HEALTHCARE WASTE MANAGEMENT FOR HOSPITALS IN RESOURCE-CONSTRAINED SETTINGS: WHAT DETERMINES EFFECTIVE IMPLEMENTATION?

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ABSTRACT

Jacqueline Au McPherson: Healthcare Waste Management for Hospitals in Resource-Constrained Settings: What Determines Effective Implementation?
(Under the direction of John E. Paul)

The effective management of healthcare waste is a critical component of a hospital's infection control program and is central to occupational safety for healthcare workers and the health of the environment and community. In low-income countries, where hospital administrators are burdened by resource constraints and struggle to maintain basic health services, healthcare waste management (HCWM) can be a significant challenge. There are, however, examples of hospitals in low-income countries that are effectively implementing HCWM systems that use new technology and practices and focus on reducing, reusing and recycling their waste. This research aimed to identify the determinants of effective implementation of the HCWM systems in three such hospitals located in Kathmandu, Nepal.

This study utilized a multiple case study design with a mixed methods approach. A conceptual model for implementation effectiveness of complex innovations in organizational settings was used to guide the study design.

The key findings from this study identified four determinants that facilitated effective implementation across all sites including 1) the presence of an innovation champion within the hospital who advocated for use of the system; 2) a strong perception of the primary users (nurses and ward attendants) that use of the system contributed to fulfillment of their group values such as doing no harm to patients and service to the community; 3) a partnership with a technical organization; and 4) strong implementation policies and practices. The study identified one determinant that acted as a barrier to effective implementation across all sites; hospital staff perceived that it was difficult for hospital visitors to comply fully with policies that required visitors to segregate all waste at source. There were differences in motivation to adopt and implement HCWM systems depending on the type of hospital (private, public,

non-profit). The length of implementation and level of management engagement were also found to influence the level of implementation effectiveness.

The findings suggest that large hospitals in low-income countries like Nepal can effectively manage their waste through systems that minimize harm to the environment, hospital staff and surrounding communities. The study provides recommendations for the type of support and inputs needed for effective implementation.

To Bob, Lyle and Madeline

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LIST OF ABBREVIATIONS

DoHS	Department of Health Services
EHIA	Environmental Health Impact Assessment
EPA	Environmental Protection Agency
GGHH	Global Green and Healthy Hospitals
HCWM	Healthcare Waste Management
HIV	Human Immunodeficiency Virus
IPPs	Implementation Policies and Practices
IRAT	Individualized Rapid Assessment Tool
IRB	Internal Review Board
ISO	International Organization for Standardization
JAR	Joint Annual Review (Nepal)
MDG	Millennium Development Goal
MoHP	Ministry of Health and Population
MWM	Medical Waste Management
MWTA	Medical Waste Tracking Act
MTR	Midterm Review
NGO	Non-Governmental Organization
NHRC	Nepal Health Research Council
NHSP	Nepal Health Sector Programme
OPD	Outpatient Department
UNC-CH	University of North Carolina, Chapel Hill
UN GEF	United Nations Global Environment Facility
UK	United Kingdom
WHO	World Health Organization

CHAPTER 1: INTRODUCTION

1.1 Statement of the Problem

Healthcare facilities throughout the world provide essential prevention, treatment and care services to improve health and quality of life. Paradoxically, one of the byproducts of these services, healthcare waste,[1] creates potential risk for injury, infection, and environmental pollution. The effective management of healthcare waste is a critical component of a healthcare facility's infection control program and is central to occupational and environmental safety for healthcare workers (1). While approximately 80% of waste generated from the healthcare industry is classified as non-risk (non-infectious, non-hazardous) general waste, the remaining 20% is considered hazardous and needs specialized handling, treatment and disposal (2). Properly managed, hazardous waste should pose no threat to humans or the environment. Yet for most healthcare facilities, especially in low-income countries, the management of healthcare waste is a formidable challenge. A 2002 WHO study of 22 low-income countries showed that 18 to 64% of healthcare facilities did not use proper disposal methods for healthcare waste (3).

Over the past decade, the volume of healthcare waste in low-income countries has significantly increased due to exponential population growth, the expansion of healthcare facilities and higher utilization of disposable items (4-6). The problem is particularly acute in South Asia[2], the most densely populated region of the world with more than 20% of the world's population and three of the ten most

[1] See Appendix 1 for definitions of key terms.

[2] South Asia, defined by the United Nations geographical regions classification, includes Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka.

populous countries: India, Pakistan and Bangladesh (Table 1) (6). Healthcare facilities throughout South Asia, constrained by limited resources and often struggling to meet the most basic health needs of the populations they serve, often neglect the management of healthcare waste. Numerous descriptive studies from South Asia indicate that the majority of healthcare facilities have under-resourced, antiquated and poorly-managed systems for the treatment and disposal of hazardous waste (5,7). There are, however, also striking examples of successful implementation of healthcare waste management (HCWM) systems in South Asia that can be studied to better understand the key determinants for effective implementation. One such example from Nepal is described below.

Table 1: Estimates of Medical Waste Generation in South Asia

Country	Waste Generation	
	Kg/bed/day	Tons/year
Bangladesh	0.8 - 1.7	93,000 (Dhaka)
Bhutan	0.27	73
India	1.0 - 2.0	330,000
Nepal	0.5	365
Pakistan	1.1	250,000
Sri Lanka	0.4	6,600 (Colombo)

Source: Visvanathan, 2006

1.1.1 A Case Study from Nepal

In 2010, a dramatic change occurred in a large government hospital in Kathmandu, Nepal. Previously, this hospital, like most healthcare facilities in Nepal, had no proper system for the management of healthcare waste. Hazardous waste, including infectious materials, syringes, blood bags and body parts, were mixed together with general non-hazardous waste and dumped outside on the grounds of the hospital or onto the streets of Kathmandu. Waste pickers scavenged through the trash each day, collecting plastic and used syringes for resale. Although the Government of Nepal had passed

legislation regulating HCWM and the facility reportedly had HCWM policies in place, these policies were not properly implemented (8).

In July 2010, the hospital administration made the decision to adopt a non-incineration HCWM system. The hospital established a model ward to demonstrate state-of-the-art waste management. They used the model ward to train all hospital staff, purchased two large steam autoclaves for disinfecting waste, and established additional projects linked to the HCWM system such as gas production from bio-degradable waste using bio-digestion, fertilizer production using vermiculture, and construction of a place to store and contain items that used mercury (8). In January 2013, the Office of the Prime Minister lauded this healthcare facility as the gold standard for HCWM and publicly announced that all hospitals in the city must manage their waste in accordance with the law or face severe penalties including closure (9).

The successful implementation of a non-incineration HCWM system in this hospital, operating in a severely resource-constrained setting, was remarkable in that it happened at a time of great social and political upheaval in the country. The healthcare waste problem had been lingering for years and was only one of many problems that the hospital was facing. How was the decision made to adopt this new system? Why was the implementation so successful?

Following this example, two other large healthcare facilities in Kathmandu made the decision to adopt and replicate this non-incineration HCWM model. The implementation process started in each facility with varying degrees of success. The factors that enabled or limited implementation effectiveness in each facility were not well understood.

1.1.2 Understanding Healthcare Waste Management - An Implementation Science Approach

The adoption and implementation of a non-incineration HCWM system takes time, resources and organizational commitment to develop new practices and technologies, establish recording and reporting systems, train staff, monitor implementation, maintain equipment and upgrade the system as needed. This type of new system is referred to in the literature as a complex innovation, defined as:

> Ideas, practices or technology that are perceived as new by the adopter and that require active coordinated use by multiple members to achieve organizational benefits (10).

The implementation of complex innovations that require cultural shifts and new technology often has a low rate of success (11). Research that seeks to better understand this process of implementation for complex innovations, particularly in resource-constrained settings, will contribute to improvement of implementation effectiveness and, finally, the outcomes of the innovation.

The primary research questions for this study were

1) How do hospitals in resource-constrained settings implement non-incineration HCWM systems; and
2) What are the organizational determinants (facilitating factors and barriers) to effective implementation?

To address these questions, the study utilized an implementation science approach. The literature provided several conceptual frameworks for implementation effectiveness of complex innovations that could be used to guide this type of research (10-13). Many of these conceptual frameworks were tested in high-income countries in various sectors including manufacturing and healthcare (12,13). This study contributed to the literature by testing a conceptual framework in a low-income country.

Specifically, this dissertation research aimed to identify the key determinants of effective implementation for non-incineration HCWM systems for hospitals in resource-constrained settings through case studies of three hospitals in Kathmandu, Nepal. The conceptual framework for implementation effectiveness that was used for this study is discussed in detail in Chapter 3: Methodology.

1.2. Background

1.2.1 Healthcare Waste Management in South Asia

The World Health Organization (WHO) defines six categories of hazardous waste although some categories are not relevant in every healthcare facility in South Asia (Table 2) (6,14).

Table 2: Hazardous Waste Classification

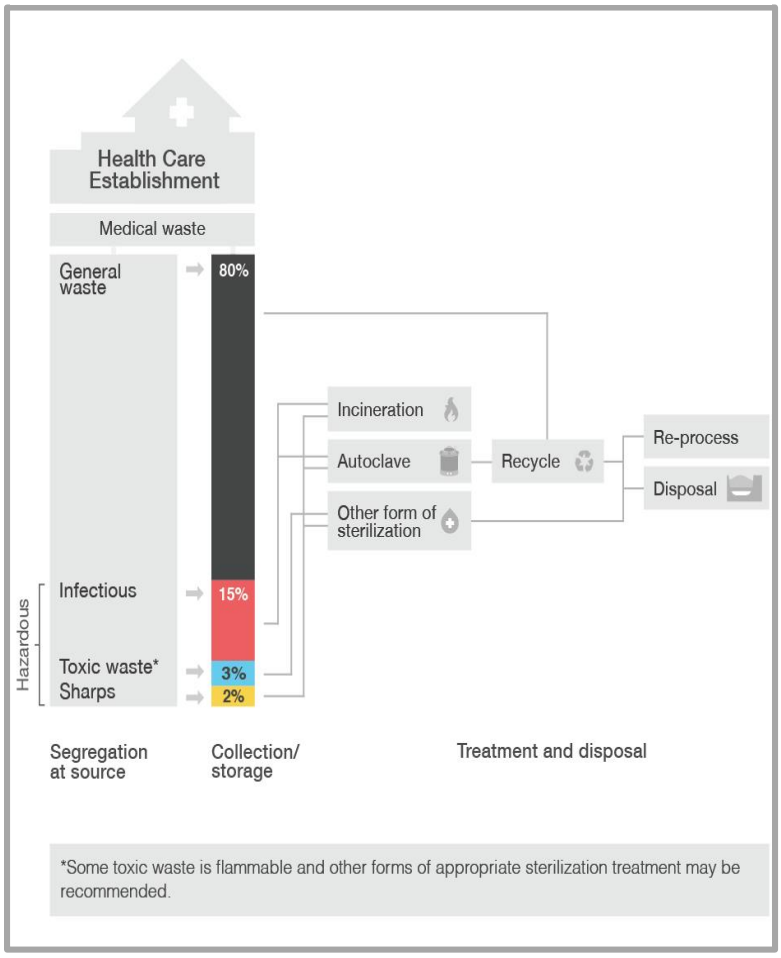
Waste Category	Description
Infectious Waste	Waste that may contain pathogens and pose a risk of disease transmission. Examples include laboratory cultures, waste from isolation wards, materials or equipment that were in contact with infected patients or excreta.
Pathological Waste	Human tissues, organs or fluids; body parts; fetuses, placentas, unused blood products.
Sharps Waste	Sharp waste. Examples include needles, infusion sets, scalpels, knives, blades, broken glass and pipettes.
Pharmaceutical Waste (including cytotoxic waste)	Waste containing pharmaceuticals. Examples include pharmaceuticals that are expired or no longer needed; items contaminated by or containing pharmaceuticals (bottles, boxes). Cytotoxic waste containing substances with genotoxic properties (i.e., can cause genetic damage). Examples include waste containing cytostatic drugs (used in cancer treatment) and genotoxic chemicals.
Chemical	Waste containing chemical substances. Examples include laboratory reagents, film developer, disinfectants that are expired or no longer needed, and solvents. Waste with high content of heavy metals including batteries, broken thermometers, blood-pressure gauges, etc.
Radioactive	Waste containing radioactive substances. Examples include unused liquids from radiotherapy or laboratory research, contaminated glassware, packages or absorbent paper.

Source: WHO, 2013

The volume and type of healthcare waste varies widely and depends on several factors such as the type of healthcare facility and department, proportion of outpatients, waste segregation practices, classification system for hazardous waste, procurement practices for toxic products, waste minimization policies and practices, use of disposable items, patient income status and country income status (14,15). For example, tertiary hospitals generate more hazardous waste than primary health centers; surgical units

generate more hazardous waste than emergency departments; healthcare facilities with strict policies on waste segregation at source generate much lower quantities of hazardous waste; and high- and middle-income countries in Asia generate higher amounts of healthcare waste than low-income countries (6,16).

Segregation of healthcare waste at source is the first and most important step in the HCWM process in a healthcare facility (Figure 1). Segregation of hazardous and non-hazardous waste protects healthcare workers, reduces the amount of hazardous waste in need of treatment, minimizes impact on the environment and significantly reduces costs (17). In most healthcare facilities in South Asia, this critical component is either poorly implemented or bypassed completely (7,18,19). Often hazardous waste is mixed with general waste and either dumped illegally, burned in open pits or unregulated incinerators, or disposed of through the municipal waste system (2,5,7).



Following segregation at source, healthcare waste is transported to a storage facility. Depending on the type of waste, the healthcare facility may choose to treat the waste by disinfection (chemical or thermal) or sterilization (steam or microwave irradiation) and dispose of it through the regular municipal waste management system. Alternatively, many healthcare facilities skip treatment and dispose of healthcare waste through incineration or burying in a pit. Ideally the treatment and disposal techniques

should depend on the type of hazardous waste. In low-income countries, however, there are multiple factors that drive treatment and disposal techniques including presence or absence of government legislation and regulations, policies of the healthcare establishment and the available resources to invest in treatment and disposal technology.

Problems related to mismanagement of healthcare waste

The highest risk of disease transmission from healthcare waste is at the point of generation; thus, there have been only a limited number of reported cases of infectious disease outbreaks in the general population in South Asia due to healthcare waste. In March 2009, a hepatitis B outbreak in Gujarat, India claimed at least 60 lives and affected 240 people. The outbreak was initially linked to contaminated needles and subsequent investigation uncovered an illegal black market trade in healthcare waste (20,21). In 2008, seven children in western Afghanistan were reportedly infected with hepatitis B and other infectious diseases while scavenging through healthcare waste (22). A study from 2002 reported that scavengers in Karachi, Pakistan report three to five needle stick injuries per day while sifting through healthcare waste searching for items to resell although there were no data regarding infection rates from this practice (23).

Healthcare waste mismanagement poses a more serious threat to healthcare workers and waste handlers who are in daily contact with hazardous waste products including infectious waste. A 2013 study to determine bacterial agents in clinical waste showed the presence of nosocomial pathogenic bacterial strains (24). Sharps are a particular concern. A 2005 study that assessed the global burden of disease attributable to contaminated sharps injuries among health workers showed that occupational exposures are a substantial source of Hepatitis C virus, Hepatitis B virus and HIV infections (25). The health impact on healthcare workers is rarely monitored in South Asia.

Mismanagement of healthcare waste can also have a negative impact on the environment and human health through the use of combustion and low-burn incinerators for healthcare waste disposal. Healthcare waste incinerators are a leading source of dioxin, a highly toxic substance and known human carcinogen. Dioxin exposure can result in multiple health problems including birth defects, hyperactivity

in children, suppressed immune function and infertility (26). Incineration also produces other toxic pollutants including airborne mercury and toxic ash residue that can leach into water supplies (27). Although most high-income countries have already substantially reduced reliance on incineration for healthcare waste disposal, the use of this method is increasing in South Asia (28,29). This is due, in part, to concerns of governments, donors and public health professionals about the growing amount of waste. In resource-constrained settings, healthcare facilities may be forced to dispose of large volumes of waste through low-cost techniques such as open burning, locally-produced incinerators or unregulated centrally-located incinerators.

Global conventions related to healthcare waste management

Over the past decade there has been increasing global interest in the topic of HCWM. The WHO has developed a number of policy papers and guidelines for management of healthcare waste in low-income countries (30-32). Two global conventions have come into force that address specific aspects of HCWM: the Stockholm Convention on Persistent Organic Pollutants (POPs) and the Basel Convention on the Transboundary Movements of Hazardous Wastes and their Disposal.

The Stockholm Convention specifically addresses the problem of unintended release of dioxins from the use of incinerators in the management of healthcare waste and recommends cessation of open burning (33). The Basel Convention focuses on the reduction and proper management of hazardous waste, including waste generated from healthcare activities (34). All countries in South Asia have signed, ratified or acceded to the Basel Convention and all but Bhutan have signed, ratified or acceded to the Stockholm Convention (Table 3) (2,33,34).

Table 3: Global Conventions that Address HCWM

Convention	Description	Status: Global and South Asia
Stockholm Convention on Persistent Organic Pollutants (adopted in 2001; entered into force on May 17, 2004)	Legally binding global treaty to protect human health and environment from persistent organic pollutants (POPs). Recommends reduction of incineration of medical waste due to release of dioxins.	As of 2013, 178 countries are party to the convention and 152 countries have signed the treaty
		South Asia Afghanistan: 02/2013 accession Bangladesh: 05/2001 signed; 03/2007 ratified Bhutan: not signed India: 05/2002 signed; 01/2006 ratified Nepal: 04/2002 signed: 03/2007 ratified Pakistan: 12/2001 signed: 04/2008 ratified Sri Lanka 09/2001 signed; 12/2005 ratified
The Basel Convention on the Transboundary Movements of Hazardous Wastes and their Disposal (adopted in 1989; entered into force on May 5, 1992)	International treaty to reduce movement of hazardous waste (except toxic waste) across borders.	As of 2013, 179 states and the European Union are party to the convention and 53 countries have signed the treaty.
		South Asia Afghanistan: 03/2013 accession Bangladesh: 04/1993 accession Bhutan: 08/2002 accession India: 03/1990 signed; 06/1992 ratified Nepal: 10/1996 accession Pakistan: 07/1994 accession Sri Lanka: 08/1992 accession
Source: http://chm.pops.int/Countries/StatusofRatifications/tabid/252/Default.aspx and http://www.basel.int/Countries/Statusofratifications/PartiesSignatories/tabid/1290/language/en-US/Default.aspx#a-note-1;		

With the exception of Afghanistan, all countries in South Asia have developed national policies that either specifically address HCWM or regulate the disposal of hazardous waste through a broader environmental policy (Table 4). While India, Sri Lanka and Bangladesh have had legislation in place for decades, the national policies in Bhutan and Nepal were only recently developed (35,36). In early 2013, Afghanistan acceded to the Stockholm Convention and the Basel Convention, signaling an interest in establishing a legislative framework for handling hazardous waste. The WHO has also developed policy papers and guidelines for the management of waste in healthcare facilities in low-income countries (3,30,31).

Table 4: National Policies in South Asia related to HCWM

Country	National Policies, Acts, Regulations
Afghanistan	No current policies
Bangladesh	Bangladesh Environment Protection Act, 1995 Biomedical waste management rules 2008
Bhutan	Waste Prevention and Management Act 2009 Waste Prevention and Management Regulation 2012
India	Biomedical Waste (Management and Handling) Rules, 1998 (amended Mar 2000, Jun 2000, 2003
Nepal	National Healthcare Waste Management Guidelines 2002 Solid Waste Management Act 2011
Pakistan	Hospital Waste Management Rules, Aug 2005
Sri Lanka	National Environment Act No 47, 1980 Draft National Policy on MWM, 2001

Although there is some recognition of the HCWM problem, efforts to develop comprehensive strategies for improvement in South Asia are hampered by limited understanding of the current policies. Despite the international treaties, WHO guidelines and adoption of national policies in some South Asian countries, HCWM policies have not been fully implemented in healthcare facilities across much of the region.

1.2.2 Healthcare Waste Management in Nepal

Background on Nepal

Nepal, a landlocked country in South Asia that lies between China and India, has a population of 27.8 million and a rich and complex culture (37). The country has significant geographic, economic and political challenges. Nepal is classified as low-income and ranks 145 out of 187 countries with a Human

Development Index[3] of 0.54 (South Asia average is 0.58) (38). The Gross National Income is only $730 per capita (2013) and approximately 25% of the population lives below the poverty line (37). Public spending on health in 2011 was 5.4% of Gross Domestic Product (38).

The Nepal Health System

The Nepal health system has been in a state of flux since the national elections held in November 2013. Although the health system was slated for restructuring based on decisions regarding decentralization of power to state and local bodies, the political situation has remained unclear.

Currently, the Nepal Ministry of Health and Population (MoHP) is working under the Nepal Health Sector Programme (NHSP) II (2010-2015). The midterm review for NHSP II was conducted in February 2013 showing mixed results, with good progress on a number of Millennium Development Goal (MDG) indicators and limited progress on others (39). The MoHP also leads a collaborative process for reviewing progress on the NHSP II through a Joint Annual Review (JAR) with the MoHP, donor community and civil society (40). The most recent JAR was conducted in February 2015. The NHSP III (2015-2020) documents have been drafted under the leadership of a committee chaired by the Minister of Health and include a strategy document, implementation plan and results framework (41).

Healthcare Waste Management in Nepal

HCWM in Nepal is a low priority and has received only intermittent attention over the past two decades although this has slowly started to change in the past few years.[4] In October 1996, Nepal signed the Basel Convention and in December 1997, the MoHP held a workshop titled National Workshop on Hospital Waste Management (42). The outcome of the workshop was a set of recommendations that included implementation of legislation for HCWM, the establishment of cooperative waste treatment facilities, and the development of national guidelines and a training program (42).

[3] A composite measure of life expectancy, years of schooling and income.

[4] See Appendix 2 for a summary of progress in Nepal on HCWM.

In 2002 the World Bank provided financial support to the MoHP to move forward with these recommendations. The Nepal Health Research Council (NHRC), an autonomous body originally created under the MoHP to promote scientific research, worked in collaboration with WHO and the MoHP to develop two documents: National Health Care Waste Management Guidelines and Training Manual for Medical Professionals (43). The Guidelines provided details on policies and process with a focus on feasibility. For example, they gave mention to WHO's nine categories[5] and the State of India's ten categories of hazardous waste, with a final recommendation to simplify the process in Nepal by narrowing this to just three categories—sharps, hazardous waste and general waste—given the limited resources at most facilities for segregation. It is unclear whether the training manual was ever used. In 2002, the MoHP also drafted legislation for the regulation of HCWM and submitted this to the Nepal Parliament. However, due to the volatile political situation, the legislation was not passed at that time (42).

In 2003, the World Bank supported a national study to assess the status of HCWM in government healthcare facilities with the aim of developing a strategic framework and action plan. The study found extremely poor HCWM practices, but the findings were questioned because it used only secondary data collected from a non-governmental organization (NGO) and there were no field visits to sites outside the Kathmandu Valley. When the report was disseminated there were also concerns raised about the presentation of costs. The budget projections for the adoption of HCWM in a healthcare facility were, in some cases, higher than the budget for the entire facility (42).

Since 2003 there have been a handful of studies published in the literature about HCWM in Nepal, all with similar findings: no facility-level policies or guidelines in place about HCWM; inadequate HCWM systems; and lack of knowledge among health workers about HCWM (44-47). Although some larger hospitals reportedly had incinerators on site, they did not incorporate anti-pollution control devices.

[5] WHO's categories of hazardous waste was amended in 2013 to six categories.

There were no central facilities for waste disposal and approximately 300 tons of healthcare waste was reportedly burned each year in hospital compounds throughout the country (48).

There are now over 4,000 public and private healthcare facilities in Nepal (not including approximately 13,000 small primary health centers) that generate an estimated 2,000 tons of healthcare waste annually with no oversight for its management from any regulatory body (49). In May 2012 the Government approved a bill titled Solid Waste Management Act 2011 that included provisions to levy fines against institutions for violating the law (36). Although there is still no robust system for monitoring compliance of healthcare facilities, there has been increasing interest in HCWM from donors, international and national NGOs and hospital administrators with successful examples of systemic changes in select facilities (8).

The MoHP conducted its 2nd Joint Annual Review (JAR) of the Nepal Health Sector Programme II (NHSP II) in January 2012. It was noted in the 2012 JAR report that the situation with HCWM in Nepal continued to pose a hazard to human and environmental health. The JAR recommended implementation of the following before mid-March 2012: 1) print and distribute the Environmental Health Impact Assessment (EHIA) Plan to healthcare facilities and measure compliance, 2) assess the situation of healthcare waste, including placenta pits, at different health facilities, and 3) develop a "strategy for healthcare waste management based on geographical locations and volume of waste generated at different facilities." (40)

The January 2013 JAR assessed progress made on the 2012 JAR recommendations. The 2013 JAR final report stated that although the EHIA Plan was distributed in workshops, the situational analysis was not completed and the monitoring of health facilities for compliance with HCWM policies was also pending. The report also detailed progress on HCWM, with recognition given for HCWM activities conducted in one hospital in Pokhara and one hospital in Kathmandu. In addition, the MoHP assigned the Department of Health Services, Management Division, as the focal unit for HCWM for all hospitals and health facilities, under the policy guidance of the Curative Care Division of the MoHP. The JAR 2013

action points for the MoHP were to scale up this model in other zonal and regional hospitals by April 2013 and present the progress on compliance of HCWM guidelines in the January 2014 JAR (50).

From September to December 2012, an external team conducted an independent Midterm Review (MTR) of the NHSP II for the Government of Nepal. These results were also shared during the 2013 JAR (39). The MTR team commented on the progress of the agreed upon actions for HCWM from the JAR 2012, stating that:

> Nepal does not have a focused regulatory framework for healthcare waste management but the Department of Health Services (DoHS) has prepared HCWM Guidelines and an Orientation Manual. The MoHP and DoHS agreed that this activity has been extremely delayed and assured the World Bank mission that a detailed Action Plan will be ready by end August (2013), in time for discussions during the midterm review. The midterm review was not made aware of any Action Plan (39).

The MTR also reported findings and recommendations related to nine output areas, including Output 7: Improved Physical Assets and Logistics Management, under which HCWM was a key component. The findings were as follows:

- Lack of institutional integration of HCWM in health offices and enforcement of rules are a risk to effective waste management;
- Incinerators at healthcare facilities are not present or not adequately managed, creating a risk for staff and environment;
- Improper healthcare waste disposal creates an immediate risk for population and environment near health facilities (39).

The MTR made two recommendations related to HCWM. These were to 1) include objectives, targets and budgets in the annual workplan budget to improve HCWM at facilities at all levels, and 2) in the short-term, agree on budget and minimum criteria to contract out healthcare waste disposal to private sector. The overall recommendation from the MTR was to scale up district decentralization in a few pilot sites focused on establishing equitable, quality health services through a basket fund that, among other things, would fund improved waste management and facility maintenance (39).

The January 2014 JAR reported that the MoHP had started the process to implement a new model for HCWM in four zonal hospitals—Koshi, Janakpur, Bheri, and Seti—based on the 2013 JAR recommendations. A follow up recommendation was made for further scale up to two more hospitals. The report acknowledged that compliance for HCWM had still not been assessed although new HCWM guidelines were drafted and waiting for endorsement (51). The latest February 2015 JAR report stated that the HCWM guidelines had been revised and were now consistent with international standards. The report also reported that orientation and trainings had been provided to concerned health officials on HCWM including on-site coaching for hospital in-charges and nurses and that separate budget allocations were made specifically for HCWM by zonal and regional hospitals. For other hospitals, resources were allocated under MoHP's district strengthening programme, thus ensuring budget for all 75 districts for this purpose. The reported goal of the government is to now roll out the guidelines to 1000 public and private health facilities by the end of September 2015 (41).

1.3 Significance of the Problem

In the face of severe resource constraints and the increasing volume of healthcare waste generated in Nepal and other South Asian countries, it is critical that policy makers, public health professionals and healthcare administrators have access to current financial and technical information to guide decisions around the regulation and management of healthcare waste. A well-managed HCWM system would increase cost efficiency, protect healthcare workers and reduce environmental risk. There are striking examples of effective implementation of non-incineration HCWM systems in healthcare facilities in Nepal but a lack of understanding about why the implementation was successful. Gaining insight into how some healthcare facilities have effectively implemented a new system for HCWM will be an important step forward, especially as more healthcare facilities express interest in upgrading their systems.

1.3.1 Contribution to the Literature

Currently there are very few published articles from Nepal related to HCWM and most of these are studies that measured waste generation rates and described HCWM practices. There were no studies found from Nepal or elsewhere in South Asia that used a conceptual framework to explore the implementation process for HCWM systems in individual hospitals. This study seeks to fill this gap and provide insight into how hospitals that are severely resource constrained can successfully implement a complex innovation.

1.3.2 Policy Implications

Although it is possible for forward-thinking hospital administrators to make pioneering changes in the HCWM systems in their individual facilities, to have broader impact on the management of healthcare waste across a state or country requires government intervention. Experience from high-income countries has shown that strong regulatory bodies and robust external monitoring systems are critical for ensuring the proper management of healthcare waste. In South Asia, only India currently has a system in place for HCWM regulation at the state level. In Nepal, given the competing priorities of the MoHP and the Ministry of Environment, Science and Technology, the task of developing a regulatory system for HCWM has been difficult. The findings and recommendations from this study will be shared with key relevant donors and policy makers in Nepal with the goal of catalyzing action towards developing a robust regulatory system for HCWM in Nepal and spreading this innovation to other hospitals in Nepal and South Asia.

CHAPTER 2: LITERATURE REVIEW

2.1 Overview

This review covers two main bodies of literature: 1) HCWM and 2) implementation science. The section on HCWM reviews the global literature with an in-depth focus on the policies and practices in South Asia. The implementation science section includes a brief overview of the field of implementation science.

2.2 Healthcare Waste Management

2.2.1 A Global Overview of Healthcare Waste Management

The growing global interest in HCWM is reflected in the scientific peer-reviewed literature. An increasing number of single and multi-country studies have been published in the last decade on topics such as HCWM policies and practices, healthcare waste generation, new technologies for healthcare waste disposal and models for assessing HCWM systems. These studies are predominantly found in journals that are focused on environmental protection and waste management. The Journal of Waste Management & Research, for example, devoted a substantial part of the June 2008 and June 2009 editions to studies on healthcare waste (52,53).

The global conversation around healthcare waste has recently expanded to include a larger environmental agenda for healthcare facilities and a movement towards greener hospitals (54,55). There are several global initiatives that advocate for examination of hospital systems with the aim of reducing costs and impact on the environment. For example, the Global Green and Healthy Hospitals (GGHH) Network, a project under the international coalition, Health Care Without Harm, has members representing over 12,500 hospitals worldwide, tackling environmental challenges and setting goals for

healthcare facilities related to ten core areas: leadership, chemicals, waste, energy, water, transportation, food, pharmaceuticals, buildings and purchasing (56)

Although these efforts to raise the profile of healthcare waste and the environment have met with some success, the research shows that many countries still lack legislative frameworks and regulatory controls for healthcare waste disposal (7,57). Many healthcare facilities around the world, especially in low-income countries, do not have even the most rudimentary systems for segregating waste. In many places, treatment technology is outdated and disposal options are primitive or non-existent.

A 2009 systematic literature review exploring HCWM practices in 40 countries found a number of recurrent themes related to failed implementation. The primary themes that emerged were that healthcare workers were "undertrained, uninformed and had limited access to waste segregation systems." (5) There were also substantial problems related to disposal systems and confusion on who bears ultimate responsibility for the management of healthcare waste (5). A 12-country study in South East Asia conducted in 2010 reinforced these findings and offered recommendations centered on changing the mindset of stakeholders including academics, policy makers, patients and their families, health workers and funders (7). Three key areas were identified for priority support for governments and healthcare facilities: developing policies and legislation, budget support, and technology and knowledge management (7). The most recent systematic literature review on waste management in 2015 reviewed 150 studies from Africa, Asia, Middle East and Latin America (57). The findings showed significant differences in HCWM across countries related to economic conditions, particularly with treatment and disposal practices. There were also examples of best practices across a range of low-, middle- and high-income countries.

2.2.2 Healthcare Waste Management in High-Income Countries

In the summer of 1988, syringes and other healthcare waste washed up on beaches on the eastern coast of the United States (29). This "syringe tide", combined with HIV hysteria, ignited a media frenzy and public panic that resulted in 50 miles of beach closures and over $1 billion in lost revenue for the local tourist industry (58,59). Although much of this medical waste was later acknowledged by the

Environmental Protection Agency (EPA) to originate from illegal injecting drug use and home healthcare, the public outcry over perceived illegal dumping of medical waste led to rapid congressional action to pass federal regulations for healthcare waste disposal through the Medical Waste Tracking Act (MWTA) (60,61). This two-year Act provided the first official definition of healthcare waste in the United States, set standards for healthcare waste management, established a system for tracking waste and provided a structure of fines and punishments for non-compliance.

The MWTA expired in 1991 and since that time healthcare waste disposal in the United States has been primarily regulated at the local and state level; thus, definitions and approaches differ among states (62). The exception is toxic healthcare waste, including emissions from healthcare waste incineration, which is regulated by federal laws (29,63).

In 1997, the EPA released guidelines that called for emissions limits for healthcare waste incinerators due to the release of toxic substances (dioxins and furans). Healthcare institutions in the United States began looking for alternative disposal methods since the cost of outfitting incinerators with anti-pollution control devices was high and public opinion towards incineration was negative (64,65). A 2003 study in Massachusetts, where hospitals were incinerating nearly all of the hazardous healthcare waste, investigated waste generation patterns and the cost effectiveness of treatment and disposal options in three hospitals (66). The study concluded that a combination of on-site incineration and microwave technology was the most cost effective option along with stricter segregation of waste (66). A 2003 review detailed the advantages and disadvantages of conventional and alternative technologies for infectious waste treatment including microwave, chemical and pyrolysis treatments (67).

In 2009, the EPA issued stricter guidelines for incinerators that were challenged in court by two industry groups and upheld (68). The result was a dramatic decrease in the number of healthcare waste incinerators from an estimated 6,200 in 1988 to only 57 operating in 2011 across the country (69).

Hospitals are the biggest producers of healthcare waste in the United States. Although hospitals make up only about 1% of all health-related facilities in the country, they produce approximately 70% of the total annual healthcare waste (63). Estimates on the total amount of waste generated in the United

States vary widely with hospitals reporting an approximate average of 0.5 kilograms of waste generated per bed-day (63).

In the United Kingdom (UK) and Europe, HCWM regulations and practices have evolved over several decades (70). There are multiple factors that have driven this process. After the 1970s, the volume of healthcare waste expanded due to increased use of disposable equipment and supplies, overwhelming the incineration system under the National Health Service. The older incinerators did not meet strict emission standards and were taken out of service. In the 1980s the UK also experienced incidents, similar to those in the United States, of intensified public concern over transmission of infectious diseases through healthcare waste. This led to more stringent regulations about the management and disposal of infectious and other hazardous waste (71). Despite this, there were still documented problems with haphazard collection and storage of waste in UK hospitals (70).

A survey of HCWM in five European countries in 2003 showed wide differences by country in the classification of healthcare waste, disposal practices and costs (72). A study in Canada showed similar variations across provinces, particularly with regard to regulatory practices (73). More recent legislation from the European Union in 2008 has now streamlined the approach to HCWM throughout Europe, including the UK (28).

In other high- and middle-income countries, HCWM is uniformly regulated under one governing body (74-76). The focus in most developed countries now is on improving treatment/disposal technologies and practicing the 3Rs: reduce (minimize waste), reuse (decrease use of disposable items) and recycle (77). The lessons learned and best practices for HCWM in high- and middle-income countries can and should be shared and applied to low-income settings (16).

2.2.3 Healthcare Waste Management in South Asia

Legislative Frameworks, National Policies and Guidelines

References to national policies appear in many of the research studies on HCWM in South Asia. Studies from Pakistan, for example, indicate that facilities are expected to follow the 2005 Pakistan Bio-Safety Rules and WHO guidelines although it is unclear whether health administrators know exactly how

to implement these rules in their own facilities (78-80). One exploratory study in 2007 reported that health managers from two large Pakistani hospitals were aware of the national policies and guidelines on HCWM, although could not produce the documents when requested (81). One problem identified by these Pakistani health managers was the lack of detail in the 1998 national policies that made it difficult to uniformly implement HCWM practices across hospitals. Evidently, the hospital had not yet seen the updated and very detailed 2005 national policies (81).

Studies from healthcare facilities in India also referred to the Government of India 1998 Biomedical Waste (Management and Handling) Rules (82-84) and its subsequent amendments in 2000 and 2003 (85-87). These rules detail the regulations on waste management and outline the legal obligations of state governments and health facilities in this process. The document contains guidelines for all steps in the waste management process. It also states clearly that disposal is the responsibility of the generator:

> "It shall be the duty of every occupier of an institution generating bio-medical waste which includes a hospital, nursing home, clinic, dispensary, veterinary institution, animal house, pathological laboratory, blood bank by whatever name called to take all steps to ensure that such waste is handled without any adverse effect to human health and the environment." (88)

Several studies from India referred directly to this clause that specifies that facilities are responsible for their own waste disposal. The regulations are reportedly enforced by the State Pollution Control Boards. The lack of reference to policies and guidelines at the facility level in India may be because the national policies already provide very explicit operating procedures on the waste management process. Thus, healthcare administrators might not see the need for another set of guidelines for their individual facility. This practice is not ideal as the step-by-step process of HCWM should be specific to a facility.

In Bangladesh, there are no national policies or acts that specifically regulate the management of healthcare waste. Recent studies from healthcare facilities in Dhaka referred only to WHO guidelines for control of healthcare waste with no mention of the Environment Protection Act (1995) or the Biomedical Waste Management Rules (2008) from Bangladesh (89,90). One 2011 survey with healthcare workers in

multiple facilities in Dhaka stated that the problem with HCWM was lack of regulation and oversight by the government (91).

In Nepal, the Solid Waste Management Act 2011 outlines local government authority to control hazardous waste disposal (47). Several other policies and acts in Nepal also address aspects of HCWM, for example, the Labor Act (1991) that covers occupational health and safety and requires removal of hazardous waste from the workplace; the National Urban Sanitation Policy (2007) that promotes healthy, livable environments; the Environment Protection Act (2010) that regulates emissions and controls pollution, and others (47).

There were no HCWM-focused studies found for Bhutan and very few for Sri Lanka. Although both countries produce relatively small amounts of healthcare waste compared to other countries in South Asia, this volume is expected to increase. One 2005 study from Sri Lanka explored the broader issue of municipal waste management and included a review of the legislation and national policies that govern disposal of waste, including healthcare waste (92).

There are significant gaps in the literature on policy formulation and implementation at the healthcare facility level. Only one study was found from a hospital in Nepal that reported on the development and successful implementation of a comprehensive HCWM policy at the hospital based on WHO guidelines and the Nepal national HCWM guidelines (93). The study did not address the motivation behind the change although a second paper published from this hospital reports change in pre- and post-test scores using a rapid assessment tool for HCWM and shows a very low pre-implementation score. This low score may have motivated the management to act (94). Aside from this study, the question of how the topic of HCWM gets put on the agenda of healthcare facility administrators in low-income countries, especially given the constrained resources and other health priorities, is left unanswered.

Further exploration is needed on what drives the development of HCWM policy at the facility level and under what circumstances both national policy and facility-level policy implementation is monitored and enforced by regulatory bodies and health administrators in South Asia.

Healthcare Waste Management Practices in South Asia

In stark contrast to the lack of facility-based HCWM policy information in the peer-reviewed literature for South Asia, there was an abundance of data on waste management practices, with detailed descriptions of waste segregation, collection and disposal in healthcare facilities in South Asia. These descriptions, based on both direct observations and interviews with healthcare workers, provided strong evidence of significant problems with the waste management systems in healthcare facilities throughout the region. There was reportedly little to no adherence to either facility-level or government policies. Reasons for gaps and system failures included lack of training of healthcare workers in HCWM processes and lack of monitoring and enforcement of regulations.

Waste segregation is the most important step in the waste management process and the point at which the volume of hazardous waste can be minimized. Waste minimization would contain costs and reduce the risk to health personnel and the environment (95,96). Although waste segregation is a relatively simple process if implemented systematically throughout a hospital or clinic, it is largely ignored in most facilities in South Asia. A 2008 study in hospitals, private clinics and diagnostic centers in Bangladesh, reported that some facilities segregated the waste but then mixed it together at disposal with no treatment for the infectious waste (97). Another study from Bangladesh reported that 65% of healthcare facilities collected their waste without segregation and deposited it in the municipal waste bins for collection (98). Likewise, studies from India showed that healthcare facilities did not have the proper supplies for waste segregation, did not follow regulation color codes, did not segregate at source and often left the task of segregation to waste pickers who would scavenge for materials for resale (99-102).

The treatment and disposal of healthcare waste was also mismanaged in many healthcare facilities in South Asia. Studies reported improper disposal of waste with onsite open burning; sales of syringes and needles to waste pickers; sub-standard incinerators; unsecured storage areas; and, dumping of waste in areas outside of facility premises (98,103,104). There were no incentives for proper waste disposal since healthcare waste was mostly unregulated with no fines or punishments imposed on facilities that did not follow government policies. These findings were consistent with the 2009

systematic literature review that examined healthcare waste disposal practices and challenges in 40 low-income countries, including 21 in Asia, and the 2010 review on HCWM practices and their effect on environment and human health. (5,24). There were a number of barriers to good practices identified, many related to policy issues. These included lack of policies and guidelines at the health facility, no enforcement of government policies and lack of training of staff.

There were some limited studies that showed good disposal practices and some facilities reported using a central facility for disposal of healthcare waste (87,105). There were two main drivers for implementation of good practices including engagement of an external organization, such as WHO, to assist with the development of the system of waste management, and outsourcing healthcare waste disposal to private sector companies. Centralized healthcare waste disposal sites are common in many middle-income countries in Asia and can increase cost efficiency and lower environmental risk, since these sites often have the resources to invest in more advanced technology (76,81).

Gaps in the literature

There is a dearth of information in the literature on policy implementation and rigorous analysis of the link between policy and practices in HCWM. To address this gap in the literature, health researchers should identify opportunities to explore the topic of HCWM on several levels including 1) setting the policy agenda, 2) policy implementation, 3) innovation implementation, and 4) policy-related knowledge and attitudes among healthcare workers. Implications for future research related to practices include testing new models and interventions to improve practices, introducing new technologies into healthcare facilities and exploring how these new technologies are then implemented. Another potential area for future research and a noticeable gap in the literature was testing management modalities and facility-based interventions to assess whether they lead to improvements in HCWM. There are several possible interventions that could be tested at sites in South Asia, including the introduction of financial incentives for the facility through waste recycling and biogas production, the use of waste management committees to monitor processes, and the introduction of regulatory mechanisms at various levels in the health system.

2.3 Implementation Science

Implementation is defined in the literature as a "specified set of activities designed to put into practice an activity or program of known dimensions." (106). Implementation is distinct from adoption, defined as "a decision to make full use of an innovation as the best course of action available" (107). Adoption occurs prior to implementation and signifies an intention to implement. The transition between adoption and implementation, particularly in organizations, can be lengthy and complex (108).

There are multiple challenges associated with implementation and numerous examples of programs that were supported by positive results from efficacy trials, adopted and introduced with great enthusiasm, only to fail when programmers attempted to implement them in real world conditions (109).

Although implementation processes can be observed and studied, researchers often face challenges in measuring determinants of implementation effectiveness (110). The implementation process is complex with a variety of multi-level factors that impact on success, especially in the context of the "messy…under-resourced public health settings around the world." (111). The gap in understanding about how to move from positive research results (i.e., efficacy trials) to effective practice (i.e., implementation and scale-up) has led some public health researchers to propose a shift in focus away from efficacy trials and towards practice-based implementation research, where the focus would be to identify factors that lead to successful and sustainable scale up of programs and innovations that have high public health impact (111). This area of implementation research has been referred to generally as implementation science, defined as "the scientific study of methods to promote the systematic uptake of research findings and other evidence-based practices into routine practice, and, hence, to improve the quality and effectiveness of health services" (112).

Interest in the field of implementation science among healthcare practitioners and public health professionals has grown in the past decade. In 2006, Implementation Science, an open access, peer-reviewed online journal, began publication of articles that specifically focus on increasing knowledge about methods for implementation research and the translation of research into practice. In 2013, the

journal achieved an Impact Factor of 3.47 and ranked 8th among 217 journals on health policy worldwide. One of the reasons for creating a new journal was to provide a "flagship home" for implementation research since previously this research was published across a wide range of journals making it difficult to access (112). Even now, numerous articles continue to be published in several specialty areas that seek to understand the reasons for implementation success and failure and identify factors that influence implementation effectiveness (12,13,108,110,113-117).

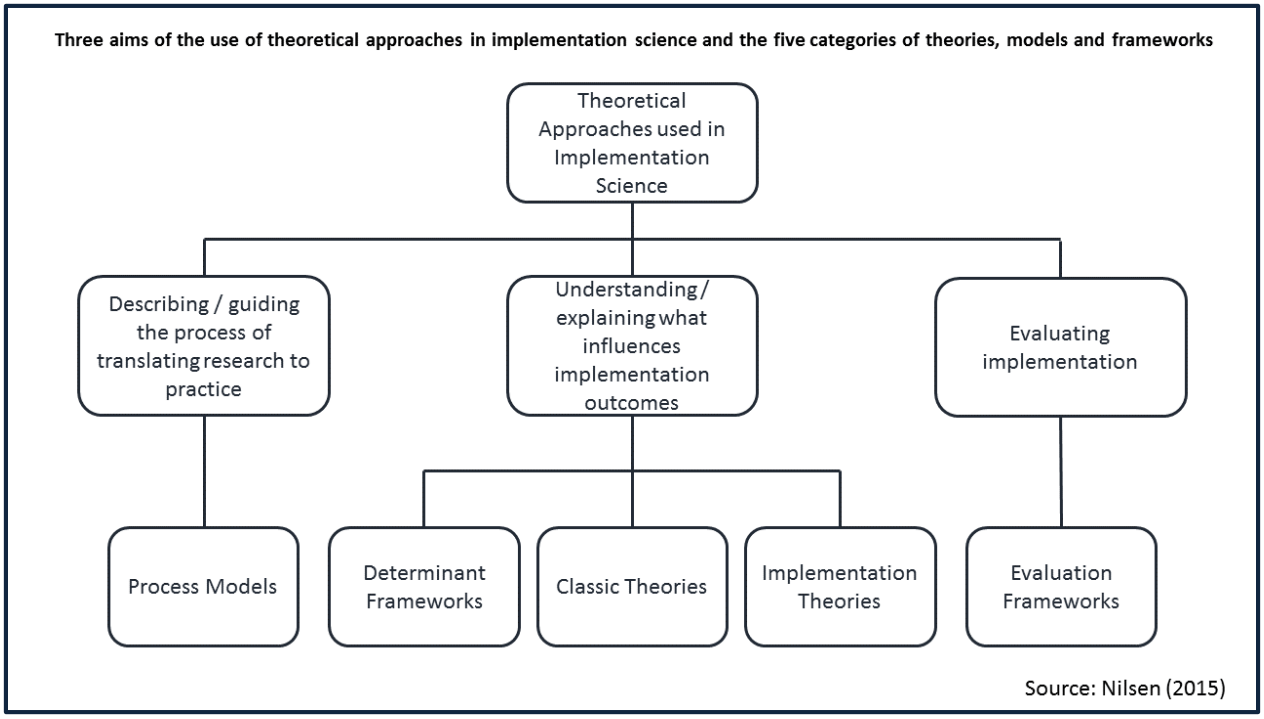
In the past decade, a number of systematic literature reviews were published on implementation research in the health field. Four of these reviews addressed key areas in implementation: best practices in scale-up and sustainability of innovations in health service delivery and organizations; implementation processes and the multi-level influences on implementation effectiveness; the impact of implementation on program outcomes; and the core components needed for effective community-based interventions (106,109,118,119). Although these reviews addressed different questions and different types of programs, all four systematic reviews identified eleven common factors that influence implementation: funding, skill proficiency, work climate, shared decision making, coordination with other agencies, formulation of tasks, leadership, program champion, management support, training and technical assistance (109).

Based on these reviews and other published studies, a number of implementation frameworks, models and theories have been developed and used to guide implementation research (120). One review found that many of these theories had overlapping constructs and each missed some important elements (121). Another review synthesized information from 25 implementation frameworks to construct the Quality Implementation Framework, a "conceptual overview of the critical steps that comprise the process of quality implementation" (122). The most recent systematic review assessed the comprehensiveness of 49 existing implementation frameworks to determine the types of frameworks in use, the similarities and variations in frameworks across innovations and whether the frameworks addressed all the concepts that could affect implementation of an innovation (123). The review showed that many of the frameworks were innovation-specific and lacked core concepts related to implementation. The study offered a decision tool for researchers and programmers that can be used to

select an appropriate framework or a combination of frameworks to guide research or project implementation (123).

In an attempt to bring order to the plethora of theories, models and frameworks that have emerged in the implementation science literature, one recent paper proposed a taxonomy with five categories of theoretical approaches to achieve three broad aims (Figure 2) (124).

Figure 2: Implementation Science Theories, Models and Frameworks



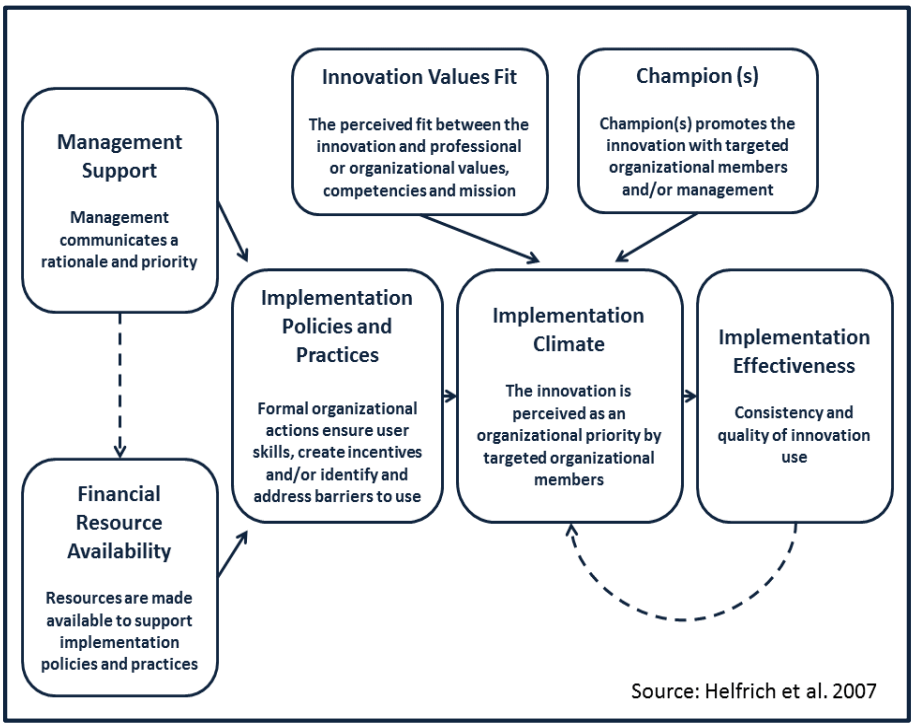
This structure provides a useful way for implementation researchers to assess gaps in the implementation science literature. In the case of low-income countries, for example, there have been numerous studies that use evaluation frameworks to evaluate implementation of interventions (125). There is, however a significant gap in the literature related to the use of implementation theories in low-income countries to identify and explain what influences implementation outcomes. This study seeks to fill this gap by conducting research using implementation theory to identify organizational determinants of implementation effectiveness in a low-income country context.

CHAPTER 3: METHODOLOGY

3.1 Conceptual Framework

This research used a conceptual framework that was specifically designed to study complex innovations at the organizational level. The hypothesis of the framework is that "implementation is a function of management support and resource availability, mediated by the organization's specific policies and practices and the ensuing implementation climate" (Figure 3) (10). The framework includes the dependent variable of implementation effectiveness and six key constructs that impact on implementation effectiveness: management support, financial resource availability, innovation values fit, champion(s), implementation policies and practices (IPPs), and implementation climate. The conceptual and operational definitions for the six key constructs are described in Appendix 3.

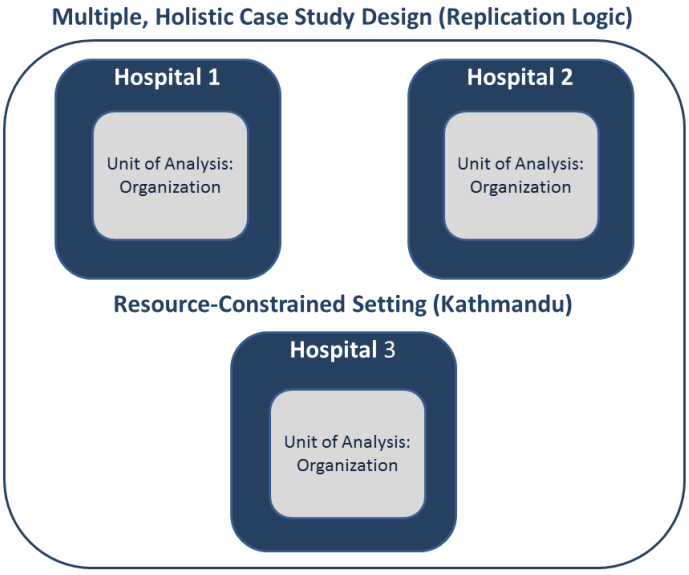
Figure 3: Conceptual Framework for Implementation Effectiveness



3.2 Study Design

This research used a multiple, holistic case study design using theoretical replication logic for data analysis (Figure 4). The case study design was selected because this methodology is highly relevant for explaining a present phenomenon that requires in-depth description. It is the preferred method when the primary research questions ask how and why and the researcher has little control over events (126). The research included three cases and each case was treated as a separate study. The design was holistic because there was only a single unit of analysis: the organization (126,127). Theoretical replication logic was used because these three cases varied in type of hospital and governance structure. The first facility was a private hospital, the second was a government hospital, and the third was a non-profit hospital that was run by an NGO. It was expected that this variable would show different patterns in specific constructs in the model such as financial resource availability.

Figure 4: Study Design



The cases were selected for this study based on two criteria: 1) location (all hospitals were located in Kathmandu Valley) and 2) implementation length (the hospital administration officially adopted the innovation of interest in this study, non-incineration HCWM system, and started implementation by January 2014). This allowed for at least one year of implementation prior to the start of the data collection in December 2014. There were three hospitals in Kathmandu that met this criteria. The Principal Investigator met with each hospital director and explained the purpose of the research. The hospital directors granted written permission to conduct the research at each site.

The Principal Investigator consulted with two experts who had specialized skills and global experience in the field of HCWM systems in resource-constrained settings. These experts were consulted on research protocol and measures of implementation effectiveness and other constructs in the conceptual framework. They were also requested to review case study results and provide advice on the plan for change.

3.3 Data Collection Methods and Sources

This study used a mixed methods approach that drew on the strengths of both qualitative and quantitative research and multiple sources of evidence in order to triangulate the data. The phenomenon of interest was the implementation of the HCWM system and the data was collected in order to "provide multiple measures of the same phenomenon." (126) The methods included 1) document review, 2) in-depth interviews, 3) semi-structured interviews, 4) direct observations and 5) a quantitative survey to measure implementation effectiveness (Table 5). A detailed case study protocol was developed and pilot tested in one hospital and a case study database was created to organize the data.

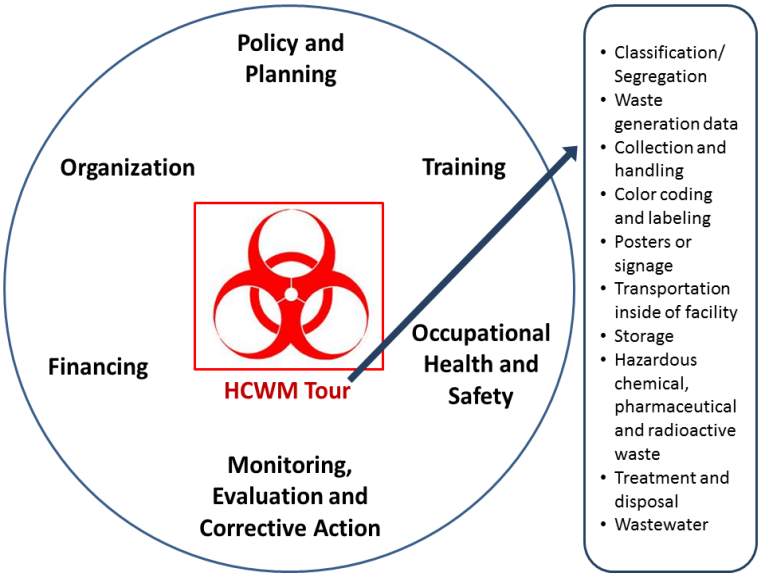
Table 5: Data Methods and Sources

Method	Source	Details
Rapid Assessment Survey	HCWM Coordinators	Used the Individualized Rapid Assessment Tool
Document Review	Hospital Administration	Meeting minutes, hospital policy documents, hospital HCWM guidelines, hospital layout
Key Informant Interviews	Hospital Directors HCWM Coordinators	Seven total interviews (in one hospital interviewed both the current and former director)
Semi-Structured Interviews	Hospital staff and external people involved with MWM at the site	23 total interviews
Direct Observations	Hospital site	HCWM system, wards, waste treatment centers, collection and recycling sites

3.3.1 Survey - Individual Rapid Assessment Tool

A rapid assessment of the HCWM system was conducted at each hospital site using the Individualized Rapid Assessment Tool (IRAT) developed in 2009 by the United Nations Global Environment Facility (UN GEF) (128). This tool was designed specifically for individual healthcare facilities to measure the state of the HCWM system. The tool was simple to administer and provided an automatic score at the end of the data collection that was used as a proxy for implementation effectiveness. If took approximately one hour to complete including an initial interview with the HCWM coordinator (0.5 hours); tour of the facility and post tour interview with the HCWM coordinator to review the score (0.5 hours).

Figure 5: Components of the IRAT Tool



One index score for implementation effectiveness was calculated for each site based on scores from two parts: an interview and a facility tour. Part I (the interview) included questions in six topic areas: 1) organization; 2) policy and planning; 3) training; 4) occupational health and safety; 5) monitoring, evaluation and corrective action; and 6) financing. Part II (the facility tour) covered questions regarding the waste management process including classification and segregation, waste generation data, collection and handling, color coding and labeling, posters or signage, transportation inside health facility, storage, hazardous chemical, pharmaceutical and radioactive waste, treatment and disposal and wastewater (Figure 5Figure 5).

3.3.2 Document Review

Review of documentation was a critical data collection method for this study to trace the progress of implementation and triangulate document information with data collected from in-depth interviews, observations and the IRAT survey. Collection of documentation followed a standardized protocol that was applied across all sites. The Principal Investigator, after receiving verbal approval from the hospital administration to access relevant documents, requested the following types of documents in person from the HCWM Coordinator:

1) Minutes of meetings during which the process of adoption or implementation of the HCWM system was discussed;
2) Documents that referred to the HCWM policies or practices or the adoption or implementation of the HCWM system;
3) Hospital policy documents / standard procedures / guidelines related to infection control and HCWM including the process of handling healthcare waste in the facility; and
4) HCWM-related documents such as reports, proposals, budgets, contracts, internal records, internal studies, evaluations.

Summaries of all documents were prepared in English. Any contradictory information was followed up with the HCWM Coordinator and explored further to clarify discrepancies. The documentation also lead to additional questions for investigation. Separate results related to document review were not included in Chapter 4: Results, since the primary purpose of the document review was to verify results from other data collection methods.

Document review methodology had a number of strengths including stability of the data (allowed for repeated viewings), specificity of the data (included dates, names, details), and historical aspect of the data (provided recorded information from events that occurred in the past). Weaknesses of this method included selection bias since some of the documentation was incomplete and reporting bias since some of the documents were based on the document author's interpretation of events.

3.3.3 Key Informant Interviews

In Nepal, the director of the hospital is in charge of leading the formulation of policies and guidelines for hospital systems and an instrumental figure in the implementation of any complex innovations. For this research, the director of the hospital at each study site was considered a key informant. If there was a change in directors within one year prior to the adoption of the HCWM system, then the previous director was also considered a key informant and interviewed.

Each hospital had a HCWM coordinator and this person was also considered a key informant since she was directly in charge of implementation of the HCWM system.

Prior to beginning the key informant interviews, the Principal Investigator provided information to the key informant about the study and obtained written informed consent for the interview in either English or Nepali language, based on the preference of the respondent (Appendix 4).

Key informant interviews were held in English or Nepali depending on the preference of the informant. The Principal Investigator is fluent in Nepali and did not use a translator for this study. Notes were taken by computer during most interviews and all interviews were audiotaped (with consent from key informant) except one because the key informant did not consent to audiotaping. The interviews followed the Key Informant Interview Guide for the director or HCWM coordinator with flexibility to probe and follow other areas of key interest that emerged during the interview (Appendix 5). Interview notes were expanded immediately following the interview and audiotapes were used for verification. These expanded interview notes were used for data analysis.

The key informants were asked to provide names of other persons to interview in the hospital including nursing staff, hospital workers or others involved with HCWM and any external individuals who were critical to the adoption and/or implementation process for HCWM.

3.3.4 Semi-structured Interviews

At each case study site, semi-structured interviews were conducted with hospital staff including matrons, nurses, ward attendants, HCWM staff or others involved with HCWM. The Principal Investigator requested names for possible respondents with the key informant(s). The semi-structured

interview guides were used for each interview (Appendix 5). One interview was conducted in each hospital with an individual external to the hospital who was directly involved with the adoption or implementation of the HCWM system (Table 6).

The interviews lasted from 30 minutes to one hour and most were conducted in Nepali language. The Principal Investigator took notes on the computer during the interview. All interviews were audiotaped (with consent from the respondent). Interview notes were expanded immediately following the interview using the audiotapes for verification. The expanded interview notes were used for data analysis.

Table 6: Interview Respondents and Number per Case Study Site

Respondent	Hospital A	Hospital B	Hospital C	Total
Hospital Director	1	2	1	4
HCWM Coordinator*	1	1	1	3
Hospital Staff**	7	6	7	20
External People***	1	1	1	3
Total	10	10	10	30

* These were current staff members: Nursing Supervisor, Matron, Head of Housekeeping

** Included Matron (1), Ward In-Charge (4), Nurse (7), Ward Attendant/Helper (5), HCWM Staff (3)

*** People providing technical assistance to the hospital

3.3.5 Direct Observations

Direct observation visits were conducted at each study site (two in Hospitals A and C and three in Hospital B). One of the observation visits was conducted as part of the IRAT survey at each site. Detailed notes were taken during each observation visit. The visits included observation of the HCWM process for segregation, collection, handling, storage and disposal. Observations of the hospital equipment and supplies used for HCWM were also collected. In addition, the Principal Investigator observed areas of the hospital that did not yet have the HCWM system in place.

Informal observations were also made and recorded throughout the study. The Principal Investigator received oral permission from the hospital HCWM Coordinators in all sites to take photographs to record the HCWM process. There were no photos taken of patients or private rooms.

Data collected from observations was used in the IRAT survey and triangulated with data collected from in-depth interviews and document review. Observation data was directly used in the IRAT survey as part of the survey protocol. Separate results related to observation visits were not included in Chapter 4: Results, since the primary purpose of the observations was for the IRAT survey (reported separately under IRAT results for each case study and in the cross-case analysis) and to verify results from other data collection methods.

3.4 Data Management

Confidentiality of the data was maintained at all times. Copies of documents collected through the document review were electronic and stored in a password-protected computer that was accessible only by the Principal Investigator. All documents were deleted upon completion of the study.

To protect the confidentiality of interview data, each respondent was given a unique numeric identifier. Names and numeric identifiers of all respondents were kept in a locked password-protected computer file separate from study protocols and transcripts. Respondent names were not included in transcripts; respondents were identified through numeric codes only. The files were accessible only to the Principal Investigator.

Audiotapes were used to review and expand interview notes. The audiotapes were kept on a password-protected computer and each individual interview file was also password-protected. Interview transcripts were stored securely in electronic format on a password-protected laptop accessible only to the Principal Investigator. All audiotapes were deleted upon completion of the study.

3.5 Data Analysis

3.5.1 Qualitative Data Analysis

The expanded interview notes from thirty key informant and semi-structured interviews were coded and analyzed using a qualitative freeware package, QDA Miner Lite[6]. The data were systematically coded based on a pre-defined code database using a structured codebook in order to organize the data. Initially, the codebook was compiled based on the conceptual framework used in this study and included all constructs in the model, inclusion and exclusion criteria, examples of when to use a code and when not to use a code and a table for tracking changes to codes. This ensured reliability of the data analyses. Additional codes were included based on similar research in the literature and new codes were added as themes emerged from the data (109,114,118,127,129). Content analysis, defined as "a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes and patterns," was conducted for all interviews.(130).

The Principal Investigator used a set of criteria to determine the salience and valence of each construct in the framework and of other potential determinants that emerged from the data from each hospital site (Table 7). Combinatorial logic was used to examine the pattern of covariance among constructs in order to test the hypothesis of the model. For example, according to the conceptual framework, the constructs of management support and resource availability were both determinants of IPPs. Therefore, combinatorial logic would be demonstrated if the data showed that strong management support and high availability of resources led to strong IPPs. Likewise, if management support and resource availability were both weak, then IPPs should also be weak. If there was a combination, such as weak management support and high availability of resources (or vice versa), then IPPs could be weak, moderate or strong depending on the context.

[6] http://provalisresearch.com/products/qualitative-data-analysis-software/freeware/

Table 7: Criteria for Determining Salience and Valence

Definition		Criteria
Salience	Was the theme/issue present or absent from the interview data?	• The # of interviews per case study site where the theme appeared > 5; AND # of hits (coded text) per case study site > 15; OR • The theme/issue was verifiable from another source of data collected from the case study site (documents, survey, observations); OR • There was strong face validity (the statement was made by a key informant on a topic that fell under his/her area of expertise)
Valence	If the theme was present, was it strong, moderate or weak?	• Strong (favorable): At least 70% of comments were positive or neutral • Moderate (both favorable and unfavorable): Neither the percentage of positive comments nor the percentage of negative comments were greater than 70%; there was a mix of positive, negative and neutral comments • Weak (unfavorable): At least 70% of comments were negative or neutral

The data were also analyzed for temporal ordering and attribution. This involved a close examination of the data to determine whether the order of the constructs in the model fit the pattern that emerged from the data. For example, according to the model, strong IPPs should lead to a positive implementation climate. Was this, in fact, the case? Or did a positive implementation climate lead to the development of strong IPPs? Taking this analysis one step further, were we able to attribute the strong implementation climate to a combination of strong IPPs, an innovation champion and high innovation-values fit as the conceptual framework suggests? The results of this analysis are presented in Chapter 4: Results – Section 4.4.7.

3.5.2 Case Study Analysis

The case study analysis involved within-case analysis and between-case analysis using pattern-matching logic that "compared an empirically-based pattern with a predicted one" made before data collection (126). The predicted pattern was based on the relationships between independent and dependent variables in the conceptual framework for implementation effectiveness. For example, the

framework predicted that an innovation champion was critical for a positive implementation climate that in turn affected implementation effectiveness. The data collected from sites verified whether this was, in fact, a necessary component of the framework in all sites. Matching patterns supported the conceptual framework. If patterns did not match, the Principal Investigator developed / investigated potential alternative constructs.

Between-case analysis was conducted to compare hospitals across variations in implementation effectiveness. Each construct was compared across all three hospital sites and across the outcome variable of implementation effectiveness, noting key differences and similarities.

3.6 Strengthening the Study Design

There were four standard tests used to establish the quality of the research design: internal validity, external validity, construct validity and reliability (126). These tests and the tactics that were used in this research to address these tests are described below.

3.6.1 Internal Validity

Internal validity is defined as "the approximate validity with which we infer that a relationship between two variables is causal or that the absence of a relationship implies the absence of cause" (131). Since this case study research sought to determine causal relationships between constructs within the conceptual framework for innovation implementation, the threats to internal validity needed to be addressed. There were several tactics that were employed to address concerns with internal validity during the design and analysis phases of the study. The first tactic was testing the conceptual framework across multiple cases with theoretical replication logic. Each subsequent case that followed the conceptual model strengthened the internal validity of the results. The second tactic was triangulation using multiple data sources. The research used the analytic technique of pattern matching that compared the empirical findings with the predicted findings based on the conceptual framework. Rival explanations were considered through an iterative process (126).

3.6.2 External validity

External validity is defined as "the approximate validity with which we can infer that the presumed causal relationship can be generalized to and across alternate measures of the cause and effect and across different types of persons, settings, and times." (131) Although this study was not designed for generalizability, the plan for change did rely on the extent to which the findings would transfer to other sites in Nepal and other countries in the South Asia region. The use of a conceptual framework in the study design and multiple cases strengthened external validity.

3.6.3 Construct Validity

Construct validity refers to the validity of inferences that measures actually represent the construct of interest. This was challenging in this particular research study due to the lack of operational measures for several of the constructs (independent variables) in the conceptual framework, such as implementation climate and innovation-values fit. To meet the test of construct validity, the variables were specifically defined based on previous published literature using this framework (11,132). The definitions were used consistently across all case study sites. Multiple sources of data were converged for each operational measure.

3.6.4 Reliability

Reliability refers to the ability to repeat the study with the same parameters and get the same result. To guard against threats to reliability, the Principal Investigator developed a detailed case study protocol and a case study database. Periodic data audits were performed to review the data documentation process and ensure protocol was being followed and data was filed consistently. The final case study analysis and summary reports were written to address reliability, including enough information to follow the logical steps towards a conclusion.

3.7 Ethical Review

Ethical review and approval was granted from two review boards: The University of North Carolina, Chapel Hill (UNC-CH) IRB on September 18 2014 and the Nepal Health Research Council (NHRC) Internal Review Board (IRB) on December 3 2014.

CHAPTER 4: RESULTS

This chapter presents individual case study reports followed by a cross-case analysis for three hospitals located in Kathmandu, Nepal. The case study reports provide a brief description of the hospital, the level of implementation effectiveness achieved by the hospital for the HCWM system and the determinants of implementation effectiveness that were identified in the study. These results were based on hospital scores from the IRAT survey and a detailed analysis of in-depth interviews, triangulated with data collected from observations and document review (see Chapter 3: Methodology). The cross-case analysis explores the similarities and differences across sites in pre-implementation, startup and implementation phases of the HCWM system, determinants of implementation effectiveness, and the patterns and congruence/ incongruence between the constructs in the conceptual framework (Figure 3).

4.1 Case Study A

4.1.1 Background

Hospital A is a private hospital located in the Kathmandu Valley. The hospital has 100+ beds in private rooms, semi-private rooms and a general ward. The hospital also has an emergency room and an outpatient department and offers services in several specialty areas. The average occupancy rate from September to November 2014 was 80% and the average number of outpatient visits was 500 per day in the same period. The hospital primarily serves foreigners and middle-to-upper-class Nepali citizens.

The Hospital Director reports to the Board of Directors of the hospital. Any new programs or systems for the hospital must be proposed to and approved by the Board of Directors.

4.1.2 Findings

Implementation Effectiveness - Results from Individualized Rapid Assessment Tool Survey

The HCWM system in Hospital A was launched in late 2012 and implementation had been ongoing for approximately two years at the time of data collection for this study. The results showed that Hospital A has achieved a medium level of implementation effectiveness, scoring 88% on the Individualized Rapid Assessment Tool (IRAT) survey (Table 8).

The IRAT survey included two parts. Part I of the IRAT assessed six components related to overall systems management: organization, policies, training, occupational safety, monitoring and financing.[7] Hospital A scored 37.5 out of 47 total points (80%) on Part I indicating a medium level of implementation effectiveness for these components. Part II of the IRAT covered eleven components of the HCWM system: segregation, waste generation data, collection/handling, color coding/labeling, signage, transport, storage, hazardous waste, treatment/disposal, onsite treatment[8] and wastewater treatment. Hospital A scored 84.5 out of 91 total points (93%) on Part II indicating a high level of implementation effectiveness for these components.

Determinants of Implementation Effectiveness - Results from In-Depth Interviews[9]

Analysis of data from ten in-depth interviews conducted in Hospital A identified several salient factors that facilitated effective implementation of the HCWM system. These factors included three constructs from the conceptual framework used in this study (Figure 3): significant resources allocated for the establishment and maintenance of the HCWM system; a variety of clear and consistent implementation policies and practices (IPPs); and the presence of an internal innovation champion (the

[7] See Appendix 6 for detailed questions and scores under each component of the IRAT for three hospitals.

[8] The IRAT also has a component for facilities that treat waste offsite. This component was not included as all hospitals in this study treated waste onsite.

[9] Findings from interviews were triangulated with data from observations and document review.

appointed HCWM Coordinator) who played a critical role in implementation, advocating for resources and communicating with the HCWM unit and the hospital administration to resolve problems.

Table 8: IRAT Scores for All Hospitals

Variable	Scale	Hospital A	Hospital B	Hospital C
Length of Implementation		2 years	4 years	1 year
Implementation Effectiveness Overall (High, Medium, Low)[10]	H,M,L	M	H	M
Implementation Effectiveness Score (Sum of Parts I and II)	138	122	126	111.5
Implementation Effectiveness Percentage	100%	88%	91%	81%
Part I – Initial Interview	0-47	37.5	40.5	30
1. Organization	0-8	8	8	8
2. Policy and Planning	0-11	8.5	9	3
3. Training	0-12	11	11	11
4. Occupational Health and Safety	0-7	2	4	2
5. Monitoring, Evaluation and Corrective Action	0-2.5	2	2	2
6. Financing	0-6.5	6	6.5	4
Part II – Post Inspection Tour Interview	0-91	84.5	85.5	81.5
7. Classification and Segregation	0-7	7	7	7
8. Waste Generation Data	0-2	1.5	2	2
9. Collection and Handling	0-19	18.5	19	17.5
10. Color Coding and Labeling	0-6	6	6	6
11. Posters or Signage	0-0.5	0.5	0.5	0.5
12. Transportation Inside Health Establishment	0-2	1.5	1.5	1.5
13. Storage	0-2.5	2.5	2.5	1.5
14. Hazardous Chemical, Pharmaceutical and Radioactive Waste	0-5	5	5	5
15. Treatment and Disposal	0-28	28	28	27
16. For facilities with onsite treatment	0-15	14	14	13.5
17. Wastewater	0-4	0	0	0

[10] High $\geq$ 90%; Medium 80-89%; Low $\leq$ 79% (Note: The Principal Investigator, in consultation with HCWM experts, considered IRAT scores of 90 and above as a high level of implementation effectiveness; scores of 80-89 as a medium level of implementation effectiveness and scores below 80 as a low level of implementation effectiveness for the purposes of this study. These cutoff points are higher than what is normally used with IRAT when comparing facilities since implementation had been ongoing in all hospitals for more than one year with expert technical assistance.

Another critical factor that had a positive effect on implementation in Hospital A was partnerships. Although the construct of partnerships was not included in the conceptual framework, it emerged as a salient and strong positive determinant in Hospital A. During the pre-implementation phase, the hospital formed a contractual partnership with a local NGO (hereinafter referred to as NGO A) for technical assistance[11]. Although this partnership had ended by the time of data collection, respondents credited NGO A for providing the guidance needed to establish a strong system. Staff members from NGO A and the hospital jointly designed the system and monitored implementation for one year. NGO A brought external technical credibility to the process.

The study identified three salient factors that exerted mixed (both favorable and unfavorable) effects on implementation in Hospital A. These included management support, innovation-values fit, and implementation climate. These three factors were also constructs in the conceptual framework.

The management support in Hospital A was considered moderate. The hospital management gave strong support in favor of establishing the new HCWM system and committed a significant amount of resources towards its establishment and ongoing implementation. The hospital management was motivated to implement the new system to meet the requirements for ISO[12] certification. However, once the system was operational, the HCWM Coordinator was more engaged in the day-to-day management. Some respondents stated that they would have also liked to see the Director visibly promote and support the system during implementation.

In Hospital A, innovation-values fit diverged across groups of employees within the hospital. Several respondents reported that doctors would not follow the system in the beginning and refused to attend any trainings about waste management. This might have been because doctors did not see a fit

[11] This was a contractual partnership; Hospital A paid NGO A for their work. This is the same NGO that provided assistance in Hospitals B and C (see Section 4.2 Case Study B and Section 4.3 Case Study C)

[12] International Organization for Standardization

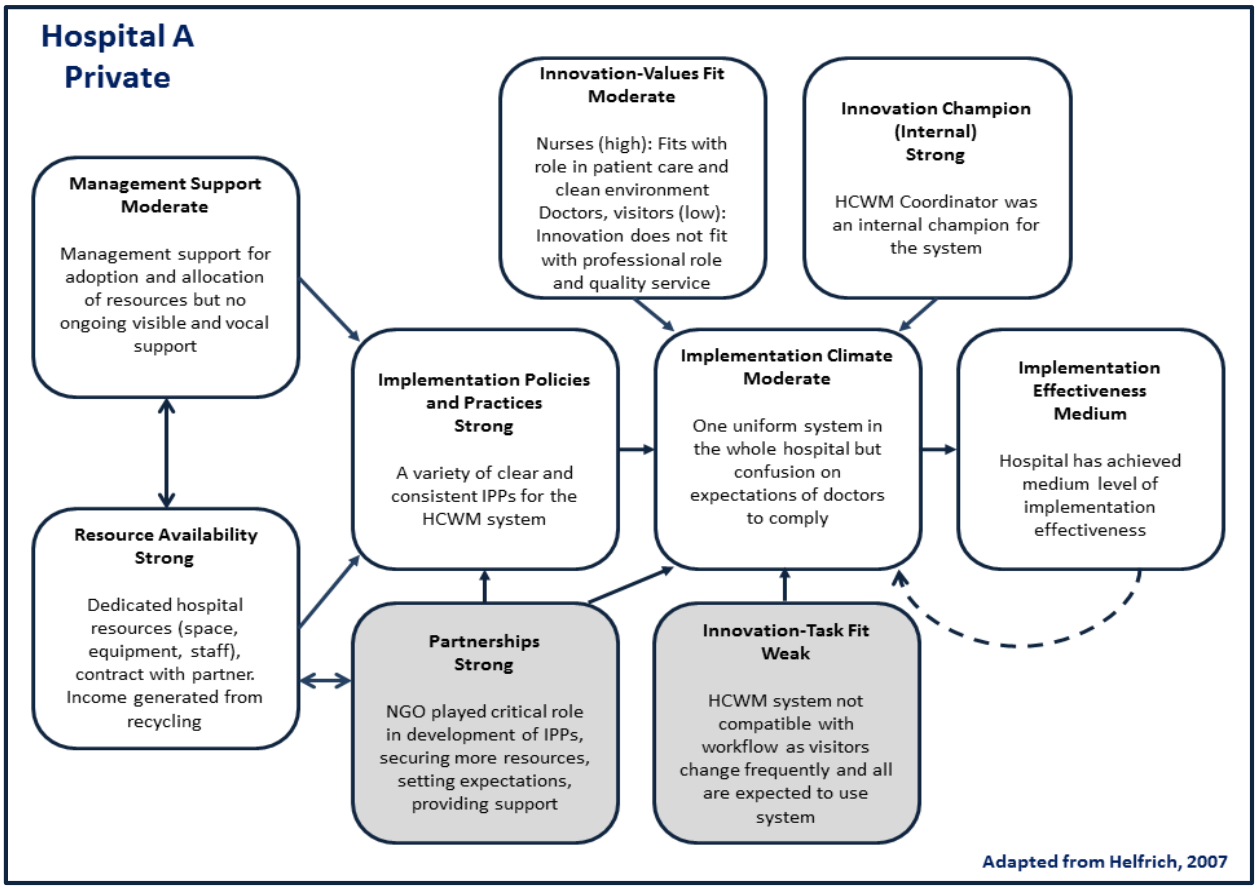
between use of the system and their primary professional duty to treat the patients.[13] In contrast to doctors, the nurses and ward attendants perceived that use of the innovation led to a cleaner, safer environment both inside the hospital as well as in the community. These divergent perceptions had an impact on implementation climate, which was also moderate. Although this was the only hospital in the study that had one uniform HCWM system throughout the hospital, there was still some confusion expressed by respondents about whether the hospital expected use of the HCWM system from doctors. There were no consequences for non-compliance and doctors routinely ignored the rules on segregation of waste and expected the ward staff to do this for them.

Innovation-task fit was identified as a barrier to effective implementation. Hospital staff found it difficult to enforce use of the system with hospital visitors given the transitory nature of this group, the constant need to educate new visitors, and the inconvenient location of bins for segregation of waste.

Based on these case study findings, Figure 6 presents a revised conceptual framework that shows organizational factors that affected implementation effectiveness of the HCWM system in Hospital A.

[13] This could not be confirmed by doctors as they were not available for interviews for this study.

Figure 6: Organizational Factors for Implementation Effectiveness of HCWM System - Hospital A



4.2 Case Study B

4.2.1. Background

Hospital B is government hospital located in the Kathmandu Valley with 100+ beds. The hospital also has an emergency ward and an outpatient department (OPD). The average occupancy rate of the hospital is 80% with nearly 300,000 outpatient visits each year (790/day). The hospital provides tertiary care in several specialty areas. The majority of patients that use this hospital are poor and most services are provided free of charge. The hospital is chronically understaffed and operates on limited resources. It relies on a system of volunteer nurses in order to meet the needs for patient care in the wards.

The Hospital Director serves for two years and reports to the Hospital Board. All major decisions must be approved by the Hospital Board.

4.2.2 Findings

Implementation Effectiveness - Results from Individualized Rapid Assessment Tool Survey

The HCWM system in Hospital B was launched in July 2010 and implementation had been ongoing for 4.5 years at the time of data collection for this study. The results showed that Hospital B has achieved a high level of implementation effectiveness, scoring 91% on the IRAT survey (Table 8). The hospital scored 40.5 out of 47 total points (86%) on Part I of the IRAT, indicating a medium level of implementation effectiveness for these components and 85.5 out of 91 total points (94%) on Part II indicating a high level of implementation effectiveness for these components (see Appendix 6 for details on the specific components).

Determinants of Implementation Effectiveness - Results from In-Depth Interviews[14]

Analysis of data from ten in-depth interviews conducted in Hospital B identified several salient factors that facilitated effective implementation of the HCWM system. These factors included all six constructs from the conceptual framework used in this study: a high level of sustained management support from the former hospital director; significant resources allocated for the HCWM system (especially space and staff); a variety of clear and consistent IPPs; the presence of two strong innovation champions working in tandem to advocate for the system; innovation-values fit - a good fit between use of the HCWM system and the values of nurses and ward attendants (primary users of the HCWM system); and a positive implementation climate.

Another critical factor that had a positive effect on implementation was partnerships, which emerged as a salient and strong determinant in Hospital B. In 2010, during the pre-implementation phase, the hospital entered into a non-contractual partnership with NGO A[15]. NGO A became part of the hospital

[14] Findings from interviews were triangulated with data from observations and document review

[15] This was the same NGO that provided technical assistance in Hospital A and Hospital C (thus, it is also referred to here as NGO A). There was only one organization in Nepal with the expertise and experience to provide this type of assistance. Hospital B did not pay NGO A for their work but NGO A was given office space in the hospital.

HCWM team and was instrumental in advocating for hospital resources to be dedicated to waste management. NGO A also provided technical assistance to the hospital to establish the system, develop IPPs, and support the HCWM staff in implementation.

The effectiveness of the HCWM system itself (innovation effectiveness) was also identified as a key determinant for continued implementation success. Respondents described the impact that this innovation has had on the hospital and environment including reduction in both non-risk and risk waste, income from recycling, cleaner and safer work environment, and international recognition for the hospital.

Innovation-task fit emerged from the data as an important construct with a moderate effect on implementation climate. Respondents perceived that it was very difficult at first to implement the system during the first two years because of limited training, limited staff and lack of understanding about the system itself. However, over time the high level of management support and resources, combined with strong IPPs, created an environment that was conducive to implementation.

Based on the criteria used to identify determinants, there were no salient factors that acted as a barrier to effective implementation in Hospital B. However, some respondents described two factors that may have exerted negative effects on implementation climate: innovation-values fit for doctors and external climate.

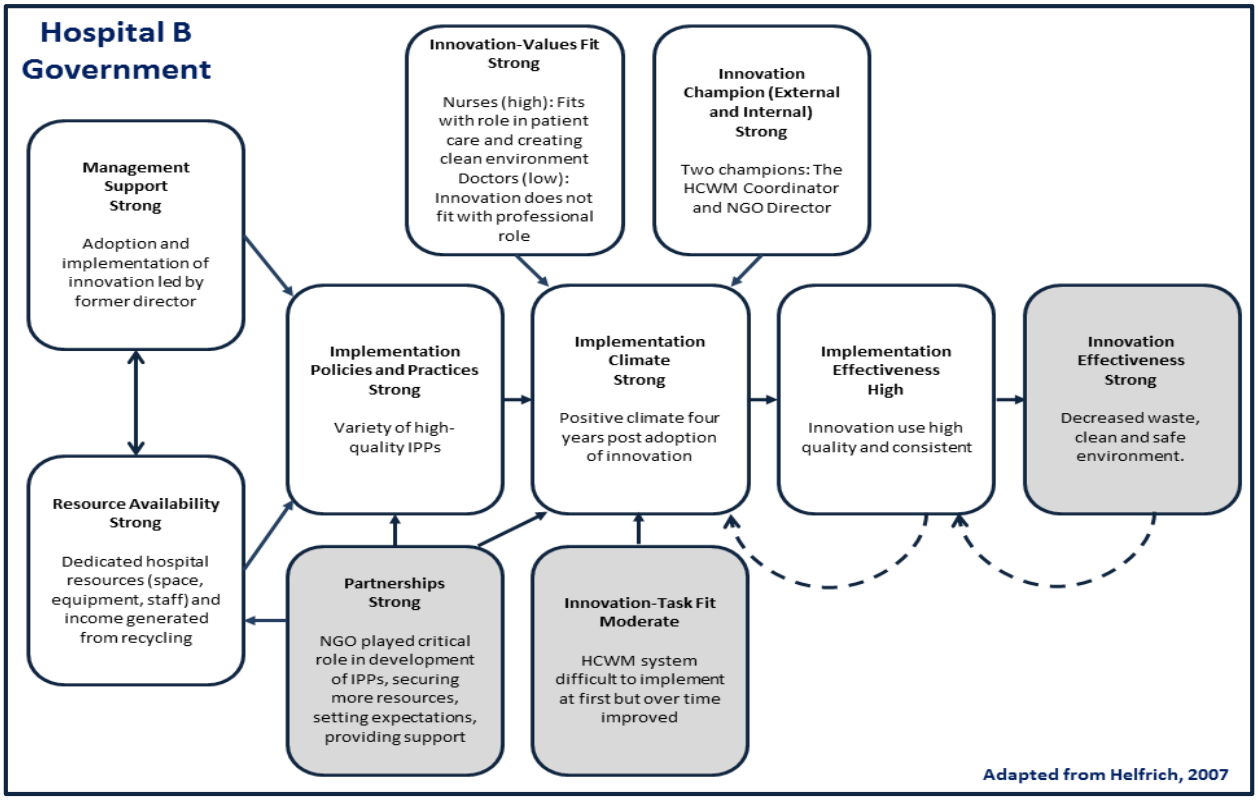
There was a poor fit between the HCWM system and the professional values of doctors (innovation-values fit). Respondents (nurses, ward attendants) reported that doctors were not willing to segregate waste themselves and viewed this as taking time away from their primary role of treating patients. Although this barrier might be overcome with stronger directives from management, the doctors played a relatively minor role in system implementation and thus, lack of compliance by doctors had not impacted implementation effectiveness. Nurses and ward attendants reported that they remind doctors to segregate the waste when appropriate and, if they refuse, simply segregate it themselves.

A couple of respondents identified external climate as a barrier to positive implementation climate. New government regulations restricted hiring of support staff on contracts. This hampered

expansion of the HCWM system to the outpatient department (OPD) since two additional waste collectors would be needed to implement the system in OPD.[16] The risk and non-risk waste from OPD was mixed together and dumped each day on the grounds directly across from the hospital's waste treatment facility in an area that had high staff, patient and visitor traffic. The waste was collected every three to four days by external waste collectors and taken to the municipal landfill. The respondents described this practice and questioned whether the hospital was still prioritizing the HCWM system. This could impact implementation climate in future if staff perceive that hospital-wide implementation of the HCWM system is neither expected nor supported by the hospital.

Figure 7 presents the revised conceptual framework based on these case study findings that shows organizational factors that affected implementation effectiveness of the HCWM system in Hospital B.

Figure 7: Organizational Factors for Implementation Effectiveness of HCWM System - Hospital B



[16] This is the only department in the hospital not covered by the HCWM system.

4.3 Case Study C

4.3.1 Background

Hospital C is a 100+ bed non-profit hospital located in central Kathmandu. The hospital was established over two decades ago and operates under a Nepali NGO. The hospital also has an emergency room and an OPD. The average occupancy rate is about 75% and the hospital sees approximately 250 outpatients per day. The hospital provides tertiary care in several specialty areas.

The Hospital Director reports to the Hospital Board of Directors and new programs or systems must be approved by this Board.

4.3.2 Findings

Implementation Effectiveness - Results from Individualized Rapid Assessment Tool Survey

The HCWM system in Hospital C was launched in December 2013 and implementation had been ongoing for one year at the time of data collection for this study. The results showed that Hospital C has achieved a medium level of implementation effectiveness, scoring 80% on the IRAT survey. Hospital C scored 30 out of 47 total points (64%) on Part I indicating a low level of implementation effectiveness for these components and 81.5 out of 91 total points (89.5%) on Part II indicating a medium level of implementation effectiveness for these components (see Appendix 6 for details on the specific components).

Determinants of Implementation Effectiveness - Results from In-Depth Interviews[17]

Analysis of data from ten in-depth interviews conducted in Hospital C identified several salient factors that facilitated effective implementation of the HCWM system. These factors included four constructs from the conceptual framework used in this study: a variety of clear and consistent IPPs; a positive implementation climate; innovation-values fit—a strong fit between the HCWM system and the

[17] Findings from interviews were triangulated with data from observations and document review.

values of users; and two strong innovation champions—an internal staff person and an external person—working together to advocate for resources and strong implementation.

Another critical factor that had a positive effect on implementation was partnerships, which emerged as a salient and strong determinant in Hospital C. The hospital formed a partnership with NGO A for technical assistance during the pre-implementation stage.[18] Some respondents stated that this partnership was a critical factor in implementation success. The partner worked closely with hospital staff to establish IPPs that were technically sound, fit well within the hospital system and ensured high-quality implementation during all steps of the HCWM system, from segregation of waste to final disposal of waste. The partner placed one staff member within the hospital to work daily with the appointed HCWM Supervisor to monitor the system and resolve any problems.

Another key factor that emerged in Hospital C was a high level of organizational readiness for change. The hospital staff stated that prior to adoption they were eager to implement a proper HCWM system but did not have full knowledge about treatment and disposal options. The hospital management was also aware of the government regulations on medical waste disposal that were put in place under the Nepal Solid Waste Management Act, 2011, and was trying to bring the hospital into compliance and to minimize harm to the community from hospital waste.

Factors that exerted mixed (both favorable and unfavorable) effects on implementation effectiveness included management support, resource availability, and innovation-task fit.

Some respondents stated that despite resource limitations—budget constraints and severe space restrictions—in Hospital C, the hospital management was willing and able to provide the necessary resources to support the adoption of the HCWM system and the startup and implementation of the system in a few hospital wards for one year. While in general respondents praised the management for this

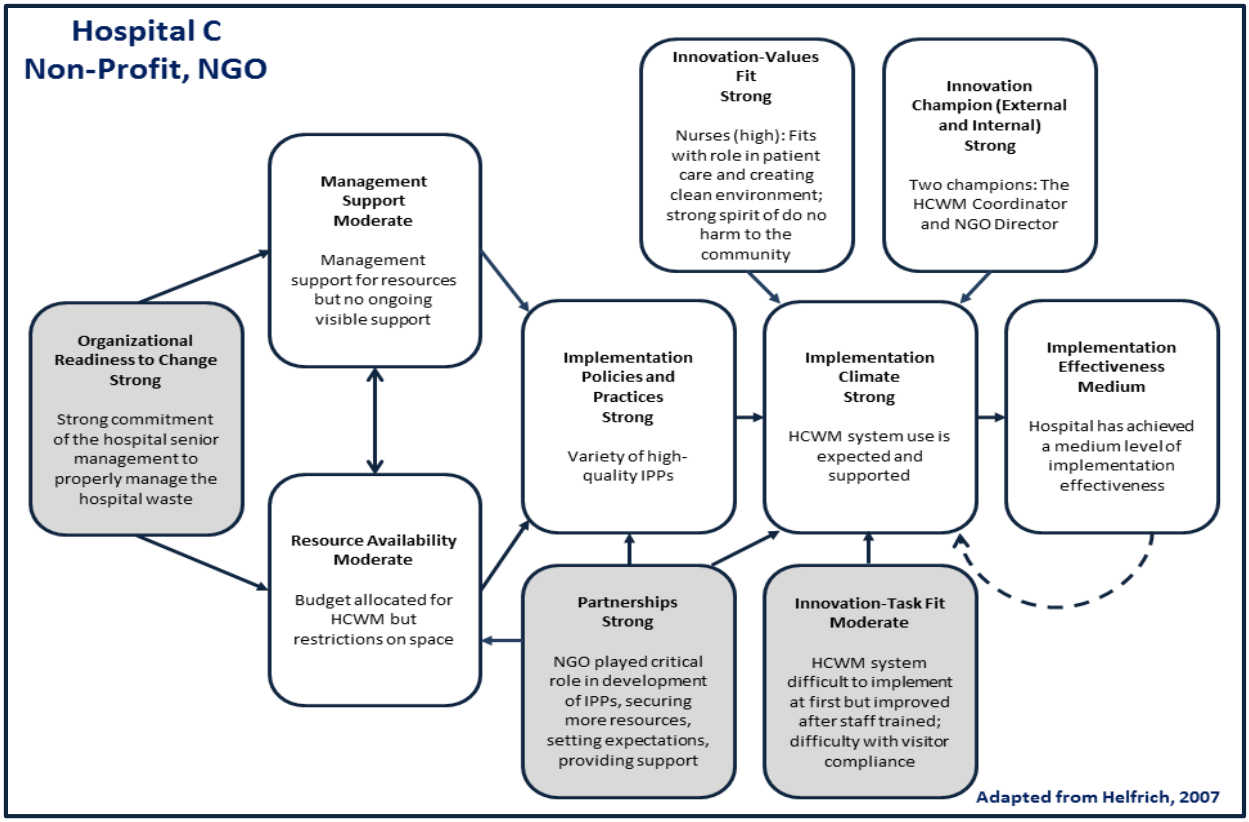
[18] This was the same NGO partner that provided technical assistance in Hospital A and Hospital B, thus, it is also referred to here as NGO A

support, some commented on the lack of ongoing involvement from management during the implementation period.

Innovation-Task Fit was also a factor in Hospital C that had mixed effects on implementation. Some respondents commented that the system was easy for staff members to understand once they were trained. A couple of respondents talked about the challenges to implementing the system because of space constraints. In addition, the patients' visitors played a large role in patient care and so were always present in the wards by the bedside. The system design required visitors to also segregate all waste at source. Several respondents talked about this expectation for hospital visitors to engage in implementation and the difficulty of incorporating them into the system given the fluid nature of this group and the constant need to educate new visitors. A couple of respondents mentioned that the practices were now adjusted and visitors receive instruction about the HCWM system at the time of registration. Respondents perceived that this new practice improved compliance of visitors in waste segregation.

There were no factors identified as barriers to implementation in Hospital C. Figure 8 presents the revised conceptual framework based on these case study findings that shows organizational factors that affected implementation effectiveness of the HCWM system in Hospital C.

Figure 8: Organizational Factors for Implementation Effectiveness of HCWM System - Hospital C



4.4 Cross-Case Analysis

4.4.1 Background

The sites selected in this study were all large hospitals (100 + beds) located in the Kathmandu Valley in Nepal. Each hospital had a unique governance structure—one private hospital, one government hospital and one non-profit hospital that is run by a Nepali NGO.

4.4.2 Pre-Implementation

Prior to implementation of the new HCWM system, all three hospitals had attempted various ways to manage waste, including open burning, incineration, burying, dumping and disposal through the municipal waste stream. Despite reported attempts by some hospital staff to segregate waste at source, untreated risk waste was usually mixed back together with non-risk waste and disposed by any means available. Hospitals B and C were criticized in the local press and by the surrounding communities for the use of incinerators and for dumping risk waste in public places.

4.4.3 Startup

All hospitals required technical assistance to establish and monitor initial implementation of the HCWM system. There was only one NGO in Nepal (NGO A) with the expertise and experience to assist in this task. Since NGO A provided technical assistance to all three hospitals, the process for startup was similar and included 1) assessing the current system, 2) training all hospital staff, 3) setting up a management committee, 4) procuring the necessary equipment and supplies and 5) establishing the components of the system including segregation, collection, storage, treatment and disposal/recycling. In all three hospitals, the system was introduced slowly, with implementation starting in only one ward for several months. This gave time for staff to adapt to the new procedures and resolve problems while the implementation was still limited. From that point onwards, the rollout and implementation of the system varied widely between hospitals.

Hospital A, a private hospital, was able to roll out implementation to the entire hospital over a period of 12 months. This hospital had the financial resources to scale up quickly, was not hampered by

government restrictions on hiring, and wanted the system in place quickly for ISO certification. In Hospital B, the scale-up progressed over a two-year period that staff described as difficult. After four years of implementation, the hospital had still not fully rolled out the system. This was due to government restrictions that prevented the hospital from hiring the additional staff necessary for completing expansion of the system to the outpatient department. The scale-up in Hospital C had just started and there were only four wards covered at the time of data collection.

4.4.4 Implementation Effectiveness

Implementation Effectiveness – Combined Results from Individualized Rapid Assessment Tool Survey

The three hospitals in this study had been implementing the HCWM system for varying lengths of time. Hospital B had the longest implementation period of 4.5 years, Hospital A had the second longest implementation period of two years and Hospital C had the shortest implementation period of one year. The scores that each hospital achieved on the IRAT survey were associated with duration of implementation. Hospital B achieved the highest score of 91%, indicating a high level implementation effectiveness. Hospital A achieved the second highest score of 88% and Hospital C the lowest score of 81% (Table 8). Both Hospitals A and C were classified as having medium levels of implementation effectiveness.[19] These findings were corroborated by data from observations and document review.

The variability in the overall scores was primarily attributable to Part I of the IRAT survey. Hospitals A and B both showed a medium level of implementation effectiveness on Part I and Hospital C showed a low level of implementation effectiveness in this section. Part I covered six components related to management of the system: 1) organization, 2) policy and planning, 3) training, 4) occupation health and safety, 5) monitoring, evaluation and corrective action, and 6) financing.[20] The three hospitals had equal scores on component 1 (organization), component 3 (training) and component 5 (monitoring,

[19] IRAT scores >90 = high level of implementation effectiveness; 80-89 = medium level of implementation effectiveness; <80 = low level of implementation effectiveness. See Footnote 10.

[20] See Appendix 6 for detailed questions and scores under each component of the IRAT for three hospitals.

evaluation and corrective action). Hospital B scored higher than Hospitals A and C on the other three components. These findings mirrored results that were obtained through document review, observations and interview data. Although none of the hospitals had HCWM policies, Hospitals A and B had draft protocols in place, albeit in English and not yet disseminated to staff members. Hospital B was the only hospital that provided vaccinations for HCWM staff. Hospital C did not have sufficient budget for HCWM and both Hospitals A and C did not yet have a long-term financing mechanism in place.

Part II of the IRAT survey focused on eleven core components of the HCWM system (Table 8). The scores on Part II of the IRAT survey were similar across hospitals, likely in part because the hospitals had all received technical assistance from the same partner (NGO A) to establish these core components of the HCWM system. The slight differences among hospitals were due to 1) in Hospital A, a higher than acceptable percentage of infectious waste generated, and 2) in Hospital C, lack of knowledge of HCWM workers on handling spills and needle sticks; lack of a contingency plan for treatment of infectious waste in the event of a shutdown of the treatment center for repair; and location of the waste treatment site that is easily accessible to the public due to space limitations.

4.4.5 Determinants of Implementation Effectiveness

Analysis of data from in-depth interviews identified several common salient factors that affected implementation effectiveness across the hospital sites.

Table 9 presents a summary of these factors by hospital. The valence for each factor—whether the factor was present and favorable for implementation effectiveness (+), present and both favorable and unfavorable (+/–), or present and unfavorable/ absent (–)—was determined based on analysis of coded text segments done by the Principal Investigator.[21]

[21] See Chapter 3: Methodology for description of criteria to determine salience and valence.

Table 9: Ten Salient Factors Affecting Implementation Effectiveness

Factor (Determinant)	Hospital A	Hospital B	Hospital C
1. Management Support	+ / –	+	+ / –
2. Resource Availability	+	+	+ / –
3. Implementation Policies and Practices	+	+	+
4. Innovation-Values Fit	+ / –	+	+
5. Innovation Champion	+	+	+
6. Implementation Climate	+ / –	+	+
7. Partnerships	+	+	+
8. Innovation-Task Fit	–	+ / –	+ / –
9. Organizational Readiness for Change	Not salient	Not salient	+
10. Innovation Effectiveness	Not salient	+	Not salient
Implementation Effectiveness	Medium	High	Medium

\+ Strong: Indicates factor was present and favorable for implementation
+/- Moderate: Indicates factor was present but mixed (both favorable and unfavorable) for implementation
\- Weak: Indicates factor was unfavorable for implementation
Note: factor ratings determined from interview data based on analysis of Principal Investigator

This section presents detailed narrative for the ten factors (determinants) that affect implementation effectiveness, including similarities and differences across sites and the effect of the factor on implementation effectiveness as well as on other constructs within the conceptual framework.

Determinant 1: Management Support

Management[22] support varied across hospitals (Table 10). Respondents from Hospital B reported the presence of strong and sustained management support while respondents from Hospital A and

[22] Management refers to Hospital Director.

Hospital C reported moderate management support. Similarities across the three hospitals included strong management support for 1) adoption of the system and 2) allocation of resources for startup and implementation. This was the minimum level of support required to launch the new system. Regardless of the type of hospital, the head of the hospital and the entity to which they reported had to approve the introduction of any new innovation. Further, in these hospitals the management controlled the resources (money, space, equipment, staff time) that made implementation possible.

Table 10: Management Support - Main Themes and Illustrative Quotes

Construct	Hospital A Private	Hospital B Government	Hospital C Non-profit
Implementation Effectiveness	Medium	High	Medium
Management Support (MS) Summary	+ / –	+	+ / –
	There was strong MS for adoption of the HCWM system and sufficient resources allocated for implementation. Limited communication from management to staff about the system. *"The head of the hospital was very interested in hospital waste management and public health…he is very committed to the waste management." [Hospital staff]* *"From management… they are supportive but they don't push it or talk about it." [Hospital staff]*	Former Director led the effort to introduce the system; became internal Innovation Champion and played critical role in overcoming initial internal resistance to change. Current Director was also supportive but had many other priorities. *"The management would say, 'We have to do waste management. It's very important.' The Director (former) was very encouraging. It was necessary for the administration to do that. They needed to encourage and they did." [Hospital staff]*	There was MS for adoption of the HCWM system and sufficient resources allocated for limited implementation. Lack of ongoing involvement and interest from management. *"Management was cooperative and created a friendly environment; although they had budget and space problems they were still positive." [Hospital staff]* *"I feel like they should give more ongoing help. Like sometimes they should come to see us or guide us. They should get involved and show some interest." [Hospital staff]*

The difference between the hospitals was in the level of management engagement post startup. In Hospital B, nearly all respondents described the leadership of the former Hospital Director and his

support for the HCWM system as extraordinary and sustained over a period of four years. Respondents in Hospitals A and C described strong support for startup but little to no communication from management to staff during implementation.

Determinant 2: Resource Availability

Resource availability was strong in Hospitals A and B and moderate in Hospital C (Table 11). The resources needed for implementation included technical assistance, staff positions, space, equipment, supplies and ongoing maintenance of the system.

Table 11: Resource Availability - Main Themes and Illustrative Quotes

Construct	Hospital A Private	Hospital B Government	Hospital C Non-profit
Implementation Effectiveness	Medium	High	Medium
Resource Availability Summary	+	+	+ / –
	Allocated resources for five HCWM staff, building construction, autoclave, supplies and maintenance. Earned about US$250 per month from recycling. *"First there was the construction of this whole building. This was a parking lot before, so the hospital first allocated this area for the waste management. They also invested in all of the logistics to run the system. For the design and construction of the building I don't know the exact cost but the hospital paid for it all." [Hospital staff]*	Allocated resources for six HCWM staff, building construction, demonstration bio-digester, training room and equipment. Earned US$300 per month from recycling; saved US$120 per month on waste disposal charges. Generated about US$11,000 since implementation started. *"The autoclave treatment center was previously a mortuary house but it was not in use. The area where the current treatment center is located was also being used as a dumping site for old equipment. It was all cleaned up and then the infrastructure [for HCWM] was built." [Hospital administrator]*	Allocated resources for two HCWM staff, autoclave, supplies. Severe budget constraints and space problems. Earned US$30 per month from recycling. *"The system started one year ago and mainly the problem was space. There is no space in this hospital. But we wanted to make it work, so there was a small passage where the mortuary was and that's where we did it [waste treatment]. But that space was enough for only one ward so we started." [Hospital staff]*

Reported costs of startup and implementation varied widely across hospitals and most were not verifiable. All hospitals were earning income from recycling a portion of the hospital waste. Hospital A and Hospital B earned about US$250-300 per month. Hospital C earned only US$30 per month; there was much less waste to recycle since the system was operational in only a few wards. Respondents in Hospital C recognized that this amount should increase as the hospital expands the coverage of the HCWM system and the volume of waste available for recycling grows.

Hospital C had the greatest limitations on resources. Space was a key resource and at a premium in this hospital and it was difficult to identify an appropriate place for the waste treatment center. At the time of data collection, treatment of high risk waste in Hospital C was conducted in a narrow corridor and small room situated directly across from the hospital canteen; this was not ideal given its proximity to food, but it was the only space available.

Each hospital had made efforts towards institutionalizing the HCWM system financing. Hospital A added a line item for waste management in the hospital procurement software so expenditures could be tracked over time and Hospital B had plans to include waste management into their next budget cycle. All three hospitals deposited income from recycling into the hospital accounts.

Determinant 3: Implementation Policies and Practices (IPPs)

IPPs to support the HCWM system were present and strong in all three hospitals and had an overall positive effect on implementation climate (Table 12). The IPPs were developed with external assistance. Since there was only one local NGO (NGO A) in Nepal with the capacity, experience and expertise to provide technical assistance on hospital waste management, the same partner assisted each hospital on the development of IPPs. Thus, initially the IPPs were similarly defined across all hospitals. However, over time the set of IPPs evolved at each site as staff members took ownership of the system and tailored practices to match the culture of their hospital. Respondents discussed IPPs related to 1) hospital policies, 2) management of the HCWM system, 3) staff and training, 4) monitoring of the HCWM system, and 5) incentives.

Table 12: Implementation Policies and Practices - Main Themes and Illustrative Quotes

Construct	Hospital A Private	Hospital B Government	Hospital C Non-profit
Implementation Effectiveness	Medium	High	Medium
IPPs Summary	+	+	+
	Strong, well-defined IPPs in place supported implementation of the HCWM system, which scaled up quickly throughout the hospital. *"No [there are no policies], but it's written right there on the wall. You can just read it there [points to the wall where there is signage] and if you can't read there's a picture... Staff can see it and know what to do." [Hospital staff]* *"We had an orientation class for the whole staff but the doctors didn't attend at all. I told the doctors that if one person breaks the system it breaks for everyone. And they would say, 'Why should we go to a waste management class, we're not going.' And they didn't." [Hospital staff]*	Strong, well-defined IPPs were established with technical assistance from NGO A and further evolved over time as staff members took ownership of the system and tailored approaches to match the culture of the hospital. *"There are no policies about HCWM. We keep learning how to do it, there's nothing written down. We got the knowledge from training." [Hospital staff]* *"In the committee meeting all department heads will be there and all of the information that needs to be disseminated is discussed there and the heads go to their units and talk to their subordinates and it flows from there to their support staff and will go also through housekeeping to their support staff."[Hospital administration]*	Strong, well-defined IPPs in place to support implementation. System was new so IPPs were still evolving. *"To set up the system we used the government policies and the waste management guidelines. So we used this to set it up properly." [NGO A worker]* *"I've asked them for the Standard Operating Procedures but they tell me to wait until the complete system is in place." [Hospital staff]* *"Sometimes we hold committee meetings and if we need to do more trainings for nursing or support staff I manage the training." [Hospital staff]* *"For the orientation [on waste management] for doctors we called them and waited for hours but no doctors came. And we gave up, just left it." (Hospital staff]*

Hospital Policies

There were no hospital policies related to HCWM in any of the sites in this study; this was described by respondents as the norm in Nepal. Hospital A and Hospital B had draft manuals of standard operating procedures for HCWM that were developed by NGO A, but these manuals were in English language and had not been distributed to staff.[23] In Hospital C, a couple of respondents voiced the desire for written protocols but stated that they were advised (by NGO A) to wait until the system was fully rolled out so the policies, rather than being imposed from the start, could reflect practices that developed over time with staff input and were based on the realities that staff faced within the hospital setting.

A few respondents from each site stated that they followed WHO/international guidelines to set up the system and noted the presence of clear signage throughout the hospital that displayed instructions in writing and pictures about the system and procedures. This signage was viewed as critical to implementation success as it gave the system legitimacy. Since patients and visitors were an integral part of making the system work, this signage was important for the staff to refer to while orienting visitors. This was particularly true for the pictures as many of the hospital users were illiterate, especially in Hospital B. One respondent stated that if there had been a written policy document but no signage, it is likely that the document would not be read by staff (and certainly not by visitors and patients) and the system not implemented correctly, if at all.

Management of the HCWM System

A high-level HCWM committee, that included the Hospital Director, was formed at each hospital during the pre-implementation phase. The HCWM committee was seen as a venue for solving problems and making decisions about the HCWM system. In Hospital B, this committee was reportedly still active although it was not clear how often they met.[24] In Hospital A the committee had met during the first year

[23] Confirmed by document review.

[24] Document review confirmed high committee activity throughout the first year of implementation. Recent meeting minutes were not available for review.

but was no longer active at the time of data collection.[25] Instead there was a smaller committee that included the five waste management unit staff members and the HCWM coordinator. This committee met regularly to discuss issues and resolve problems. In Hospital C the HCWM committee had been active during the first three months of system startup but had only met once after that.

Staff and Training

Each hospital appointed a focal person for waste management to oversee implementation of the HCWM system. The focal person was called the HCWM Coordinator and the expectations from hospital management were that the duties of the Coordinator would be done in addition to their regular full-time positions with no extra compensation for this work.

Each of the HCWM coordinators held full-time senior level positions and had been working at the hospital for many years.[26] They were specifically chosen because of their expressed interest in the topic and all became champions of the system. Most respondents viewed the role of the HCWM coordinator as critical for successful implementation.

Each hospital also hired additional staff to work on specific tasks related to implementation of the HCWM system. Hospital A established an entirely new waste management unit and hired four waste collectors/ segregators and a HCWM Supervisor to manage the system. Hospital B hired six support staff (waste transporters, waste segregators, autoclave technicians) and Hospital C hired two support staff (waste collectors - although later decided that one person was enough and assigned the second person to work as a ward assistant). These staff members had well-defined roles and responsibilities within the system. Their roles were critical to ensuring high-quality and consistent implementation. All respondents (hospital staff) were able to clearly articulate their roles and responsibilities in the HCWM system implementation.

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[25] Unable to confirm the meetings from the first year from document review as the minutes had been misplaced.

[26] In Hospital A – 17 years; In Hospital B – 28 years; In Hospital C – 21 years.

All hospitals held an initial training on infection control and waste management for hospital staff prior to the launch of the new system. There was no plan in place for refresher trainings and staff that joined after the launch of the system were trained on the job. The exception was Hospital C where rollout was slow and a refresher training was needed prior to expansion into new wards.

Monitoring the HCWM System

Each hospital had a slightly different system of monitoring implementation of the HCWM system, but all hospitals had two things in common: 1) the monitoring was decentralized in each hospital and 2) the HCWM Coordinator played a major role in oversight.

Hospital B had the most robust monitoring system of the three hospitals. There was a strong sense of ownership of the HCWM system throughout the hospital and multiple levels of staff were engaged in monitoring. Self-monitoring in each ward was a critical part of the system. The Ward-in-Charge played a key role in making sure the system was effectively implemented. Ongoing monitoring was also done by nurses and ward attendants. This included orienting patients and visitors about the system and correcting mistakes in waste segregation as they were made. Waste collectors also monitored the system and reported any issues to the HCWM coordinator since they had a vested interest (reduced occupational risk and ease of doing their work) in making sure the system was working.

Hospitals C had a similar decentralized monitoring system. Respondents from Hospital C described a multi-level monitoring system that included individual ward supervisors and hospital staff who worked on the wards. The structure of the monitoring system in Hospital A could not be clearly discerned from interview data. Respondents stated that monitoring was done by housekeeping staff, nurses and the HCWM supervisor.

Incentives

None of the hospital offered incentives to staff for use of the HCWM system. Although Hospital A, as a private hospital, had more flexibility than government hospitals with regards to salary levels, promotions and rewards, there was no system of monetary incentives or rewards in place for staff that correctly used the HCWM system, nor were there punishments for non-compliance. Similarly, Hospitals

B and C also did not offer any incentives or rewards for innovation use. However, the HCWM system in Hospital B won national acclaim and the staff members received continuous recognition for their work from government and external visitors. Some respondents also described the simple reward of working in a clean and healthy environment.

Determinant 4: Innovation-Values Fit

Innovation-values fit was high in all hospitals among nurses, housekeeping staff and ward attendants; these were the primary users of the HCWM system (Table 13). These groups perceived that use of the innovation contributed to their core values to do no harm to patients and provide a clean and safe environment for their recovery. They also felt that the system contributed to improved infection control and a better environment for the community. Respondents from Hospital C put particular focus on the community since they were run by a well-established Nepali NGO that had a long history of work in the community.

In Hospitals A and B, innovation-values fit was reportedly poor among doctors. Respondents stated that most doctors did not see a role for themselves in waste management and would not follow the system. The doctors also did not attend any trainings on waste management. This may be because doctors in general did not see a fit between use of the system and their primary professional duty to treat the patients.[27] Waste segregation at source was historically done by nurses and ward attendants. Although in Hospital B the lack of compliance by doctors did not negatively impact implementation effectiveness, in Hospital A, respondents raised questions about the expectations of the hospital for implementation use among doctors. This had a negative effect on implementation climate. Respondents from Hospital C reported that, in general, doctors had a positive attitude towards the HCWM system.

Table 13: Innovation-Values Fit - Main Themes and Illustrative Quotes

Construct	Hospital A Private	Hospital B Government	Hospital C Non-profit

[27] This could not be confirmed by doctors as they were not available for interviews for this study.

Implementation Effectiveness	Medium	High	Medium
Innovation Values Fit Summary	+/–	+	+
	Doctors reportedly did not see a fit between use of the system and their primary professional duty to treat the patients. Nurses and ward attendants perceived that use of the innovation led to a cleaner, safer environment both inside the hospital and outside. It was difficult for staff to continuously instruct new patients and visitors about the waste segregation system. Visitors would often demand waste bins in their rooms. *"Everyone likes the new system. It's good the way it is. It's cleaner for the patients and the staff and it doesn't smell. We have to remember that patients come in sick and we don't want to make them sicker." [Hospital staff]*	Doctors reportedly did not see a fit between use of the system and their primary professional duty to treat the patients. Nurses and ward attendants perceived that use of the innovation contributed to their core values to do no harm to patients. Staff placed high value on the reputation of the hospital. Many respondents had been working at this hospital for decades and expressed pride that their hospital was seen as a role model for HCWM in the country and internationally. *"The hospital really values this system. There is a shift in the staff. This system is for everyone. As many people come here to the hospital, the environment needs to be nice. The segregation system that we use, visitors need to know we do that and should follow it." [Hospital staff]*	Respondents stated that they had a duty to do no harm to patients and the community. *"Now the infectious waste is autoclaved and only then is it disposed. It's better for the environment and for other people. Like before we would collect all the waste and the municipal waste collector would come and take it all away. And it wasn't properly managed and processed. At least now the hospital's risk waste is not posing a threat." [Hospital staff]* *"It's a public responsibility. The hospital has to do this for the public, we can't do harm."* [*Hospital staff]* *"The doctors don't know so they ask us, 'Sister, where do I throw this?' like their gloves, and we guide them. But they do it when we tell them how." [Hospital staff]*

Determinant 5: Innovation Champion

All three hospitals had a strong internal innovation champion (Table 14).

Table 14: Innovation Champion - Main Themes and Illustrative Quotes

Construct	Hospital A Private	Hospital B Government	Hospital C Non-profit
Implementation Effectiveness	Medium	High	Medium
Innovation Champion Summary	+	+	+
	The HCWM coordinator was an innovation champion - strong advocate for the establishment and implementation of the HCWM system. *"The Coordinator is the one pushing this system. She tells people what to do, if they don't do it she scolds them. She is really the one behind it. If she sees someone mixing infectious and non-infectious waste she'll make them do it again." [Hospital staff]* *"The real champion in this hospital is the HCWM Coordinator…She is very motivated. This waste management system is successful because of her." [Hospital staff]*	There were two very strong, charismatic and passionate innovation champions who were advocates for the system; an external champion (NGO A Director) and an internal champion (Hospital Director). *"It would never have happened if the director (former) hadn't been here. It would never have been a success. None of the staff wanted to do it. But we would say that this is coming from the director, not the nursing staff. The director came and wanted to do it so everyone else wanted to do it." (Hospital staff]* *"He [NGO A director] took a lot of risk for us, it was so hard at first. Without him there is no way the system would have worked."[Hospital staff]*	There were two innovation champions who were advocates for the system; external (NGO A Director) and internal (HCWM Coordinator). *"[The HCWM Coordinator] is the most active and dedicated. She is the champion. Maybe because she is very close to the hospital and wants something good in this hospital, something better for the hospital." [Hospital staff]* *"There was a big gap in the assessment process and the NGO A Director kept pushing to do it." [Hospital staff]*

In Hospital A, the champion had worked for nearly two decades in the hospital and held a position of authority. She had been appointed as HCWM Coordinator by the hospital management and was a staunch advocate for the system. Hospital C had a similar champion who had also been appointed as HCWM Coordinator by the Hospital Director. She had worked over 20 years in the hospital and her interest in HCWM predated the launch of the new system.

Hospital B also had a committed HCWM coordinator who was a strong advocate for the system. However, when asked about whether anyone stood out as a champion in the hospital, respondents overwhelmingly referred to the former Hospital Director given his role in establishing the system and his outspoken public advocacy for HCWM over a long period of time.

In Hospital B and Hospital C, respondents also identified a strong external champion, the Director of NGO A. Although he was well known to the management in all three hospitals and instrumental in building the reputation of these hospitals as leaders in HCWM, his presence was less visible to ward staff in Hospital A. The Director of NGO A worked closely and in tandem with the internal champions to advocate for the HCWM system.

Determinant 6: Implementation Climate

Hospitals B and C reported a strong implementation climate and Hospital A reported a moderately positive implementation climate (Table 15). Most respondents in the three hospitals perceived that the HCWM system was a hospital priority, stating that use of the system was expected and part of the hospital operations, although the non-compliance of doctors in Hospital A created some confusion about expectations for use of the system.

This perception of expectation for use of the system was reinforced in every hospital through highly visible colored waste bins and signage that were placed in each area of the hospital where the system was operational. The signage had both pictorial and written instructions (in Nepali and English language) about how to segregate waste. There were also prominent signboards in each hospital that listed the names of hospital staff that were responsible for the HCWM system.

Respondents overwhelmingly reported that support for the system was strong, including training, equipment, staffing and infrastructure support. There were no rewards for using the system nor punishments for not using it.

Table 15: Implementation Climate - Main Themes and Illustrative Quotes

Construct	Hospital A Private	Hospital B Government	Hospital C Non-profit
Implementation Effectiveness	Medium	High	Medium
Implementation Climate	+/–	+	+

Determinant 7: Partnerships

The construct of Partnerships was not a part of the conceptual framework used in this study, but emerged as a salient issue in all three hospitals (Table 16).

Table 16: Partnerships - Main Themes and Illustrative Quotes

Construct	Hospital A Private	Hospital B Government	Hospital C Non-profit
Implementation Effectiveness	Medium	High	Medium
Partnerships Summary	+	+	+
	Hospital A formed a contractual partnership with NGO A for technical assistance to establish the HCWM system and monitor implementation for one year. *"NGO A was involved in every part of establishing the system, like training and implementation and procurement."[Hospital staff]*	Hospital B formed a close collaborative partnership with NGO A that has lasted five years. The partner had office space at the hospital so partner staff members were onsite daily. *"I want to say thanks though to [NGO A], they helped us with the whole system. They gave us technical support…it wasn't just our hospital that did this and they played a huge role in waste management and treatment for the hospital. They gave us a lot of help."[Hospital staff]*	Hospital C formed a partnership with NGO A for technical assistance and the partner donated time for this work. Respondents reported that this partnership was a critical factor in implementation success. *"The head of NGO A told the hospital management about the HCWM system and they thought about launching it in the whole hospital. NGO A gives trainings and NGO A staff calls meetings from time to time when there is a problem." [Hospital staff*

Respondents described the importance of the partnership that the hospital formed with NGO A for technical assistance to establish the HCWM system. The type of relationship formed between the partner and hospital was notably different at each site. The partnership between NGO A and Hospital A was contractual and specified for a fixed period of time. The partnership with Hospital B was based on a shared vision for HCWM with no contract or financial payments for services. The partnership with Hospital C was still in flux and the contract had not yet been signed at the time of data collection although the work had been ongoing for one year.

Determinant 8: Innovation-Task Fit

Like Partnerships, the construct of Innovation-Task Fit was not a part of the conceptual framework used in this study, but emerged as a salient issue in all three hospitals (Table 17).

Table 17: Innovation-Task Fit - Main Themes and Illustrative Quotes

Construct	Hospital A Private	Hospital B Government	Hospital C Non-profit
Implementation Effectiveness	Medium	High	Medium
Innovation-Task Fit	–	+ / –	+ / –
Summary	The new HCWM system consumed more time. It was difficult to force use of the system with hospital visitors given the fluid nature of this group and the need to continuously train new visitors. *"The system is good. If everyone did it then it would be great. But the patients don't understand. What do you put where? They used to put it all in one place. They don't agree to read where the waste goes and put it in the right place. For all waste, or just the general waste? They basically say it's too hard, just put all the waste in one place. We get in fights when we ask them to do it right." [Hospital staff]*	It was difficult at first to implement the system because of limited training, limited staff and lack of understanding about the system itself. This improved over time but respondents remembered this period of time well. *"At first it was so dirty. There was a lot of waste and not very many people to clean it up so it was very hard. Now the ward is very clean. And now since everyone knows what to do it isn't so hard. We have now separate people for waste and so the cleaners don't have to take the waste out. The hospital is nice and we teach other hospitals." [Hospital staff]*	Implementation was challenging due to space constraints, especially in some wards where the waste bins were outside of the wards. It was difficult to force visitors to use the system but they now instruct new patients/visitors about the HCWM system at registration, which has made it easier for staff in the wards. *"It would be better if the bins were inside the wards. They're outside the ward. So if you want to throw something away you have to go out into the corridor. It's because there's no room, but it's hard. There are no buckets next to the bed. In the wards where the system hasn't been implemented yet they have the bins all in the room although it's mixed together." [Hospital staff]*

Innovation-Task Fit was weak in Hospital A and moderate in Hospitals B and C. Respondents discussed a number of challenges with implementation including the extra time needed to segregate

waste, limited training and space constraints. The overall task that created implementation difficulties across all hospitals was the need to continuously educate visitors about the HCWM system and the expectation that hospital visitors would segregate non-risk waste (plastic, paper, food, bottles) at source. Hospital A had the most problem with this issue since the visitors expected waste bins to be provided in the private hospital rooms and complained about this to staff, with many refusing to segregate waste. In Hospital B the visitor issue was mentioned as a challenge but also an opportunity to educate people about waste management and recycling. The one exception was the emergency room, where patient flow was very high and it was difficult to control visitors. Hospital C had revised the IPPs in an attempt to ease the burden on hospital staff, by informing patients and their visitors about the HCWM system and the hospital rules on waste segregation at source at the time of registration.

Determinant 9: Organizational Readiness for Change

Although Organizational Readiness for Change was not a construct in the conceptual framework used in this study, it was identified as salient and positive in Hospital C (Table 18). Respondents stated that the hospital management and senior staff in Hospital C had a longstanding interest in waste management, dating back to the time the hospital was first established. The challenge they reportedly faced was lack of knowledge about treatment and disposal options. The hospital management expressed serious interest in adopting a new HCWM system in 2011 after the government announced new regulations on HCWM, but was hampered by the limited availability of resources. This led to a long delay between initial interest and adoption of the system, which finally took place in December 2013.

Although organizational readiness for change was not a salient issue in Hospital B, there was high personal readiness for change of the Hospital B Director. In fact, the decision to adopt the new HCWM system in July 2010 was driven primarily by two individuals—the Director of Hospital B and the Director of NGO A—who were passionate about the environment and interested in building a successful model for healthcare waste management in a government hospital. At that time there was little to no government interest in or oversight of hospital waste management; thus, government regulations and compliance were not factors in the decision to adopt the new system. Although the environment in Hospital B (described as

unclean by a few respondents) and the negative articles in the press might have been factors that contributed to the change, most respondents credited the charismatic personalities and strong personal readiness for change of these two directors as the key factors driving adoption of the new system. The directors worked together to advocate for the system and overcome internal resistance to change from some staff in Hospital B, who initially viewed the new system as more work with no added benefit.

Table 18: Organizational Readiness For Change - Main Themes and Illustrative Quotes

Construct	Hospital A Private	Hospital B Government	Hospital C Non-profit
Implementation Effectiveness	Medium	High	Medium
Organizational readiness for change	Not salient	Not salient	+
Summary	There was high readiness for change from management due to need for certification. *"We put the new system in because about 2-3 years ago the government made waste management compulsory or they would fine the hospital and we started the process so we wouldn't get fined." [Hospital staff]* *"This was set up two years ago. Before two years we had such type of system that we sent all the waste to the municipal dumpsite. Then there were new laws passed by the government." [Hospital staff]*	Respondents mentioned the personal readiness for change of the Director and the high resistance to change of the staff. *"The nurses thought it would be more work. They tried before to have that kind of system but it wasn't complete from point of generation to treatment and final disposal. So they segregated everything that they could but then when transporting the waste, the transport staff would collect it all in the same bucket and mix it all anyway so they would say, 'Why are we segregating if everything will be mixed?' They didn't see the point since it all ended up in the same place." [Hospital staff]*	Prior to adoption of the new HCWM system, the hospital staff were interested but did not have full knowledge about treatment and disposal options. *"We were ready to do this long before the program came, it's just that we didn't know what the alternative was to incineration." [Hospital staff]* *"We didn't have good information on the treatment system and recycling. We wanted to learn about how to set up a proper system and launch it here. We collaborated with the health ministry and WHO but really we just didn't know about the treatment part." [Hospital staff]*

The organizational readiness for change was also not a salient issue in Hospital A. The motivation to adopt the system was based on practical reasons – the new waste management system was a requirement for ISO certification (which was a priority of the hospital management) and the hospital staff also referred to the need for the hospital to be in compliance with new government regulations.[28]

Determinant 10: Innovation Effectiveness

Although a few respondents from Hospitals A and C spoke about the overall impact of the HCWM system, the effectiveness of the innovation itself emerged as a salient and strong issue only in Hospital B (Table 19). This was likely associated with the longer length of implementation time in Hospital B, where most respondents had noticed a variety of positive changes. Respondents reported that the amount of hospital waste that flows into the municipal waste stream decreased, along with the associated fees for disposal of this waste. The recycling program provided a steady source of income for the hospital that contributed to ongoing maintenance of the system. Respondents perceived that working conditions improved dramatically after introduction of the HCWM system; patient wards were cleaner; and there was a perceived reduction in risk of injury from needle sticks. Hospital B was also publicly lauded by the government as a leader in HCWM systems. The HCWM team conducted numerous tours of the system for national and international visitors from hospitals, medical schools and other health and environmental institutions.[29] The benefits realized by the hospital from the HCWM system created momentum to mobilize additional resources. The divergence in innovation-values fit across groups became less important as nurses and ward attendants who used the system gained credibility and felt empowered to request doctors to comply with the system. This led to a stronger implementation climate as the nurses and ward attendants contributed to the expectation that use of the HCWM system was expected and supported.

[28] Although the government regulations were not enforced at that time.

[29] Verified from document review of visitor books from 2011 to present.

Table 19: Innovation Effectiveness – Main Themes and Illustrative Quotes

Construct	Hospital A Private	Hospital B Government	Hospital C Non-profit
Implementation Effectiveness	Medium	High	Medium
Innovation Effectiveness Summary	Not salient	+	Not salient
	A few respondents commented on the effect from the HCWM system. *"Everyone likes the new system. It's cleaner for the patients and the staff and it doesn't smell. We have to remember that patients come in sick and we don't want to make them sicker." [Hospital worker]* *"I think we have less needle sticks now since we're carefully segregating. And we aren't hearing noise from outside the hospital now. We have an autoclave system. Before people just took the infectious waste. And we had it in the streets." [Hospital staff]*	Most respondents remarked on a number of positive effects from the HCWM system. *"It's been great since the system started, before whatever we did, it didn't make a difference. People used to complain, it smelled and was dirty. It didn't matter what we did, the complaints didn't stop. They used to say 'What are you doing? It is so dirty!' That isn't a problem anymore. People are more conscious. Now everyone is happy." [Hospital staff* *"It's a huge benefit for the hospital and for us. Before we could cut ourselves on sharp objects like syringes. Or get infections from wounds. Now we don't worry about that." [Hospital staff]*	A few respondents commented on the effect from the HCWM system. *"They can reuse everything and sell waste. That's a big advantage. It keeps the community safe. At least from the side of the hospital we should keep the community safe."[Hospital staff]* *"It's good to collect the waste all in one spot. It's hard for the waste collectors if we don't do it, if we mix the paper and plastic and needles all in one place they could get stuck with needles." [Hospital staff]* *"There is less infection in the ward but we have no data. We can only give the data of risk and non-risk waste percentage and the risk waste has decreased." [Hospital staff]*

4.4.6 Facilitators and Barriers across Hospitals

Table 20 presents a summary of the facilitators and barriers for implementation effectiveness that were common across at least two of the three hospitals that participated in this study.

Table 20: Common Facilitators and Barriers for Implementation Effectiveness

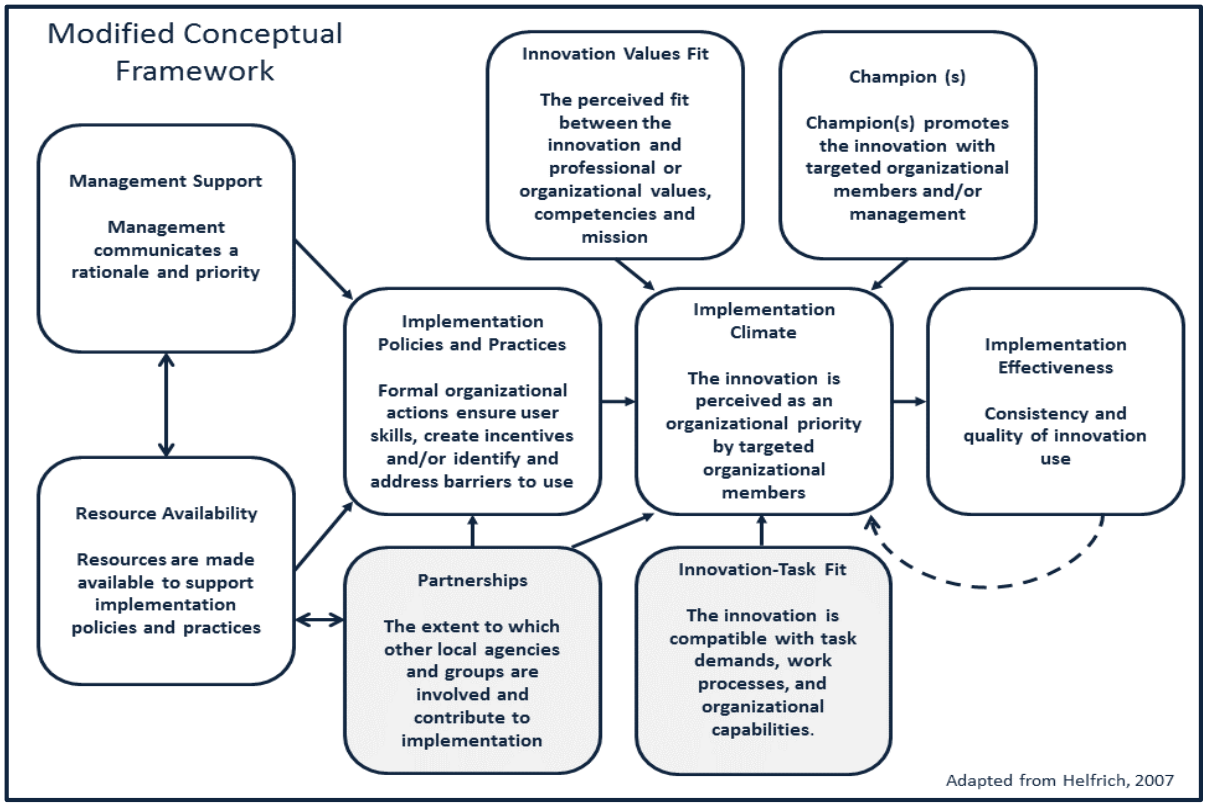
Construct	Facilitators	Barriers
Management Support	Management supported adoption, allocated resources for implementation and invited external technical assistance.	Decreased management support over time and largely symbolic during implementation.
Resource Availability	Hospitals invested in equipment, space and new staff for system implementation and establishing a recycling system to generate income.	Space constraints were a problem in two hospitals.
Implementation Policies and Practices	Strong IPPs established with external technical assistance; IPPs allowed to evolve and adjust over time.	None
Innovation-Values Fit	Nurses and ward attendants perceived that the innovation fit well with their values of patient care, do no harm, clean and safe environment.	Doctors did not see a role for themselves in the HCWM system.
Innovation Champion	Hospitals had internal and external champions who were strong advocates for the system.	None
Implementation Climate	Users perceived that HCWM system was a regular part of the hospital operations and use was expected.	Users perceived that the hospital did not expect doctors to use the system. Use by visitors was not well supported.
Partnerships	The partner provided critical technical assistance for establishing IPPs and advocating for more resources for the system.	None
Innovation-Task Fit	When tasks were difficult the users adjusted IPPs so that innovation-task fit improved over time.	The practice of segregation at source by visitors was problematic.

4.4.7 Expected vs Observed Relationships between Constructs in the Conceptual Framework

Based on the findings from this study, the original conceptual framework was modified to include the six constructs from the original framework by Helfrich et al. and two additional constructs—partnerships and innovation-task fit—that were salient across all study sites (10). The final modified framework presents key determinants of implementation effectiveness for complex innovations in hospitals in low-income, resource-constrained settings (Figure 9).

The relationship between constructs in the modified conceptual framework were analyzed using pattern matching and combinatorial logic to see whether the observed patterns were the same as those hypothesized in the framework.[30] The results are described below.

Figure 9: Modified Conceptual Framework for Implementation Effectiveness



[30] For detailed explanation of this methodology see Chapter 3: Methodology; Section 3.5: Data Analysis

Management Support → Implementation Policies and Practices

The conceptual model hypothesized that strong management support would lead to strong IPPs. The findings from this study did not support this expected relationship between management support and IPPs across all sites.[30] Where management support was strong (Hospital B), IPPs were strong. However, where management support was moderate (Hospitals A and C), IPPs were also strong. A plausible alternative theory that explained this discrepancy in the observed vs. expected relationships was the presence of a strong partner that provided technical assistance to establish and monitor the IPPs. The study results showed that there was a minimum level of management support needed to create the IPPs; in each hospital the management sought out the partnership, provided the resources and appointed a hospital staff member as the HCWM coordinator who could act on behalf of the management and work closely with the partner on development of IPPs. However, sustained heavy management involvement over time was not needed for strong IPPs.

If management support had been weak or absent, the partnership would most likely not have been enough to overcome this, and IPPs would probably also have been weak. This hypothesis could not be confirmed from this study since there were no hospitals with weak management support.

Resource Availability → Implementation Policies and Practices

The conceptual model hypothesized that strong resource availability would lead to strong IPPs. The findings from this study did not support this expected relationship between resource availability and IPPs across all sites unless the construct of partnerships was factored into the model. Where resource availability was strong (Hospital A and B), IPPs were also strong. However, where resource availability was moderate (Hospital C), IPPs were still strong. This was most likely due to the presence of the external partner that provided technical assistance to set up IPPs and monitored the pace of implementation to match the available resources.

Partnerships → Implementation Policies and Practices

Although the original conceptual framework did not include the Partnerships construct, this salient and strong theme was observed across all hospitals. The partner played a critical role in these hospitals in the provision of technical assistance to develop high-quality IPPs. Where the management support and/or resource availability was only moderate, the strong and positive influence from the partnership appears to have helped create strong IPPs. Although each hospital had a unique relationship with the partner, the effect on IPPs seems to have been similar across all sites.

Partnerships → Resource Availability

The partnerships construct also had an observed effect on resource availability. The partner advocated for hospital resources to support the system and assisted the hospitals in establishing the recycling center to generate additional resources. This had an overall positive effect on resource availability in all sites. Although resource availability in Hospital C was only moderate, this was primarily due to the severe constraints on space. The partner reportedly worked closely with the hospital management over a long period of time to identify and advocate for potential areas for waste treatment and storage, so it is likely that without the partner the resource availability would have been weak, or the system might have been adopted much later or not at all.

Partnerships → Implementation Climate

The partnerships construct was strong across all sites and the expected effect on implementation climate (strong) was observed in Hospitals B and C. The partner worked closely with hospital staff in these hospitals for an extended period of time, encouraging compliance, providing support when needed including guidance, on-site training and technical assistance. In Hospital A, the observed moderate implementation climate might have been associated with other constructs such as weak innovation-task fit or moderate innovation-values fit.

Implementation Policies and Practices → Implementation Climate

IPPs were strong across all sites and the expected effect on implementation climate was seen in Hospitals B and C. Although there was some variation on IPPs across these sites, nearly all respondents felt that expectations for system use were clear and supported by the hospital based on the policies and practices that were in place. Since IPPs were not the only construct affecting implementation climate, the expected vs. observed outcomes in Hospital A were different.

Innovation Values Fit → Implementation Climate

The study results supported the expected relationship between innovation-values fit and implementation climate presented in the conceptual framework. Where innovation-values fit was strong, as in Hospitals B and C, implementation climate was strong. Where innovation-values fit was moderate, as in Hospital A, implementation climate was moderate.

Innovation Champion → Implementation Climate

Innovation champions were present and strong in all hospitals. In Hospitals B and C, where there was a powerful combination of both an internal champion and an external champion working together to advocate for use of the system, there was an observed positive effect on implementation climate. In Hospital A, although there was a strong internal champion, the implementation climate was only moderate. This observation also fits the conceptual framework since implementation climate is affected by a number of constructs. An alternative explanation could be that the combination of both an external and internal champion was more powerful and had a greater effect on implementation climate.

Innovation-Task Fit → Implementation Climate

Although the observed effects of innovation-task fit on implementation climate did not exactly align with expected effects, there was some rationale for this at each site. In Hospital A innovation-task fit was weak and implementation climate was moderate. This could be explained by the numerous other constructs that positively affected implementation climate. In Hospital B, innovation-task fit was moderate and implementation climate was strong. This might be due to the nature of the statements from

respondents, who described many difficulties from the first two years of implementation. Many of these problems around task fit have since been resolved so innovation-task fit has now improved. In Hospital C, innovation-task fit was moderate and implementation climate was strong. Similar to Hospital A, this might simply be due to the effect on implementation climate from the other constructs, which were all strong.

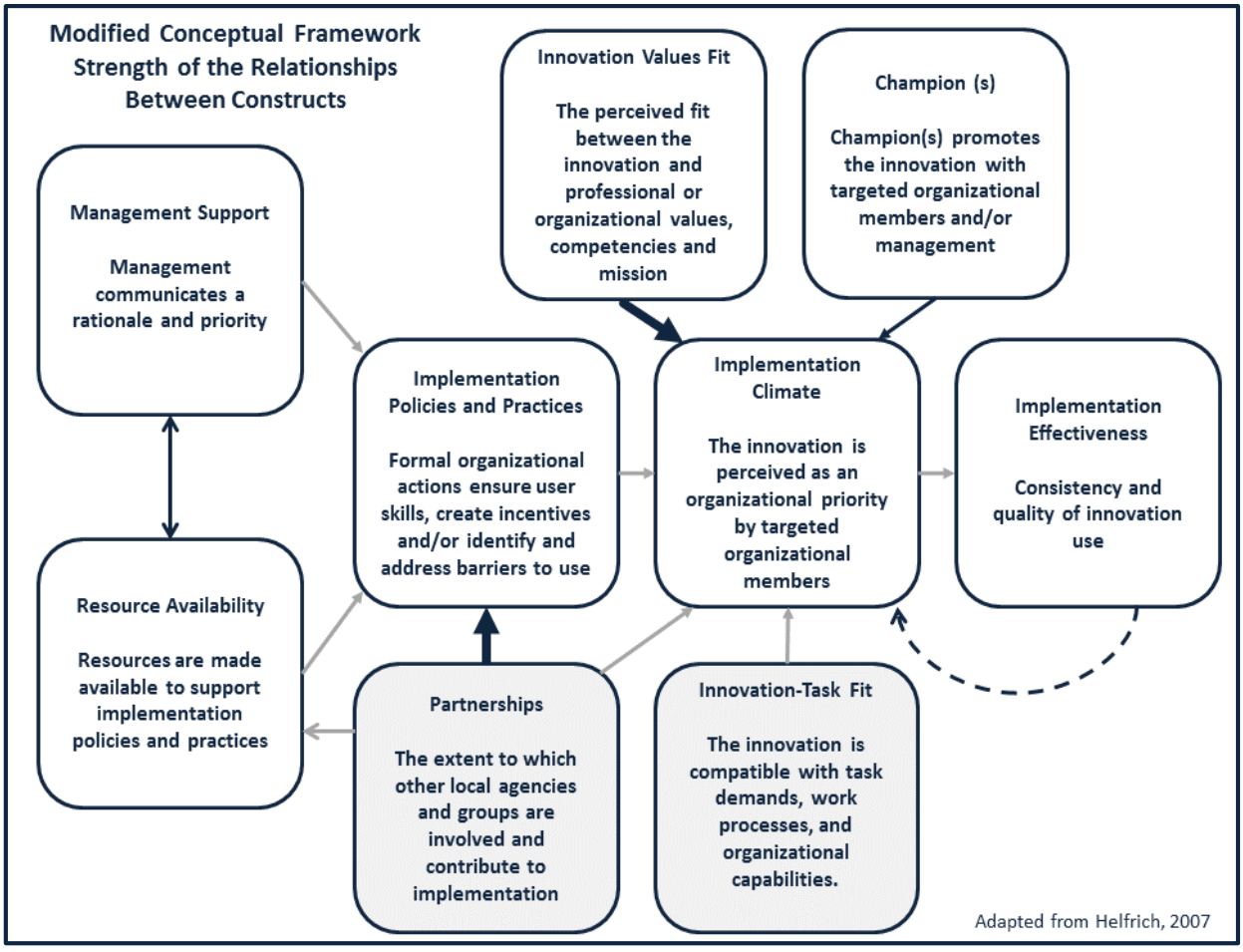
Implementation Climate → Implementation Effectiveness

The expected relationship between implementation climate and implementation effectiveness was observed in Hospital A (where both implementation climate and implementation effectiveness were medium) and Hospital B (where both implementation climate and implementation effectiveness were strong). In Hospital C, this expected relationship was not observed. Although implementation climate was strong, implementation effectiveness was only medium. This could have been due to the short implementation time in Hospital C.

4.4.8 Summary of Results for Modified Conceptual Framework

Figure 10 presents a graphic representation of the observed relationships in this study. The strongest effects (observed in all three case study sites and shown by dark thick arrows in Figure 10) were between 1) the partnerships construct and its effect on IPPs and 2) the innovation-values fit construct and its effect on implementation climate. There were strong relationships observed in two sites between the innovation champion construct and its effect on implementation climate and the bi-directional relationship between the management support and resource availability constructs (shown by dark thin arrows in Figure 10). Finally, the remaining hypothesized relationships were all demonstrated, but to a lesser degree, in at least two case study sites (shown by light thin arrows in Figure 10). Thus, the findings from this study showed the applicability of the modified conceptual framework for use in a low-income country and the relationships between constructs were demonstrated with varying degrees of strength.

Figure 10: Strength of Observed Relationships between Constructs



CHAPTER 5: DISCUSSION

Hospital administrators in Nepal are frequently inundated with multiple demands for resources and forced to make choices between basic critical needs, such as water supply for the hospital versus fuel for the generator when electricity fails. Hospital budgets usually do not cover operational costs and patient loads frequently exceed capacity, especially in government hospitals. In the face of these and other competing organizational priorities, the management of healthcare waste is often overlooked. Most hospital managers and staff of healthcare facilities in Nepal, with limited options for waste treatment and disposal, will revert to whatever system is available to handle waste. This means that most hospital waste is either incinerated, openly burned or dumped untreated into the municipal waste stream. This study has explored whether non-incineration waste management solutions are a viable alternative for hospitals in Nepal and, if so, what administrators and policy makers can do to ensure that hospitals have the support needed for effective implementation of these systems.

This discussion chapter includes four sections: 1) Key Determinants for Implementation Effectiveness based on the primary research questions and the cross-case study analysis; 2) Applicability of the Conceptual Framework and its potential use for studying implementation effectiveness in organizational settings in low-income countries; 3) Limitations of the Study; and 4) Recommendations for Further Research.

5.1 Key Determinants for Implementation Effectiveness

The primary research questions in this study were 1) how do hospitals in resource-constrained settings implement non-incineration HCWM systems; and 2) what are the organizational determinants (facilitating factors and barriers) to effective implementation? Each study site had been implementing the

non-incineration HCWM system for at least one year with varying levels of implementation effectiveness. This section discusses 1) four facilitating factors of implementation effectiveness across all hospitals; 2) one challenge faced by all hospitals; 3) two factors that differentiated between hospitals with high and medium levels of implementation effectiveness; and 4) two factors that varied by type of hospital with no impact on implementation effectiveness. Table 21 presents a summary of the key findings from this study.

Table 21: Summary of Key Study Findings

Key Study Findings
There were four factors that facilitated implementation effectiveness across all sites. • The presence of internal and external innovation champions • A strong partnership with NGO A • Clear and consistent IPPs • A strong fit between HCWM system use and values of primary users (nurses, ward attendants)
There was one barrier to implementation effectiveness across all sites. Hospital visitors did not use the system consistently
There were two factors associated with higher implementation effectiveness. • Longer implementation length • Stronger engagement of top management
There were two factors that varied by type of hospital. All hospitals achieved adequate implementation effectiveness despite this variation. • Resource availability • Motivation for adopting non-incineration HCWM

5.1.1 Facilitating Factors for Implementation Effectiveness

There were four facilitating factors for implementation effectiveness that were salient and strong across all sites: innovation champions; partnerships, IPPs and innovation-values fit for nurses and hospital workers.

Innovation Champions

Innovation champions have been identified in several systematic reviews as a positive influencing factor in innovation implementation in organizational settings (109,118,133). Internal champions, especially those holding positions of authority within the organization, have been shown to play a key role in encouraging implementation and behavior change among staff (113,127).

The findings in this study were consistent with the literature. The presence of champions in each hospital was shown to be a critical factor in implementation success. The internal champions in Hospitals A and C were both appointed to serve as HCWM Coordinators by the hospital management. Although some studies show that appointed champions are usually ineffective, this was not the case in either hospital (121). These internal champions were reportedly enthusiastic about the implementation of the non-incineration HCWM system and both were influential in creating expectations for innovation use and positive change. This is consistent with the findings from one study that showed that formally designated innovation champions were effective in promoting implementation (113). The effectiveness of these internal champions could also have been because these individuals were chosen based on their pre-existing interest in or inclination to support the new HCWM system.

The presence in two of the hospitals of highly-placed innovation champions, an internal person and an external person, deserves mention. This combination of champions strengthened support for the innovation both within and outside of the hospitals and led to a variety of unforeseen benefits. This internal/external combination of champions is worthy of further study to better understand whether and how this relationship enhances implementation effectiveness (Table 23).

Partnerships

The importance of partnerships in the implementation process has been shown in several studies and systematic reviews (106,118,119,134). Partners can bring technical skills, resources, enthusiasm and different perspectives into the implementation process (109). One study showed that partners and resource organizations are strongly associated with effectiveness of organizational practices (135). In low-income countries like Nepal, often new hospital initiatives will necessarily include one or more external funding or technical assistance partners.

Partnerships have been characterized in the literature as external factors outside of the sphere of control of the organization (135). There are, however, cases where the line between the organization and the partner blurs and a partner becomes embedded within the organizational structure. This may occur

more in organizations in resource-constrained settings where technical partners often work in close proximity with organizational counterparts. This type of symbiotic partner relationship was also seen in this study between NGO A and Hospital B. The partner had, in essence, become part of the hospital HCWM system, working side-by-side with hospital staff and maintaining offices at the hospital. While the partner relationship in the other two hospitals did not develop to this degree, the long term partnership in each location was still a critical, if not the most important factor for implementation success. The passion and determination of NGO A and its leader has clearly pushed forward the implementation of non-incineration HCWM in Nepal. Without this partner it is quite likely that HCWM approaches in Nepal might have taken years to advance beyond incineration.

The findings from this study highlight the need to further explore the dynamics of partner-organization relationships, and how and what type of partnerships may affect innovation implementation in resource-constrained settings (Table 23).

Implementation Policies and Practices

Several studies have demonstrated the importance of developing innovation-specific IPPs that are clearly communicated, realistic and result in the perception by users that implementation is expected, supported and rewarded (108). One study found that, more than the specific content of the IPPs, it was "the consistency of practice and the degree to which they reward the use of the innovation" that affects implementation effectiveness (136). The literature also highlights that different combinations of IPPs can have a similar effect on implementation climate (113).

IPPs were found to be a key factor in implementation effectiveness in this study. Strong IPPs were especially important because all hospitals had dual systems of HCWM in place for periods of time and there was high risk of confusion among staff about the hospital priorities and expectations. This confusion was largely avoided with practices such as the use of clear and consistent signage in all wards where the system was in place and hiring separate HCWM staff for waste collection, transport and recycling.

Although the hospital followed WHO and Nepal national guidelines to set up the HCWM system, the practices in each hospital evolved over time to fit the hospital culture and rhythms, available resources and staffing levels (43,137). There were specific practices at all sites that were notable and are included in the recommendations in Chapter 6: Plan for Change (Table 23).

Innovation-Values Fit – Nurses and Hospital Staff

Innovation-values fit can increase users' understanding of the rationale behind the innovation and the potential impact of innovation use (136). The study findings showed strong innovation-values fit among the primary innovation user groups in the hospital: nurses, ward attendants and HCWM staff. The types of values that emerged from the data fell into two broad categories: professional values and community values. Respondents perceived that use of the new HCWM system aligned with their values as healthcare professionals: better patient care, cleaner wards, safer work conditions and improved infection control. Respondents also described how use of the system contributed to the wellbeing of the wider community and that the hospital had a duty to do no harm and manage its own waste.

The study findings also showed weak innovation-values fit for doctors. Since the HCWM system in these hospitals was designed around nurses and ward attendants as primary users and monitors, this did not substantially impact on implementation effectiveness (Table 22).

Table 22: Facilitating Factors for Implementation Effectiveness in All Sites and Implications

Facilitating Factors	Implications
Innovation champions	• Appointed internal innovation champions can be effective in promoting change. • A combination of internal and external champions can be powerful in not just pushing innovation use within the organization but also advocating for recognition of the organization externally.
Partnerships	• Partnerships can play a critical role in achieving implementation effectiveness in resource-constrained settings. • Partners can become an integral part of the organizational structure for innovation implementation.
Implementation Policies and Practices	• Strong IPPs can help avoid confusion when the innovation has not been fully implemented throughout the organization. • IPPs should be allowed to evolve over time to fit the culture and rhythms of the organization.

Facilitating Factors	Implications
Innovation-Values Fit for nurses and hospital workers	• Innovation use can align with the values of users related to different areas, for example, their job, the community and the environment. • Divergent innovation-values fit within an organization may not effect implementation effectiveness if the innovation-values fit of the primary user groups is strong.

5.2.2 Barriers to Implementation Effectiveness

While each hospital had a unique set of barriers to implementation effectiveness, there was one challenge common to all: poor innovation-task fit for waste segregation (Table 23). Staff from all hospitals struggled to enforce segregation of waste at the point of generation by visitors of patients. This included both segregation of risk waste from non-risk waste and further segregation of non-risk waste into plastic, paper and bio-degradable waste. Each hospital dealt with this issue in a different way. The private hospital simply removed all individual waste bins and made it mandatory for visitors to dispose of waste in colored bins in the hall. Although visitors complained, the nurses referred to the government regulations on hospital waste management and the hospital rules, explaining that this was just the system and the staff were required to implement it. The non-profit hospital established the practice of informing visitors at registration in order to avoid confrontations in the ward. In the government hospital the staff learned over time how to effectively use the signage to educate visitors on infection control, recycling and the environment. This reportedly worked well in the wards, but it did not work in the emergency room because the visitor flow was high.

Recommendations for addressing this barrier are included in Chapter 6: Plan for Change.

Table 23: Barriers to Implementation Effectiveness in All Sites and Implications

Barriers	Implications
Innovation-Task Fit for total waste segregation among visitors	• Hospitals that struggle with the concept of total waste segregation may opt to more broadly segregate waste at point of generation into only risk and non-risk waste. • Hospital staff in low-income countries can use the policy of total waste segregation as an opportunity to educate the public (hospital visitors) about waste management, environmental issues and recycling.

5.2.3 Factors Associated with Higher Implementation Effectiveness

The results of this study showed two differentiating factors that partially explained the differences between the high implementation effectiveness achieved in Hospital B and the medium level of implementation effectiveness achieved in Hospitals A and C: 1) length of implementation and 2) management engagement.

Length of Implementation

At the time of this study Hospital B had been implementing the HCWM system for 4.5 years, over twice as long as Hospital A and four times longer than Hospital C. This difference in implementation period was associated with implementation effectiveness based on IRAT scores (the longer the implementation period, the higher the score on the IRAT). The lower scores in Hospitals A and C were mainly due to issues that could be corrected over time (Appendix 6).

The issue of implementation length was also reflected in the interview data from Hospital B. Respondents reported that the first two years of implementation (i.e., the current implementation period of Hospitals A and C) were very difficult. There were no other government hospitals implementing this system at the time so Hospital B was breaking new ground. The staff was comfortable with the status quo and resistant to change. It took about two years to roll the system out to all hospital wards. Implementation reportedly became easier over time as the system evolved, staff became more engaged and implementation problems were slowly addressed. A few respondents from Hospital B reported that they had now reached the point where the HCWM system was institutionalized and part of mandatory hospital operations in the wards.

Despite these findings from Hospital B, the relationship between implementation length and implementation effectiveness was complex and associated with the time of introduction of the innovation, the hospital governance structure and available resources for implementation (as discussed in Section 5.1). For example, although Hospital A had a much shorter implementation length, the management scaled up the system throughout the hospital in just one year and achieved an implementation

effectiveness score that was slightly below 90% (cutoff for high level). There were several reasons that Hospital A may have achieved this level of scale-up and implementation effectiveness more quickly than Hospital B. Hospital B was a much bigger hospital with a large number of staff, limited resources and complicated political relationships. Hospital A had resources and motivation to scale up the HCWM system quickly. Perhaps more importantly, most respondents in Hospital A were also aware that this new model for HCWM was working successfully in Hospital B. A few respondents in Hospital A had toured the facilities in Hospital B and met the HCWM staff there. This existing model, with 2-3 years of lessons learned and best practices to share, may have shortened the length of time that Hospital A needed to achieve full scale up and a medium-high implementation effectiveness score of 88%.

Hospital C also had a relatively high score on the IRAT given only one year of implementation, indicating that all of the critical pieces were in place for the system (although the IRAT score was only for the four wards of the hospital where the innovation was in place). The slow rollout in Hospital C was similar to that in Hospital B and mainly due to restrictions on availability of space. Based on the experience from the other two hospitals, implementation effectiveness in Hospital C should improve over time.

These findings suggest that hospitals with limited resources that adopt this innovation can achieve effective implementation quickly but may experience lengthy scale-up periods for facility-wide coverage. In hospitals that have time-bound incentives to implement quickly (such as external certification processes) and the resources to do so, a high level of implementation effectiveness can be achieved in a relatively short period of time for an entire facility (Table 24).

Management Engagement

Research studies have shown that when an innovation requires employees to work in collaboration, management support becomes a critical factor in implementation success (138). The non-incineration HCWM system is an example of this type of innovation since it has high task interdependence and requires the engagement of multiple levels of staff within the hospital setting.

The management in Hospital B was deeply engaged with and invested in the success of the HCWM system, from idea generation to adoption through four years of implementation. The Hospital Director shaped the implementation context through consistent and clear communication to hospital staff that the innovation was a hospital priority, championing the idea of non-incineration HCWM both within and outside of the hospital. Given the resource and political constraints that government hospitals face in Nepal, this level of management engagement is critical for adoption and implementation of innovations.

In both Hospitals A and C management support during implementation was largely symbolic and there was very little management engagement. Although this was a notable difference between Hospital B and Hospitals A and C, there was no apparent impact on implementation effectiveness in the latter two hospitals, aside from a few comments from hospital staff that they would have liked to see more ongoing visible support from the directors. This might have been due to the presence of strong internal innovation champions on staff at both hospitals. These HCWM Coordinators were appointed by management and in positions of authority over users of the system. Once the top management support was clear and resources dedicated, these coordinators could take over as strong representatives of management.

These findings highlight the complexities of management support and suggest that there is a qualitative difference between management support, which was present in all sites, and management engagement, which was present only in Hospital B (Table 24). In all hospitals, management support was provided for approval to adopt the HCWM system and allocate resources for implementation. This level of basic management support has been shown in multiple studies to be a key factor in implementation success since managers set organizational priorities and control resources within the hospital setting (12,13,113). Management engagement throughout implementation, however, becomes critical in settings where there are special circumstances associated with the innovation—for example, the innovation has not been done elsewhere and the organization is playing a leadership role in pushing forward new ideas; the hospital staff are highly resistance to change; or, the setting is severely resource-constrained and the management must justify continued allocation of resources for the innovation. When conditions are more

conducive to change, engagement of mid-level managers may substitute for engagement of the top management if they have the power and authority to implement change. This finding is consistent with results from other studies where support from mid-level managers was shown to also aid or hinder implementation (108).

Table 24: Differentiating Factors for Levels of Implementation Effectiveness and Implications

Differentiating Factors	Implications
Length of Implementation	• First adopters (hospitals that are introducing a completely new innovation for the country) may experience a long period of resistance to innovation use. • Implementation improves over time as staff members become more adept at innovation use. • If resources are available, complete scale-up and high implementation effectiveness can be achieved in a short period of time, especially if the innovation is familiar to staff (e.g., adopted in other hospitals).
Management Engagement	• Management support is different than management engagement. • Management engagement is critical when the innovation is completely new, staff are resistant to change or the management has to fight for resources for the innovation. • Mid-level managers can substitute for engagement of top management if they have power and authority.

5.2.4 Factors that Varied by Type of Hospital

A multiple, holistic case study design was used to guide an in-depth exploration of how three hospitals in Nepal that operate under severe resource constraints were able to adopt and implement a non-incineration HCWM system. The choice of cases for this study was limited; only three hospitals in Kathmandu met the study criteria for inclusion. Since these hospitals differed by type and governance structure—one private hospital, one government hospital and one non-profit hospital—the initial design included theoretical replication logic, which predicted that these cases might have similar outcomes but for different, theoretically expected reasons (126). In this study, the Principal Investigator expected to see different patterns across cases for at least one critical construct in the conceptual framework: resource availability. The conceptual framework hypothesized that resource availability was important for

innovation implementation through its impact on implementation policies and practices (IPPs) and subsequently implementation climate (127).

The findings somewhat supported predicted differences in resource availability related to the type of hospital. Resource availability was high in the private hospital, moderate in the non-profit hospital[31] and high in the government hospital but mostly with respect to space.[32] Although the findings showed that the varied level of resource availability across hospitals did not impact implementation effectiveness, the differences did have an impact on the length of time needed to achieve full scale-up of the innovation throughout the hospital (discussed in Section 5.2).

In addition to resource availability, the results also showed differences associated with governance structure in the motivation of management to support the innovation (Table 25). These differences in motivation of management were not predicted, but emerged during data collection.

The management in the private hospital was interested in ISO certification to demonstrate high quality standards of care to their clientele; the HCWM system was a necessary part of the ISO certification requirements. This interest in certification is particular to private hospitals in Nepal and was not a motivating factor for the government and non-profit hospitals that serve a much different clientele. The management in the government hospital was primarily interested in building a clean environment and a long-lasting reputation for the hospital as a national leader in HCWM. Although this emphasis on reputation may be a feature of government hospitals, it was more likely related to the particular Hospital Director in place at the time of adoption of the HCWM system. The management in the non-profit hospital was motivated by community service, which was reflected in the mission statement of the NGO that runs this hospital. Adherence to a mission statement is common for NGOs in Nepal. The findings

[31] Although with severe space limitations and funding restrictions

[32] Predicted low and observed low financial resources available; high availability of space and access to equipment

suggest that, although all three hospitals were able to achieve implementation effectiveness, they did so based on very different reasons that were associated with the type of hospital and governance structure.

Although the three hospitals in this study had different governance structures, they were also similar in many ways. All were large tertiary care hospitals located in Kathmandu and facing similar constraints with water and electricity shortages, staff shortages and patient overflow. For this study, literal replication logic might have also been appropriate. However, analyzing the data with respect to difference in governance structure presented interesting findings related to 1) the relationship between availability of resources and the speed and completeness of scale-up and 2) the motivation of management that drove the adoption of the HCWM system. These findings have important implications for the development of recommendations specific to hospital type highlighted in Chapter 6: Plan for Change.

Table 25: Difference in Cases based on Governance Structure

Factor	Hospital A Private	Hospital B Government	Hospital C Non-Profit	Effect on Implementation Effectiveness
Resource Availability	Predicted: High Observed: High Implications: Rapid scale-up of innovation	Predicted: Low Observed: High (space) Implications: Slow scale-up of innovation	Predicted: Low Observed: Moderate Implications: Slow scale-up of innovation	None
Management Support and Motivation	Predicted: n/a Observed: Management support high based on motivation for ISO certification Implications: If ISO certification was required for all private hospitals, this would potentially have a positive impact on HCWM.	Predicted – n/a Observed: Management support high based on personal vision and desire to build the reputation of the hospital in HCWM Implications: Strong leadership in government hospitals is important for innovation implementation	Predicted: n/a Observed: Management support high based on desire to adhere to NGO mission statement Implications: The link between non-incineration HCWM, community and environmental health should be emphasized when introducing this innovation to non-profit NGO-run hospitals that are mission driven.	Strong positive effect in Hospital B

5.2 Applicability of the Conceptual Framework

Implementation of a complex innovation in hospitals can be particularly challenging in resource-constrained settings like Nepal. There are a number of published studies conducted in the United States that have used an implementation science lens to better understand the determinants of innovation implementation in organizational settings and illuminate best practices and challenges (113,127,136). Much less is known about implementation of complex innovations in organizational settings in low-income countries. The findings from this research contributed to filling this gap in the literature by exploring the utility of a conceptual framework for identifying determinants of implementation effectiveness of complex innovations in hospitals in Nepal.

The use of the conceptual framework in this study was helpful in categorizing and clarifying the determinants for implementation effectiveness. The original conceptual framework developed by Helfrich et al. guided the study design and interview guides, and provided insight into how different factors might interact and contribute to implementation effectiveness (127). This was important for understanding the process of innovation implementation. The main findings from this study were largely consistent with the hypothesized constructs and relationships in the conceptual framework, when modified to include partnerships and innovation-task fit (Figure 10). This suggests that the modified framework could be used to guide the planning process for adoption and implementation of HCWM systems in similar hospital settings in Nepal and South Asia. The study findings also provide support for the applicability and utility of the modified conceptual framework for future research on the implementation of complex innovations in organizations in low-income countries like Nepal.

5.3 Limitations of this Study

There were a number of limitations in this research study related to site selection, data collection and data coding/analysis.

5.3.1 Site Selection

The three sites selected for this study were all large tertiary care hospitals located in Kathmandu. As the capital of Nepal, Kathmandu is the most developed city in the country and thus, recommendations from this study may not be applicable to hospitals in other parts of the country, particularly in rural areas where health facilities face a number of human, financial and material resource challenges that differ from those in Kathmandu. In addition, the type of HCWM system that was introduced in these hospitals—non-incineration with onsite treatment of high risk waste— may or may not be appropriate for smaller hospitals or health centers.

The non-incineration HCWM system that was assessed in this study relied on a robust system of recycling services available in the city. Although there are several other cities in Nepal that also offer recycling, these services are not available in most rural areas of the country. Future studies on HCWM in Nepal and South Asia should include a variety of health facilities in rural, urban and semi-urban areas, in towns and cities where recycling is a part of the local economy, as well as in places where it is not available, in order to better understand how critical this component is to the overall system.

Another limitation was the variation of implementation length of the HCWM system at the three sites. One hospital had been implementing the innovation more than twice as long as the other two sites. There were noticeable differences in implementation that respondents attributed to the longer implementation period including task-related problems in the first 1-2 years of implementation that were resolved over time. This suggests that there is a potential period of improvement in implementation that the other two sites may have not yet gone through and that would possibly change the results. As discussed in Section 5.2.1, the variation in implementation length was also a strength of this study as it allowed for a more in-depth analysis of factors that differentiated the hospitals with different levels of implementation effectiveness.

Finally, the low number of sites included in this study was a limitation because the strength of the evidence to support the conceptual framework was dependent on replication across multiple sites.

Although the modified conceptual framework successfully explained the dynamics of introducing and implementing a non-incineration HCWM system in the sites that were studied, the question remains of whether the findings would be similar if hospitals were included in the study that were different sizes or from different geographic regions, and sites that either did not have partnerships or had different types of partners. A larger and more diverse number of sites would have further strengthened the conclusion that the conceptual framework is applicable in a low-income resource-constrained setting. This limitation is an inherent aspect of the case-study research design. It is worth noting that this design also has inherent strengths that other designs do not provide, such as the ability to study a current phenomenon in a real-world context (126). Rich descriptive data collected from multiple sources as part of the case study design can provide a holistic picture of a phenomenon and offer insights that might not be uncovered using other research designs.

5.3.2 Data Collection

Key informant and semi-structured interviews

This study relied heavily on qualitative research methods. Thus, the limitations that are inherent to these methods were also present.

All interviews for this study were conducted by the Principal Investigator and were therefore subject to personal bias. To minimize the bias, the Principal Investigator used a semi-structured questionnaire to guide the interviews and employed active listening skills and open probes to provide respondents the space to share additional information on any specific topic area. All interviews except one were recorded and therefore the Principal Investigator also had the opportunity to review the audiotapes multiple times to better understand the meaning behind the words of the informant.

There was also a potential bias in key informant reporting. The reporting could be dependent on the position that the respondent held in the hospital. For example, staff in low level positions—housekeepers, waste management workers—may not have been as forthcoming due to perceived risks to their job security if they criticized the hospital. People in higher positions, such as Hospital Directors,

Matrons and Wards-in-Charge, may have reported more positively in order to present the hospital in the best possible light. The Principal Investigator was reasonably certain that the reporting was accurate given that 1) the Principal Investigator was not representing any organization and introduced as a university student (and therefore not a threat); 2) there was a balance of positive and negative comments in most interviews; 3) strict confidentiality was ensured at the beginning of each interview, 4) the discussions were held in a private room with nobody present except the respondent and Principal Investigator; and 5) information from interviews was, as much as possible, triangulated with data collected using other methods and data sources and shown to be accurate.

The type of people interviewed for this study was also a potential limitation. Although the Principal Investigator was able to interview a broad range of staff from each site, there may have been selection bias introduced into the process since most respondents were referred by the hospital management. In addition, neither doctors nor patients/visitors were interviewed for this study. This was a limitation given that there were major findings related to these two groups. Respondents reported that both doctors and visitors of patients were not interested in waste segregation and not cooperative in using the system. The views of both groups would be important to understand in a follow up study, particularly for designing future approaches and systems for waste management.

5.3.3 Coding and Analysis

Given the time and resource constraints for this study, all of the data was collected, coded and analyzed by the Principal Investigator alone. This was a significant limitation. A second coder would have strengthened the reliability of the findings as some of the comments were open to interpretation. To minimize this limitation, a codebook was developed and utilized for this study with specific examples of when to and when not to employ a specific code. To prevent bias during analysis, the Principal Investigator discussed the findings with two external experts.

5.4 Recommendations for Further Research

The findings from this study illuminated several areas for further research. Two of these areas are highlighted below.

5.4.1 Cost-benefit Analysis of HCWM

A cost analysis of non-incineration HCWM systems was beyond the scope of this study. Thus, neither cost nor benefits data were collected during this study aside from rough estimates of equipment and other startup costs from key informants and sales records from waste recycling.

There is a paucity of information on cost-benefit analysis of HCWM in the literature. One recent (and rare) study on the benefits and costs of HCWM was from Nepal (139). It showed that hospitals can reach a break-even point and start to realize benefits if the non-incineration HCWM system covers 40% of the hospital beds at 68% occupancy rate. Sensitivity analysis showed that the best case scenario for the lowest number of beds covered to break even on costs and benefits is 40 (with a range of 40 to 152 beds, depending on implementation). This analysis included fixed (installation) and variable (process and activity) costs and did not include societal benefits (139).

There is a need for more cost-benefit analysis research on HCWM systems to provide information for hospital administrators and other decision-makers interested in the economic benefits of various types of HCWM systems. If research shows that non-incineration HCWM is economically beneficial, this information can be used for advocacy with policy makers in Nepal and South Asia for additional allocation of funds to introduce and scale-up non-incineration HCWM and establish regulatory bodies to enforce non-incineration HCWM in hospitals.

5.4.2 Modified Conceptual Framework for Implementation Effectiveness

Based on the findings in this study, the Principal Investigator suggested revisions to the original conceptual framework for implementation effectiveness developed by Helfrich et al. (127). Further research is required to determine whether the modified framework and additional constructs of partnerships and innovation-task fit are relevant to explore innovation implementation in other

organizational settings in low-income countries. Although these constructs were common to all sites in this study, this could have been due to the involvement of the same partner or the similarity in IPPs across sites or to the particular innovation itself.

CHAPTER 6: THE PLAN FOR CHANGE

On April 25, 2015 at 11:56 a.m., a magnitude 7.8 earthquake struck Nepal. The earthquake triggered avalanches and landslides, flattened villages across a number of districts, toppled buildings and temples in Kathmandu, killed more than 8,700 people, injured another 23,000 and displaced close to half a million people (140). Hundreds of aftershocks followed in the ensuing weeks and a second major earthquake occurred on May 12, 2015 that caused even more deaths and widespread panic among an already traumatized population.

The damage to the health sector was devastating. A total of 462 health facilities were completely destroyed and another 745 facilities were partially damaged (140). Major blocks of central hospitals, including the three hospitals in this study, were severely damaged. Plans for demolition and reconstruction in the health sector now stretch out over the next several years with an estimated cost of 100 million US dollars to merely return health system infrastructure to pre-earthquake status (140).

Bed capacity in Hospital B decreased by nearly half after the first earthquake due to major damage in the main building. The hospital staff struggled to move patients into areas of safety and restore the hospital to a functional level. Surprisingly, given the chaos and levels of destruction, the HCWM system was back online within three days of the first earthquake and has remained functional throughout the period of aftershocks. There were similar responses in Hospitals A and C—both hospitals were also badly damaged by the first earthquake, but the HCWM systems in both facilities were quickly back in service.

In addition to implementation effectiveness, another measure of success of an innovation is its sustainability. This concept of sustainability is complex and viewed differently depending on the health program (118). In the case of innovations and organizational change, sustainability has been defined as

"the ongoing delivery of health programs, which may be measured by the longevity of independent projects, or how well programs become institutionalized in organizations or health and social systems" (141). The post-earthquake response in the three hospitals in this study was remarkable in many ways, but of particular note was the prioritization of waste management by hospital staff. It demonstrated the degree to which this innovation has become integrated into hospital operations and, therefore, sustainable. This suggests that non-incineration HCWM is a feasible and ultimately sustainable model for effective waste management in large hospitals in Nepal.

The primary advocates for non-incineration HCWM in Nepal have been the staff members from NGO A that has featured so prominently in this study. This NGO has been on the forefront of the movement to improve hospital waste management for the past five years, largely underfunded, and relying heavily on the passion of its leader and the enthusiasm of a number of young health and environmental science professionals. The findings from this study suggest that further progress in scaling up this innovation across Nepal would require an infusion of funding to expand the availability of technical assistance (possibly beyond NGO A) and adequately compensate NGO staff for the time and effort that would be needed to move forward.[33]

This final chapter presents a plan for change specific to Nepal that includes two goals: 1) Expand non-incineration HCWM to all large hospitals (>100 beds) in Nepal and 2) Strengthen the Nepal government regulatory framework for monitoring HCWM. The ultimate aim of this plan is the sustainable integration of non-incineration HCWM in all hospitals throughout the country. This chapter includes three sections. The first section presents each goal in the plan for change. The second section outlines a step-by-step process to achieve these goals in Nepal. The last section is a brief discussion on ways to use this change to further catalyze the spread of non-incineration HCWM in other countries in South Asia.

[33] The issue of funding is discussed in section 6.2

6.1 Plan for Change in Nepal: The Goals

6.1.1 Goal 1: Expand Non-incineration HCWM to all Large Hospitals in Nepal

In addition to the three hospitals in this study, there are now several other hospitals in Nepal that have either adopted non-incineration HCWM systems or have expressed interest in using non-incineration technology to manage their waste (93,94,142,143). Since funding and technical assistance for HCWM is currently limited and there are already hospitals that are ready for change (early adopters), a two-phased approach is recommended to achieve this goal. The first phase would focus on early adopters with the assumption that these hospitals will have high organizational readiness for change and strong management support, two factors that were shown in this study to positively affect implementation effectiveness. This would help maintain steady forward progress over the next year that should gain momentum through diffusion of the innovation as potential adopters seek advice and information from early adopters (107). Once there are at least ten hospitals successfully implementing the system, the second phase would involve active promotion of non-incineration HCWM to all large hospitals in the country.

Focus on Early Adopters

In addition to the hospitals in this study, there are at least four hospitals in Kathmandu that have now completed the I-RAT survey with assistance from NGO A. These hospitals have strong management support and an expressed willingness to dedicate resources towards establishing a non-incineration HCWM system, potentially including funds to engage a technical partner for training, establishing implementation policies and practices and monitoring. Based on the findings from this case study research, a set of recommendations and key messages were developed that can be shared with NGO A and the directors of these hospitals as they launch new HCWM systems and begin implementation (Table 26).

Table 26: Study Findings, General Recommendations and Key Messages

Study Findings	General Recommendations	Key Messages for Hospital Directors
Resource availability for HCWM affected the pace of scale up but not implementation effectiveness	Hospitals with adequate resources should implement the HCWM system throughout the entire hospital at a pace that ensures effective implementation. Hospitals with limited resources can start small and scale up slowly.	You can get started now and scale up according to resources • If resources are limited, get started in one ward. • The HCWM system can be scaled up rapidly or slowly depending on resources. • The new HCWM system can run parallel to the old system if necessary provided that strong IPPs are in place.
Motivation for adopting non-incineration HCWM varied by type of hospital.	When presenting the HCWM system to hospital administrators and management teams, tailor messages about the benefits of the system (and the cost of not adopting it) based on the type of hospital and the potential motivating factors for that hospital.	There are many reasons to adopt non-incineration HCWM • Showcases your hospital as a leader in environmental change • Provides economic benefits for the hospital; • Supports accreditation / ISO certification requirements; • Complies with government guidelines on HCWM and international standards; • Follows the Do No Harm principle; • Improves infection control for patients, staff and the community; • Provides safer working conditions for hospital staff; • Provides cleaner hospital environment for everyone.
Implementation effectiveness increases with duration of implementation.	Hospital leaders should set reasonable expectations about how long it will take to reach a high level of implementation effectiveness. It could take months or, more likely, years to achieve.	Implementation gets stronger over time • Hospital staff will need time to get used to the new system and adjust practices to fit the hospital culture. • Use staff resistance as a resource to get feedback and improve the system. • Measures of implementation effectiveness will improve over time with strong implementation policies and practices.

Study Findings	General Recommendations	Key Messages for Hospital Directors
Management engagement was associated with high implementation effectiveness and mid-level managers played an important role in supporting the system.	Hospital management should stay engaged during implementation of the HCWM system and involve mid-level managers in supporting the process.	Take the lead and stay engaged • Hospital leaders should remain engaged throughout the first year of implementation, especially if staff are resistant to the change or if the hospital is the first in the district/town to introduce the system and will serve as a model site. • Leaders must communicate to staff that HCWM is a high priority for the hospital. • Mid-level managers play a critical role in HCWM system implementation and can be effective champions.
Strong internal and external innovation champions were critical for pushing the HCWM system forward.	Hospital management should find or appoint one or two champions for the system who can lead the effort to implement the HCWM system.	Your hospital needs HCWM Champions • Appoint HCWM coordinators to oversee the system; if they are already strongly aligned with environmental causes and intrinsically motivated they will become champions of the system. • Bring in external champions to work with internal champions during design if the system and early implementation.
A strong external technical partner was key to innovation success.	Hospitals should explore possible partnerships for technical assistance to establish and implement this innovation.	Form partnerships and join coalitions and networks • There are partners in Nepal who can assist with designing and establishing the system in the hospital. • Join international networks and become part of a global movement towards eliminating incineration.
Strong, clear implementation policies and practices were critical for success	Hospital management should ensure that plans and infrastructure are in place to effectively run the HCWM system; it is better to start small with the critical structures in place than to roll out quickly without the proper support.	Put in place strong policies, plans and structures to guide implementation of the system • Seek expert technical guidance to train hospital staff, develop strong implementation policies and practices, and conduct long-term onsite joint monitoring that includes both hospital staff and technical experts. • Use the tools that are already available to assess the current hospital system (e.g., I-RAT). • Take staff on tours to the hospitals that are already successfully implementing non-incineration HCWM systems.

Study Findings	General Recommendations	Key Messages for Hospital Directors
A strong fit was seen between HCWM system use and values of primary users (nurses, ward attendants)	Hospital management should acknowledge the close alignment of the HCWM system with values such as Do No Harm, care for the environment, and quality patient care, that are important to nurses, housekeeping staff and ward attendants	Openly discuss with staff how the new HCWM system fits in with the values of the hospital • Draw connections between values that are important to hospital staff and the use of the HCWM system, such as infection control, clean environment, quality patient care, community service.
It was difficult to convince hospital visitors to use the system (hospitals used a variety of techniques to improve compliance)	Hospitals should try a variety of strategies to increase segregation of non-risk waste at the point of generation with visitors. Hospitals also have the option of making this voluntary instead of mandatory, especially in places of high volume traffic such as emergency wards.	There are many ways to increase waste segregation among visitors • Develop strategic and effective communication methods to educate hospital visitors about the importance of a clean hospital environment for patient care. • Offer visitors a tour of the system; explain the importance of their role in the system and introduce them to the HCWM workers.

Actively promote non-incineration HCWM to all large hospitals in Nepal

The second phase involves actively promoting non-incineration waste management to the administrators of all large hospitals in Nepal that do not have proper waste management. There are approximately 50 large hospitals in Nepal (144,145). A 2013 Nepal hospital census report showed that large non-government (private, community, cooperative) hospitals currently pay an average of US$700 per month to manage their waste (144). Out of the 25 large hospitals included in the census, 24 reported that they segregated risk and non-risk waste at source, 18 reported that the staff had already received training in waste management with a total of nearly 250 staff designated as waste management workers across all large hospitals, and most reported using incineration, open burning, dumping or the municipal landfill to dispose of the waste. These data were self-reported and there were no observations or site visits conducted. There was no similar study done for public hospitals.

There are a number of possible venues in Nepal to promote non-incineration HCWM. These include hospital management conferences, round tables, meetings and hospital site visits. Highlighting

hospitals that are successfully implementing non-incineration HCWM systems through local media outlets and social media sites can also be an effective method in Nepal for promoting change as well as arranging tours for hospital administrators to hospitals that are successfully implementing the new system including the three hospitals in this study.

As hospital administrators show interest in adopting the system and with additional funds for technical support, the rollout of non-incineration HCWM can continue until all large hospitals have implemented the system.

6.1.2 Goal 2: Strengthen the Regulatory Framework for HCWM in Hospitals in Nepal

The results of this study suggest that compliance with government regulations is a motivating factor for some hospitals to improve HCWM practices. However, since the country passed the Solid Waste Management Act (2011), there has been little to no forward movement on establishing a functional regulatory body to monitor adherence to HCWM guidelines at the national level (40,41,43,50,51). This is not unusual; disparity between policy intention and implementation is common (146). In a low-income country like Nepal, the decision to strictly regulate HCWM throughout the country would have serious implications and would raise questions regarding feasibility. Even under normal circumstances, the cost of regulatory monitoring may be prohibitive given Nepal's geographic challenges and the shortage of human resources in the public health sector. These problems were exacerbated by the earthquakes in April and May 2015. In addition, enforcing fines or even closure of hospitals for non-compliance with HCWM regulations could result in negative health outcomes given the already low access to health care in Nepal. Thus, while strengthening the regulatory framework and enforcement mechanisms for proper HCWM is important, it will require compromise and the development of a sound process that does not overwhelm or undermine the public health system and takes into consideration the current trend towards voluntary adoption of new technologies for waste management in large hospitals in Nepal.

Over the past several years the problem of HCWM has repeatedly been raised in the Joint Annual Review (JAR) of the Nepal Health Sector Programme (NHSP) II (2010-2015). Each review has included

a set of actions for HCWM, usually with unrealistic deadlines (Appendix 2). For example, the February 2015 JAR recommendations called for roll out of the HCWM guidelines to 1000 public and private facilities by the end of September 2015 (41). It is unclear whether this meant simply disseminating the guidelines to health facility managers or full implementation of the guidelines in these facilities. If the latter, given the findings in this study about the length of time and effort it takes to effectively implement a non-incineration HCWM system in a hospital, this recommendation is clearly not feasible. In any case, the JAR recommendations will almost certainly be delayed or not implemented at all while attention is diverted to earthquake recovery. This presents an opportunity for HCWM leaders to advocate with MoHP officials for an easier, more practical and sustainable approach for the improvement of HCWM. This should include the formation of a functional regulatory body for HCWM under the Department of Health Services as part of the next Nepal Health Sector Programme (NHSP) III (2015-2020). This regulatory body could plan for a slow but steady scale-up of regulatory monitoring beginning in 2016 with the goal of complete oversight of all large hospitals by 2020. This approach would be a compromise between the ultimate long-term goal of a strict regulatory framework and the status quo, which essentially consists of no regulatory body and no formal consistent monitoring. Table 27 presents recommendations for the initial two years of the scale-up plan.

Table 27: Example of Regulatory Goals and Recommended Interim Measures for Two Years

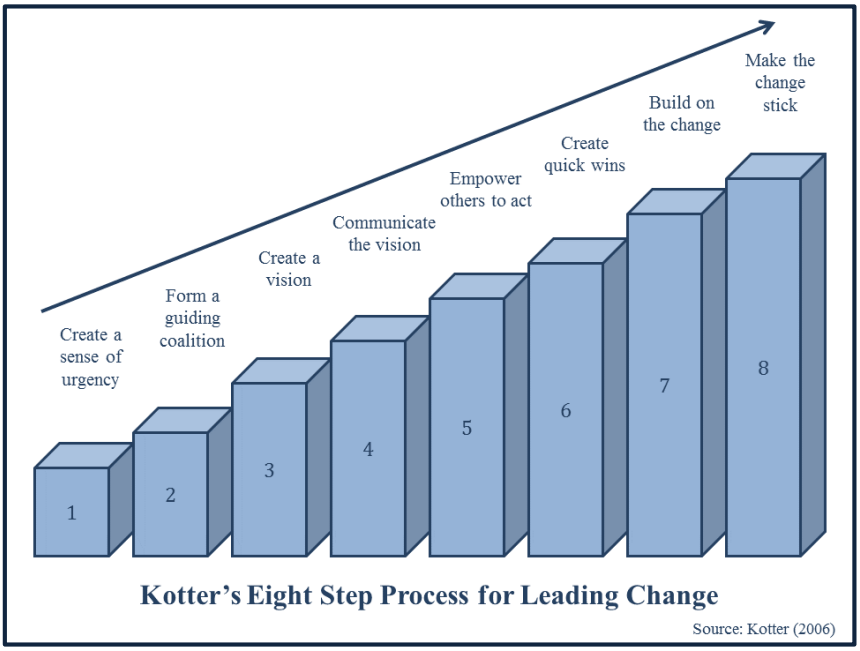
Regulatory Goal (Long Term)	Recommendations on Interim Regulatory Measures Initial Two-Year Phase (2016-2018)
Form regulatory body with full enforcement power	Form regulatory body with partial enforcement power for the first two years. Examples of partial power include the following: • The regulatory body has the power to inspect HCWM systems in hospitals but does not have the power to close hospitals. • The regulatory body does not have the power to fine or close small hospitals <50 beds. • The regulatory body has the power to request that a hospital have a waste management assessment and report scores but does not have the power to impose fines for low scores.

Regulatory Goal (Long Term)	Recommendations on Interim Regulatory Measures Initial Two-Year Phase (2016-2018)
Develop regulations in accordance with the HCWM guidelines and Solid Waste Management Act (2011)	Develop interim regulations for the first two years that consider available government human resources and the burden on some hospitals due to earthquake recovery. Examples include the following: • Restrict monitoring for the first two years to large hospitals only. • Include technical experts on monitoring visits to advise hospitals on ways to improve their systems during earthquake recovery.
Create enforcement instruments for implementation of regulations	Consider options for enforcement. Examples include the following: • Create limited enforcement instruments for the first two years. • Do not use punitive enforcement instruments (fines, disposal fees based on risk waste generated). • Use only incentive-based instruments (subsidies, soft loans for modern equipment; Value-Added Tax exemption, awards and certifications). • Publish reports on the government website or in the local media on the state of HCWM in hospitals.
Conduct training for regulatory monitors.	Lobby with donor agencies to fund training for the first two years for monitors and technical experts from local NGOs or WHO.
Conduct monitoring for all health facilities in Nepal.	Scale up monitoring over time. For first two years, consider the following: • Monitor only large hospitals (>100 beds). • Set up monitoring schedule based on availability of human resources • Set up a system of citizen monitoring that allows citizens to file complaints to the regulatory body about incidents of waste dumping or burning; take immediate action to correct the problem. • Ensure that government monitors have access to technical experts who can provide advice to hospitals for quality improvement of systems.

6.2 Plan for Change in Nepal: The Process

The plan to meet the goals described in Section 6.1 is presented below as a step-by-step process based on a widely-used and effective change model: Kotter's Eight Step Process for Leading Change (Figure 11) (147). This model presents a clear and rational approach that can be used to guide the process of change, avoid pitfalls and maintain momentum over the years that it will likely take for this transformation.

Figure 11: Kotter's Eight Step Process for Leading Change



Step 1: Create a Sense of Urgency

In light of the recent earthquakes in Nepal, this may seem a highly inopportune time to try and create a sense of urgency about HCWM—normally a low priority topic—with already overwhelmed hospital administrators and government officials focused on recovery efforts. Although, "without urgency, difficult change becomes far less likely", it is also counterproductive if people feel too much distress (148). However, given that it has taken years in some cases for hospitals, even early adopters, to move from the initial assessment of the HCWM system to adoption, and then from adoption to implementation, a sense of urgency may provide the needed impetus to accelerate this process. This is especially relevant for hospital administrators who are willing to start but have a number of other priorities that continue to push HCWM to the bottom of or even completely off the agenda.

Creating a sense of urgency simply means showing others that immediate change is necessary and possible. Necessity can be shown by announcing the intention of the government to form a regulatory body within the next year. Possibility can be demonstrated through sharing stories of successful implementation with hospital administrators and engaging the government (preferably the prime minister) and media to ensure these successes are nationally recognized. Early and potential adopters will likely need information, resources (from the hospital or outside source) and technical assistance to move forward. To ensure that information is available, a packet of information on HCWM in Nepal could be prepared and disseminated to hospital administrators[34]. This packet can also be distributed to potential funders to generate interest in HCWM. Many of the funding agencies now have environmental compliance policies that require proper disposal of medical waste for any health facilities where they provide funding. The packet might include, for example, the findings and recommendations from this study; a recently published cost-benefit study from Nepal on non-incineration HCWM systems; case study write-ups of HCWM success stories from Nepal[35]; and a fact sheet[36] advocating for regulation of HCWM in Nepal (139,142,143).

Step 2: Form a Guiding Coalition

The findings from this study have highlighted the power of partnerships to guide implementation and sustain changes in HCWM practices in the hospital setting. This step builds on this finding by expanding the partnership into a strong coalition of people with a shared commitment, technical knowledge and the power to influence change. The MoHP has a number of programmatic and technical

[34] The development of this packet must be done through a coalition of partners (see Step 2). Most of the documents have already been prepared.

[35] The Principal Investigator will share the individual case study findings from this research with directors from the three participating hospitals and seek permission to write success story briefs. There are also two previous case studies already published on the internet.

[36] See Appendix 7 for example of advocacy fact sheet.

working groups; thus, one possibility is that the coalition is expanded and established as a formal working group under the Department of Health Services. This working group would necessarily include key officials from the Department of Health Services in addition to WHO representatives, staff from NGO A, hospital directors that have adopted or intend to adopt non-incineration HCWM, donor agencies with a health portfolio such as USAID and the World Bank, international NGOs such as Health Care Without Harm and FHI 360, and private sector partners such as the company, Waste Recyclers[37]. In addition, the internal champions for HCWM identified in this study could also be invited to provide advice on what works well and what does not work well in setting up HCWM systems, what type of regulatory monitoring would be helpful and what type of monitoring might be detrimental from the point of view of hospital staff.

Step 3: Create a Vision

Creating a clear vision will be a particularly important task for the coalition of partners (working group). This may be a simple statement that aligns with global statements about HCWM, such as the elimination of incineration in all hospitals in Nepal by 2020. The vision might include creating mercury-free health facilities across the country. Creating the vision should be an iterative process to capture views from within the coalition/working group and beyond. Although the non-incineration HCWM models highlighted in this study may not be generalizable to the whole country or for smaller hospitals, they do provide tangible evidence of success for large hospitals and can be used to create this future vision.

Step 4: Communicate the Vision

Communicating a vision requires translating how the vision would work in practice and communicating this to others in a clear and compelling way. For example, if the vision was to eliminate incineration in all hospitals, a powerful way to communicate that would be demonstrating a well-

[37] This company has entered into a public-private partnership with Western Regional Hospital in Pokhara, Nepal for non-incineration HCWM.

functioning non-incineration HCWM system in Nepal. Fortunately, as shown in this study, three successful models already exist in Kathmandu. These facilities have hosted numerous tours of the waste treatment facilities to national and international groups and can continue to do so. If the vision extends to a functioning regulatory system, there is an active example in neighboring India—the Central and State Pollution Control Boards that regulate medical waste. Although this system has resource limitations and inadequate coverage, Nepal MoHP officials tasked with regulatory oversight could meet with their counterparts in India to better understand what works well and what does not work well for regulatory monitoring, given that India faces some of the same health sector challenges as Nepal.

Step 5: Empower Others to Act

To adopt this innovation in a hospital, the hospital director must have the power to act. As this study reported, the director will need the approval of the entity that governs the hospital (usually a Board of Directors) to launch a new program or system. The Board of Directors will likely request information about the HCWM system including anticipated costs and benefits to the hospital. Although this information will be included in the information packet prepared for the hospital director, the board of directors may want data specific to their own hospital, which would require additional research.

Removing obstacles to establishing a functional regulatory body for HCWM is more difficult. There is a chronic shortage of staff, time, resources and technical knowledge in the Nepal public health sector that will create challenges and impact regulatory functions under the DoHS. Inviting funders to the coalition/working group may alleviate some of the constraints around resources, but only the government will be able to effectively empower government staff to monitor and report on HCWM by explicitly including it in job tasks and compensating staff for conducting monitoring visits.

Step 6: Create Quick Wins

There are multiple ways to create quick and tangible HCWM wins. The coalition / working group should set a series of goals and benchmarks for the first year, track these over time, and celebrate each success publicly through a government website or, if appropriate, social media sites and the local media.

This would create positive momentum among the hospital community and reinforce the authority of the regulatory body. Quick wins could be simple and include, for example, the formation of the regulatory body, the start of regulatory monitoring, adoption of the non-incineration HCWM system in a hospital, or the acceptance of a hospital into the Global Green and Healthy Hospitals network.

Step 7: Build on the Change

Although the focus of this plan for change is on large hospitals, if the innovation spreads rapidly these hospitals will all have adopted non-incineration HCWM within 3-4 years. Once all large hospitals—the primary generators of healthcare waste in Nepal—have strong systems for managing healthcare waste, the focus of technical assistance can shift to hospitals with less than 100 beds. There are hundreds of these hospitals, many with 15 beds or less (144). It is unlikely that most small hospitals can manage waste treatment onsite and options for offsite centralized waste treatment and recycling plants should be explored.

There is also currently donor interest in assessing rural HCWM. NGO A has recently conducted HCWM assessments in rural health posts as part of earthquake recovery efforts although the targeted number of facilities is small and the work is limited to certain geographic locations.

Step 8: Make the Change Stick

The ultimate goal of this plan for change is to support the establishment of sustainable non-incineration HCWM systems that have been fully integrated into hospital operations. In the public sector, changes are most effective when they are institutionalized through policy, legal and regulatory frameworks (149). Eventually, the interim regulatory measures should be strengthened into a strong regulatory framework for HCWM that monitors the waste management practices of all healthcare facilities in the country.

Table 28 provides a summary of the plan for change process including recommended actions for each goal and measures of success.

Table 28: Summary Roadmap for the Plan for Change

#	Step	Recommended Actions		Measures of Success
		Expand HCWM	Regulate HCWM	
1	Create a sense of urgency	• Prepare packet of information for early/potential adopters • Recognize successful hospitals • Generate interest with funders	Develop fact sheet to advocate for stronger government regulation of HCWM	• Packets and success stories for donors and hospitals prepared and distributed • Prime Minister engaged and successful hospitals publicly lauded
2	Form a guiding coalition	Find partners with passion for HCWM and include in the coalition / working group	Include government officials and those with regulatory authority in the coalition	• Working group under DoHS formed • Multiple partners engaged
3	Create a vision	Check global statements about HCWM and consider broad visions (no incineration, mercury-free, etc.)	Consider how regulation will contribute to the vision	Shared vision among group is agreed
4	Communicate the vision	Provide tours for hospital administrators and government officials to model sites	Arrange visits to places with strong regulatory oversight (India)	• Model sites visited • Regulatory officials for HCWM from other countries visited
5	Empower others to act	Present information to the hospital Board of Directors for approval	Remove obstacles for monitors (for example, secure funds for training)	• Hospital directors empowered to act • Regulatory monitors empowered to work
6	Create quick wins	• Decide on feasible quick wins • Announce hospitals that adopt the system or join GGHH network	• Set achievable goals and benchmarks • Track achievements	Benchmarks met and goals achieved and announced
7	Build on the change	Explore options for waste management for small hospitals and healthcare posts in rural areas	Regulate central healthcare waste treatment facilities	• Non-incineration HCWM systems established at all large hospitals • Technical assistance provided to other health facilities on HCWM
8	Make the change stick	Ensure HCWM systems are sustainable at all sites through strong IPPs	Strengthen regulatory mechanisms	• Strong functioning regulatory body in place. • All healthcare facilities monitored.

6.3 Catalyzing the Spread of Non-incineration HCWM beyond Nepal

Although this study was not designed for its findings to be generalized outside of Nepal, there were three observations that suggest that the findings and recommendations could be used to contribute to improving HCWM systems in the South Asia region and beyond.

The first observation is that there has been clear interest outside of Nepal in how the three hospitals in this study have been able to successfully implement this innovation. Document review in one hospital showed multiple delegations of government officials and hospital administrators from different countries—India, Bangladesh, Bhutan, Ghana, Timor Leste—have visited the hospital and toured the waste treatment facility. These delegations were interested in establishing similar systems and a few countries requested technical assistance from NGO A staff for this work. The set of recommendations and key messages from this study could be shared with all visiting delegations as part of a package of materials (Table 26), effectively promoting Nepal as a leader among nations to drive this change in the management of healthcare waste.

The second observation is that there is a growing interest both within and outside of Nepal in the environmental impact from the healthcare industry. A reflection of this interest is the Global Green and Healthy Hospitals (GGHH) Network, a worldwide network of hospitals, healthcare facilities, health systems and organizations that now includes representation from over 12,500 hospitals. There are currently six hospitals in Nepal that have joined the GGHH Network. NGO A is a founding member of the Network (56). The Network is interested in promoting greater sustainability and environmental health in the health sector and regularly publishes case studies of members to share best practices and solutions to challenges in a variety of areas including waste management. The Principal Investigator will seek immediate permission from the three hospitals in this study to submit case study briefs to the GGHH Network website to consider for publication (142,143). Each case study will highlight the successful implementation of the HCWM system from that particular hospital.

Finally, although this research was focused on organizations and systems, there were clear examples that emerged throughout the study on the power of strong leadership. The most notable example was in Hospital B, where two charismatic and passionate leaders joined together five years ago to start a movement for change in hospital waste management approaches in Nepal. Given the state of the waste management system in that hospital at the time, in addition to the politics, resource constraints and general operating environment in the country, health management experts may have rated the chances of success very low. However, as Colin Powell stated, "Leadership is the art of accomplishing more than the science of management says is possible" (150). Further case study research in Nepal on the art of leadership in HCWM may provide valuable insights that could further catalyze the spread of this innovation in hospitals outside of Nepal and contribute to reducing the environmental impact of the global healthcare industry.

APPENDIX 1: HEALTHCARE WASTE TERMS AND DEFINITIONS

Term	Definition (63)
Healthcare facility	Hospitals, medical and dental clinics, laboratories, medical research facilities, blood banks, veterinary hospitals/clinics, mortuaries, physician's offices, pharmacies and laboratories.
Healthcare waste	(also referred to as Medical Waste) All waste generated at healthcare facilities.
Non-risk general healthcare waste	Waste that is non-hazardous and similar to regular domestic waste. Approximately 75-90% of all healthcare waste.
Hazardous waste	Waste that is potentially harmful to human health and the environment. Approximately 10-25% of all healthcare waste and includes infectious waste, toxic waste and sharps.
Infectious waste	Hazardous waste with infectious characteristics (includes pathological and anatomical waste). Approximately 15% of healthcare waste. Examples include waste contaminated with blood and its by-products, cultures and stocks of infectious agents, waste from patients in isolation wards, discarded diagnostic samples containing blood and body fluids, infected animals from laboratories, tissues, organs, body parts, human fetuses, and contaminated materials (swabs, bandages) and equipment (such as disposable medical devices).
Toxic waste	Hazardous waste with toxic characteristics (includes pharmaceuticals, radioactive waste, heavy metals). Approximately 3% of healthcare waste. Examples include highly hazardous mutagenic, teratogenic or carcinogenic drugs such as those used in cancer treatments, containers that held radioactive materials, and heavy metals such as broken mercury thermometers.
Sharps	Items that can cause punctures or wounds. Approximately 1% of healthcare waste. Examples include needles, scalpels, syringes, blades and broken glass. Often contaminated with blood and therefore infectious.

APPENDIX 2: NATIONAL PROGRESS ON HCWM IN NEPAL (1996-PRESENT)

Dates	Event	Details and Recommended Actions
Oct 1996	Basel Convention	Nepal became a signatory to the Basel Convention
Dec 1997	National Workshop on Hospital Waste Management	The outcome of the workshop was a set of recommendations that included: • Implementation of legislation for HCWM; • The establishment of cooperative waste treatment facilities; • The development of national guidelines and a training program.
Jan 2002	Document development	Nepal Health Research Council developed two HCWM documents: • National Health Care Waste Management Guidelines; • Training Manual for Medical Professionals.
Apr 2002	Stockholm Convention	• Nepal became a signatory to the Stockholm Convention • Nepal drafted legislation for regulation of healthcare waste; submitted to Parliament but never enacted.
2003	World Bank Study	World Bank commissioned study on HCWM that found extremely poor practices in HCWM but results were questioned.
Mar 2007	Stockholm Convention	Nepal ratified the Stockholm Convention
Jan 2012	Joint Annual Review (JAR) of the Nepal Health Sector Program (NHSP) II (2010-15)	JAR 2012 Findings The situation with HCWM in Nepal continued to pose a hazard to human and environmental health. Recommended actions from JAR 2012 (To be completed by mid-March 2012): • Print and distribute the Environmental Health Impact Assessment (EHIA) Plan to healthcare facilities and measure compliance; • Assess the situation of healthcare waste, including placenta pits, at different health facilities; and • Develop a strategy for healthcare waste management based on geographical locations and volume of waste generated at different facilities.
May 2012	Legislation	Nepal passed the Solid Waste Management Act 2011 that included medical waste; translated to English in Aug 2012

Dates	Event	Details and Recommended Actions
Sep-Dec 2012	Midterm Review (MTR) of NHSP II	MTR Findings: • Nepal does not have a focused regulatory framework for HCWM but the Department of Health Services (DoHS) has prepared HCWM Guidelines and an Orientation Manual. The MoHP and DoHS agreed that this activity has been extremely delayed and assured the World Bank mission that a detailed Action Plan will be ready by end August (2013) in time for discussions during the MTR. The MTR was not made aware of any Action Plan. • Lack of institutional integration of HCWM in health offices and enforcement of rules are a risk to effective waste management. • Incinerators at healthcare facilities are not present or not adequately managed, creating a risk for staff and environment. • Improper healthcare waste disposal creates an immediate risk for population and environment near health facilities. Recommended actions from MTR: • Include objectives, targets and budgets in the annual work plan budget to improve HCWM at facilities at all levels. • In the short-term, agree on budget and minimum criteria to contract out healthcare waste disposal to private sector. • Scale up district decentralization in a few pilot sites focused on establishing equitable, quality health services through a basket fund that, among other things, would fund improved waste management and facility maintenance.
January 2013	2013 Joint Annual Review of NHSP II - shared MTR Report	JAR Findings • Recommendation #1 from JAR 2012 completed; • Recommendations #2 and #3 from JAR 2012 not completed; • HCWM activities conducted in Western Regional Hospital in Pokhara and Bir Hospital in Kathmandu; • MoHP assigned the Department of Health Services, Management Division, as the focal unit for HCWM for all hospitals and health facilities, under the policy guidance of the Curative Care Division of the MoHP Recommended actions from JAR 2013 • Scale up Bir Hospital model in other zonal and regional hospitals by April 2013 • Present to the January 2014 JAR the progress on compliance of HCWM guidelines and feasibility to scale up.

Dates	Event	Details and Recommended Actions
January 2014	2014 Joint Annual Review of the NHSP II	JAR 2014 Findings • MoHP implemented the HCWM model from Bir Hospital and Western Regional Hospital in four other hospitals—Koshi, Janakpur, Bheri, Seti—as per the recommendation of JAR 2013. • MoHP assigned the Management Division/DoHS as the focal unit for HCWM for all districts and lower level health facilities • MoHP assigned the Curative Health Division/MoHP as the focal unit for all health facilities above district hospitals. • Last year's JAR had recommended that compliance on National HCWM Guidelines be assessed but not much progress was made. The new national HCWM guidelines were drafted but had not yet been endorsed. Recommended actions from JAR 2014 (to be completed by Sep 2014) • MoHP extend the Bir Hospital model of HCWM to two additional hospitals. • Assess the compliance to the National HCWM Guidelines in public and private health facilities.
January 2015	Joint Annual Review of the NHSP II and drafting of NHSP III (2015-20)	JAR 2015 Findings • The HCWM guidelines were revised and are now consistent with international standards. • The orientation and trainings were provided to concerned health officials on HCWM including on-site coaching for hospital in-charges and nurses • Separate budget allocations were made specifically for HCWM by zonal and regional hospitals. For other hospitals, resources were allocated under MoHP's district strengthening program, thus ensuring budget for all 75 districts for this purpose. Recommended actions from JAR 2015 Roll out the guidelines to 1000 public and private health facilities by the end of September 2015.

APPENDIX 3: DEFINITIONS OF KEY CONSTRUCTS

Conceptual Definition	Operational Definition
Implementation is "a specified set of activities designed to put into practice an activity or program of known dimensions." (106)	The specified set of activities designed to put into practice a functioning, non-incineration healthcare waste management system
Complex Innovation is "an idea, practice or technology that is perceived as new by the adopter and that requires active coordinated use by multiple members to achieve organizational benefits." (11,127)	A non-incineration healthcare waste management system, implemented for the first time in a hospital, that includes waste minimization, segregation, handling, treatment and disposal (including recycling)
Implementation Effectiveness is the overall pooled or aggregate consistency and quality of innovation use (11)	The consistency and quality with which the hospital implements non-incineration HCWM systems measured using the Individualized Rapid Assessment Tool.
Management Support is the commitment of managers to stand behind the change effort with the necessary resources to conduct transformation and invest in quality implementation policies and practices (151).	Commitment of the hospital directors to support transformation to a non-incineration HCWM system with the necessary resources, policies and practices to implement the innovation.
Financial Resource Availability is the "cushion of actual or potential resources which allows an organization to adapt successfully to internal pressures for adjustment or to external pressures for change in policy as well as to initiate changes in strategy with respect to external environment." (152)	The financial resources available to the hospital for implementation of the HCWM system.
Implementation Policies and Practices are the formal strategies, plans, practices, structures that the organization uses to roll out the innovation and the actions that follow from those strategies (151)	The formal strategies, plans, structures used by the hospital and the practices followed by the hospital workers to support the implementation of HCWM.
Implementation Climate is a shared perception among organizational members that the innovation is a major organizational priority that is promoted, supported and rewarded by the organization. (11,127,132)	Shared perceptions of HCWM system users (hospital staff) that the HCWM is a hospital priority and promoted, supported and rewarded by the hospital.

Conceptual Definition	Operational Definition
Innovation Values Fit describes "the extent to which [organizational members] perceive that the use of the innovation will foster (or conversely, inhibit) the fulfillment of their values." (11)	The extent to which hospital staff (hospital director, HCWM coordinator, nurses, HCWM workers) and others who interact with the HCWM system perceive that HCWM will fulfill their values.
Champion(s) is a "charismatic individual who throws his or her weight behind an innovation, thus overcoming indifference or resistance that the new idea may provoke in an organization (107)	A charismatic, influential individual from either the hospital staff or outside the hospital who throws his or her weight behind the establishment of non-incineration HCWM in hospitals in Nepal.

APPENDIX 4: INTERVIEW CONSENT FORMS

Consent Form

Title of Study
Healthcare Waste Management Systems for Hospitals in Resource-Constrained Settings: What Determines Effective Implementation?

Principal Investigator
Jacqueline McPherson, MPH, DrPH (candidate) Department of Health Policy and Management, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina.

Purpose
Identify the key determinants of implementation effectiveness of healthcare waste management systems for hospitals in resource-constrained settings.

Potential Benefits
The research is designed to benefit the greater healthcare system in Nepal by gaining new knowledge about what determines effective implementation of healthcare waste management systems in hospitals. The final study results will be shared with the staff members in participating hospitals and the Ministry of Health. This should lead to better understanding about what is needed to implement a successful healthcare waste management system in the hospital setting in Nepal. You may not benefit personally from participating in this research study. However, you may benefit by gaining insights into systems within your own hospital facility and other participating hospitals' facilities.

Potential Risks
There are no anticipated personal risks for your participation in this study. Everything you say will be strictly confidential and your identity will not be mentioned. You may not want to answer some of the questions. If that is the case, you are free to refuse to answer them.

Privacy Protection
The Principal Investigator listed on this form is the only person who will have access to information that links individual participants to the responses from the interviews. Participants will not be identified in any report or publication about this study.

Consent

I, _____, understand that I am being asked to participate in a University of North Carolina study to answer questions relating to healthcare waste management.

I understand that it is my voluntary choice to participate in this study, and I also understand that I may refuse to answer any question during the interview and/or withdraw from the study at any time without penalty.

A summary of the results of my interview will be made available to me upon completion of the study, should I request a copy. I understand what this study involves and I freely agree to take part. A copy of this written consent form will be provided to me upon request.

I understand that my verbal consent after having this form read to me shall constitute my consent as if I had signed this consent below.

_____
Signature of participant

_____
Name of participant

_____
Date

If you have any questions or concerns, either prior to or following your participation, please do not hesitate to contact me.

Jacqueline McPherson at +977-198510-33842 or by email at jamcpher@live.unc.edu

APPENDIX 5: INTERVIEW GUIDES

Key Informant Interview Guide: Hospital Director

Namaste! Thank you for taking the time to talk to me today and participate in this study. My name is Jackie McPherson and I am a doctoral student at the University of North Carolina, Gillings School of Global Public Health. I am conducting research for my doctoral dissertation.

My research is focused on medical waste management systems in hospitals in the Kathmandu valley. The aim of the research is to identify the key factors that affect implementation of medical waste management systems in hospitals in resource-constrained settings. The results will be shared with policy makers, hospital administrators and hospital staff in Nepal and South Asia to improve the implementation of medical waste management systems in hospitals.

I would like to ask you some general questions about the adoption and implementation of the medical waste management system in *(name of hospital)*. Your participation is entirely voluntary and your personal identity and the name of the hospital will be kept confidential throughout this research and will not be reported in the dissertation or any reports, papers or articles that are published from this research. You may decline to answer any question in the interview or to end the interview at any time. You will not receive any compensation for your involvement in this research. The interview is designed to take one hour. Do you have any questions?

I would like to record the interview to make sure that I do not miss any information. The interview recording will remain secure and will only be used for this research. The recordings will be deleted at the completion of the dissertation. At any time if there is something that you do not want recorded, please let me know and I will turn off the recording. Do I have your permission to record?

Interview Guide: Hospital Director

Date:

Respondent Code:

Number of years in position:

General

Can you tell me more about the Hospital Director position at (*name of hospital)*?
(Is the director appointed by government? If not, what is the process to hire the director? Does the director have the autonomy to begin new innovations in the hospital such as the Health Care waste management HCWM system? If not, what is the process?)

Healthcare Waste Management System

1. Please tell me about the hospital's current HCWM system?
    a. What was your involvement with the establishment of the new system?
    b. When and how did it get started? (*Describe how the hospital decided to set up the new system. If s/he was not involved, ask for general impressions based on what s/he might have heard)*
    c. What were/are the costs associated with startup? What are the implementation costs with
        i. Segregation?
        ii. Storage?
        iii. Transportation?
        iv. Disposal?
        v. Personnel?
        vi. Additional equipment?
        vii. Anything else?
    d. Are there any cost benefits for the hospital? (*For example, do they make money from the recycling? How much?)*
    e. What has your experience been with the system?
    f. Describe the process from source to disposal? How is the waste segregated? How does it get transported? Does the hospital outsource medical waste treatment and/or disposal? Does the hospital recycle any medical waste?
2. What did the hospital do before this system was implemented?
3. What were some of the key drivers to getting the system started?

4. What were some of the challenges in getting the system started?
5. How is the HCWM system managed? Please describe the system of management? Who is involved and what are their roles? Is there a committee that manages the system, an individual or something different?
6. What types of policies or guidelines does the hospital have around waste management?
7. What types of differences do you notice with the new system? (*Are they measuring differences, for example, reduction in sharps injuries?*)

Management Support

Management Support is the commitment of the hospital director to support transformation to a non-incineration HCWM system with the necessary resources, policies and practices to successfully implement the innovation.

8. When the HCWM system first started, how supportive were you of the overall system? Were there specific things that you did to show your support? How has your level of support changed over time?
9. How does the hospital management communicate about the HCWM system with the hospital staff?

Financial Resource Availability

Financial Resource Availability is the financial resources available to the hospital for implementation of the HCWM system.

10. How is the HCWM system funded?
    a. Where do the resources come from?
    b. Who makes the decision on the budget that will be used to support the HCWM system?
    c. Are there other in-kind contributions?
    d. How have the funding sources changed over time?
    e. How do the costs now compare to the costs before you implemented the new system?

Implementation Policies and Practices

The formal strategies, plans, structures used by the hospital and the practices followed by the hospital workers to support the implementation of HCWM.

11. What policies and procedures are in place to support the HCWM system?
12. How are the hospital staff members oriented on the policies and procedures for the HCWM system?
13. How often are the policies reviewed and/or updated?
14. What hospital staff members are working on the HCWM system and what are their roles?
15. What skills and knowledge do you feel are necessary for these hospital staff to have in order to successfully implement the HCWM system? What does the hospital do to ensure that these staff have this level of skills and knowledge?
16. What education and training does the hospital provide for staff on HCWM?

Probes:

a. Who provides the training?

b. How often is training provided? Is there a written training plan and schedule for refresher trainings?

c. Who is trained?

17. What types of incentives (or disincentives), if any, are available to staff for properly (or improperly) managing medical waste?

18. What type of system do you have for internal monitoring or inspection of the HCWM system?

19. What, if any, difficulties have you experienced with staff accepting or following the HCWM system?

Probes:

a. How committed are staff to following the HCWM system?

b. Were there any groups who seemed reluctant or unsure about implementing the HCWM system?

Innovation Values Fit

The extent to which hospital staff (hospital director, HCWM coordinator, nurses, HCWM workers) and others who interact with the HCWM system perceive that this innovation will fulfill their values and the values of the hospital.

20. How does the new HCWM system fit in with the values of the hospital? (Probe for reasons such as contributing to a cleaner, safer, healthier environment for staff; a safe environment for the community; ensuring the hospital does no harm; maximizing profit through sustainable means like recycling waste; etc.)

21. How does the new HCWM system fit in with your own personal values?

Champion(s)

A charismatic, influential individual from either the hospital staff or outside the hospital who throws his or her weight behind the establishment of non-incineration HCWM in hospitals in Nepal.

22. Were there (are there) any individuals who stand out as champions of the HCWM system? This could be someone from within the hospital or outside of the hospital. By champion, I mean someone who is instrumental in pushing the system forward and who was/is personally vested in making it successful.

Implementation Climate

Shared perceptions of HCWM system users (hospital staff) that the HCWM is a hospital priority and promoted, supported and rewarded by the hospital.

23. How has the hospital prioritized the HCWM system?

24. Do all staff members know what their role is in the HCWM system and what they are personally supposed to do?
25. Do staff members receive feedback on how well they are doing implementing the HCWM system?
26. Are staff members enthusiastic about the system? If yes, how do they demonstrate this? If no, how do they show it?

Implementation Effectiveness

The consistency and quality with which the hospital implements non-incineration HCWM systems

27. How effective do you think the implementation of the HCWM system has been?
28. Is there anything that you wish the hospital would have done differently in setting up the system? In implementation?
29. Do you have any advice for other hospitals that would like to set up HCWM systems?

Semi-Structured Interview Guide: Hospital Worker

Namaste! Thank you for taking the time to talk to me today and participate in this study. My name is Jackie McPherson and I am a doctoral student at the University of North Carolina, Gillings School of Global Public Health. I am conducting research for my doctoral dissertation.

My research is focused on medical waste management systems in hospitals in the Kathmandu valley. The aim of the research is to identify the key factors that affect implementation of medical waste management systems in hospitals in resource-constrained settings. The results will be shared with policy makers, hospital administrators and hospital staff in Nepal and South Asia to improve the implementation of medical waste management systems in hospitals.

I would like to ask you some general questions about the adoption and implementation of the medical waste management system in *(name of hospital)*. Your participation is entirely voluntary and your personal identity and the name of the hospital will be kept confidential throughout this research and will not be reported in the dissertation or any reports, papers or articles that are published from this research. You may decline to answer any question in the interview or to end the interview at any time. You will not receive any compensation for your involvement in this research.

The interview is designed to take one hour. Do you have any questions?

I would like to record the interview to make sure that I do not miss any information. The interview recording will remain secure and will only be used for this research. The recordings will be deleted at the completion of the dissertation. At any time if there is something that you do not want recorded, please let me know and I will turn off the recording. Do I have your permission to record?

Interview Guide: Hospital Worker (e.g., nurse, waste worker, lab technician, etc.)

Date:

Respondent Code:

Number of years in position:

General

Can you tell me more about your work as a *(name of position)* at (*name of hospital)*? What is your role in the new healthcare waste management (HCWM) system?

Healthcare Waste Management System

30. Please tell me about the hospital's current HCWM system?
    a. What was your involvement with the establishment of the new system?
    b. When and how did it get started? (*Describe how the hospital decided to set up the new system. If s/he was not involved, ask for general impressions based on what s/he might have heard)*
    c. What were/are the costs associated with startup? What are the implementation costs with
        i. Segregation?
        ii. Storage?
        iii. Transportation?
        iv. Disposal?
        v. Personnel?
        vi. Additional equipment?
        vii. Anything else?
    d. Are there any cost benefits for the hospital? (*For example, do they make money from the recycling? How much?)*
    e. What has your experience been with the system?
    f. Describe the process from source to disposal? How is the waste segregated? How does it get transported? Does the hospital outsource medical waste treatment and/or disposal? Does the hospital recycle any medical waste?
31. What did the hospital do before this system was implemented?
32. What were some of the key drivers to getting the system started?
33. What were some of the challenges in getting the system started?

34. How is the HCWM system managed? Please describe the system of management? Who is involved and what are their roles? Is there a committee that manages the system, an individual or something different?
35. What types of policies or guidelines does the hospital have around waste management?
36. What types of differences do you notice with the new system? (*Are they measuring differences, for example, reduction in sharps injuries?*)

Management Support

Management Support is the commitment of the hospital director to support transformation to a non-incineration HCWM system with the necessary resources, policies and practices to successfully implement the innovation.

37. When the HCWM system first started, how supportive was the hospital management of the overall system? Were there specific things that they did to show their support? How has their level of support changed over time?
38. How does the hospital management communicate about the HCWM system with the hospital staff?

Financial Resource Availability

Financial Resource Availability is the financial resources available to the hospital for implementation of the HCWM system.

39. How is the HCWM system funded?
    a. Where do the resources come from? Is the information about resource availability for this system shared with the staff? If yes, in what way?
    b. Who makes the decision on the budget that will be used to support the HCWM system?
    c. Are there other in-kind contributions?
    d. How have the funding sources changed over time?
    e. How do the costs now compare to the costs before the hospital implemented the new system?

Implementation Policies and Practices

The formal strategies, plans, structures used by the hospital and the practices followed by the hospital workers to support the implementation of HCWM.

40. What policies and procedures are in place to support the HCWM system?
41. How are you oriented on the policies and procedures for the HCWM system?
42. How often are the policies reviewed and/or updated?
43. What hospital staff members are working on the HCWM system and what are their roles?
44. What skills and knowledge do you feel are necessary for these hospital staff to have in order to successfully implement the HCWM system? What does the hospital do to ensure that these staff have this level of skills and knowledge?

45. What education and training does the hospital provide for staff on HCWM?

    Probes:

    a. Who provides the training? How often is training provided?

    b. Is there a written training plan and schedule for refresher trainings?

    c. Who is trained?

46. What types of incentives (or disincentives), if any, are available to staff for properly (or improperly) managing medical waste?

47. What type of system does the hospital have for internal monitoring or inspection of the HCWM system?

48. What, if any, difficulties have you experienced with the new HCWM system?

    Probes:

    a. Do you feel committed to following the HCWM system?

    b. Were there any groups who seemed reluctant or unsure about implementing the HCWM system?

Innovation Values Fit

The extent to which hospital staff (hospital director, HCWM coordinator, nurses, HCWM workers) and others who interact with the HCWM system perceive that this innovation will fulfill their values and the values of the hospital.

49. How does the new HCWM system fit in with the values of the hospital? (Probe for reasons such as contributing to a cleaner, safer, healthier environment for staff; a safe environment for the community; ensuring the hospital does no harm; maximizing profit through sustainable means like recycling waste; etc.)

50. How does the new HCWM system fit in with your own personal values?

Champion(s)

A charismatic, influential individual from either the hospital staff or outside the hospital who throws his or her weight behind the establishment of non-incineration HCWM in hospitals in Nepal.

51. Were there (are there) any individuals who stand out as champions of the HCWM system? This could be someone from within the hospital or outside of the hospital. By champion, I mean someone who is instrumental in pushing the system forward and who was/is personally vested in making it successful.

Implementation Climate

Shared perceptions of HCWM system users (hospital staff) that the HCWM is a hospital priority and promoted, supported and rewarded by the hospital.

52. How has the hospital prioritized the HCWM system?

53. Do all staff members know what their role is in the HCWM system and what they are personally supposed to do?

54. Do staff members receive feedback on how well they are doing implementing the HCWM system?
55. Are staff members enthusiastic about the system? If yes, how do they demonstrate this? If no, how do they show it?

Implementation Effectiveness

The consistency and quality with which the hospital implements non-incineration HCWM systems

56. How effective do you think the implementation of the HCWM system has been?
57. Is there anything that you wish the hospital would have done differently in setting up the system? In implementation?
58. Do you have any advice for other hospitals that would like to set up HCWM systems?

APPENDIX 6: COMPLETE RESULTS – IRAT SURVEY

Variable	Scale	Hospital A	Hospital B	Hospital C
IE Overall (High, Medium, Low)[38]	H,M,L	M	H	M
IE Score (Sum of Part I and Part II)	138	122	126	111.5
IE Percentage	100%	88%	91%	81%
Part I – Initial Interview	0-47	37.5	40.5	30
Organization	0-8	8	8	8
Is there a person in charge of healthcare waste management?	5	5	5	5
Is there a permanent committee that deals with healthcare waste management and meets on a regular basis?	1.5	1.5	1.5	1.5
Are the roles and responsibilities regarding healthcare waste management made clear to the staff?	1.5	1.5	1.5	1.5
Policy and Planning	0-11	8.5	9	3
Does the healthcare facility have written policies dealing with healthcare waste management?	2	0	0	0
Does the healthcare facility have written plans, manuals, or written procedures dealing with healthcare waste management?	2	2	2	0
Are the policies, plans, manuals, and/or written procedures consistent with national laws, regulations, and any permits?	3.5	3.5	3.5	0
Does the healthcare facility have a plan for recycling or waste minimization?	1.5	1.5	1.5	1.5
Does the healthcare facility policy explicitly mention a commitment to protect the environment?	0.5	0	0.5	0
Is the healthcare facility mercury-free? OR Does the healthcare facility have a policy or plan to phase out mercury?	1.5	1.5	1.5	1.5
Training	0-12	11	11	11

[38] High $\geq$ 90%; Medium 80-89%; Low $\leq$ 79%22

Variable	Scale	Hospital A	Hospital B	Hospital C
Does the facility have a training program on healthcare waste management for managers, health professionals, waste workers, and auxiliary staff?	5	5	5	5
Does the training program include relevant national laws and regulations?	1	1	1	1
Does the training program include the following: segregation, collection and handling of sharps waste,use of proper containers and bags for infectious waste, color coding, 3/4th fill rule, use of personal protection equipment by waste workers, transport, storage, and treatment?	2	2	2	2
Are the staff trained, including new staff when they begin their employment?	3	3	3	3
Is there refresher training at least once a year?	1	0	0	0
Occupational Health and Safety	0-7	2	4	2
Do the policies and plans related to healthcare waste management include occupational health and safety (including policies for needle-stick injuries or exposure to blood splatter)? OR Does the facility have separate occupational health and safety policies that include needle-sticks and exposure to blood?	3	0	0	0
Are the workers who collect, transport and treat waste provided with the proper personal protection equipment (gloves, shoes or boots, and aprons)?	2	2	2	2
Are the health workers and workers handling waste given hepatitis and tetanus vaccinations?	2	0	2	0
Monitoring, Evaluation and Corrective Action	0-2.5	2	2	2
Is there a system of internal monitoring or inspection to determine compliance with healthcare waste management requirements?	1	1	1	1
Is there a system of taking corrective action when practices or technologies related to healthcare waste management do not meet the requirements?	1	1	1	1

Variable	Scale	Hospital A	Hospital B	Hospital C
Are policies and/or plans reviewed or updated at least once a year?	0.5	0	0	0
Financing	0-6.5	6	6.5	4
Does the facility have an annual allocation in its budget for healthcare waste management?	4	4	4	4
Is the current budget sufficient for healthcare waste management?	2	2	2	0
Does the facility have a long-term financing plan or mechanism to cover the costs for sustainable healthcare waste management?	0.5	0	0.5	0
Part II – Post Inspection Tour Interview	0-91	84.5	85.5	81.5
Classification and Segregation	0-7	7	7	7
Are the wastes properly segregated at the source according to different categories?	5	5	5	5
Are the health workers familiar with the classification and segregation requirements?	2	2	2	2
Waste Generation Data	0-2	1.5	2	2
Have the amounts of total waste and infectious waste produced per day been measured? If yes, put the figures below; if no, provide the best estimate below.	1	1	1	1
Information only: Total waste (infectious and non-infectious) generated on average (in kilograms per day)	*n/a*	*91*	*403.48*	*192*
Information only: Total waste minus recycled or reused waste (in kilograms per day)	*n/a*	*53*	*327.15*	*86*
Information only: Infectious waste generated on average in kilograms per day	*n/a*	*35*	*87.77*	*40*
Percentage of infectious waste relative to total waste (if greater than 3% and less than 25%, score 0.5)	0.5	0 (38)	0.5 (22)	0.5 (21)
Information only: Kilograms infectious waste per bed per day	*n/a*	*0.3*	*0.2*	*0.3*
kilograms unrecycled waste per bed per day (score if less than 6 kg/bed/day	0.5	0.5 (0.5)	0.5 (0.7)	0.5 (0.6)
Collection and Handling	0-19	18.5	19	17.5
Are used syringe needles collected WITHOUT recapping?	2	2	2	2

Variable	Scale	Hospital A	Hospital B	Hospital C
Is sharps waste collected in sharps containers or destroyed using needle destroyers?	5	5	5	5
Are the sharps containers puncture-resistant and leak-proof? OR Are the needle destroyers approved under existing regulations or standards?	2	2	2	2
Are the sharps containers filled only 3/4th full? OR Are the needle-destroyers well maintained?	2.5	2.5	2.5	2.5
Are the sharps containers or needle-destroyers always available?	1	1	1	1
Are the sharps containers or needle-destroyers properly placed such that they are easily accessible to personnel and located as close as possible to the immediate area where the sharps are used?	1.5	1.5	1.5	1.5
Do the health workers know what to do in the event of a needle-stick injury? OR Are the health workers familiar with the policy on needle-stick injuries?	1	1	1	0
Are the plastic bags used for non-sharps infectious waste of good quality? OR Do you use specialized containers that are disinfected, cleaned and reused and do not require a plastic bags?	1	1	1	1
Are plastic bags always available? OR are specialized containers always available?	1	1	1	1
Are the bag holders or hard containers holding the plastic bags of good quality? OR Do you use specialized containers that are disinfected, cleaned and reused and do not require a plastic bags?	0.5	0.5	0.5	0.5
Are the infectious wastes removed at least once a day?	1	1	1	1
Do the waste workers know what to do if sharps or infectious waste is accidentally spilled? OR Are the waste workers familiar with the spill clean-up plans?	0.5	0	0.5	0
Color Coding and Labeling	0-6	6	6	6
Does the healthcare facility use a system of color coding for different types of wastes?	3	3	3	3

Variable	Scale	Hospital A	Hospital B	Hospital C
Are the colors of the waste containers consistent with the color coding?	2	2	2	2
Are the infectious waste bags colored or labelled in accordance with the policies or regulations?	1	1	1	1
Posters or Signage	0-0.5	0.5	0.5	0.5
Are there posters or signs showing proper segregation of healthcare waste?	0.5	0.5	0.5	0.5
Transportation Inside Health Establishment	0-2	1.5	1.5	1.5
Is the waste transported away from patient areas and other clean areas?	0.5	0	0	0
Is the waste transported in a closed (covered), wheeled transport cart?	1	1	1	1
Is the transport cart cleaned at least once a day?	0.5	0.5	0.5	1.5
Storage	0-2.5	2.5	2.5	1.5
Does the storage area meet the proper requirements?	1	1	1	0
Is the storage area kept clean?	0.5	0.5	0.5	0.5
Are the wastes removed before the maximum allowable storage time is exceeded?	1	1	1	1
Hazardous Chemical, Pharmaceutical and Radioactive Waste	0-5	5	5	5
Are hazardous chemical, pharmaceutical, and radioactive wastes segregated from infectious and general non-risk wastes? (Put Y in column C if the facilities does not generate these categories of waste.)	4	4	4	4
Does the healthcare facility have a plan for the treatment and disposal of hazardous chemical, pharmaceutical, and radioactive wastes? (Put Y in column C if the facilities does not generate these categories of waste.)	1	1	1	1
Treatment and Disposal	0-28	28	28	27
Does the healthcare facility treat its infectious waste (either on-site or at an off-site treatment facility) before final disposal?	25	25	25	25
Are laboratory cultures and stocks of infectious agents treated within the healthcare facility before being taken away from the facility?	2	2	2	2

Variable	Scale	Hospital A	Hospital B	Hospital C
Is there a contingency plan for the treatment of infectious waste in the event that the treatment technology is shut down for repair?	1	1	1	0
For facilities with onsite treatment	0-15	14	14	13.5
Is the waste transported safely to the treatment area?	0.5	0.5	0.5	0.5
Is the treatment area located in a place that is easily accessible to the waste worker but not accessible to the general public?	0.5	0.5	0.5	0
Does the healthcare facility have a program of regular inspection and periodic maintenance of the treatment technology?	3	3	3	3
Is the treatment system clean, operating properly, and well maintained?	3	3	3	3
Does the treatment system destroy or mutilate sharps waste in order to prevent reuse?	1	1	1	1
Does the healthcare facility use an approved non-incineration treatment technology such as an autoclave-shredder, integrated steam treatment system, or microwave unit? If yes, put Y in column C and skip to QUESTION # 60.	6	6	6	6
If the facility uses an incinerator: Does the incinerator meet international standards?	3	0	0	0
If the facility uses an incinerator: Are PVC plastics kept out of the waste that is burned?	0.5	0	0	0
Is the waste that is treated in an alternative technology disposed of in a sanitary landfill? OR Is the incinerator ash buried in a hazardous waste landfill?	1	0	0	0
Wastewater	0-4	0	0	0
Does the healthcare facility treat its wastewaste (liquid waste) before being released? OR Is the healthcare facility connected to a sanitary sewer that is linked to a wastewater treatment plant?	3	0	0	0
Does the treated wastewater from the healthcare facility meet national or international standards?	1	0	0	0

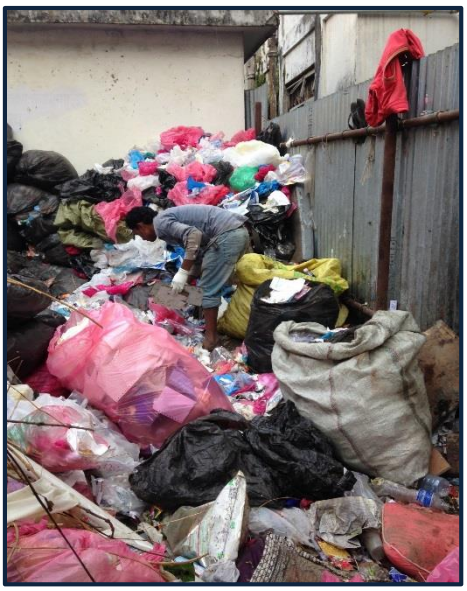
APPENDIX 7: EXAMPLE ADVOCACY SHEET FOR HCWM

Below is an example of a two-page advocacy sheet that can be used to create a sense of urgency with policy makers to implement interim regulatory measures to manage healthcare waste.

Each year a total of 300 tons of healthcare waste is improperly disposed of in hospitals compounds across Nepal[1]

Burning: The use of open burning and incineration in Nepal releases dioxins, mercury and other toxic chemicals into the environment. This exposes healthcare workers and the public to serious environmental hazards.

Dumping: Untreated medical waste is dumped outside of hospital compounds in Nepal, exposing the public to contaminated syringes and needles, blood-borne pathogens, mercury and other toxic substances.



Mixing: General non-hazardous waste (paper, plastic, food) is often mixed together with hazardous waste in Nepali hospitals. This practice 1) makes ALL waste hazardous; 2) poses an occupational risk to health workers, especially for needle sticks which can transmit Hepatitis B virus, Hepatitis C and HIV; and 3) greatly increases the cost of disposal.[2]

The Government of Nepal must regulate healthcare waste management to protect Nepal's health workers and help keep cities safe and clean

Keep health workers and communities safe

- The Nepal Solid Waste Management Act 2011 stipulates that hospitals are responsible for properly managing the waste that they produce.[3] The Ministry of Health and Population, Department of Health Services (DOHS), is responsible for creating the regulatory structure necessary to enforce this law.
- Enforcing MWM guidelines in hospitals will result in a cleaner, safer environment.[4] The DOHS can protect Nepal's healthcare workforce and ensure a safe hospital environment for them and the general public who use these facilities through the establishment of non-incineration HCWM systems.

The DOHS must create the regulatory structure for healthcare waste management in partnership with hospitals and technical experts

Properly regulated healthcare waste management is a win-win situation for both the Government of Nepal and hospitals

- As part of the regulatory structure, the DoHS should provide technical assistance to hospitals to establish non-incineration healthcare waste management systems; this can be done in coordination with WHO and local NGOs with waste management expertise.
- Non-incineration HCWM results in economic benefits for the hospital.[5]
- Hospitals can earn income from recycling decontaminated medical waste; Hospitals in Kathmandu are earning up to $300 US dollars each month from recycling.[6]
- Hospitals that roll out modern HCWM systems have reported improvements in staff morale due to the cleaner, safer and more pleasing work environment.[6,7]

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