or come into being?

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4.3 What contribution/s can you or your facility make toward/s a provincial-wide health care waste information system?

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4.4 What role could you or your facility play in a provincial-wide health care waste information system?

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4.5 How should your or your facility's role as part of a provincial wide network be determined?

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4.6 Which other organisations (apart from your facility) should be involved with the provincial wide health care waste information system?

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4.7 How will you and your facility interact with these other organisations?

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4.8 How will you and your facility interact with the provincial health care waste information system?

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4.9 Who or what currently determines your interaction?

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4.10 Who or what should actually determine this interaction?

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4.11 What concerns will you have when participating in the health care waste information system?

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………………………………………………………………………………………………

4.12 How should these concerns be addressed/handled?……………………..……………..

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4.13 What factors would encourage you or your facility in becoming part of a provincial wide health care waste information system?

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4.14 What factors would hinder you or your facility in becoming part of a provincial wide health care waste information system?

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4.15 What barriers would threaten a provincial wide health care waste information system?

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………………………………………………………………………………………………

4.16 What would make you or your facility, accept a provincial wide health care waste information system?

………………………………………………………………………………………………

4.17 What would cause you or your facility not to accept a provincial-wide health care waste information system?

…………………………………………………………………………………………………

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4.18 What needs to be done so that a provincial-wide health care waste information becomes an everyday part of your daily activities?

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…………………………………………………………………………………………………

Thank You Very Much For Your Time and Cooperation

Appendix B2: DEA&DP questionnaire

Integrated Pollutant and Waste Information System (IPWIS)
Training Workshop
Cape Town, March 2007

EVALUATION QUESTIONS

1. What are your overall impressions of the IPWIS training logistics and organisation?

GOOD

2. Were you given adequate opportunity to participate in the IPWIS training sessions?

YES

3. Are the presentations and materials provided easy to follow?

YES

4. Are you confident you will be able to operate IPWIS on your own after attending this training session?

UNCERTAIN ⇒ NEED TO REFRESH BEFORE STARTING

5. Did you feel comfortable voicing your opinion in a language of your preference? If not please suggest any improvements.

YES

6. Was the definition / terms used during the sessions easy to understand and follow?

YES

7. Did officials from D: EADP i.e. the IPWIS team display an acceptable level of understanding and were they able to transfer such knowledge to you through the training session?

YES

8. Was time allocated per session adequate and managed acceptably as scheduled?

YES/NO ALLOW FOR 3 DAYS

9. What is your opinion of the venue for this training?

FAIR ⇒ TOO MANY DISTRACTIONS ⇒ AIRCON ⇒ SETUP MUST BE LIKE LECTURE ROOM

10. Please provide any suggestions for further improvement on the quality of this training and the IPWIS system, i.e. any problem or issues of concern regarding the usability of the system.

OPEN TELEPHONE LINE FOR ~~ANY~~ GIVING ADVICE OVER PHONE WHEN UNCERTAIN WHAT TO DO NEXT ON SYSTEM

6

Integrated Pollutant and Waste Information System (IPWIS)
Training Workshop
Cape Town, March 2007

EVALUATION QUESTIONS

What are your overall impressions of the IPWIS training logistics and organisation?

It's a good and important system. Well organized.

2. Were you given adequate opportunity to participate in the IPWIS training sessions?

Fairly so yes.

3. Are the presentations and materials provided easy to follow?

Presentations are easy to follow, but more practice is needed.

4. Are you confident you will be able to operate IPWIS on your own after attending this training session?

With regular practice yes. It should be implemented soon

5. Did you feel comfortable voicing your opinion in a language of your preference? If not please suggest any improvements.

Yes

Was the definition / terms used during the sessions easy to understand and follow?

New system, new terminology no surprises (normal PC program jargon).

7. Did officials from D: EADP i.e. the IPWIS team display an acceptable level of understanding and were they able to transfer such knowledge to you through the training session?

Yes.

8. Was time allocated per session adequate and managed acceptably as scheduled?

Yes except for the problems experienced.

9. What is your opinion of the venue for this training?

Acceptable for the type of training...

10. Please provide any suggestions for further improvement on the quality of this training and the IPWIS system, i.e. any problem or issues of concern regarding the usability of the system.

The system is OK. The problems experienced with the program affected the session flow. Try not to schedule maintenance during training period, it's disruptive...

Appendix C: List of documents sourced from DEA&DP

Cape Peninsula
University of Technology

FACULTY OF APPLIED SCIENCES: DEPARTMENT ENVIRONMENT AND OCCUPATIONAL STUDIES

08 December 2009

To Mr. K. Chetty
Deputy Director: Air Quality
Department of Environmental Affairs and Development Planning
Western Cape Provincial Government

Re: Health Care Waste Information Research Project: Permission to Access and Retrieve Information

Our conversation this morning refers. Permission is hereby requested to access and retrieve the following information:

1. Duties and dispute procedures (regarding IPWIS) of WCPG and SITA as reflected in the business agreement.
2. User requirement specification for IPWIS: September 2004
3. Build or buy recommendation for IPWIS: July 2004
4. Project initiation document for IPWIS: 2005
5. Functional specification design: July 2004
6. Training manual: The safe management and minimization of health care waste: May 2004
7. IPWIS permitting process flow diagram
8. IPWIS External attendance register and evaluation responses: Workshops 5-6 and 12-13 march 2007
9. External training workshop invitation and agenda

Please be assured that all information will be kept confidential and only the researcher will have access to it. A copy of the analysed information (as it will appear in the general research report) will be given to you for verification and confidentiality purposes.

Thank you and trusting that my request will meet your approval.

Yours sincerely

Brian Delcarme: Lecturer/Researcher

Appendix D1: Messages, to verify responses, sent to respondents

From: Brian Delcarme
To: [redacted]@pgwc.gov.za
Date: 2010/03/30 12:44 PM
Subject: Verifying responses
Attachments: Respondent SDo2.doc; Chpt 5 Final.doc

Hi [redacted]

Attached, please find a copy of the transcript of the interview regarding IPWIS as well as the findings and discussion of the research. Your responses appears as SD02 in the findings.

Please review both and inform me if I had captured and interpreted your responses accurately.

Also feel free if you wish to add on any additional information or comments.

Thank you and awaiting your response.

Regards
Brian

From: Brian Delcarme
To: [redacted]@pgwc.gov.za
Date: 2010/03/30 12:48 PM
Subject: Verifying responses
Attachments: Respondent KA01.doc; Chpt 5 Final.doc

Hi [redacted]

Attached, please find a copy of the transcript of the interview regarding IPWIS as well as the findings and discussion of the research. Your responses appears as KA01 in the findings.

Please review both and inform me if I had captured and interpreted your responses accurately.

Also feel free if you wish to add on any additional information or comments.

Thank you and awaiting your response.

Regards
Brian

-----Original Message-----
From: Brian Delcarme [mailto:delcarmeb@cput.ac.za]
Sent: Tuesday, March 30, 2010 12:39
To: [redacted]
Subject: Verifying responses

[redacted]

Attached, please find a copy of the transcript of the interview regarding IPWIS as well as the findings and discussion of the research.
Your responses appears as MIS02 in the findings.

Please review both and inform me if I had captured and interpreted your responses accurately.

Also feel free if you wish to add on any additional information or comments.

Thank you and awaiting your response.

Regards
Brian

Appendix D2: Message, to verify responses, received from respondents

From: [redacted]@pgwc.gov.za>
To: "Brian Delcarme" <delcarmeb@cput.ac.za>
Date: 2010/05/03 06:32 am
Subject: Re: Hi [redacted]

hi , there sorry i have been on leave and i have checked all the documentation there is nothing that i see wrong or anything i feel id like to comment on.

>>>
From: "Brian Delcarme" <delcarmeb@cput.ac.za>
To: [redacted]@pgwc.gov.za>
Date: 4/28/2010 2:29 PM
Subject: Hi [redacted]

Hi [redacted]

Have you completed the comments on the transcript? Time is running out for me.

Regards
Brian

From: [redacted]y@pgwc.gov.za>
To: "Brian Delcarme" <delcarmeb@cput.ac.za>
Date: 2010/05/03 08:44 am
Subject: response

** High Priority **

Good morning

sent this thro on Friday but it still does not appear on sent items

sending it again did not include the big doc...test this first

regards

[redacted]r@capetown.gov.za>
To: Brian Delcarme <delcarmeb@cput.ac.za>
Date: 2010/03/30 02:03 PM
Subject: RE: Verifying responses
Attachments: Respondent MIS02.doc

Hi Brian,

Please find my amended responses. I didn't read through the whole chapter 5 though.

Regards

[redacted]

[redacted]GIS & MIS

[redacted]

City of Cape Town

[redacted]

Address: 19th Civic Centre (4bay), Hertzog Boulevard

P.O. Box 298, Cape Town 8000

Appendix E: Ethics approval

University of Cape Town
ETHICS COMMITTEE

Commerce Faculty
2.26 Leslie Commerce Building Upper Campus
Postal address: UCT Private Bag Rondebosch 7701
Telephone: (021) 650 2696
Fax: (021) 650 4369
Email: comsec@commerce.uct.ac.za

18 April 2005

Mr Brian Delcarme

Dear Brian

PROJECT ON THE DEFINITION AND INSTITUTIONALISATION OF AN INTEGRATED HEALTH CARE WAST INFORMATION SYSTEM FOR EFFECTIVE WASTE MANAGEMENT IN THE WESTERN CAPE

Having received your documentation associated with your project on the "Definition and Institutionalisation of an integrated Health Care Waste Information System for effective Waste Management in the Western Cape" the Chairperson, Prof. Jeff Bagraim hereby give your project final approval on behalf of the Commerce Faculty Ethics in Research Committee.

Please note that if you make any substantial change in your research procedure as it impacts upon the experiences of your subjects, you must re-apply to the Committee for approval.

I wish you good success with your research.

Regards,

Prof Jeff Bagraim
Chair, Ethics in Research Committee

Appendix F1: Permission letter from City of Cape Town

CITY OF CAPE TOWN | ISIXEKO SASEKAPA | STAD KAAPSTAD

Civic Centre
12 Hertzog Boulevard
Cape Town 8001
P O Box 2815 , Cape Town 8000
Ask for: Dr I Toms
Tel: 021 4002100
Fax: 021 421 4894

Iziko loLuntu
12 Hertzog Boulevard
Cape Town 8001
P O Box 2815 , Cape Town 8000
Cela: Qrh I Toms
Umnxeba: 021 4002100
Ifeksi: 021 421 4894

Burgersentrum
Hertzog-boulevard 12
Kaapstad 8001
Posbus 2815 , Kaapstad 8000
Vra vir: Dr I Toms
Tel: 021 4002100
Faks: 021 421 4894

E-mail: ivan.toms@capetown.gov.za
Website: http://www.capetown.gov.za
Ref:
Filename: N:\wpdocs\city Health\letters\Research ~ B Delcarme.doc

CITY HEALTH

2006-10-06

Mr Brian Delcarme

Dear Mr Delcarme

PERMISSION TO CONDUCT RESEARCH AT THE CITY OF CAPE TOWN HEALTH CARE FACILITIES

Your letter dated 2006-08-29 refers.

Permission is hereby granted for your research. The attached project summary form needs to be completed by yourself and returned to my office.

Please liaise with Mr J Schippers regarding the implementation of your research within City Health. He can be contacted on 021 400 2321.

Yours sincerely

DR IVAN TOMS
EXECUTIVE DIRECTOR: CITY HEALTH

Appendix F2: Permission letter from the Provincial Government of the Western Cape

From: "Deborah Cana" <Dcana@pgwc.gov.za>
To: "Donna Stokes" <Dstokes@pgwc.gov.za>, "Elizabet...
Date: 2007/02/13 02:49
Subject: Permission granted for research to be conducted within your institutions

CC: <delcarmeb@cput.ac.za>
Dear all,

Dr Vallabhjee has granted permission to Mr Brian Delcarme to conduct research on waste management at your institutions. [please find attached letter]

Mr Delcarme will be in contact with you should he need to make an appointment.

Kind regards

Deborah Cana
Administrative Assistant to Dr K Vallabhjee
Office of the Chief Director
Regional Hospitals, APH & EMS
Tel: +27 [021] 918-1530
Fax: +27 [021] 948-3343
E-mail: dcana@pgwc.gov.za

Appendix G: Letter: Informed consent

UNIVERSITY OF CAPE TOWN

Department of Information Systems

Leslie Commerce Building
Engineering Mall · Upper Campus
OR Private Bag · Rondebosch 7701
Tel: 650 2261
Tel. Add.: ALUMNI, Cape Town
Fax No: (021) 650-2280

12 March 2004

TO THE RESPONDENT

Thank you for agreeing to discuss your possible participation in a research project that focuses on a Health Care Waste Information System for health care waste management at Provincial and Local Government level in the Western Cape. Participation is entirely voluntary, but we would naturally welcome your contribution sincerely. All data obtained through the interviews to be conducted will be anonymous, and no personal details of any respondent will be disclosed to anybody but the researchers. The data will solely be used for academic purposes in the course of this particular study.

The attached documentation provides more information about the objectives of the study, and we respectfully request you to confirm your participation through signing the appropriate document.

Sincerely

BRIAN DELCARME
Researcher

PROF JD ROODE
Supervisor

Dear Respondent

My name is Brian Delcarme, a PhD registered student in the Information Systems Department at the University of Cape Town. I am conducting research in fulfilment of the requirements for the Doctorate in Information Systems.

This research focuses on the Development and Institutionalisation of a Health Care Waste Information System for health care waste management at Provincial and Local Government level in the Western Cape. The main purposes are to determine the extent to which provincial and local health departments contribute to the definition of information systems and how a health care waste information system manifests itself and become institutionalised.

The objectives of the study are to:

- Provide a detailed description of the entire process of integrated health care waste information systems definition (for health care waste management) within the departments of health in the Western Cape.
- Identify the most important technical and non-technical actors that form the network associated with the definition and institutionalisation of an integrated health care waste information system.
- Establish how these actors are recruited, the relationships between them, their interest, how their interest are aligned, what values they hold, and the existing/potential roles they play.
- Describe the explicit anticipations (scenarios) of use held by the various actors.
- Describe how a due process approach could contribute towards the success of an integrated health care waste information system

We will be asked questions to which there are no right or wrong answers, just honest responses. All questions should be answered as accurately and completely as you can, regardless of how satisfied or dissatisfied you are with conditions at your facility and/or within the health system. **ALL OF YOUR ANSWERS WILL BE TREATED IN THE STRICTEST CONFIDENCE.**

You have the right not to participate in this research but we would encourage you to do so because this study will generate new knowledge and make a valuable contribution to the fields of information systems and environmental health. The information will benefit your organisation and the health care system in general. Your identity will be kept secret and all information will be generalised in a research report. Nobody will know who provided what information.

Please make sure you read every question and the instructions that go with it. If you do not know the answer to a question then please write: Do not Know.

If you do not want to answer a question then leave it blank.

Thank you Brian Delcarme