A Policy Framework for the Improvement of Health Care Waste Management in Indonesia

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ABSTRACT

Indonesia is a developing country in the South East Asian region (SEAR), with a total population of 237,641,326, in 2010, living in 33 provinces. In line with economic development and decentralisation of the health system, the number of health care establishments steadily increases to keep up with population growth and public needs.

Institutions delivering health services, including hospitals and health centres (HCs), inevitably generate a tremendous amount of wastes, a fraction of which are infectious and hazardous. The majority of health care institutions do not manage their medical wastes, properly, to minimise their risks. Consequently, their wastes are unsafe for patients, health care workers, waste handlers and the general population. These can spread health care-acquired infections (HAI).

The Government of Indonesia (GoI) enacted a number of laws and regulations to govern the implementation of sound environmental management, municipal solid waste management (MSWM), and hazardous waste management. However, there is no clear policy framework to ensure safe health care waste management (HCWM), in accordance with such laws and regulations.

A cross-sectional study was carried out in 2010 to develop a suitable policy framework for sustainable HCWM. It employed concurrent mixed methods, including quantitative and qualitative inquiries, consisting of mailed survey questionnaires and in-depth interviews, waste audits and onsite observations. The mailed survey, using a structured questionnaire, reached 237 sample public hospitals across 27 provinces. In-depth interviews with relevant policy makers were conducted in eight hospitals, five HCs from five provinces, and four institutions at the central level, including the Ministries of Health (MoH), and Environment (MoE), as key stakeholders. The waste in eight large hospitals across five provinces was audited.

A large hospital in Queensland, Australia, was studied for observable best practice of HCWM, as a lesson learned and a comparable case study. Regulations and policies governing HCWM of the Queensland Government, the implementation of the Waste Management Hierarchy (WMH), 3R’s (reduce, reuse, and recycle), cleaner production (CP), privatisation of waste treatment and disposal, infection control program (ICP) and
occupational health and safety, were examined. The researcher, importantly, observed the operative leadership in the overall HCWM in the hospital.

IBM Statistical Programs for Social Science (SPSS) versions 19 and 20 were used to analyse quantitative data of 194 variables, to obtain descriptive and inferential statistics, whereas, qualitative data were analysed manually, using content analysis. The inferential statistics applied multivariate logistic and linear regression analyses.

The research findings were presented as descriptive and inferential statistics, and triangulation results, to identify and explain a number of important variables for developing a policy framework. The descriptive statistics presented more than 100 variables of the current HCWM status, including hospital characteristics, waste generation per occupied bed per day, stages of the WMH, compliance with relevant regulations, 3R practices, resources and training, the availability of other programs within hospitals, such as, ICP, and health promoting hospitals (HPH). The medical waste generation ranges from 0.01 to 1.60 kg/bed/day with an average of 0.4395kg/bed/day.

The inferential statistics analysis reveals that the determinants of general waste generation were: the number of inpatients (p<0.001), the number of outpatients (p=0.0143), and location of hospitals, which was divided into Java-Bali islands, and outside Java-Bali islands (p=0.0393). Moreover, the determinants of medical waste production were: the number of inpatients (p<0.001), the number of outpatients (p<0.001), and the availability of routine budgets for HCWM (p=0.0137).

Regarding the determinants of compliance with relevant regulations and policies, the logistic regression analysis found that the determinants of compliance with waste segregation at source were: availability of routine budgets for HCWM (p=0.0421), availability of waste management plans (p=0.0020), availability of central policy (p=0.0010), and availability of hospital manager guidelines (p=0.0209). The determinants of compliance with the colour coding system were: availability of a waste management unit (p=0.0146), availability of in-room SOPs (p=0.0027), class of hospital (p=0.0098), and location of hospitals (p=0.0027).

The qualitative findings indicated that the majority of hospitals and HCs were aware of their weaknesses in performing HCWM. However, they managed their wastes as
business as usual, since strict enforcement was absent. Some of them blamed limited resources and guidance as main causes of their failures. The majority of hospital managers and HC sanitarians expected a clearer policy, to facilitate compliance with the relevant regulations. One key policy maker at central level criticised the current lack of coordination among the stakeholders concerned, and the lack of serious commitment to perform their HCWM roles.

The study attempted to formulate policy recommendations with a framework to improve HCWM in Indonesia, covering technical, managerial, socio-cultural, and ecological, public health perspectives, and applying HPH concepts, within novel leadership values.
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STATEMENT OF ORIGINALITY

I certify that this work has not previously been submitted for a degree or diploma in any university. To the best of my knowledge and belief, the thesis contains no material that has been published or written by any other person, except where due reference is made in the thesis itself.

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To my daughters, Anggia and Ansika; and my son-in-law, Fuji, my thanks for their patience and support. I thank my beautiful little granddaughter, Syifa, for her patience. I could see in her eyes when we chat via Skype that she missed me. I am looking forward
to playing with you all day long, visiting our favourite places, and enjoying being together. My loving thanks to my only son, Puguh, for assisting me in biostatistics analysis. I wish you could continue to pursue your dream to get a doctoral degree in health economics in a developed country.

Finally, with all the love, sacrifices, encouragement and support that I’ve received, some of which I’ve acknowledged above, I hope to help Indonesian hospitals in improving their HCWM, so that HAI would no longer be a burden for people at risk, whether they be patients, the wonderful health service professionals and staff, waste management services staff, volunteers, visitors, or the general public.
**ABBREVIATIONS**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>3R</td>
<td>Reduce, Reuse, and Recycle</td>
</tr>
<tr>
<td>3T’s</td>
<td>Time, Temperature and Turbulence</td>
</tr>
<tr>
<td>ABS</td>
<td>Australian Bureau of Statistics</td>
</tr>
<tr>
<td>ACHS</td>
<td>Australian Council on Health Care Standards</td>
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<tr>
<td>ADB</td>
<td>Asian Development Bank</td>
</tr>
<tr>
<td>AIDS</td>
<td>Acquired Immune Deficiency Syndrome</td>
</tr>
<tr>
<td>AIHW</td>
<td>Australian Institute of Health and Welfare</td>
</tr>
<tr>
<td>AL</td>
<td>Steam Autoclaves with sanitary landfill</td>
</tr>
<tr>
<td>AOX</td>
<td>Absorbable Organically Bound Halogens</td>
</tr>
<tr>
<td>AP</td>
<td>Acidification Potential</td>
</tr>
<tr>
<td>BOD</td>
<td>Biochemical Oxygen Demand</td>
</tr>
<tr>
<td>BOR</td>
<td>Bed Occupancy Rate</td>
</tr>
<tr>
<td>BPS</td>
<td>Statistics - <em>Badan Pusat Statistik</em></td>
</tr>
<tr>
<td>CB</td>
<td>Chlorinated Benzenes</td>
</tr>
<tr>
<td>CDC</td>
<td>Centres for Disease Control and Prevention</td>
</tr>
<tr>
<td>CDR</td>
<td>Crude Death Rate</td>
</tr>
<tr>
<td>CEHSRD</td>
<td>Centre of Ecology and Health Status Research and Development</td>
</tr>
<tr>
<td>CMR</td>
<td>Child Mortality Rate</td>
</tr>
<tr>
<td>CMRF</td>
<td>Community Medicine Recovery Fund</td>
</tr>
<tr>
<td>COD</td>
<td>Chemical Oxygen Demand</td>
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<tr>
<td>CI</td>
<td>Confidence Interval</td>
</tr>
<tr>
<td>CP</td>
<td>Cleaner Production</td>
</tr>
<tr>
<td>CRTT</td>
<td>Centre for Radioactive Treatment Technology</td>
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<tr>
<td>DEHA</td>
<td>Department of Health and Ageing</td>
</tr>
<tr>
<td>DERM</td>
<td>Department of Environment and Resource Management</td>
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<tr>
<td>DHS</td>
<td>District Health Service</td>
</tr>
<tr>
<td>DKI</td>
<td><em>Daerah Khusus Ibukota</em> (Special Capital Territory)</td>
</tr>
<tr>
<td>DoH</td>
<td>Department of Health</td>
</tr>
<tr>
<td>DoHA</td>
<td>Department of Health and Ageing</td>
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<tr>
<td>DVT</td>
<td>Deep Vein Thrombosis</td>
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<tr>
<td>EE</td>
<td>Eco Efficiency</td>
</tr>
<tr>
<td>EEE</td>
<td>Electric and Electronic Equipment</td>
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<tr>
<td>Acronym</td>
<td>Full Form</td>
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<tr>
<td>EIA</td>
<td>Environmental Impact Assessment</td>
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<tr>
<td>EMD</td>
<td>Environment Ministerial Decree</td>
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<tr>
<td>EPA</td>
<td>Environmental Protection Agency</td>
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<td>EPR</td>
<td>Extended Producer Responsibility</td>
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<td>EU</td>
<td>European Union</td>
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<tr>
<td>FDA</td>
<td>Federal Food and Drug Administration</td>
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<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
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<tr>
<td>GNP</td>
<td>Gross National Product</td>
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<tr>
<td>GoI</td>
<td>Government of Indonesia</td>
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<tr>
<td>GP</td>
<td>General Practice</td>
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<tr>
<td>GPSC</td>
<td>Global Patient Safety Challenge</td>
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<tr>
<td>GTZ</td>
<td>Gesellschaft für Technische Zusammenarbeit</td>
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<tr>
<td>GWP</td>
<td>Global Warming Potential</td>
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<tr>
<td>HAI</td>
<td>Health Care Acquired Infection</td>
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<tr>
<td>HBV</td>
<td>Viral Hepatitis B</td>
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<tr>
<td>HCs</td>
<td>Health Centres</td>
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<tr>
<td>HCV</td>
<td>Viral Hepatitis C</td>
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<tr>
<td>HCW</td>
<td>Health Care Waste</td>
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<td>HCWM</td>
<td>Health Care Waste Management</td>
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<tr>
<td>HDI</td>
<td>Human Development Index</td>
</tr>
<tr>
<td>HITH</td>
<td>Hospital in the Home</td>
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<tr>
<td>HIV/AIDS</td>
<td>Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome</td>
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<td>HPH</td>
<td>Health Promoting Hospitals</td>
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<td>HWI</td>
<td>Hazardous Waste Incinerator</td>
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<td>HWMP</td>
<td>Hazardous Waste Management Permit</td>
</tr>
<tr>
<td>IDHS</td>
<td>Indonesian Demographic and Health Survey</td>
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<tr>
<td>IHA</td>
<td>Indonesian Hospital Association</td>
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<tr>
<td>IMR</td>
<td>Infant Mortality Rate</td>
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<tr>
<td>ICP</td>
<td>Infection Control Program</td>
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<tr>
<td>ISO</td>
<td>International Organization for Standardisation</td>
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<tr>
<td>ISWA</td>
<td>International Solid Waste Association</td>
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<tr>
<td>LCA</td>
<td>Life Cycle Assessment</td>
</tr>
<tr>
<td>LE</td>
<td>Life Expectancy (at birth)</td>
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<tr>
<td>LOS</td>
<td>Length of Stay</td>
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<td>Acronym</td>
<td>Full Form</td>
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<tr>
<td>MDGs</td>
<td>Millennium Development Goals</td>
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<tr>
<td>MMR</td>
<td>Maternal Mortality Rate</td>
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<tr>
<td>MoE</td>
<td>Ministry of Environment</td>
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<tr>
<td>MoH</td>
<td>Ministry of Health</td>
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<tr>
<td>MSW</td>
<td>Municipal Solid Waste</td>
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<tr>
<td>MSWM</td>
<td>Municipal Solid Waste Management</td>
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<tr>
<td>NAAE</td>
<td>National Agency for Atomic Energy</td>
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<tr>
<td>NEU</td>
<td>Net Energy Use</td>
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<tr>
<td>NHMRC</td>
<td>National Health and Medical Research Council</td>
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<tr>
<td>NHRA</td>
<td>National Health Reform Agreement</td>
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<tr>
<td>NHS</td>
<td>National Health Service</td>
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<tr>
<td>NIHRD</td>
<td>National Institute of Health Research and Development</td>
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<tr>
<td>NIMBYs</td>
<td>“Not in my backyard” syndrome</td>
</tr>
<tr>
<td>OR</td>
<td>Odds ratio</td>
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<tr>
<td>OSHA</td>
<td>Occupational Safety and Health Administration</td>
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<tr>
<td>P2</td>
<td>Pollution Prevention</td>
</tr>
<tr>
<td>PAH</td>
<td>Polycyclic Aromatic Hydrocarbons</td>
</tr>
<tr>
<td>PATH</td>
<td>Program for Appropriate Technology in Health</td>
</tr>
<tr>
<td>PCBs</td>
<td>Polychlorinated Biphenyls</td>
</tr>
<tr>
<td>PCDD</td>
<td>Polychlorinated Dibenzo p Dioxin</td>
</tr>
<tr>
<td>PCDF</td>
<td>Polychlorinated Dibenzo Furan</td>
</tr>
<tr>
<td>PCN</td>
<td>Poly Chlorinated Napthalene</td>
</tr>
<tr>
<td>PEP</td>
<td>Post Exposure Prophylaxis</td>
</tr>
<tr>
<td>PERSI</td>
<td>Persatuan Rumah Sakit Indonesia (Indonesian Hospital Association)</td>
</tr>
<tr>
<td>PFI</td>
<td>Private Finance Initiative</td>
</tr>
<tr>
<td>PPE</td>
<td>Personal Protective Equipment</td>
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<tr>
<td>PPLI</td>
<td>Prasadha Pamunah Limbah Industri (Industrial Waste Disposal Site)</td>
</tr>
<tr>
<td>QEPA</td>
<td>Queensland Environmental Protection Agency</td>
</tr>
<tr>
<td>RA</td>
<td>Risk Assessment</td>
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<tr>
<td>RBWH</td>
<td>Royal Brisbane and Women’s Hospital</td>
</tr>
<tr>
<td>SEAC</td>
<td>South East Asian Countries</td>
</tr>
<tr>
<td>SAR</td>
<td>Severe Acute Respiratory Syndrome</td>
</tr>
<tr>
<td>SE</td>
<td>Standard Error</td>
</tr>
<tr>
<td>SEAR</td>
<td>South East Asian Region</td>
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</table>
SENIC  Study on Efficacy of Nosocomial Infection Control
SOM  Senior Official Meeting
SOP  Standard Operating Procedures
SPSS  Statistical Programs for Social Sciences
SWM  Solid Waste Management
TEC  Total Environment Centre
tetR  Gene types tetracycline resistant determinants
TOC  Total Organic Compounds
UK  United Kingdom
UMCOR  United Methodist Committee on Relief
UNDP  United Nations Development Program
UNICEF  United Nations Children’s Fund
UNEP  United Nations Environmental Programme
UN  United Nations
UP  Universal Precautions
US  United States
VOC  Volatile Organic Compound
WAPS  World Alliance for Patient Safety
WCED  World Commission on Environment and Development
WHO  World Health Organisation
WMH  Waste Management Hierarchy
WWTPs  Waste Water Treatment Plants
1. INTRODUCTION

1.1 BACKGROUND OF THE STUDY

The widespread of environmental pollution has been a major issue that impacts the environment and human health, for several decades, now. The publication of Agenda 21 of the Earth Summit in 1992 raised the awareness of the importance of waste management among developing countries, including Indonesia. The Government of Indonesia highlighted the need to manage and control the generation of waste, by advocating reuse, recycling, and composting of waste, promoting environmentally sound treatment and disposal of waste, and extending waste service coverage (United Nations [UN], 2002). The importance of sustainable management of waste, including WMH, has also been emphasised in the Solid Waste Management Act No. 18/2008. However, many stakeholders concerned, have not been engaging to comply with, or to achieve, sound waste management; as currently, many waste streams are not fully managed, and therefore, potentially pollute the environment, and negatively impact the surrounding community’s health, as well as, other people along their disposal sites.

In addition to the lack of awareness of stakeholders in sustainable waste management, many policy makers and politicians lack awareness about health care wastes (HCW), especially, hazardous medical wastes, generated in hospitals and other health care establishments, and their significant contribution to environmental pollution (Irianti, 2005). For instance, the majority of hospitals, either owned by government, or private companies, dispose of their wastes inappropriately; thus, polluting the environment, and creating health hazards, including injuries from contaminated syringes and other sharps wastes (Sasimartoyo, 2004).

Moreover, Indonesian hospitals consume about 500 litres of clean water/bed/day, most of which is used in cleaning processes (Sasimartoyo, 2004). This is much more than the average water consumption in households which is about 100 litres/day. Another example of the ignorance of the importance of safe HCWM in Indonesia is the absence of adequate policies or regulations to manage HCWM safely, so that HCW may be reduced at the point of generation, in terms of volumes and hazardousness (Irianti, 2005; Irianti & Herat, 2008a).
Indonesia has paid some attention to the importance of safe HCWM since 1999, when the World Health Organisation (WHO) published a guideline for safe HCWM, to guide developing countries to establish HCWM, according to their own capabilities, resources and technologies (Prüss, Giroult, & Rushbrook, 1999). A study on hospital sanitation was conducted by the Indonesian MoH, funded by the WHO Country Office for Indonesia, including the assessment of existing hospital waste management (Sasimartoyo, 2004). The results revealed that hospital waste management was far from satisfactory, in terms of the availability of relevant regulations, segregation practices, provision of colour-coded plastic bins, temporary storage, and treatment technology (Sasimartoyo, 2004). After more than a decade, there has been no improvement, since the majority of health care institutions do not comply with, or follow, the guidelines to improve environmental health conditions in health care settings.

The increased use of disposable medical devices and hazardous substances also leads to high generation of HCW and their attendant risks. For instance, the use of radiopharmaceuticals in diagnosis and treatments of cancer should be vigilantly monitored, since some of these medicines are not metabolized and they will be discharged into wastewater sewers through human excrement and urine (Emmanuel et al., 2005; Brown, Kulis, Thomson, Chapman, & Mawhinney, 2006; Barquero, Agulla, & Ruiz, 2008; Boillot & Perrodin, 2008a; Duong et al., 2008). Without better understanding of the importance of environmentally sound HCWM, this situation could escalate the risks of medical waste related infections and deplete our natural resources (WHO, 2004a; Townend & Cheeseman, 2005; El-Haggar, 2007).

Health care waste is a by-product of health care service activities. A small proportion of HCW (15-25%) poses great risks to the health of health care workers, waste operators, the community and the environment; hence, it needs to be managed safely (Prüss et al., 1999). To achieve safe, sustainable HCWM, there needs to be a comprehensive study on the amount of waste produced, the types of HCWM available, policies that currently exist, and additional factors, like, identifying the different stakeholders of public health (Prüss et al., 1999; Almuneef & Memish, 2003; Alagöz & Kocasoy, 2008; Diaz, Eggerth, Enkhtsetseg, & Savage, 2008).

In line with the health sector decentralisation policy since 2000, the number of hospitals in Indonesia is increasing (MoH, 2011). The provision of community health services
Aside, hospitals are being used by local governments as sources of local income (Collins & Green, 1999; Kristiansen & Santoso, 2006). Therefore, there is a need for constant monitoring of the quality of service of hospitals to ensure the safety of patients, workers, and the surrounding community. This need gets more emphasized, as the rising number of hospitals means a greater use of disposables, and it is easy to predict that the amount of HCW generated will be even higher (Daschner & Dettenkofer, 1997; Gómez, Petrović, Fernández-Alba, & Barceló, 2006).

Although the proportion of medical waste that falls into the category of hazardous waste is only 15-25%, it certainly poses a great risk, as the number of hospitals and other health care facilities are increasing, thus raising the level of risks, if the wastes are not managed safely (Prüss et al., 1999; WHO, 2004a; Irianti & Sasimartoyo, 2005). For example, WHO (2004a) predicted the risk of sharps waste, which was only 1% of the total HCW in 2000, to be as big as being able to spread hepatitis B (HBV) infections in as many as 21 million cases (32% of new cases), 2 million hepatitis C (HCV) cases (40% of new cases), and 260 thousand HIV infections (5% of new cases). Runner (2007) also found that there has been unsafe handling of bodily fluids from patients. Considering the possibility of harmful viruses and bacteria in bodily fluids, there is a high risk of HAI. It is, therefore, highly important that a comprehensive study is conducted to develop a policy framework to help ensure safe and sustainable HCWM (Irianti & Herat, 2008a; Irianti & Herat, 2008b).

1.2 NEED FOR CURRENT RESEARCH

Various studies conducted in developing countries, found that ineffective HCWM is due to a lack of clear regulation and policies on safe and sustainable HCWM (Mattoso & Schalch, 2001; Nessa, Quayum, & Bharkat-e-Khuda, 2001; Phenxay. et al., 2005; Abdulla, Abu Qdais, & Rabi, 2008; Alagöz & Kocasoy, 2008; Hassan, Ahmed, Rahman, & Biswas, 2008; Mbongwe, Mmerek, & Magashula, 2008; Ananth, Prashanthini, & Visvanathan, 2010; Hossain, Santhanam, Nik Norulaini, & Omar, 2011). This resulted in many hospitals not complying with relevant regulations, managing their wastes unsafely, and disposing of those without prior treatment, together with general waste, in municipal waste disposal sites (Sasimartoyo, 2004; Chaerul, Tanaka, & Shekdar, 2008a; Mbongwe et al., 2008). Had they known that segregation of
wastes at source will reduce both, the costs and risks, to workers, patients, and the general public, they would consider managing their wastes better, so as not to compromise human health while also being cost-effective (Prüss et al., 1999; Almuneef & Memish, 2003, Ananth et al., 2010; Botelho, 2012).

The WHO (2004a) has provided guidelines and documents on short-term and long-term policies of HCWM. However, many countries have not yet followed these for many reasons – the main one being an economic. With the estimated costs of managing medical wastes being around 5-10 times more than those for general wastes, many hospitals do not manage their medical wastes as they should (Matosso & Schalch, 2001; Irianti & Sasimartoyo, 2005).

In contrast, many developed countries like the United Kingdom (UK) and Australia, implement stringent regulations on HCWM, which were preceded by socialisation of policies with all stakeholders (National Health and Medical Research Council [NHMRC], 1999; Watt, Sword, & Krueger, 2005; Tudor, 2007). These countries have also set standards in ICP and HPH that actively involve health care workers, especially nurses (Raza, Kazi, Mustafa, & Gould, 2004; Whitehead, 2004). Therefore, such a clear policy framework that encompasses regulatory, management, technical, and socio-behavioural aspects of health care culture and environments, based on a comprehensive study, is a necessity in Indonesia.

1.2.1 Lack of awareness amongst stakeholders, health care communities, and the general community
Health care waste management in Indonesia has not been given the attention it deserves by the management team of health care providers, the government, and the general public (Sasimartoyo, 2004; Chaerul et al., 2008a; Irianti & Herat, 2008b). There was never a HCW audit in each representative hospital class as an input to establishing a comprehensive and sustainable HCWM plan. In regard to current HCWM, Sasimartoyo (2004) found that only 55.3% of hospitals segregated their wastes at source into two or more categories, general and medical wastes. Ananth et al. (2010) found that among 12 Asian countries, Indonesia was at the stage of low status of safe HCWM, since it only partially followed the stages of WMH. Moreover, Ananth et al. (2010) pointed out that many hospitals managing their wastes using incinerators have not been following the best practice. Hence, high risks for the environment and the community are expected.
when there is ineffective, unsafe and unsustainable HCWM (Duerink et al., 2006; Chaerul et al., 2008a; Irianti & Herat, 2008a).

The situation is worsened by unsafe practices of liquid HCWM. The majority of health care establishments do not have wastewater treatment plants (WWTPs), and they only rely on septic tanks for wastewater treatment (Sasimartoyo, 2004). Even though they have WWTPs, they do not operate them regularly, to minimise the consumption of energy. Therefore, it is common knowledge that health care wastewater may flow onto public streets, exposing many people to its dangers, especially during the flood season.

Other programs that closely relate to HCWM in hospitals, such as, ICP, have not been integrated yet, since waste management is not considered to be as important as ICP (Irianti & Herat, 2008a). In fact, ICP, by itself, in Indonesia, does not guarantee prevention of transmission of infectious diseases, as it does not provide basic resources, such as, specially trained nurses, on-site guidelines, standard operating procedures (SOP), personal protective equipment (PPE), and hand-washing facilities (Irianti & Herat, 2008a).

Duerink et al. (2006) revealed that without having sufficient facilities for ICP in place, it is likely that this program would result in non-compliance with its guidelines for isolation precautions, and, in turn, this will compromise the safety of patients and health care workers. It is estimated that there are 1.4 million people infected with HAI annually, and most of those cases occur in hospitals in developing countries that have not yet implemented safe infection control and HCWM (Pittet et al., 2008).

1.2.2 Lack of clear regulations and policies

The Government of Indonesia has enacted relevant Acts and regulations providing for waste management and hazardous wastes. These regulations, categorise a fraction of hospital wastes which are termed ‘medical wastes,’ as hazardous wastes. However, no clear policies have been formulated to enforce the regulations. It is evident that a majority of health care institutions do not comply with such regulations, and continue to dispose their wastes improperly, without being penalised (Sasimartoyo, 2004; Irianti & Herat, 2008a). These kinds of situations occur in other developing countries, too, indicating the absence of clear regulations and policies on sustainable HCWM (Mattoso & Schalch, 2001; Nessa et al., 2001; Phenxay et al., 2005; Abdulla et al., 2008; Alagöz
& Kocasoy, 2008; Hassan et al., 2008; Irianti & Herat, 2008a; Mbongwe et al., 2008; Ananth et al., 2010; Hossain et al., 2011). Many hospitals in Indonesia were found to dispose of their medical wastes without prior treatment, together with general waste, in an open dump (Sasimartoyo, 2004; Chaerul et al., 2008a). Moreover, many hospitals which treated their medical wastes could not meet the standard requirements as stated in the Health Ministerial Decree No. 1204/2004, since they used small-scale incinerators, which were, basically, ineffective treatment technologies (Sasimartoyo, 2004).

As mentioned earlier, there are a few existing policies and regulations related to HCWM, including the Solid Waste Management Act 18/2008, Government Regulations on Hazardous Waste Management (Nos. 18 and 85/1999), and several ministerial decrees, which, however, have not been integrated into a comprehensive framework, and lack clear and implementable mechanisms. Even the Solid Waste Management Act 18/2008 only regulates municipal solid waste (MSW), and HCW is only mentioned in the article defining waste streams. Therefore, there is confusion among stakeholders with different roles and interests (Irianti & Herat, 2008a; Irianti, Chu, & Herat, 2009).

Within the Indonesian MoH, HCWM only forms a part of the Health Ministerial Decree No. 1204/2004 concerning the Environmental Health Standards of hospitals. There are no other specific guidelines for HCWM to assist health care institutions, and motivate them to comply with regulations on hazardous waste management Nos. 18 and 85/1999 (Irianti et al., 2009). Each hospital or HC relies on the guidelines provided by local governments, depending on its location and ownership, and therefore, they only respond if an accident in HCWM occurs (Irianti et al., 2009).

Several scientists have critically commented about the effectiveness of existing regulations and policies in developing countries like Indonesia. For instance, Agamuthu (2004) in his editorial in the Waste Management journal made an interesting statement regarding the implementation of sustainable waste management in developing countries. He noted that generally, developing countries adopt their legislation from developed countries, and that these will not be effective in improving the situation, if there is no waste management system already established. Combined with incompetent and corrupt policy makers, who only prioritise their own interests of economic benefits, sustainable waste management, including HCWM, will not be implemented. This is true of
Indonesia, where an evidence-based policy with clear targets and practices does not exist, making sustainable waste management far from reality.

1.2.3 Lack of best practices of HCWM

Best practices of HCWM can be determined by activities like reduction of waste generation, segregation at source, waste collection according to characteristics, using colour coded bins and plastic bags, and, waste treatment and disposal using appropriate methods and technologies (Prüss et al., 1999; El-Haggar, 2007).

In regard to segregation of wastes at source, Sasimartoyo (2004) found that only 55.3% of Indonesian hospitals segregate their wastes into medical and non-medical wastes, before dumping them in final disposal sites with general wastes. The only known means of managing wastes is the use of incinerators that generally do not fulfil the temperature requirements and the types of waste allowed to be incinerated (Sasimartoyo, 2004; Irianti & Herat, 2008a). In addition to not fulfilling the temperature requirements, the WHO (2004b) found that these small-scale incinerators are not suitable to be used on-site as they are not compliant with best practice operational standards.

The presence of a large number of scavengers who daily collect and sell wastes from municipal solid waste (MSW) and medical wastes, contribute to an illegal 3R practice in Indonesia. Instead of creating economic benefits, these practices pose health risks to the scavengers themselves, and to the general population, who come into contact with the medical wastes. These kinds of practices are illegal and the relevant authorities monitor them, but they are not easy to eliminate, or even reduce, since there were no clear, referable policies (Irianti & Herat, 2008b). Similar practices were also reported from Dhaka, Bangladesh, where some HC personnel supply the scavengers with medical wastes for monetary benefit (Patwary, O’Hare, & Sarker, 2011).

In addition to the non-suitability of the incineration technology being used, they also produce dioxins and furans that are carcinogenic pollutants. Although the current usage of small-scale incinerators is within certain standards and under supervision of the Ministry of Environment (MoE), the WHO suggests that developing countries should reduce the use of incinerators due to their negative impacts (WHO, 2004b).
Another problem with landfills as final disposal sites for MSW, including residues of incinerated medical wastes, is the non-availability of sanitary landfills in Indonesia. Local governments made no progress in implementing MSWM in accordance with the Solid Waste Management Act No. 18/2008. Several incidents of public objections to insanitary landfills, have been recorded in big cities, like Jakarta and Bandung.

In Malaysia, in comparison, the government improved its land filling system with developments in waste policy and regulations, e.g., the introduction of The Solid Waste and Public Cleansing Management Bill, 2007 (Agamuthu, Fauziah, & Khidzir, 2009a; Agamuthu & Fauziah, 2011). As for HCW, Malaysia established proper clinical waste management systems in the 1980s, in accordance with the Environmental Quality (Scheduled Wastes) Regulations, 1989, under the Environmental Quality Act (Khew, 2008; Razali & Ishak, 2010; Hossain et al., 2011). Following the study of HCW conducted in 1992, the Malaysian MoH, in collaboration with the MoE, developed a policy and guidelines for the Management of Clinical and Related Wastes in Hospitals and Health Care Establishments in 1993 (Khew, 2008). A structured HCWM framework was clearly established, and each stakeholder concerned, has defined roles and responsibilities in the “Clinical Waste Management System,” with the attendant privatisation of clinical waste treatment and disposal (Khew, 2008). Even though constraints have been encountered, there were considerable improvements in the development of the HCWM system.

Hospitals in Indonesia also generated significant amounts of radioactive waste, particularly in the big hospitals providing cancer treatment, using radionuclides. However, no accurate data was available about the generation of radioactive wastes from health care activities (Irianti, 2009a). The hospitals are responsible for providing temporary storage for radioactive wastes before sending them to the Centre for Radioactive Treatment Technology (CRTT), and also, storage for short-lived radionuclides. The government has formulated regulations and guidelines for managing radioactive wastes from medical processes (National Agency for Atomic Energy [NAAE], 1999).

In terms of the use of mercury in health care settings, all hospitals use them for diagnostic devices, such as thermometers, and blood pressure monitors. Mercury can also be released from incinerators of medical waste. The release of mercury as by-
products has never been controlled as a source of potentially heavy metal pollutants (Irianti, 2009b), and its adverse health impacts are veritable. Evidently, there is neither assessment nor a plan to replace mercury related devices with non mercury related devices in public hospitals, as there will be insufficient funds to buy new devices, and since the focus is on other prioritised programs. The WHO (2005) has introduced a mercury elimination policy to be followed by its member countries, including Indonesia. Until recently, there has been no clear information regarding the mercury elimination program and its progress in Indonesian hospitals.

Sufficient and reliable data and information are imperative to conduct sustainable HCWM. This is not the case with HCWM in Indonesia. Currently there is no comprehensive study on factors that influence implementation of HCWM, including policies that accommodate sustainable HCWM (Irianti & Herat, 2008a). A study related to waste handling and universal precautions (UP) conducted in Kariadi hospital in Semarang (Duerink et al., 2006) proved that early awareness on infection control are not yet effective, as there are many nurses and health care workers who do not wash their hands, properly, before and after activities, and do not wear PPE when handling medical wastes. This is due to the insufficient number of PPE and water basins for hand washing, as well as, a habit of not washing hands and using PPE (Duerink et al., 2006; Irianti & Herat, 2008b).

In terms of ICP, Raza et al. (2008) and Pittet et al. (2008) stress that hospitals in developing countries should undertake ICP and safe HCWM as means to protect the health of patients and workers, despite limitations in budgets. Surveillance and implementation of early awareness involving trained personnel are both crucial. Tudor, Barr, and Gilg (2007) states that trained personnel are useful not only in terms of knowledge gained through training, but also help to change the mindset towards safer HCWM. Ways to do so include availability of facilities and infrastructure, SOP and availability of clear policies and continuing plans (Tweedy, 2005; Irianti & Herat, 2008a).

Ananth et al. (2010) also emphasise the importance of changing mindsets of all stakeholders towards sustainable HCWM, especially, in developing countries. They believe that without vibrant thoughts of involved policy makers and relevant stakeholders to develop suitable policies containing workable strategies, the overall goal
to prevent HCW related pollution and diseases will not be achieved. Irianti et al. (2009) add that stakeholders concerned, at the national level, pay little attention to the importance of safe HCWM, since there is no clear policy even within its responsibility to improve HCWM.

Su, Chiueh, Hung, and Ma (2007) suggest that policies in waste management, in general, greatly influence MSWM, and this model can be implemented in health care settings. Pasang, Moore, and Sitorus (2006) state that the problems in solid waste management (SWM) in DKI Jakarta, as a big city, are due to factors, such as, unavailability of clear management strategies, planning and implementation not involving stakeholders, lack of coordination between sectors that are in charge, and lack of skills in the management sector.

An appropriate approach for sustainable HCWM would be, as stated in El-Haggar (2007), a “cradle-to-cradle for sustainable development.” This approach applies the analogy of HCWM as being identical to the food chain, where waste at the end of one link is the raw material for the next industrial stage. Krrishnamohan and Herat (2000) also propose a similar approach in managing wastes by applying the industrial ecology concept, emphasising the 3Rs. This can be implemented if there is comprehensive data on regulations and policies, HCWM hierarchy and its resources, community acceptance of HCW facilities, and local socio-economic and cultural aspects relating to wastes.

Looking at these three issues at a deeper level, it is apparent that the lack of clear regulations and policies is the main problem. This results in a lack of understanding of the importance of HCWM among stakeholders and the general public, while health care institutions neglect to pursue safe HCWM according to best practices. Therefore, a suitable policy framework, based on scientific evidence, to address the existing problems of HCWM in Indonesian health care institutions is needed for achieving sustainable HCWM in the near future.

1.3 AIM

To develop a suitable policy framework for the improvement of HCWM in Indonesia.
1.4 OBJECTIVES

- To explore the examples of best practices of HCWM in developed countries, particularly in Queensland State of Australia
- To describe the current status of HCWM in Indonesia
- To identify the stakeholders concerned, and their roles in HCWM in Indonesia
- To analyse the existing policies related to HCWM in Indonesia
- To determine causes of failure in existing HCWM in Indonesia
- To identify factors for developing a policy framework which could improve the status of HCWM in Indonesia

1.5 OUTLINE OF RESEARCH

This research focuses on eliciting pertinent factors to developing a suitable policy framework for improving the status of HCWM in Indonesia. In particular, attention is paid to general hospitals owned by governments, which provide public health services. A number of aspects of HCWM were investigated, including waste streams, definition of wastes, stages of the WMH, availability of regulations and policies that indirectly or directly influence them, and the availability of other related programs within the hospitals that were studied. Particular interest is shown to the current implementation of HCWM in several hospitals in Queensland, as a lesson learnt for future sustainable HCWM in Indonesia.

The research was designed by synthesising quantitative and qualitative findings from selected hospitals and other sources, based on the nature of inquiry of the study, and using instruments like structured and semi-structured questionnaires for in-depth interviews. Multiple linear regression and logistic regression analyses were used to determine predictors of HCWM, while IBM SPSS versions 19 and 20 were used for statistical analysis of quantitative data. Qualitative data was also utilised for answering research questions which cannot be obtained from quantitative data. The overall findings will thus be considered adequate for developing policy recommendations for the improvement of HCWM in Indonesia.
1.6 RESEARCH RATIONALE

Little is known concerning the failures of many health care institutions in Indonesia in complying with existing environmental regulations, and minimising the risks for their patients and personnel, and the general population, from contracting HAI and occupational diseases caused by unsafe HCWM. This is because there is no comprehensive study regarding a suitable policy framework for sustainable HCWM, including the implementation of WMH, current regulations and policies, roles of stakeholders and the reasons behind the weaknesses of current HCWM. Meanwhile, the availability of existing regulations and policies has been questioned since there have been no effective legal enforcements to protect human health from risks of medical waste-related injuries and infections.

Several studies conducted mainly in developing countries indicate that poor HCWM is related to unclear policies, which obviously can be seen from the lack of waste management plans, limited finance, untrained personnel, and lack of other relevant facilities within health care institutions (Mato & Kaseva, 1999; Nessa et al., 2001; Patil & Pokhrel, 2005; Phengxay et al., 2005; Mbongwe et al., 2008; Nemathaga, Maringa, & Chimuka, 2008).

To address these issues, the present study attempts to determine a tool or framework for establishing a suitable policy that could be used to guide health care establishments to comply with relevant regulations, without compromising the safety of patients and health care workers, and with the limited resources available to implement safe HCWM. In addition to improving HCWM in Indonesia, the researcher believes that the GoI can learn from other countries which have already implemented good and best practices of HCWM, and adopt an appropriate method from neighbouring countries, like Malaysia and Australia.

Evidently, environmental management and practices within health care institutions, through the implementation of safe and sustainable HCWM, can contribute to the increasing quality of care, and the fulfilment of the ‘duty of care,’ and ‘polluter pays,’ principles (Prüss et al., 1999; El-Haggar, 2007). In the long run, incorporating HCWM into ICP, based on the principles of CP, and the fact that it could be driven by HPH, can help Indonesian health care establishments make a significant milestone in sustainable
development. Thus, the proposed policy framework can help shape the future approach to HCWM in Indonesia.

1.7 OUTLINE OF THESIS

This thesis is structured as follows:

- Chapter 1 presents the background to, and problems of, the study, together with a definition of the aim and objectives, an outline and a rationale of the research.
- Chapter 2 presents a literature review that considers development of health care settings in several countries including Australia (Queensland), existing HCWM in Indonesia, sustainable HCWM, regulations and policy frameworks, HCW and public health impacts, HAI, ICP and HPH.
- Chapter 3 explains the methodology used for the selection of research design, population and sample, data collection and management. It also presents the selected statistical analysis to predict the determinants of the study obtained from structured questionnaires and an application of mixed methods for data interpretation.
- Chapter 4 explains the results of the study including findings of best practices of HCWM from a large hospital in Queensland.
- Chapter 5 describes a current HCWM in Indonesia based on important research variables. It also presents a number of important variables as predictors of medical waste generation and compliance with the relevant regulations from selected general hospitals in Indonesia.
- Chapter 6 discusses important findings for developing a suitable policy framework for sustainable HCWM in Indonesia.
- Chapter 7 describes a proposed policy framework for HCWM to improve the current HCWM practices in order to minimise the risks of HAI and other waste related illnesses.
- Chapter 8 presents conclusions of HCWM and a suitable policy framework and recommendations for future implementation of sustainable HCWM in Indonesia.
2. LITERATURE REVIEW

This chapter provides comprehensive theories and practices of HCWM and related issues, currently available, to determine the gaps of knowledge, in an attempt to minimise them by this proposed research. Accordingly, the research findings will help formulate an appropriate policy framework for sustainable HCWM in the near future in Indonesia, whose HCWM at present is poor. Therefore, this chapter explains the development of the health care system, which mainly deals with institutions providing health care for their populations, and which, incidentally, generate HCW as by-products, impacting public health.

The literature review also covers relevant programs within health care settings, such as, ICP and HPH. These programs will be used as enabling factors for sustainable HCWM. Of course, this chapter also emphasises the important information gathered from various studies related to HCWM and its theoretical policy framework. As the issue of HCWM is within environmental management and policy, this chapter also includes CP and life cycle assessment (LCA) with regard to sustainable development principles as key approaches to be adopted.

2.1 DEVELOPMENT OF HEALTH CARE SYSTEMS

2.1.1 Health care systems in several countries

This section will briefly explore current health care systems in several countries, developed and developing, to provide information on the nature of each health care system, in order to understand the relationship of those systems to the efforts to overcome problems in HCWM. Particular attention will be paid to the health care system in Indonesia, to demonstrate its development, implicating the status of HCWM, which is being studied to develop a suitable policy framework.

Generally, a health care system can be viewed as one established within a country to provide comprehensive primary and secondary health services for its people (Gillies, 2003; Walshe, 2003). Nowadays, health care systems in many countries face huge problems due to the increase of their expenditures within the limited resources, and the demand for quality services (Gillies, 2003; Walshe, 2003). They are challenged with improving the effectiveness, efficiency and quality of their services. The following
paragraphs will discuss the important components for providing better health care services and issues arising in each selected country. Nonetheless, the nature of health care services in a country will have implications on the nature of its HCWM, and therefore, it is useful to be studied, to recommend improvements to HCWM in Indonesia.

**Australia**

As a developed country, Australia has a national system for the delivery of health care, covering all Australians, through the Medicare arrangements, so that they can access a public hospital for secondary care. The finances for this service come mainly from general taxes, including an income-related Medicare levy (Gillies, 2003). According to Duckett and Wilcox (2011), hospitals are the main institutions in the health sector, accounting for about 40% of total health expenditure, and they play an important role in the education of health professionals. Operating costs of public hospital in 2008/2009 were mainly for salaries and wages and related payments, accounting for 69.3%, as hospitals are typical of service industries (Duckett & Wilcox, 2011).

Financing of health care services is a major driver in health policy. Currently, there are four types of financing of hospital services, namely ‘capitation’, ‘historical or negotiated payment’, ‘per diem’ and ‘per case funding’ (Duckett & Wilcox, 2011, p. 203). Capitation means that hospitals will be paid a fixed payment per person for a designated population, without regard to the use of that population. While no Australian state or territory has yet implemented direct capitation, all states and territories have adopted per diem, and per case funding, and historical payments had been adopted in the past (Duckett & Wilcox, 2011).

Australia has also reformed its health system by changing the nature of hospitals as acute health care service providers from ‘fixed hospitals,’ to increasingly caring for patients in the community with support from a hospital and certain surgical procedures that can be carried out in hospital as ‘a day surgery’ (Duckett & Wilcox, 2011). This is quite contrary to the existing public perceptions of hospitals, which tend to view them as operating theatres and emergency departments, i.e., fixed hospitals.

Furthermore, in terms of health care system reform, Duckett and Wilcox (2011, p. 186) also point out:
'There has been considerable evolution in hospital management structures, with a stronger focus on managing outputs in both public and private hospitals. While the trend in public hospital governance has been towards centralisation of power, the implementation of local hospital networks is intended to devolve autonomy and decision-making to local communities'.

The implementation of new types of hospitals can be seen from the various services (Duckett & Wilcox, 2011, p. 186):

- **Dialysis** is now frequently provided in a person’s home or in satellite clinics located outside public hospitals
- **Hospital in the Home (HITH)** program allows people to receive chemotherapy, intravenous antibiotics and antiviral therapy in their homes under the supervision of hospital outreach staff
- New hospitals are being established that focus on particular services, such as dedicated surgery centres
- **In many rural areas**, hospitals have been transformed through closer integration with community health and aged care services, creating new entities that span the continuum of the community’s health care needs.

The above statements indicate that the Australian health care system attempts to provide quality health care services closer to the community, as to minimise the waiting period, and geographical distance, previously encountered in many districts or cities. More importantly, the health care system reform will empower a local community’s health care services to deal with local problems within their coverage.

Regarding hospital accreditation results, the majority of public and private hospitals were accredited either by the Australian Council on Health Care Standards (ACHS) or other agencies, with percentages of 87% (2008/2009), and 70% (2006/2007), respectively. Assessment of hospital performance was based on three functional areas: clinical, support, and corporate; against 45 separate criteria (Duckett & Wilcox, 2011). In terms of quality, the Australian public hospital system has been categorised as ‘high quality care of a standard...’ close to the best in the world, and hospital reform will continue to keep up with the needs of quality performance, using the most appropriate model (Duckett & Wilcox, 2011, p. 222).
The United Kingdom

The National Health Service (NHS) has operated the UK’s health care system since 1948. The NHS consists of various types of professionals, support workers and sub-organisations (Tudor et al., 2008a). The UK, having spent less on health care than almost any major developed country, has produced an efficient system. The NHS plan, outlining Government policy, enumerates four alternative mechanisms for future funding: ‘private insurance,’ ‘charges,’ ‘social insurance,’ and ‘rationing the service down to a fixed core.’ Each of these elements has been evaluated against the criteria of ‘efficiency’ and ‘equity’ in health care funding systems (Gillies, 2003, pp. 233-234).

Private sector contribution to the NHS has evidenced a significant rise in using the private sector and finance. The proportion of people who purchase private health care insurance has been historically low, but recent years have witnessed an increase to 11.5% of the population (Gillies, 2003).

The launch of Private Finance Initiative (PFI) in 1992, was claimed to be a solution to improving private sector efficiency. Over the next 20 years, the UK will need to share its national income with health care. It was projected that the growth of spending should be enough to keep up with the increased services of high quality across several scenarios by 2022-2023 (Gillies, 2003).

According to Moss and Totterdill (2002, p. 124), the establishment of clinical governance in NHS’s acute hospital trusts, indicates the government’s focus on advancing the agenda of ‘risk management,’ ‘clinical effectiveness,’ ‘patient involvement,’ and enhanced professional competence.’ However, they argue that the Trusts can adequately achieve patient safety, as there have been more challenges in terms of rapid technology advancement and innovation in patterns of care in turbulent political environments. Therefore, the trusts must establish an innovative vision, adaptable to increasingly unpredictable challenges, as hospitals are unique and complex social institutions (Budrys, 2005).

To conclude, the effective implementation of clinical governance should enable hospital personnel to enhance their skills by reviewing their services and identifying improvements. In this case, the trusts, with Government assistance, should provide short-term and long-term training and necessary tools to enable hospital personnel to work productively, and provide high quality health services as set out in the NHS.
A Policy Framework for the Improvement of Health Care Waste Management in Indonesia

policy. Therefore, the NHS Trusts can achieve their goal effectively and efficiently in sustainable ways.

Canada

The adoption of the Canada Health Act, 1984, was historically significant in the development of health care in Canada (Gillies, 2003). To achieve universal public coverage, the government introduced hospitalisation insurance in 1947 and the Federal Government developed it in 1957, by sharing the costs of hospitalisation insurance with the provinces. As a result, Medicare programs were created for all provinces in 1961. Health insurance has two approaches: ‘multi-payer and single payer systems’ (Gillies, 2003, p. 103). The first system was to encourage Canadians to purchase private insurance of their choice, and the poorer people had public hospitals cover, and the latter was to be provided for every citizen on the same basis through tax system. However, the above policy was debated greatly, and the 1964 Commission on Health Services declined the multi payer system, in favour of the single payer system.

The Canada Health Act was revised in November 2002 to include coverage for home care services in priority areas (Gillies, 2003). Moreover, the Canadian system has less percentage derived expenditures compared to the UK, and is comparable with the effectively regulated private system in Australia. As the Canadian system delivers a package of medical services free at the point of delivery, Gillies (2003) points out that the Canadian system is the ‘envy’ of the world.

Japan

Despite having the nearly healthiest people in the world at a comparatively lower cost than other countries like the United States (US), Japan is confronted with the increase of the elderly population, who need more health care provision (Abraham, Nishihara, & Akiyama, 2011). This condition will consume resources in acute care facilities as the length of stay (LOS) is almost three times that of the US, since they tend to use hospitals and other facilities for care for chronic illnesses. Japan has also established a universal health care system similar to Australia, where all citizens are covered by health insurance. Insured patients typically contribute 30% of the costs while the remainder is paid by the governments under this system, and they can choose any health
care facility, regardless of their insurance coverage (Matsumoto et al., 2010; Abraham et al., 2011).

To overcome its health care problems, the Japanese government introduced health care information technology in the mid 1990s to reduce service times and improve the quality of services. Moreover, in April 2009, the MoH, Labour and Welfare introduced ‘the Community Medicine Recovery Fund’ (CMRF) for each prefecture, to enhance the local community medical service and to fill the shortage of medical doctors in rural communities. Thus, Japan’s focus is to create a viable policy, involving people, towards advanced technology in the health care system for better health care services (Abraham et al., 2011).

**South-east Asian countries**

Tangcharoensathien et al. (2011), reviewed the health care reforms of seven South-east Asian countries (SEAC), viz., Malaysia, Thailand, the Philippines, Indonesia, Laos, Vietnam, and Cambodia, with the focus on financing to achieve universal coverage. The study revealed that there were two low-income countries, Laos and Cambodia, with low coverage, and five middle income countries; three of which, Indonesia, the Philippines, and Vietnam, had more than 50% coverage and clear policies, and Malaysia and Thailand, had achieved universal coverage, which was defined as, a secured access to appropriate health care services at an affordable price by all people.

The review also found that the experience of each country in health financial reforms was diverse and closely related to political decisions, historical precedence, and social values. The study concluded that the governments should take responsibility to provide basic health services for their people and protect them from being unable to have access to health care facilities, when needed (Tangcharoensathien et al., 2011). Nonetheless, health reforms should harmonise and improve all prepayment or health insurance schemes to achieve universal coverage. Of course, there are different challenges for each country in South East Asia (SEA), as their levels of health status are different. However, they have similar directions to follow in their health policies to achieve certain health indicators as part of the Human Development Index (HDI).
2.1.2 The health care system in Indonesia

Geography and demography

Indonesia, situated in the South East Asian Region (SEAR), is known as the largest archipelago in the world, with a total area of 1,919,440 sq km (Land Area: 1,826,440 sq km; Water Area: 93,000 sq km). It lies between Asia and Australia, and, between the Indian and Pacific oceans. The territory of the Republic of Indonesia spreads from 6°08' N latitude to 11°15' S latitude and from 94°45' E to 141°05' E longitude. It encompasses an estimated 17,508 islands, only 6,000 of which are inhabited (see Figure 2-1). The five main islands are: Sumatra; Java/Madura, the most fertile and densely populated islands; Kalimantan, which comprises two-thirds of the island of Borneo; Sulawesi; and Irian Jaya, which is part of the world's second largest island, New Guinea. Indonesia's other islands are smaller in size (Badan Pusat Statistik [BPS]-Statistics, 2012).

According to BPS-Statistics (2012), the population of Indonesia in 2010 was 237,641,326 people comprising 119,630,913 males and 118,010,413 females. The average annual population growth from 2000 to 2010 was 1.49%, with the lowest growth in Central Java Province, and the highest, in Papua Province.

Source: University of Texas (2002)

Figure 2-1 Map of the Republic of Indonesia
Development policy

Indonesia’s economy has grown at a relatively constant annual rate in its gross national product (GNP), of almost 7.25%, between 1992 and 1995. The GNP per capita has increased from US$ 661 to $ 978 during the same period, but later on, it decreased to US$710 in 2002. In the period 2006-2010, the economic growth rates were 5.5%, 6.3%, 6.0%, 4.5% and 6.1%, respectively (BPS-Statistics, 2012).

With the annual economic growth of 6.1% in 2010, its GNP was Rp 6,422.6 trillion, with the highest growth coming from communication and transport sectors, and the lowest from the agriculture sector. It was different in previous years, as oil and natural resources, were the predominant contributors to growth, especially, until 1990s, with several other sectors, particularly agriculture, home industries and tourism that had grown quite significantly (BPS-Statistics, 2012). In 2009, the total expenditure of health per capita was US $99, and total expenditure as of gross domestic product (GDP) was 2.4%.

Another important component of economic development is the unemployment rate. The unemployment rate in 2008 was 8.46%, and continued to decline slightly to 8.14% in 2009, and 7.40% in 2010. The slow decrease in the unemployment rate was due to the limited availability of job opportunities to accommodate the increasing number of the working-age population. It is interesting to note the unemployment rate when it is disaggregated based on education levels of the working-age population. Senior high school graduates dominated the unemployment rate (40.20%), followed by junior high school, primary school, and university graduates, which were 19.97%, 16.86% and 13.87%, respectively (BPS-Statistics, 2012).

Poverty remains a substantial problem. Poverty can be defined as economic inability of people to fulfil their basic needs (food and non food), which is measured by their expenditures in a given time (MoH, 2011). The standard of poverty line was Rp.7,000 (US$ 1.00) per day in 2009. There has been a continuous decline of those living under the poverty line, from 34.9 million (15.40%) in 2008, to 32.5 million (14.15%) in 2009, and 31.0 million (13.30%) in 2010 (BPS-Statistics, 2012).

Proportions of people living under the poverty line across big islands vary from 2008 to 2010. More than half of the poor people were living in Java Island with proportions of
57.1% in 2008, and 55.8% in 2010. The second ranking proportion of poor people was in Sumatera, with proportions of 20.9% and 21.4%. There were slight increases of poor people in Java and Sumatera in 2010. However, the proportion of poor people at national level decreased significantly from 34.9% in 2008, to 31.0% in 2010 (BPS-Statistics, 2012).

Economic development has not been seen to contribute equally to the improvement of all areas/districts in Indonesia for several reasons; thus 183 districts, 19 border districts, and 33 outer small islands, mostly of the eastern part of Indonesia, were categorised as poor and disadvantaged districts, accounting for 37.8% of total districts (MoH, 2011). This category features several factors like geographic conditions, availability of natural resources, vulnerability to disasters, social conflicts, and development policy, including public health status. A good example of the existence of inequalities is regional inequities in the health care system, particularly maternal health, which is still a major problem in rural areas.

Dependency ratio is also used as an indicator of demography of a country. This indicator is determined by the ratio of economically non-productive people (people age <15 years old and >65 years old) and economically productive people (people age 15-64 years old) in a given time. The dependency ratio is linear with the economic burden of a country, the higher the dependency ratio, the higher the economic burden of a country. According to the MoH (2011), the dependency ratio at national level in 2010 was 51.33%; whereas, at provincial level, the highest dependency ratio was in East Nusa Tenggara (73.23%) followed by Maluku (67.20%) and West Sulawesi (67.0%).

The difference between Indonesia and developed countries in terms of dependency ratio is that Indonesia has more unproductive people under 15 years, while developed countries have more people above 65 years’ age. Therefore, there will be a significant difference in the implication of health services and education.

According to the United Nations Development Program (UNDP), Indonesia’s HDI value for 2011 is 0.617—in the medium human development category—positioning the country at 124 out of 187 countries and territories (UNDP, 2011). Between 1980 and 2011, Indonesia’s HDI value rose from 0.423 to 0.617, an increase of 45.9%, or an average annual increase of about 1.2% (UNDP, 2011).
**Health policy and strategies**

The Indonesian Health Act, No. 23 of 1992, provides the legal basis for health sector activities. It stipulates the goals of the health programs as increasing awareness, willingness and ability of everyone to live a healthy life. The Act emphasises the decentralisation of operational responsibility and authority to local level, as a prerequisite for successful health outcomes, and sustainable development of the health system. In the second 25-year development plan (1994-2019), economic and human development are identified as key to national development and self-reliance of the country. Following the National Guidelines on state policy issued in 1993, strategy was adopted to improve the health and nutritional status of the population by improving the quality of health services to all, and by promoting a healthy life style with adequate housing and environmental sanitation (MoH, 2011).

In 2009, the Health Act No. 23/1992 was replaced by Health Act No.36/2009 as the former was no longer compatible with the current health situations and challenges (MoH, 2011). The new Act emphasises legal aspects, including legal rights and responsibilities of any party who has disputes related to health services. It also defines roles and responsibilities of the central government and local governments in providing comprehensive health services, focusing on promotive and preventative health services, without compromising the important curative and rehabilitative measures, and emergency health services in disaster-stricken areas.

Environmental and occupational health, are dealt with under articles 162, 163 and 164 of the new Health Act, highlighting the importance of a healthy environment in preventing or minimising risk factors, including waste related diseases and injuries, to ensure a high quality of health to the Indonesian people.

The GoI also highlights the importance of inter-sectoral coordination, joint responsibility of local governments and the community, region-specific programs, targeting vulnerable groups, by utilising appropriate information and communication programs, as part of the implementation of the decentralisation policy of 2000.

The creation of “Healthy Indonesia 2010” spurs the MoH to strengthen collaboration with other stakeholders concerned. Therefore, the MoH must be proactive to coordinate
and cooperate with all levels of the community, local governments, ministries and agencies, and the private sector, to achieve the goals of Healthy Indonesia 2010 (MoH, 2011):

- To initiate and lead the health orientation of national development
- To maintain and enhance individual, family, and public health, along with, improving the environment
- To maintain and enhance quality, accessible, and affordable health services
- To promote public self-reliance in achieving the government’s health goals.

The above goals should be achieved by providing comprehensive health services, emphasising promotive and preventative health measures with regard to minimising inequality and enhancing equity in health across Indonesia’s regions without compromising the needs of health care services, ranging from curative to rehabilitative services.

Significant reform in the Indonesian health care system fundamentally commenced in 2000, with the enactment of two new Acts, namely, Act No. 22/1999 on Local Governance, and Act No. 25/1999 on Financial Balance between Central Government and Local Governments. These two Acts are references for the implementation of the Indonesian decentralisation policy, which gives provinces and districts a large measure of autonomy to manage their own affairs, except defence, monetary and fiscal matters, foreign affairs, justice, and religion (MoH, 2009).

Therefore, decentralisation of the health system, including health care autonomy, is in place. The decentralisation policy derives legality from the above-mentioned Act No. 22/1999, which defines provincial, district, and municipality, as three levels of regional autonomy.

In line with the decentralisation policy, there are four paramount elements that serve as the pillars in formulating a National Health Development Strategy (MoH, 2009, p. 23).

- Initiating a health-oriented national development
- Professionalism
- Community Managed Health Care Program
- Decentralisation.
These four pillars of the National Health Development Strategy will require all programs to be conducted in the spirit of the new vision and mission to achieve the goal of health for all 2010, and to continue to develop on it, in the future.

Structure of health system

There are 33 provinces, and each province is sub-divided into districts, and each district, into sub-districts. As decentralisation is already implemented, the 349 districts and 91 municipalities are now the key administrative units. The organisational structure of Indonesian health system can be seen in Figure 2-2.

Each sub-district in Indonesia has at least one HC, headed by a medical doctor, usually supported by two or three sub-HCs, the majority of which are headed by nurses. Health centres mainly provide eight programs of primary health care, including maternal and child health, immunisation, nutrition and environmental health. They also have several staff to support the programs. They also have outreach activities for their communities, such as, Integrated Family Health Post (Posyandu), and they are responsible for reporting on their activities to the District Health Service (DHS), annually. Most of the HCs are equipped with four-wheel drive vehicles or motorboats to serve as mobile HCs and provide services to underserved populations in urban and remote, rural areas.

At village level, the Posyandu provides preventative and promotive health services. These posts are established and managed by the community, with the assistance of HC staff. To improve maternal and child health, midwives are being deployed to the villages.
In line with provincial government responsibility, broader decentralisation has strengthened district and municipality levels. Regional governments have also been given the authority to support, locally known as, “perbantuan,” or “medebewind” (MoH, 2011). This implies that the duties of regional development are at the district/municipality level, while development at provincial level is limited to those that are not covered by district/city, and inter-district/inter-city centres. Meanwhile, the central government has to perform the roles of formulating policy and standards, and providing guidance to the provincial and district/municipality government levels.

**Important health outcomes (mortality, life expectancy and morbidity)**

As the goal of the health system is to achieve a healthy life for all Indonesians, there are a number of health indicators to evaluate the success of health services. Important health outcomes can be determined by mortality and morbidity rates, as they are usually used as indicators of welfare of a country. Listed below are the important indicators of the current health status in Indonesia:
Mortality and life expectancy

- Infant mortality rate (IMR) is the probability that a child born in a specific year will die before reaching the age of one, if subject to current age-specific mortality rates. This is expressed as a number per 1,000 live births. The Indonesian Demographic and Health Survey (IDHS) predicted that the IMR in 2007 was 34 per 1,000 births (MoH, 2008). In 2009, the IMR decreased slightly to 30 (WHO, 2011). These rates were categorised as ‘medium,’ among SEAC. The declines of IMR were mainly achieved through the significant success of health services, and better nutrition and disease prevention, through economic improvement of households.

- Child mortality rate (CMR) is the probability of child deaths under five years of age per 1,000 live births. The IDHS (2007) estimated that the CMR in 2007 was 44, and 39 in 2009 (WHO, 2011). This rate is categorised as ‘medium,’ when compared to the normative standards of Millennium Development Goals (MDGs), and amongst SEAC. The desired rate of low CMR is below 20.

- Maternal mortality rate (MMR) is the number of registered maternal deaths due to birth, or pregnancy related complications, per 100,000 registered live births. The MMR in 2007 was 228 (MoH, 2008). The MMR is contained by ante-natal care and other health services.

- Crude death rate (CDR) is the number of deaths in a period (commonly a one-year period) divided by the mid-period population; it is usually expressed as the number of deaths per 1,000 population. According to the World Health Statistics Report (WHO, 2011), the CDR in 2010 was 6 per 1,000 persons. This rate was quite low, as it was just above Malaysia and Singapore, which were 5, and 4, respectively, considering the rank of HDI of Malaysia and Singapore were far above Indonesia (WHO, 2011).

- Life expectancy at birth (years) is the expected number of years of life remaining at a given age. According to WHO (2011), the life expectancy at birth of Indonesia in 2010 was 69 years for males, and 73 years for females, and it
was lower than that of Vietnam (72 years for males, and 76 for females), but it was higher than that of Thailand (66 years for males, and 72 for females).

Morbidity

Morbidity includes communicable and non communicable diseases, and injuries. There are many kinds of diseases related to HCW. However, this section only describes Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS), which has significantly increased, and poses a huge burden as a disease.

HIV/AIDS is categorised as a communicable disease, as it is caused by the Human Immunodeficiency virus infection, affecting the immune system of infected persons. This makes infected persons susceptible to other diseases, such as, tuberculosis and cancer (WHO, 2011). This disease is also categorised as a blood-borne disease, as it can be spread through blood from infected persons. Therefore, this disease is also an important indicator of safe HCWM, since it is related to contaminated syringes and other infectious wastes. In other words, the increased risk of HIV/AIDS, caused by punctures through contaminated syringes, would be an indicator of infectious and sharps wastes not being safely managed.

There is an upward trend of HIV/AIDS new cases in Indonesia. A significant increase was seen from 2,639 in 2005 to 4,969 in 2008. The rise of new cases also occurred in 2009 and 2010, from 3,863 to 4,158 (MoH, 2011). This increase would continue if there is no improvement in HCWM.

Health care facilities

In line with population growth, changes in patterns of diseases, and health sector decentralisation since 2000, the number of health care institutions in Indonesia is evidently increasing. In 2006, there were 1,012 general hospitals, with 118,504 beds, across 33 provinces, comprising those that are owned by the MoH, local governments at provincial and district levels, the military, and the private sector (MoH, 2011). The number of general hospitals annually increased to 1,299 in 2010 (MoH, 2011). From that number, 593 general hospitals (45.65%) were owned by private companies and the remaining (54.35%) were owned by the governments, with the total beds being 22,860, and 143,428, respectively. The numbers of general hospitals owned by the MoH and
local governments, as classified, were 10 class A, 120 class B, 250 class C, and 126 class D hospitals (MoH, 2011).

The increased number of hospitals has continued to keep up with the demand for health care services across Indonesia. The classification of hospitals is based on the availability of facilities and infrastructure, like beds for in-patients, and the level of medical services they provide to both, in-patients, and out-patients (MoH, 2011). Class A hospitals are those that have the facilities and resources to provide a wide range of specialist and sub-specialist medical services. Class B hospitals are those that have a wide range of specialist medical services, with limited sub-specialist services. Class C hospitals offer four major specialist medical services, namely obstetrics and gynaecology, paediatrics, internal medicine, and surgery. Lastly, class D hospitals are the lowest of the four levels of hospitals, and they usually exist in the districts.

In addition to the number of hospitals providing secondary health services, the number of HCs for primary health care services at sub-district levels, increased from 7,237 to 7,609 in the same period as of the hospitals (MoH, 2011). The number of HCs rose to 8,931, and sub-HCs, to 22,650 (MoH, 2011). While the ownership of HCs and sub-HCs is with local governments, there are many other health care settings owned by various parties, including clinics and health posts, which provide primary health care services.

In order to make health care services more efficient and effective in the era of decentralisation, the GoI initiated hospital autonomy units (swadana) in 1991, which gave hospitals some authority to determine hospital fees and manage a portion of their fee revenue, to cover their own daily costs of providing secondary health care services (Bossert, Kosen, Harsono, & Gani, 1997). The autonomous hospitals remain government-owned. The hospitals owned by central government are highly supervised by the MoH, and those owned by local governments, are supervised by the Ministry of Home Affairs (MHA). Under this system, the autonomous hospitals can use the fee revenue for daily costs, like salary incentives, operational (drugs, spare parts), hiring personnel, contracting food supply and laundry, excepting expenses for building construction and equipment. They can also reallocate beds within the class of services, but they have to reserve the lowest class (class III) for poor patients, as mandated by the Hospital Act No. 44/2009.
A study carried out to evaluate the implementation of hospital autonomy after 2-3 years, including aspects of finance, utilisation, personnel, quality, equity and efficiency, revealed that there was no change in hospital personnel, and the study faced difficulty in determining the impact of autonomy on the quality of services, as there wasn’t adequate data on HAI and patient satisfaction. Efficiency, measured by bed occupancy rates (BOR) and LOS, indicated only little changes (Bossert et al., 1997).

The only evidence of improvement of hospital autonomy was the management system, including, the significantly increased attendance of physicians. However, the results are insufficient to determine the impact of hospital autonomy, since the sample size was too small, and the short length of only two-three years of autonomy implementation. Hence, this study should be comprehensively followed up, in time.

Kristiansen and Santoso (2006) also assessed the impacts of decentralisation on health care services. The study found negative impacts of decentralisation and deregulation policies, as there appeared to be a lack of transparency and accountability in local governments’ financial management. Moreover, district hospitals and HCs seemed to have turned into profit making institutions.

The primary focus on preventative health was neglected to some degree, when they needed to earn money for their operational costs. Surprisingly, public hospitals often failed to provide health services to poor people with limited ability, or inability, to pay. The study also indicated that poor people tended to perceive the conditions of public health services with little complain. Finally, this study recommended that decentralisation in the health care system does not necessarily mean that all local governments have sufficient capacity to take on the full responsibility for public health services, considering the negative history of authoritarian bureaucrats in Indonesia (Kristiansen & Santoso, 2006).

In 2009, the GoI enacted Hospital Act No. 44/2009 (MoH, 2009c), to cover a number of elements of comprehensive health care services. However, there are no provisions ensuring protection for health care workers from contracting HAI, or on occupational safety and health of hospital workers, who work in a high risk environment. More importantly, the Act also does not specifically state about the duty of care or polluter-pays principles in relation to HCWM.
Nonetheless, taking into account the types and the ownership of health care settings, particularly hospitals, which vary from central government to private companies, and their being in a decentralised government system across 33 provinces, while growing in numbers, it would be impossible to establish a sustainable HCWM without the availability of clear regulations and policies.

### 2.1.3 Existing HCWM in Indonesia

**Availability of regulations and policies**

Since 1999, Indonesia has enacted Government regulations Nos. 18 and 85 (Hazardous Waste Management), based on the Environment Act No. 23/1997, replaced by Environment Act No.32/2009, which state that a fraction HCWs are categorised as hazardous wastes, since they have one or more characteristics, such as, infectious, toxic, flammable, or radioactive (GoI, 1997; GoI, 2009a). Thus, HCWs consist of general and medical wastes, and the latter are considered being potentially hazardous.

To comply with these regulations, all industries generating or in possession of hazardous waste should treat their wastes accordingly. In Indonesia, there is a company called *Prasadha Pamunah Limbah Industri* (PPLI), in Cileungsi, Bogor (West Java province) that provides hazardous waste treatment and management services. However, the cost of such treatment is relatively expensive, so that, not all industries can afford the cost of hazardous waste treatment. This company does not provide services for infectious, pressurised gas containers, explosives and radioactive wastes. As a result, the majority of hospitals treat their medical waste by using on-site or off-site incinerators, depending on their locations and capacity to pay for such treatment.

According to the regulations, the residue or ash from the incinerators should be sent to PPLI if it still contains any kind of heavy metals (MoE, 1999). On the other hand, the remaining hospitals or HCs dispose of their medical waste by on-site burning, open dumping with general waste, or even reuse or recycle them, without considering the risks they may have.

The Health Ministerial Decree No. 1204/2004, which includes HCWM, has been intended to guide health care institutions in implementing HCWM. However, this decree does not have any sanctions applicable to hospitals which do not comply with it, as it is only a guideline for improving hospitals’ environmental health. This guideline
should be adopted by local governments to formulate their regulations governing HCWM, within their jurisdictions, with relevant sanctions. Therefore, any hospital which does not comply with the local regulations can potentially be sued, accordingly.

Regarding hospital liquid waste, the Indonesian MoE provides Ministerial decree No. 58/1995 on hospitals’ effluents standards, which emphasise global organic contents, such as biochemical oxygen demand (BOD) and chemical oxygen demand (COD). However, this decree is also not effective since it also has no legal sanctions, attached. Therefore, it remains a voluntary guideline for local governments, to be adopted in their local regulations, or decrees, with legal sanctions, applicable to any hospital which does not comply with the respective regulations.

The promulgation of Solid Waste Management Act No. 18/2008 in May 2008, adding to the existing laws related to SWM, categorises HCW as a specific waste that will be regulated by central government regulations. The most interesting aspect of this Act is that it emphasises the importance of the WMH, including waste avoidance, waste reduction, reuse, and recycle. In addition, this Act clearly makes it the responsibility of the central, and local governments, to provide sufficient funds for waste management. However, the Act could not be implemented, since relevant regulations and policies that govern SWM have not yet been formulated. Moreover, this Act is intended to regulate municipal solid waste only, whereas government regulation No. 85/1999 is for regulating hazardous waste management, including medical waste from health care institutions (GoI, 2008).

In 2009, the Indonesian MoE introduced the new ministerial decree No. 18/2009 replacing the earlier decree No.68/1994 regarding Hazardous Waste Management Permits (MoE, 2009a). This decrees that all waste generators are not permitted to collect and treat their hazardous waste, unless they have adequate waste management and treatment technology, or they have co-operation contracts with other permitted parties. Moreover, the contracts must state the roles and responsibilities of each party if any environmental pollution occurred. This Act also provides procedures for obtaining hazardous waste management permits, and the permit bodies/ regulators vary according to the type and scope of waste management. For example, if dealing with transport activity, the permit should be from the Ministry of Transport (MT), whereas the scope of waste management includes whether it is at the national or local levels, such as,
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provincial or district levels; and the permits should be from the Governor/Head of District/Mayor. However, all permits will be issued only after obtaining a recommendation from the MoE.

Regulatory and policy frameworks in environmental management are a foundation for formulating comprehensive planning, implementation, evaluation, and conflict resolution purposes (Christie, 2008). In developing sustainable HCWM in developing countries like Indonesia, cross-disciplinary information is needed, especially in conditions of decentralisation, where there is no uniformity in terms of availability of resources and the level of development of each local government (Bossert, 1998; Kristiansen & Santoso, 2006). As such, a combination between engineering and public health disciplines in regulatory and policy frameworks will bring about the desired outcomes, since the engineering discipline provides a means of sanitation barriers, using appropriate technologies, and the latter provide a means of human health improvement through community development. Moreover, the status of human health should be the ultimate goal of all sectors involved in decision making to improve quality of life (Bossert, 1998).

In addition to implementing sustainable HCWM, the governments should also understand the importance of healthy public policy. In providing a healthy public policy, there is a need to collaborate relevant sectors, since health determinants are beyond the health systems (Gagnon, Turgeon, & Dallaire, 2007). The question is how to make relevant sectors outside the health sector aware of the health determinants that are beyond the health sector. This is a challenge, especially for local governments, in providing regulations within their jurisdictions, since local regulations are at the lowest stage of legal sanctions (Kristiansen & Santoso, 2006). Regular collaboration in the decision-making process is a medium for knowledge sharing and, eventually, the relevant sectors would be aware of their roles in accomplishing a better human health status.

Moreover, Christie (2008) states that a policy should contain the general principle of a government agency in providing guidance to its public administrative decision-making process. He also highlights that a policy is not law, but it is a tool to facilitate the decision-making process to ensure that outcomes of decisions are consistent (Christie, 2008). Therefore, a policy framework will be useful to accompany a regulatory
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framework that definitely constitutes a set of relevant regulations (Irianti & Herat, 2008).

Gagnon et al. (2007) distinguish the difference between public policy and healthy public policy, since the difficulty in implementing often lies in the fact that the rules established for implementation are not adequately constraining for those responsible for enforcement. To minimise the gap that exists, Christie (2008) notes that a negotiation is a means to resolve environmental conflicts based on sufficient regulations and scientific evidence. To conclude, regulatory and policy frameworks will be needed to establish a sustainable HCWM mechanism, with clearly defined roles and responsibilities of each stakeholder, upholding the essence of the duty of care to comply with relevant regulations.

In case of Indonesia, the Solid Waste Management Act No. 18/2008 would be beneficial and effective for regulating SWM, if it is complemented by sufficient and relevant regulations, and a suitable policy framework that is understood by all stakeholders. In addition to the policy framework, appropriate voluntary environmental policy instruments should be initiated, combined with regulations that are strict enough to be enforced against polluters and erring HCW institutions (Greaker, 2003; Tomer & Sadler, 2007; Wilson, Smith, Blakey, & Shaxson, 2007; Irianti & Herat, 2008a).

In order to strengthen the instruments for implementing safe HCWM, the central government can learn from international measures which are appropriate to be adopted, such as, hospital accreditation systems and the International Standards Organisation (ISO) 14000 series (Irianti & Herat, 2008a). In terms of appropriate technologies from different situations and resources, incineration and non incineration methods can be adopted after being reviewed, such as, the use of electron beam technology for infectious waste treatment (Meyers, McLeod, & Anbarci, 2006; El-Haggar, 2007).

Waste management hierarchy in health care settings

Few hospitals in Indonesia were familiar with the concept of WMH. This term is coined from the environmental philosophy of “cradle to cradle,” emphasising that “waste” is not the end of by-products, but that it could be used as raw material for other purposes (El-Haggar, 2007; Irianti & Herat, 2008a). As can be seen from the availability of waste management plans in the hospitals’ studied by Sasimartoyo (2004), only 43.67% out of
76 hospitals studied, have waste management plans that include the principles of reduce, reuse, and recycle of waste generated from the waste stream. Moreover, the majority of hospitals do not have a system of waste minimisation to reduce the cost of waste management (Irianti & Herat, 2008a). They have never performed a waste audit to determine all the types of HCW generation, as to plan waste treatment and disposal, in a way that complies with the Health Ministerial Decree of Hospital’s Environmental Health Standards (Irianti & Herat, 2008a; Irianti & Herat, 2008b).

Several donor agencies like the WHO, Asian Development Bank (ADB), United Nations Children’s Fund (UNICEF), and Gesellschaft für Technische Zusammenarbeit (GTZ), have given assistance to hospitals in disaster affected areas in Nanggroe Aceh Darussalam Province, to establish safe management of health care, by providing training for selected personnel from hospitals and initial waste management facilities; however, the results are not satisfactory, since the system is not sustained after the assistance terminates (Irianti & Herat, 2009a; Irianti & Herat, 2009b).

For instance, a survey at a district hospital conducted by the United Methodist Committee on Relief (UMCOR, 2007), in 2007, shows that the knowledge of hospital personnel about the impact of unsafe HCWM was very low, where only 16% of them - regardless of the types of personnel - knew that wastes could transmit blood-borne infections! This was so, despite some of them having been trained in a training of trainers on safe HCWM programme! In this case, the researcher assumes that this kind of system had never existed before the disaster, and HCW was not the priority of health care institutions, yet (Irianti, 2009b). Therefore, this province will need concerted efforts and time to initiate a sustainable system.

In contrast, when similar assistance was given to the health care establishments in Yogyakarta after an earthquake hit some districts and a municipality there, very satisfactory results were reaped within a short period, and the damaged system, repaired. This result was possible also because the HCWM system was in place even before the disaster, so that the local government and its hospitals were experienced in repairing and continuing the operation of their systems, after receiving assistance (CEHSRD, 2006; Irianti & Herat, 2008b). Nonetheless, these two different scenarios of existing HCWM, could help better understand the complexity of it in Indonesia.
Chaerul et al. (2008a) attempted to determine the dynamic and the role of each factor of HCWM in Jakarta by using a goal programming approach software (Stella®), which was based on all the important variables affecting HCWM. They found the number of beds and the “not in my backyard” syndrome (NIMBY) as significant variables. They also predicted that the future landfill sites in Jakarta will be full in 2020, and the rise of unmanaged wastes will be associated with the decrease of life expectancy. Therefore, they suggested that the hospitals should apply cost-effective treatment methods (Chaerul et al., 2008a).

Concerning HCWM, El-Haggar (2007) states that most of current HCWM in developing countries, are not performed in a proper or safe manner, thus posing significant environmental and human health problems. Technological advances in medical equipment and devices create more complex problems with the introduction of disposable syringes, needles, and similar items. Most treatment technologies are not cost-effective or environmentally acceptable. These technologies cannot effectively reduce the risk of waste-related diseases. For instance, the use of incinerators, on one hand, can reduce significant volumes of medical waste, but on the other hand, can produce treatment by-products like dioxins and furans (El-Haggar, 2007). This is because the operations and specifications of incinerators, like those used in Indonesia, do not meet the requirements of best practices of such technologies (Irianti, 2009b).

Diaz et al. (2008) and El-Haggar (2007) note that it would be difficult to predict the amount of medical waste generated in developing countries, since there were several factors contributing to the average generation of HCW. Moreover, Diaz et al. (2008) attempted to determine the characteristics of medical waste in several developing countries. However, they found such variability in the characteristics of the components of HCW, and quantities, that it would be necessary to perform waste audits in each country, being mindful of the factors influencing the quantities and characteristics of HCW generated.

To establish a sustainable and safe HCWM that is economically effective and acceptable, El-Haggar (2007) proposed an approach called the “cradle-to-cradle” concept. It is a concept designed to protect natural resources by applying a new life LCA that values “wastes” as raw materials for other purposes, and follows the cycle, through manufacturing and processing of raw materials, packaging, transportation and
marketing, use of product, reuse and/or recycle, and back to, the extraction of raw materials. This cycle is in total contrast with that of “cradle-to grave,” considered to be the “traditional LCA” (Ekvall, Assefa, Björklund, Eriksson, & Finnveden, 2007; El-Haggar, 2007).

Steps, including medical waste minimisation techniques, segregation at source, special handling or collection, interim storage, treatment or disinfection, and disposal, need be followed to adopt this new concept in HCWM. Finally, El-Haggar (2007) suggested using electron beam technology as the safest treatment technology, since the residue can be used as raw materials for other purposes. It thus seems that the minimisation techniques for HCW is similar to the use of green purchasing policy in hospital pollution prevention (P2) programs (Allen, 2006).

**HCW generation, segregation and storage**

Health care waste generation is influenced by such factors as: the kind of hospital, number of infectious disease beds, total number of beds, and number of outpatients per day (Tudor, 2007; Cheng et al., 2009). Types of wards and health care services also influence the amounts and characteristics of waste generated from each ward. Therefore, a hospital’s waste generation can be counted by identifying each type of waste, and weighing it to determine its type and volume or weight. In a health care institution with no waste management system, the wastes from each ward is usually collected and contained together with general waste. Until recently, there was no reliable data of the amount of HCW generated per bed from general hospitals, since there was no comprehensive study about HCWM, with waste audits and LCA (Irianti & Herat, 2008a).

In 1998-1999, a study conducted in Bekasi general hospital, Indonesia, to determine the amount of medical waste and general waste, found that the amount of infectious wastes was only 5.83% of 5.13 kg/bed of HCWs (Permadi & Wangsaatmadja, 1999). This seems to suggest that the amount of infectious waste found in that study of the hospital had applied segregation at source, as otherwise, a mixture of infectious waste and general waste would be categorised as infectious wastes. However, there was no additional information or explanation about the above figures. The report only stated that after implementation of the waste minimisation program, the amount of total HCW per day decreased from 5.13 kg/bed/day, to 2.14 kg/bed/day, because of the reduction of
recyclable wastes (Permadi & Wangsaatmadja, 1999). This study was not sufficient to determine the amount of medical waste and general waste in Indonesia, as it is only representative for class C hospitals, while there are four classes of hospitals, determined by the kinds of medical services and numbers of beds. The types of medical services and the waste management capacity are considered to be the most important factors of waste generation (Huang & Lin, 2007; Cheng et al., 2009).

The generation of HCW was also examined in 100 hospitals in Java and Bali islands, finding approximately, 3.2 kg/bed/day of solid HCW, and 416.8 litres/bed/day of liquid waste being generated (MoH, 1997). The proportions of solid general and medical wastes were 76.8% and 23.2%, respectively. This data indicates that there was no segregation at source, since the fraction of medical waste was still high. However, there was no explanation about waste generation from different classes and types of hospitals.

When appropriate waste management systems are instituted in a health care institution, segregation at source is practised, and medical and general wastes are separated, according to the relevant regulation. In more advanced HWM practices, sharps wastes and other infectious wastes, such as soiled bandages, human tissues, and laboratory wastes are also separated, depending on the types of treatment technologies. Diaz et al. (2008) and Mbongwe et al. (2008) point out that a full understanding of characteristics of medical wastes will lead to better choices of appropriate technologies. Similarly, Tudor (2007) highlighted the importance of medical waste definition and standardisation of measurement units to establish sustainable HCWM, which is, currently limited.

According to the findings of Sasimartoyo (2004), only 55.3% of hospitals studied, implement segregation at source. Hence, segregation practice at source of waste streams should be introduced to all health care personnel, and it will be the main phase of the WMH. Segregation practice will be sustainable, if there are sufficient skilled personnel, infrastructure and facilities, like trained operators, colour coded bins, special trolleys, colour coded plastics, SOPs, and adequate storages. Moreover, the segregation and collection based on colour coding should be followed by treatment and disposal units, using appropriate methods and technologies with regard to the WMH.
HCW treatment and disposal

The majority of hospitals were noted as not treating their medical wastes properly, and that incineration seemed to be the common technology used. There are many kinds of incinerators used in hospitals, however, they typically consist of one chamber, and most of them do not have temperature measurement devices, nor pollution control devices, and they have been operated for more than five years (Sasimartoyo, 2004; Irianti & Herat, 2008b). An earlier study by the MoH (1997) similarly revealed that 49% of 100 hospitals treat their wastes using incinerators, and that their performance is less than satisfactory, since they only reduce the amount of medical wastes, regardless of the best practice of their operations.

The majority of hospitals and other health care institutions continue with improper disposal of HCW, resulting in their mixing with municipal wastes, open dumping, or burning on-site (Sasimartoyo, 2004; Irianti & Herat, 2008a; Irianti & Herat, 2008b). Moreover, it was evident that most of the medical waste found its way to public disposal sites, exposing the general population living around the hospitals’ locations, to potential, unnecessary hazards (Irianti & Sasimartoyo, 2005; UMCOR, 2007; Irianti & Herat, 2008a; Irianti & Herat, 2008b).

The Program for Appropriate Technology in Health (PATH) conducted a more comprehensive study of the generation of HCW, in Yogyakarta Province (PATH, 2005), revealing several objectionable practices like the reuse of disposable syringes without proper sterilisation, used syringes scattered in HC backyards, recapping of used needles prior to disposal, and improper waste segregation. The PATH study intended to design and implement proper management of HCWs, since there were no clear policies or guidelines available for HCs. The HCWM program for HCs was successfully implemented through an off-site treatment system at a low cost, affordable to all HCs in Yogyakarta. However, improvement of the system is needed, especially with the treatment technology being used needing to be safer, since the existing program continues to use conventional incineration as only a means of reducing volumes of medical wastes (Irianti & Herat, 2008a).

There have been several private companies servicing HCW treatment and disposal in off-site waste treatment facilities, since 2009. The companies must comply with the Environment Ministerial Decree No. 18/2009 procedures concerning the HWM Permit.
In this Decree, all companies which manage hazardous waste should apply to relevant regulators, which was earlier mentioned in the section on regulatory policies in HCWM.

2.2 TOOLS AVAILABLE FOR BETTER MANAGEMENT OF HCW

This sub-chapter covers some important elements related to environmental management for better HCWM, starting with the nature of environmental management, its scope, and functions, in solving environmental problems. It also explains sustainable development, policies, international principles, CP, LCA, and management.

2.2.1 Environmental management

Environmental management was introduced in the 1970s, as a practical solution to environment-related problems, dealing with implementing and enforcing environmental policies (Barrow, 2006). It has since, become interdisciplinary, and holistic, with less emphasis on enforcement, and more, on encouragement and voluntarism. Today, with the increasing input of social sciences, and expertise from a variety of backgrounds, environmental management has become more integrative and participatory in nature (Barrow, 2006).

Moreover, Barrow (2006, p. 23) points out that environmental management attempts to gain environmental stewardship by synthesising ecology, social development, and other relevant disciplines to achieve its goal, including:

- Sustaining and, if possible, improving existing resources;
- The prevention and resolution of environmental problems;
- Founding and nurturing institutions that effectively support environmental research, monitoring and management;
- Warning of threats and identifying opportunities;
- Where possible, improving ‘quality of life;’ and
- Identifying new technology or policies that are useful.

The above goal indicates that an organisation implementing an environmental management system could improve its performance and preserve the environment, with its caring capacity, while utilising the environment.
Barrow (2006) also points out that environmental management can be divided into a number of fields, ranging from sustainable development issues to pollution recognition and control, and including, environmental assessment and impact studies. In this regard, Barnes (2011) points out that environmental management appears to overcome environmental degradation due to the exploitation of natural resources in modern industrial society.

Furthermore, Baxter (2011) mentions that the environmental management system has more defined and standardised approaches to assist any organisation to manage its functions to improve its performance, or to bring about certain outcomes, and to meet the requirements of ISO 14001. ISO 14001, which was published in 1996, and revised in 2004, provides clarification of the original text to be compatible with the ISO 9000 series quality systems standard (Baxter, 2011).

In relation to the scope of environmental management, Christie (2008) argues that environmental values are a common source of conflict when environmental problems appear. As the values are multidisciplinary, with the foundation of philosophy, economics and sociology, environmental management also provides a consensus in the decision-making process, and compromise, to achieve conflict resolution for environmental disputes.

2.2.2 Sustainable development

Today, sustainable development is a very popular term in environmental management, as opposed to, practices of traditional development, emphasising the maximum consumption of natural resources. There are many definitions of sustainable development by different experts and organisations, however, the dimension of its process is similar as a dynamic to halt the destruction of irreplaceable natural resources and pollution on the earth (Everard, 2011).

According to Baker (2006), sustainable development emerged in the public arena in 1980, with its focus on ecological sustainability, rather than social and economic problems. The term reached its highest popularity when Brundtland formulated sustainable development in the broader context of the means by which today’s needs are met without compromising the needs of tomorrow’s generations (World Commission on
Environment and Development [WCED], 1987). It encompasses the chain of economy—society—environment, for assuring a better life for all people (Baker, 2006).

Furthermore, Everard (2011) points out that within the concept of sustainable development, there will be an ongoing need for adaptation and innovation in shifting future economic conditions with respect to environmental pressures and social needs. There are several principles underlying the successful implementation of sustainable development, which will be explored in the next section.

### 2.2.3 International sustainability principles

Several fundamental principles for achieving sustainable development have been established to guide the implementation of any development in the right direction. The principles have been used internationally, and they can be adopted to the formulation and implementation of safe HCWM, as to prevent the negative impacts of HCW generation. These key principles are as follows (Prüss et al., 1999; Everard, 2011; Stookes, 2011):

- **The precautionary principle**
  
  The precautionary principle indicates that preventative measures should be taken where there is a scientific uncertainty, along with cumulative and potential hazards, identified in large areas, or could expand over a long duration. Moreover, the lack of scientific evidence should not delay the application of effective control measures. In this regard, O’Riordan and Jordan (1999) suggested that in the absence of full scientific evidence, other good sciences/considerations, such as, ethical, moral or political, will be required to formulate legitimate policy decisions, applying the precautionary principle. In relation to HCWM, this principle can be applied in preventing diseases caused by mismanagement of radioactive wastes used in health care facilities, as the wastes contain carcinogenic materials, destroying human tissues, and leading to the manifestation of cancer.

- **The prevention principle**
  
  The prevention principle allows measures to be applied before carrying out an activity, to prevent the negative impacts that may arise from that activity. Therefore, each country should provide regulations for preventing or controlling
wastes or emissions, capable of causing pollution. This principle can be applied in immunising health care workers from blood-borne infections spread by contaminated syringes or other wastes.

- **The polluter pays principle**

  The polluter pays principle holds that all waste generators should be responsible for safe waste management by following 3R initiatives, and by complying with relevant regulations and policies. This principle indicates that preventative action should be taken and environmental degradation should be overcome at source, with the polluter bearing the cost, accordingly.

- **The proximity principle**

  The proximity principle specifies that treatment and disposal of waste should be done on-site if technically and environmentally acceptable. This principle is to avoid additional costs and risk related to transport and the possibility of community resistance. This also opposes the practices of waste exports which are not allowed by the Basel Convention.

The above principles should also guide all activities utilising the environment, and affecting the quality of life of all creatures, as all stakeholders are interconnected, and inevitably share the universe with its finite resources. Also, we have responsibilities to ensure that our future generations will be entitled to a liveable world.

### 2.2.4 Policies

An environmental policy is a statement of an organisation with respect to the environment, as its operations, to a certain degree, has an influence on the environment (Baxter, 2011). It also covers a “commitment” to progressively improve the organisation’s environmental performance, and to comply with relevant legal and other requirements relating to the environment (Baxter, 2011). Moreover, Kraft (2007) argues that environmental policy has been exceeding its traditional scope as it includes government actions affecting human life in relation to environmental problems. According to Australia’s Federal Court as cited by Christie (2008), a policy can facilitate the integrity of the administrative decision-making process. Therefore, environmental policy should be utilised for understanding related regulations, dealing
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with environmental problems and health, particularly dealing with HCWM in Indonesia, which is currently unclear and difficult to understand by stakeholders.

Environmental policy in an organisation can be integrated with other policies, such as, health and safety, or it can be a sole document, which is usually in a written statement and signed by managers or the chief executive (Baxter, 2011). Therefore, in an organisation like a hospital, the availability of an environmental or hospital policy should be easy to access by its workers or other parties. This would have a significant influence to encourage all parties to comply with such a policy, and it would also indicate that the organisation is ready to achieve its goal in protecting the hospital community and the environment.

The examples of environmental aspects of an organisation’s operation, which is similar to a hospital, are as follows (Baxter, 2011, p. 266):

- Emission to air;
- Release to water;
- Disposal of waste and contamination of land;
- Use of energy, raw materials and natural resources;
- Land use and habitat loss;
- Disposal of the organisation’s products by customers; and
- Environmental performance of contractors and suppliers.

This indicates that hospitals inevitably utilise the environment for their activities to provide health care services. As such, they have also a responsibility to preserve the environment by implementing an environmental management system. This responsibility should explicitly appear in their policies.

An environmental policy relates to health policy, too, as the latter seeks to resolve the health related problems, while ill-health itself, could be an outcome of environmental problems. As Calman and Smith (2001) point out, the roles of the precautionary principle in public health policy are clear enough. For instance, they argue:

“If society’s core purpose is to protect the health and well being of the population as a whole from some risk or threat to health, then society also needs to decide on the nature of the precautionary principle framework within which it is to operate.
Policy makers need to identify which risks should come under the purview of the principle and which should not”. - Calman and Smith, 2001, p. 193.

The above statement indicates that policy makers who set out a health policy should clearly determine risk factors related to the environment, to protect public health within their framework, adopting the precautionary principle, and by utilising all relevant sources of information, even though there is an uncertainty about the magnitude of health hazards. Moreover, the health policy makers should utilise the availability of risk assessment results for obtaining more information, instead of the precautionary principle, as the latter will be used when epidemiological data are rare but potential health hazards are identified. Therefore, an anticipatory action to minimise the harm can be taken.

According to Barraclough and Gardner (2008), health policy and other public policy have similarities. Moreover, health care, and public health, influences almost every aspect of people’s lives, beyond a narrow concern with medical care, and, as such, it is imperative to analyse health policy in relation to HCWM. Hill (2009, p. 5) provides different types of policy analysis which are categorised into “analysis of policy” and “analysis for policy.” The former includes studies of policy content, studies of policy outputs and studies of policy process; whereas the latter consists of evaluation, information for “policy making,” “process advocacy,” and “policy advocacy” (Hill, 2009, p. 5). In relation to the study conducted, the researcher applied both of the types of analyses, to some extent, as to elicit information from primary data obtained from the mailed survey and in-depth interviews, as well as, literature review of regulations and policies pertaining to HCWM, which are currently available in Indonesia.

There are a number of definitions of policy, available in the literature, though they are all, similar in nature. Hill (2009) adopts the definition of policy from Chamber’s dictionary as: “a course of action, especially one based on some declared and respected principle”. Furthermore, Hill (2009) argues that policy is not a concrete phenomenon and different people will use the word “policy” in different ways, depending on its context or objectives.

Health policy analysis, as Crinson (2009) points out, must look at related fields, based on the contents to be analysed. However, there is no exact border of each scope, as health itself can be defined as narrowly as “curative care,” or broadly, to include public
health and more. As such, policy in any field is rather dynamic in nature and difficult to limit in scope, and avoid overlapping with other fields. It should involve a consideration of multidisciplinary expertise and appropriate evidence, to formulate an evidence-based policy.

Smith and Larimer (2009) also point out that public policy (including health policy), is categorised as an answer for addressing a problem with regard to efficiency, as its methodology is oriented to identifying the most efficient solution to a given problem. This is closely related to the rational approach, as it is based on the assumption that a better policy is more comprehensive, and more accurate, when it is supported by empirical information. As such, when addressing HCWM, a health care policy, combined with an environmental policy (since the locus of the problem is in the health care establishments and the nature of the problem is potential environmental pollution), will certainly be needed to overcome the problem.

Once an environmental policy is formulated, the organisation should establish environmental programs to translate the policy into a set of actions to improve its environmental performance. Before setting the program, the organisation should assess the significance of environmental impacts to identify the likely negative impacts of the organisation’s operation during normal conditions, periods of maintenance and shutdown, and during emergencies (Baxter, 2011). This can be the most difficult phase, even though many techniques and tools are available. Therefore, a professional judgment will be important to address the significant environmental impacts, and with the assistance of stakeholders, this assessment can be carried out properly.

An interesting term/phrase related to waste management is what Smith (2004, p. 204) called “the policy paradox in hazardous waste management”. This term notes that when the policy implementation phase chooses to minimise the risk of hazardous waste, it always leaves behind the actual burden caused by the wastes, and the existing problems will be eventually paid for, or dealt with, in some way, by future generations. This example came from the US experience in implementing an environmental policy dealing with hazardous waste management. A similar scenario could arise in Indonesia, where there has been a lack of commitment to implement a suitable environmental policy based on the real problems. Hence, the creation of an appropriate policy framework would be a necessity for better HCWM in Indonesia.
2.2.5 Cleaner production

Cleaner production is defined by the United Nations Environment Programme (UNEP) as “the continuous application of an integrated preventative environmental strategy to process products and services to increase efficiency and reduce risks to humans and the environment” (UNEP, 2012).

Cleaner production could be applied to minimise generation of wastes and emissions from businesses and industrial activities, by redesigning technologies and procedures throughout the product life cycle, efficiently and effectively. In this approach, waste streams and causes are identified and options to waste generation and screening are determined (van Berkel, 2007). Therefore, CP is a useful strategy for avoiding the generation of pollutants before they are created. Thus, the goal of CP is to protect the environment and human health in an economically efficient manner (Wolnik & Fischer, 2006; Miller, Burke, McComas, & Dick, 2008).

Herat (2000) proposed flexible learning for CP amongst professionals, so that, they can be pioneers in their fields to implement CP concepts to achieve better environmental management. This approach can also minimise the barriers to implementing CP in industries, including the health care industry.

Unnikrishnan and Hegde (2006) also state that the application of CP technologies is not only desirable from the point of a pre-emptive environmental strategy, but also makes good economic outcomes. CP practices have proved to solve waste related problems by conserving resources like energy, raw materials and personnel, improving yield and reducing treatment/disposal costs in many industries (Unnikrishnan & Hegde, 2006).

In Australia, the CP implementation framework was introduced in 1998, and re-invigorated under the new umbrella of Eco-efficiency (EE) in February 1999, thereby confusing the meaning (van Berkel, 2007). The experience of Western Australia can be used as an example of the evolution of CP in Australia.

The key CP development in West Australia started in 1996 covering four periods; namely groundwork, experimentation, roll-out and reorientation (van Berkel, 2007). In 2001, the Labour government introduced reforms in waste and environmental policy and their implementation and enforcement, with the renewal of a strategic commitment to zero waste (van Berkel, 2007). CP and EE were advocated in Western Australia as
“complementary concepts,” with EE focusing on the strategic side of business, and CP on the operational side (production) to achieve P2.

The concept and strategy of CP developed by Rene van Berkel (2000) can be seen in the following figure.

![Figure 2-3 Cleaner production concepts](source)

This concept of CP is relevant to health care industries. For instance, waste minimisation, as the most desired action in the WMH, can be achieved by adopting a green purchasing policy. The policy promotes the use of bulk materials for direct or indirect purposes in hospitals. Combined with good housekeeping, it helps reduce the amount of waste generated. Toxic use reduction can be adopted by replacing mercury related products and devices. According to the WHO (2005), health care facilities release 5% mercury via air and 10% via water. Therefore, CP can help reduce the burden of hospitals as a source of pollution.
Dealing with barriers which may be encountered in implementing CP in health care facilities, the CP strategy can be integrated with HPH’s strategies. This can enable changing of mindsets of existing health care managers, through raising awareness of the importance of CP in complying with regulations, and at the same time, their economic benefits, as well as, promoting healthy hospitals. In the long-term, hospitals could also achieve a significant reduction of HAI. This would also affect the hospital’s revenue, by reducing the LOS of patients, as they would not suffer from other diseases caused by unhealthy hospital environments (Irianti, 2009a).

In the health care sector, CP is best known as P2 to achieve healthy hospitals, and has been successfully implemented in health care establishments in Canada (Wolnik & Fischer, 2006). According to Allen (2006), health care facilities do not produce a ‘product,’ nor operate a fabrication ‘process’ whose outputs can be readily recycled, reused or reprocessed. Therefore, many CP options are not readily applicable to health care facilities, since their generation of by-products, happens differently. Several options that can be implemented in hospitals, include:

- **Process or equipment modification**;
- **Product and/or chemical substitution or elimination**;
- **Loss prevention and housekeeping**;

**Figure 2-4 A two-pronged CP strategy**

Source: Van Berkel (2007, p. 745)
Waste segregation and improvement in efficiency;
Closed-loop recycling.

These options could be adopted by Indonesian hospitals, even with their different capacities and resources, and they could try to implement CP to minimise potential pollutants, based on their own targets determined by an environmental assessment tool like LCA.

In developed countries like Canada, P2 in hospitals began with integration into regulations (Allen, 2006). Requirements of effluent standards applied to all health care facilities at the point of discharge, and enforcement of its application can be tracked through municipal servicing contracts and permits (Allen, 2006). The regulations also encourage health care institutions to develop detailed plans to reduce levels of effluents below the stipulated discharge limits, to eventually reach minimal or zero discharge. This kind of regulation should be adopted as it restricts the effluent levels, and also, encourages health care establishments to improve their sanitation systems.

Cleaner production emphasises human and organisational dimensions of environmental management, including good plant operation to avoid accidental discharges (Unnikrishnan & Hegde, 2006). To effectively implement CP in any industry, effort should be made to identify a driving force to promote it. It is commonly argued that one of the principal ways to trigger CP and to ensure its proper implementation lies with government capacity to establish a legislative framework for environmental prevention and protection, supported by an enforcement system (Ciccozzi, Checkenya, & Rodriguez, 2003).

Furthermore, Ciccozzi et al. (2003) underline the important factors influencing the promotion of CP in developing countries. These include the economic climate, the political/legal environment, available skills and attitudes, beliefs, and values of waste. Similarly, Stone (2000) also states that CP is not only about changing raw materials, processes and products, but also, about changing corporate culture and the attitudes of people.

Cleaner production was introduced to industries in Indonesia in 1993, to encourage them to adopt environmental management, with regard to natural conservation and P2 (Marshal, 2009). However, only a few kinds of industries adopted CP as they had
experienced economic benefits from CP. The CP concept and policy have not yet influenced the health care sector to adopt them. It may mean that the CP policy is not clear enough, since there aren’t enough regulations and guidelines for its implementation. There is also a lack of dissemination of information about CP to the health care sector. The existing policy thus needs to be reviewed in anticipation of the dynamics of the health care sector’s needs, and harmonised with other instruments like the Solid Waste Management Act No. 18/2008.

Initially, hospitals can focus on applying P2 technologies, such as, formalin distillation, ethylene oxide elimination, glutaraldehyde substitution, and mercury-free sphygmomanometers, depending on their priorities of implementing CP.

2.2.6 Life cycle assessment (LCA)

Life cycle assessment is an environmental tool for assessing the impacts of industrial products through their life cycle, i.e., from the source of raw material through production process, use and disposal (cradle). Therefore, LCA can guide decision making, by identifying potential environmental impact transfers from one media to another, and provide an estimation of cumulative environmental impacts, arising from all phases in the product life cycle (Curran, 2008).

According to Curran (2008), LCA was first introduced in the late 1960s as a tool to finding options over limitation of raw materials and energy resources, and continued to be used for environmental problem analysis in SWM, which began emerging as a global issue. This led to the development of LCA standards in the ISO 14000 series (1997-2002, and updated in 2006) (Curran, 2008; Cleary, 2009).

Moreover, Curran (2008, p. 2169) describes LCA as a tool to assess environmental aspects and potential impacts associated with a product, process, or service, by:

- appropriately selecting a functional unit;
- clearly defining the goal and scope of the study;
- compiling an inventory of relevant energy and material inputs and environmental releases;
- evaluating the potential environmental impacts associated with identified inputs and releases; and
- interpreting the results to help decision makers make a more informed decision.
Cleary (2009) conducted a comparative review of LCA, used in SWM, from 2002-2008, from 20 publications, to assess the following ten elements: (1) study area and scale; (2) goals of the reviewed LCAs; (3) functional units; (4) system boundaries; (5) types of data sources; (6) environmental impacts; (7) sensitivity analysis; (8) use of LCA computer models; (9) economic costs of MSW treatment; and (10) the quantitative results for net energy use (NEU), global warming potential (GWP) and acidification potential (AP). The overall results found that there were unclear goals and scope definition, amongst 20 LCA analysts, conducting LCAs of MSWs.

According to Ekvall et al. (2007), LCA is not only useful for determining the best option of SWM to reduce environmental impact, but also for assessing indirect environmental impact from the surrounding system of waste management. However, the traditional LCA cannot be used for predicting the appropriate time for investment in waste management plants, as it is a static model. Hence LCA is valid only for current investment of a waste management strategy. Moreover, LCA cannot be used to plan the change of waste flows, and another study to determine the change of waste flows need be added to the traditional LCA tool.

Another disadvantage is that LCA model’s sum of parameters of pollution and the fate of these parameters in different treatment process is sometimes unknown (Ekvall et al., 2007). Therefore, LCA cannot predict the actual environmental impact caused by different types of chemical substances, accurately, as it only counts chemicals aggregately, as compounds, such as, polyaromatic hydrocarbons (PAH), volatile organic carbons (VOC), and total organic compounds (TOC). In order to assess the actual environmental impact with respect to site-specific knowledge, Ekvall et al. (2007) suggest other methods, such as an environmental impact assessment (EIA), or risk assessment.

Another study using LCA was conducted by Zhao, van der Voet, Huppes, & Zhang (2009) in China, to assess the difference of environmental performance between incinerator and non-incinerator treatments for medical wastes. They employed five alternatives of two types of waste treatment technologies: the hazardous waste incinerator (HWI) alternatives include three energy recovery efficiencies based on the lower heating value of medical waste: 0% (without energy recovery), 15% (conventional), and 30% (optimized); and, the steam autoclaves with sanitary landfill
(AL) alternatives include two situations: 0% (landfill gas ignited on site) and 10% (conventional). The study concluded that the HWI with high energy recovery is better than the non-incinerator treatment method. However, this study did not assess the emission of dioxins and its formation from the HWI method, which could introduce some uncertainty.

The application of LCA in Indonesia is quite rare, as it is time consuming and relatively expensive (Gunamantha & Sarto, 2012). Therefore, a simplified LCA was adopted by Gunamantha and Sarto (2012) in Yogyakarta City, Sleman and Bantul Districts, to assess environmental profiles of different SWM options to replace the uncontrolled land-filling system that should be done by 2014, as mandated by the Solid Waste Management Act No. 18/2008. The options assessed were: the land-filling system with or without energy recovery, incineration, gasification, and anaerobic digestion. The study revealed that the LCA was useful to determine environmental profiles of SWM treatments to produce energy, and direct gasification was best in generating energy, with respect to environmental performance (Gunamantha & Sarto, 2012).

2.3 SUSTAINABLE HCWM

2.3.1 Overview of HCWM in several countries

Health care establishments, including hospitals, were traditionally perceived as places delivering curative health services where sick people were admitted and cured, either as outpatients or inpatients. They have special duties or a mission, and are regarded by their communities as essential places to obtain medical treatment from, and not as places that pollute the environment. Therefore, they are ignored as institutions or industries that represent occupational and environmental threats.

In the US economy, health care is the largest single industrial sector – accounting for approximately, $2 trillion dollars per year, equivalent to 16% of the economy, and predicted to rise to 20% by 2015 (Brannen, 2006). Moreover, Brannen (2006) points out that health care institutions consume considerable resources for their activities. Consuming 11% of all commercial energy use, and being within the top ten water users, they produce huge amounts of wastewater, containing toxic laboratory substances, cleaning chemicals, and pharmaceutical compounds (Brannen, 2006).
The provision of high-quality health care in the USA has resulted in a tremendously high environmental cost, and this was ignored by the health care sector and environmental regulators, until the mid-1990s, as health care seemed to be immune to scrutiny, due to their duties (Brannen, 2006). In the late 1990s, the US EPA found that the health care industry, largely, did not comply with basic environmental regulations. It is significant to note that the rate of non-compliance amongst the general industry was one in 30 inspections, compared to one in two facilities, in the health care sector.

US health care facilities are still responsible for the generation of at least 2 million tons of waste, annually. Ten years ago, health care facilities were identified as the fourth largest source of mercury emissions, and second leading source of dioxins discharged from 6,200 medical waste incinerators (Brannen, 2006). Today, however, medical incinerators are only fewer than 100, but many municipal waste incinerators remain operating (Brannen, 2006).

Miller et al. (2008) suggest that P2 and CP approaches can be implemented to overcome the significant environmental problems faced by US hospitals. These two approaches start with education at various levels and settings, encouraging a fundamental commitment to a healthier environment, and changing the way health care facilities operate. In addition to the above solution, Zarker and Kerr (2008) highlight the importance of fully integrating environmental, economic and social drivers that can sustain environmental programs, focusing on pollution prevention.

Similarly, Brannen (2006) also recommends implementing ‘hospitals for a healthy environment,’ which articulate environmental stewardship activities within hospitals, engaging health care communities, patients and hospital staff, and empowering them to accomplish the duty of care. These activities include safer building products, clean air, energy and water efficiency, environmental education, and practical waste-volume and toxicity reduction programs.

Japan has also faced problems with HCWM, as there are many health care facilities and limited land available for controlled landfills. The management of infectious waste materials was regulated in 1992, under the amended Waste Disposal Law of 1991 (Miyazaki & Une, 2005; Miyazaki, Imatoh, & Une, 2007). In the amended Waste Disposal Law of 1991, infectious wastes are defined as the infectious waste materials generated in health care facilities, as a result of medical care or research, containing
pathogens that have the potential to spread infectious diseases (Miyazaki & Une, 2005). Infectious waste materials become non-infectious after they have lost infectivity by an intermediate treatment, such as, incineration, melting or sterilization, and they are buried in a controlled landfill.

General waste from health care institutions are managed by the same approach as MSW, through waste reduction, promotion of recycling, volume reduction by intermediate treatment, and environmentally sound final disposal (Tanaka, 1999). The government also applies stringent regulations on air pollution caused by incinerators, which are a common means of municipal and infectious waste treatment at intermediate treatment facilities (Orloff & Falk, 2003; Miyazaki & Une, 2005). Furthermore, Tanaka (2007) stated that concerted efforts have been taken to improve the performance of incinerators by issuing the Law concerning Special Measures against Dioxins in July 1999. Sufficient examinations were carried out to establish the accurate standards of effluents and emissions from incinerators. Strict monitoring and controlling overcame the polychlorinated biphenyls (PCBs) problem, and several chemical treatment facilities have been provided for all PCBs waste (Tanaka, 2007). More importantly, Japan has also promoted extended producer responsibility (EPR) as a new public policy instrument. All these efforts are intended to achieve a sustainable society in Japan (Tanaka, 2007).

Each health care institution must engage a waste contractor authorised by a prefectural government to treat and dispose of infectious waste. More than 90% of health care facilities outsource their infectious waste treatment and disposal (Tanaka, Kaneko, Takahara, & Shekdar, 2004). The costs include collection and transportation, the quantity of waste, container, and treatment in an incineration plant. A contractor determines the infectious waste container, which has been regulated since 1995. According to them, the cost of infectious waste management is much higher (almost ten-fold) than that of the cost of general waste management.

While delivering high quality health care services, the health care institutions are also responsible for intensive education on proper infectious waste procedures to reduce the cost of such treatment and disposal (Miyazaki & Une, 2005). In terms of sustainable management of general waste from health care facilities, Japan continues to implement the 3R policy, with a clear framework for achieving the sound material-cycle society,
and so far, has achieved remarkable results (Tanaka, 2007; Takiguchi & Takemoto, 2008).

Generation of HCW and their treatment/disposal costs in England tend to increase rapidly (Tudor, Noonan, & Jenkin, 2005; Woolridge, Morrissey, & Phillips, 2005). An Audit Commission (1997, cited in Tudor, 2007) in London, revealed clinical waste production ranging from under 0.25 tonnes/bed/year to 1.2 tonnes/bed/year. The contributing factor to the rise of HCW production in the UK and other countries has been associated with the use of disposables in UP procedures (Prüss et al., 1999; Tudor, 2007).

The Department of Health (DoH) in the UK has tried to implement the sustainable development concept in its business policy, including health care policy. In spite of facing limitations in integrating the concept of sustainable development, the UK has implemented sustainable HCWM to achieve resource efficiency, and to protect human health and the environment, by reducing HCW generation (Tudor, 2007). A number of efforts to reduce, reuse, and recycle HCW, in compliance with available regulations, have been put in place.

To translate such concept into action, so as to have more accurate data on waste generation measurement, Tudor (2007) conducted a study in 2004 concerning the generation of HCW, based on two main variables: namely, department type, and, activity levels. He used waste audits taking into account moisture contents of wastes, and fraction of waste bags, from selected departments, and stratified the occupants. He revealed that there were two determinants of waste generation pattern, and each determinant was not linear in influencing the pattern (Tudor, 2007). Tudor et al. (2007) also found that there was a gap between intended behaviour and actions of health care staff dealing with recycling. Therefore, they suggested greater focusing on the policy that encourages active involvement of staff to perform positive actions to sustain efforts on reducing and recycling wastes within the health care institutions.

Townend, Cheeseman, Edgar, and Tudor (2009) reviewed the determinants of the development of HCWM in the UK over the past 60 years. They revealed remarkable changes in the generation of HCW due to several factors in the environmental, social, legal, and economic fields. The UK experience will definitely be very useful for other countries to follow, in terms of its strengths and weaknesses, and lessons learned. The
various instruments for regulating HCWM have been tested and renewed in order to improve the environmental performance, and to determine the best solutions, considering the economic and social aspects of high quality health services for their people. Moreover, Townend et al. (2009) emphasise the importance of a national policy as a first stage in initiating sustainable HCWM in a country where such a system is absent, like Indonesia.

China has, approximately, 298,997 health care facilities. These generate a considerable amount of wastes, and a survey in several cities recorded an estimated 0.8 kg/bed of medical wastes (Duan, Huang, Wang, Zhou, & Li, 2008). The definition of HCW is similar to the WHO definition, that is, wastes characterised by infectious, toxic substances, deriving directly or indirectly, from health care facilities and other related activities (Prüss et al., 1999; Yang et al., 2009). The Chinese government defined HCWM policy in the 1990s, and a national plan was issued by the State Council in 2004, after the outbreak of Severe Acute Respiratory Syndrome (SARS) in 2003 (Yang et al., 2009).

Incineration is the present means of waste treatment technology used in China, as it has several advantages (Duan et al., 2008; Yang et al., 2009). Duan et al. (2008) also revealed that there was little attention given to medical wastes, and almost 90% of them were disposed of, together with MSW. However, due to increasing awareness of environmental pollution and technology advancement, there arose the need to use non-incineration technology to fulfil the Stockholm Convention requirements on pollution control (Yang et al., 2009). The Chinese government continues to improve their HCWM system, by reviewing the existence system and developing a framework for sustainable HCWM.

Another interesting system is seen in Korea, where HCWM was regulated by the Medical Law, under the Ministry of Health and Welfare, until 1999. The HCW was practically being disposed of, along with MSW, in municipal landfill sites, without treatment prior to disposal.

The Korean National Assembly amended the Waste Management Act in 1999 to overcome the problems arising from HCW, and for better management along the WMH, and the MoH is responsible for the implementation of the Act. The Act defines medical waste as “any solid waste generated by medical treatment facilities and laboratory
facilities operating in a hospital setting and is considered to be potentially hazardous to health” (Jang, Lee, Yoon, & Kim, 2006, p. 107). This definition is similar to the WHO definition of medical waste (Prüss et al., 1999) that was also adopted by the Indonesian MoH (Irianti & Sasimartoyo, 2005).

In Korea, the generation of medical wastes has also risen significantly, partly as the result of using disposable materials. In 2002, the production of medical waste was 33,980 tonnes from 44,478 health care facilities, or equivalent to 0.14 to 0.49 kg/bed/day, assuming a 100% BOR (Jang et al., 2006). Approximately 60% of medical waste was from general hospitals, which account for only less than 0.7% of total waste generators (Jang et al., 2006).

As medical waste is categorised as hazardous, the Korean Government has established an on-line manifest system, since 2002, to monitor the involvement of all parties in HCWM, so as to achieve a high degree of reliability and cost saving through real time waste tracking (Jang et al., 2006).

In terms of treatment technology, incineration was the preferred waste treatment method available until 2002. The second preference was stream sterilisation with shredding. Interestingly, Yang et al. (2006) also stated that recycling of placentas for pharmaceutical products was common. As the existing small-scale incinerators are not equipped with air pollution control devices, the need for more large-scale incinerators and other technology for better medical waste management is therefore a major challenge for Korea (Jang et al., 2006).

Health care waste generation in several countries can be seen in Table 2-1. This table provides information on generation of general and medical wastes from several countries which have been published from 1997 to 2012. The amounts of waste generation vary since there are several factors influencing them.
### Published studies on HCW generation in several countries around the world

<table>
<thead>
<tr>
<th>Year</th>
<th>Country</th>
<th>General Waste</th>
<th>Medical Waste</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>Tanzania</td>
<td>-</td>
<td>0.66 kg/patient/day</td>
<td>Mato &amp; Kassenga (1997)</td>
</tr>
<tr>
<td>2001</td>
<td>India</td>
<td>-</td>
<td>0.53-2.23 kg/bed/day*</td>
<td>Patil &amp; Shekdar (2001)</td>
</tr>
<tr>
<td>2004</td>
<td>Iran</td>
<td>0.76-10.67 kg/bed/day</td>
<td>0.23-4 kg/bed/day (infectious)</td>
<td>Askarian, Vakili, &amp; Kabir (2004)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.01-0.13 kg/bed/day (sharps)</td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>Brazil</td>
<td>2.675 kg/bed/day</td>
<td>0.570 kg/bed/day</td>
<td>Da Silva, Hoppe, Ravanello, &amp; Mello (2005)</td>
</tr>
<tr>
<td>2005</td>
<td>Mauritius</td>
<td>-</td>
<td>0.072-0.179 kg/patient/day</td>
<td>Mohee (2005)</td>
</tr>
<tr>
<td>2005</td>
<td>Lao DPR</td>
<td>-</td>
<td>0.38-0.62 kg/bed/day</td>
<td>Phengxay et al. (2005)</td>
</tr>
<tr>
<td>2006</td>
<td>Korea</td>
<td>-</td>
<td>0.14-0.49 kg/bed/day*</td>
<td>Jang et al. (2006)</td>
</tr>
<tr>
<td>2007</td>
<td>Jordan</td>
<td>-</td>
<td>1.88-3.49 kg/bed/day</td>
<td>Bdour, Altrabsheh, Hadadin, &amp; Al-Shareif (2007)</td>
</tr>
<tr>
<td>2008</td>
<td>Jordan</td>
<td>-</td>
<td>0.5-2.2 kg/bed/day (90% infectious and 10% sharps)</td>
<td>Abdulla et al. (2008)</td>
</tr>
<tr>
<td>2008</td>
<td>Croatia</td>
<td>1.04 kg/bed/day</td>
<td>0.16 kg/bed/day</td>
<td>Marinković, Vitale, Holcer, Džakula, &amp; Pavić (2008)</td>
</tr>
<tr>
<td>2009</td>
<td>Taiwan</td>
<td>2.41-3.26 kg/bed/day</td>
<td>0.19-0.88 kg/bed/day</td>
<td>Cheng et al. (2009)</td>
</tr>
<tr>
<td>2009</td>
<td>Bangladesh</td>
<td>-</td>
<td>1.50-1.71 kg/bed/day</td>
<td>Patwary et al. (2009)</td>
</tr>
<tr>
<td>2009</td>
<td>Iran</td>
<td>2.439 kg/bed/day</td>
<td>1.039 kg/bed/day</td>
<td>Taghipour &amp; Mosaferi (2009)</td>
</tr>
<tr>
<td>2009</td>
<td>Libya</td>
<td>-</td>
<td>0.364 kg/patient/day</td>
<td>Sawalem, Selic, &amp; Herbell (2009)</td>
</tr>
<tr>
<td>2009</td>
<td>China</td>
<td>-</td>
<td>0.5-0.8 kg/bed/day</td>
<td>Yong, Gang, Guanxing, Tao, &amp; Dawei (2009)</td>
</tr>
<tr>
<td>2010</td>
<td>Nigeria</td>
<td>-</td>
<td>0.62 kg/person/day (outpatient)</td>
<td>Abah &amp; Ohimain (2010)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.81 kg/bed/day (inpatient)</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>Taiwan</td>
<td>3.97 kg/bed/day</td>
<td>2.08 kg/bed/day</td>
<td>Cheng, Li, &amp; Sung (2010)</td>
</tr>
<tr>
<td>2010</td>
<td>China</td>
<td>-</td>
<td>0.77-1.22 kg/bed/day</td>
<td>Ruoyan et al. (2010)</td>
</tr>
<tr>
<td>2011</td>
<td>Turkey</td>
<td>4.23 kg/bed/day</td>
<td>2.11 kg/bed/day</td>
<td>Eker &amp; Bilgili (2011)</td>
</tr>
<tr>
<td>2011</td>
<td>Greece</td>
<td>-</td>
<td>1.204 kg/bed/day</td>
<td>Komilis, Katsafaros, &amp; Vassilopoulos (2011)</td>
</tr>
<tr>
<td>2012</td>
<td>Greece</td>
<td>-</td>
<td>0.012-0.72 kg/bed/day</td>
<td>Komilis, Fouki, &amp; Papadopoulos (2012)</td>
</tr>
</tbody>
</table>

*Assumes 100% BOR.
2.3.2 Sustainability and the HCWM hierarchy

Sustainability

Many writers use the terms “sustainability” and “sustainable development” in relation to environmental management. Whilst sustainability is “a state of indefinite continuance”, sustainable development is “a process of development where we stand today towards that ideal state” (Everard, 2011).

According to Lombard (2002, p. 9) Sustainability has several elements including:

- Economic component
- Ecological component
- Social component

There are also four principles of sustainability:

- Futurity
- Ecological integrity
- Social justice
- Participation

The elements and principles of sustainability are important for establishing sustainable HCWM, as those elements not only provide direction to prevent environmental pollution due to HCW generation, but also encourage waste generators to derive economic incentives by managing their waste accordingly. Moreover, in terms of the social element of sustainability, a suitable HCWM policy promotes the education and empowerment of the health care community, by increasing their awareness of, and concern for, pollution and waste, and assists in the development of knowledge, skills, values and commitment (Lombard, 2002; Townend et al., 2009). Participation is also important to establish roles and responsibilities of each actor in HCWM, and raise awareness and commitment to achieving the goal of sustainable HCWM.

In terms of ecological principles, HCWM should consider promoting the use of environmentally friendly products and technologies, such as, mercury-free devices, autoclaving, and electron beam technology, instead of using conventional incinerators
To achieve sustainable HCWM, waste generators need to systematically follow the five tiers of the WMH.

**HCWM hierarchy**

The WMH is a direction tool for implementing sustainable waste management strategies, including HCWM, emphasising that waste avoidance should be an ultimate goal for any approach to waste management, including the health sector. The order to be followed to systematically approach waste management: avoidance of waste generation, and recovering materials for reuse, repair and recycle, as far as, is practical, economical, feasible and harmless. WMH is popularly associated with the terms “reduce, reuse, and recycle” (3Rs) as a means of waste minimisation. The five tiers of WMH are in Figure 2-5 (DERM, 2010b).

![Figure 2-5 Waste management hierarchy](image)

Source: modified from DERM (2010b).

**Reduction of HCW generation**

The prevention/avoidance of HCW generation is the first step towards better HCWM. This includes establishing green purchasing restrictions, evaluation of medication management, and good house-keeping of medical and non-medical products and appliances, and stock management of chemical and pharmaceutical products (Prüss et al., 1999; Tweedy, 2005). Another alternative is to select products that are less wasteful or generate less hazardous waste (Prüss et al., 1999; Tweedy, 2005).
McGurk (2004) also provided evidence from California, that a reduction of medical wastes program could be implemented independently by six strategies:

- Eliminating solid wastes from the medical waste stream
- *Bio-Elite* red bag
- Blue wrap recycling
- Reusable sharps containers
- Sharps containers manufactured with recycled plastic
- Recycling single use medical devices

Of course, all these strategies could not be applied without the necessary service for their implementation being available; thus developing countries, like Indonesia, could implement the strategies adoptable by their levels of service and technology.

➢ **Reuse of HCW**

According to Prüss et al. (1999), some medical and other equipment used in health care facilities may be reused, where they are designed for reuse, following proper sterilisation, etc., according to their manufacturers’ instructions. Reusable items may include certain sharps, like scalpels and hypodermic needles, syringes, glass bottles and containers, etc.

Before sterilisation of reusable items, they should be collected separately from non-reusable items, washed properly (especially, in the case of hypodermic needles, where infectious droplets could be trapped), and may then be sterilised (Prüss et al., 1999). The description of thermal and chemical sterilisation of reusable items can be seen in the following:

**Thermal sterilisation**

- **Dry sterilization**
  
  Exposure to 160 °C for 120 minutes or 170 °C for 60 minutes in a “Poupinel” oven.

- **Wet sterilization**
  
  Exposure to saturated steam at 121 °C for 30 minutes in an autoclave.
Chemical sterilisation

- Ethylene oxide
  - Exposure to an atmosphere saturated with ethylene oxide for 3–8 hours, at 50–60°C, in a reactor tank; the so-called “gas-sterilizer” tank should be dry before injection of the ethylene oxide. Ethylene oxide is a very hazardous chemical; this process should therefore be undertaken only by highly trained and adequately protected technical personnel.

- Glutaraldehyde
  - Exposure to a glutaraldehyde solution for 30 minutes. This process is safer for the operators than the use of ethylene oxide, but is microbiologically less efficient. (Prüss et al., 1999, p. 60).

Recycle of HCW

Previously, Prüss et al. (1999) stated that health care establishments uncommonly recycle their medical waste, except for the recovery of silver from fixing-baths, used in processing X-ray films. However, they agreed that several types of medical wastes could be recycled. In California, for instance, there are many types of single-use surgical instruments that can be included in recycling programs (McGurk, 2004):

- Arthroscopic shavers
- Arthroscopic wands
- Burrs, bits and blades
- Reamers and rasps
- Lap scissors, dissectors and graspers
- Laproscopic trocars
- Ultrasonic scalpels
- Electrophysiology catheters
- SCD/DVT sleeves
- Femostop
- Inflation devices
- Pneumatic tourniquet cuffs
- Pulse oximeter sensors
- Biopsy forceps

McGurk (2004) also stated that Vanguard Medical Concepts, Inc., which had approval from the federal Food and Drug Administration (FDA) to reprocess single-use medical devices, estimated that recycling of medical devices could reduce medical disposal costs from surgery by, as much as, 70%.

Reduce, reuse, and recycle of general waste
Reduce, reuse and recycle (3R) approach is fundamental to achieving sustainable waste management in developed and developing countries, as mandated by Agenda 21. The progress of the development of such approach has been reviewed by many countries or organisations, so as to evaluate the drivers and the constraints to implementation of such an approach.

There is no doubt that the ultimate goal of sustainable waste management is a better quality of life, by conserving material for today’s generation, as well as, for future generations (Tanaka, 2007). In the efforts to achieve the goal, Agamuthu, Fauziah, and Khidzir (2009b) provided an approach to determine the driving factors of sustainable waste management. Those drivers can be adopted by any country, based on its locality, under a practical and realistic policy.

Krishnamohan and Herat (2000) also highlighted the importance of the 3R approach to reduce the depletion of the environment caused by wastes as source potential anthropogenic pollutants. They provided an example of industrial ecology practices, by performing waste exchange, to maximise the benefits among industries practising it. For the health care industry, they mentioned the possibility of synthesising drugs from chemical waste streams, which is being practised by US scientists.

Health care industries like hospitals can implement 3R by practising recycling of e-waste, in collaboration with the supplier of electrical and electronic equipment (EEE). Herat (2007; 2008c) also mentioned the involvement of manufactures in e-waste management as EPR. E-waste recycling is not an easy task due to their sheer numbers, and the presence of toxic materials, like heavy metals, in them.

Moreover, Herat (2008d) suspected the possibility of contamination of solid waste from toxicants generated from e-waste. He stated that there were more than 1000 different substances, many of which are hazardous to human health that can enter through direct and indirect routes such as the food chain. Therefore, urgent action to counter the problem arising from e-waste pollution is needed through implementing safe waste management.

According to Memon (2010), the recycling system of HCW can be integrated into SWM, as they share the same goal. Previously, SWM aimed at minimising the health hazards on the environment. Recently, another dimension, i.e., resource conservation
and recovery, has been recognised as a significant factor of SWM (Memon, 2010). Moreover, Memon (2010) stated that the 3R approach in integrated SMW bears double benefits: 1) the reduction of environmental and health impacts; and 2) the maximisation of the use of all stages of SWM. In this regard, Tanaka (2007) also proposed steps to promote a lifestyle, consuming fewer materials, through education and learning.

Vietnam has also implemented the 3R initiative, by providing a policy framework, covering strategies and plans of action. This framework also targeted the improvement of financial resources and capacity, toxic substance reduction technologies, and involvement of stakeholders and citizens (Chi & Long, 2011).

Twenty countries and eight international organisations came together to promote the 3R initiative. They held a Senior Official Meeting (SOM) on the 3R initiative in Japan from 6-8 March 2006 (MoE Japan, 2006). They discussed the implementation of 3R initiatives in participating countries, international promotion of the 3Rs, and further steps for the 3Rs. The meeting covered significant ground at national level in Asia, and also proposed the development of an international waste observatory, international and regional co-operation, with Japan as the leading country. The meeting recommended the promotion of LCA and integrated approaches, quantitative target setting, and institutional capacity development. The SOM successfully facilitated the exchange of information and experiences between the participating countries.

Sakai et al. (2011) also studied the development of policy concerning 3R implementation in SWM systems. The study covered the European Union (EU), USA, Korea, Japan, China and Vietnam. The progress of each country varied, depending on its capacity and priority. The overall results indicated that 3R policies were developed beyond the waste management strategies, to include synergistic effects on reduction of green house gas emissions, and to secure resources.

### 2.3.3 Waste treatment technologies

Basically, there are two types or processes of waste treatment technologies, including incineration and non-incineration processes. This section briefly describes each technology, currently used by many countries, to treat and dispose of HCW (Prüss et al., 1999; Health Care Without Harm, 2001).
Several factors should be considered before choosing an appropriate technology to treat medical wastes, so as to achieve optimum cost effectiveness of the chosen technology (Prüss et al., 1999, p. 77; Health Care Without Harm, 2007, p. 6). These include:

- Throughput capacity
- Types of waste treated
- Microbial inactivation efficacy
- Environmental emissions and waste residues
- Regulatory acceptance
- Space requirements
- Utility and other installation requirements
- Reduction of waste volume and mass
- Occupational safety and health
- Noise and odour
- Automation
- Reliability
- Level of commercialisation
- Technology manufacture/vendor background
- Cost
- Community and staff acceptance

**Incineration**

The basic principles of incineration are the balancing of time, temperature and turbulence of incineration (3T’s). It typically consists of one or two furnace chambers with different temperatures. There are many types of incinerators available, ranging from conventional to advanced, incinerators. The examples of incineration technologies are given by Vallero and Peirce (2003), such as, Rotary Kiln Multiple Hearth, Fluidized Bed, Liquid Injection, and Multiple Chamber Incinerators.

- Incinerators

Incinerator technology mainly uses combustion for treating various waste streams. Incinerators have several advantages: their technology is mature and widely used, and they reduce the volume and weight of waste significantly, and render it unrecognisable. They also disinfect wastes completely, and accept all types of wastes, and potentially,
recover heat/energy in large scale systems. Other advantages: the basic scientific principles and engineering designs of the technology are well understood, and an incinerator can be operated in a relatively small space, compared to landfill system. The disadvantage of incineration is that the equipment is capital intensive, especially the refractory material, lining the inside walls of the combustion chamber. An incinerator requires a very skilled operator, and, in addition, includes the cost of fuel. It may also emit hazardous pollutants to the air (dioxins, furans, heavy metals, acid gases, etc), thus requiring monitoring and control (Prüss et al., 1999; Health Care Without Harm, 2001; Vallero and Peirce, 2003; Yang et al., 2009).

Non-incineration

Non-incineration technology has four main categories, based on the fundamental processes used to treat waste, namely, thermal, chemical, irradiative, and biological. On the other hand, a mechanical process is required supplementarily, for all fundamental processes. The descriptions for non-incineration technologies are as follows:

- **Steam sterilisation/autoclaving**

  In this method, waste is exposed to high pressure steam. This process is called wet heat sterilisation. Waste has to be shredded before the treatment process, so that the exposed surface areas of the waste are increased, and steam can effectively penetrate all its parts. The system needs relatively low investment and operation costs, and it produces low hazard residue, and does not pollute the air (Prüss et al., 1999; Health Care Without Harm, 2001; Emmanuel & Stringer, 2007; Yang et al., 2009).

- **Chemical disinfection**

  The waste has to be shredded before being exposed to chemical disinfectants. There are various chemical disinfectants that can be used like chlorine. The efficacy of the system should be tested through the development of biological testing. Its appropriateness is, however, not clear (Prüss et al., 1999; Health Care Without Harm, 2001).

- **Dry heat treatment technology**

  This technology has long been used for the sterilisation of medical supplies, instruments, and equipment. The wastes to be treated in this system need longer times to
expose the wastes to higher temperatures than moist heat treatment technology (Prüss et al., 1999; Health Care Without Harm, 2001).

- Irradiation

This technology is called electron beam, and is commonly used to treat medical products with radiation for sterilisation purposes. It usually uses Cobalt-60 that emits high speed gamma rays. Another type of irradiation is UV-C, or ultra violet radiation in the C range (253.7nm, also known as germicidal or shortwave) (Prüss et al., 1999; Health Care Without Harm, 2001).

- Microwave treatment

The important factors of this system are the moisture content of waste, microwave strength, duration of exposure, and, extent of waste mixture. Waste is first ground and shredded to improve the effectiveness of the system, and then sprayed with water for maintaining moisture. The advantages of the system are: unrecognisable waste, significant volume reduction, free of liquid discharge, and polychlorinated dibenzo-p-dioxins (PCDDs or dioxins) or polychlorinated dibenzofurans (PCDFs or furans) emission free. Meanwhile, the disadvantages of the system are: moderate to high investment cost, chemical and pharmaceutical wastes are not allowed, and, possibly, incomplete disinfection (Prüss et al., 1999; Health Care Without Harm, 2001; Yang et al., 2009).

2.3.4 Occupational health and safety

Occupational health and safety is an important aspect of protecting health care workers and patients from physical, biological and chemical hazards that may be found in health care environments. According to Tweedy (2005), there are several aspects that need inclusion in the occupational health and safety program, especially, for health care personnel, who handle wastes, including, PPE, injury prevention, and provision of post-exposure prophylaxis (PEP).

Provision of PPE

Personnel handling HCW, particularly medical ones, must wear appropriate PPE. The effectiveness of PPE depends on their selection according to intended use, properly trained personnel in their use and functions, and the equipment being properly tested,
maintained, and worn. They should also be available adequately for all personnel dealing with hazardous waste in the workplace. An ongoing safety program should encourage staff to constantly wear protective gear when they are working (Tweedy, 2005). For example, personnel should wear plastic or rubber aprons when there is a potential for splashing, and rubber-soled shoes to prevent slips and falls. Moreover, Tweedy (2005) adds that personnel should wear protective eyewear or shields if splashes of a hazardous substance are likely. Similarly, employees who may contact hazardous drugs, blood, or other body fluids, should wear impervious, or low-permeability gowns. When contaminated, the gowns should be properly stored in the area of use, and soiled gowns be washed or discarded.

**Occupational injury prevention and surveillance**

Prevention of exposure remains the most effective measure to reduce the risk of HIV transmission to health workers. The priority is to train health workers in prevention methods, complying with UP, and wearing appropriate PPE. Health care facilities should provide induction programs for new personnel, covering all elements of infection control, occupational health and safety, and workplace conditions (WHO, 2002; Tweedy, 2005). Moreover, health care facilities should establish injury surveillance for HCW related infections and injuries, apart from other disease surveillance, to determine the epidemiology of waste related diseases (WHO, 2002; Tweedy, 2005).

The risk of exposure to needle-sticks and other sharps waste exists in health care settings, where PPE supplies are limited, and the rates of HIV infection in the patient population are high (WHO, 2002; Tweedy, 2005). The availability of PEP may reduce the occurrence of occupationally acquired HIV infection in health care workers. It is believed that the availability of PEP for health workers will serve to increase staff motivation to work with people infected with HIV, and may help retain appropriately trained and experienced staff (WHO, 2002).

Post exposure prophylaxis is a short-term, antiretroviral treatment, to reduce the likelihood of HIV infection after potential exposure, either occupationally, or through sexual intercourse. Within health care facilities, PEP should be provided, as part of a comprehensive universal precautions package that reduces exposure of health care personnel to infectious hazards (WHO, 2002).
The risk of transmission of HIV from an infected patient through a needle-stick, where the skin is punctured by a sharp, is less than 1%. The risk of transmission from exposure to infected fluids or tissues is estimated to be lower than from exposure to infected blood (WHO, 2002). The proper use of supplies, staff education, and supervision needs, should be outlined clearly in institutional policies and guidelines. Regular supervision in health care settings can help reduce the risk of occupational hazards. If injury or contamination results in exposure to HIV infected material, post exposure counselling, treatment, follow-up and care should be provided by health care facilities (WHO, 2002; Tweedy, 2005). Furthermore, Tweedy (2005) suggests that needleless systems can also be implemented as to prevent needle-stick injuries by modifying medication procedures to non-needle use. For example, intravenous medication or fluids may be administered through a catheter port, using a non-needle connection. There is also an array of devices that prevent needle-stick injuries, including:

- **Syringes with a sliding sheath that shields the attached needle after use**
- **Needles that retract into a syringe after use**
- **Shielded or retracted catheters**
- **Intravenous medication delivery systems that use a catheter port with a needle housed in a protective covering** (Tweedy, 2005, p. 341).

### Health care worker immunisation

Health care organisations should establish a comprehensive written policy concerning worker immunisation, related to health hazards in the workplace. According to Tweedy (2005), several types of immunisation for workers dealing with patients and wastes, are as follows:

- **Rubella** – workers considered to be at risk or who have direct contact with pregnant patients should be immunised against rubella
- **Hepatitis B** – workers exposed to blood-borne pathogens should be given the vaccine within 10 days of their job assignment
- **Measles** – should be given to any personnel susceptible by history or serology
- **Influenza** – to help personnel prevent the transmission of influenza from them to patients.
2.4 HCW AND PUBLIC HEALTH IMPACTS

2.4.1 Hazards of HCW

Health care wastes contain a fraction of medical waste which is of a hazardous nature, due to one or more of the following characteristics (Prüss et al., 1999, p. 20):

- it contains infectious agents;
- it is genotoxic;
- it contains toxic or hazardous chemicals or pharmaceuticals;
- it is radioactive;
- it contains sharps.

People in contact with hazardous HCW are potentially at risk, including those within health care facilities that generate hazardous waste, and those outside these sources, who, either handle such waste, or are exposed to them, as a consequence of unsafe management. The main groups at risk are the following (Prüss et al., 1999; Allsopp, Costner, & Johnston, 2001; Tweedy, 2005):

- medical doctors, nurses, health-care auxiliaries, and hospital maintenance personnel;
- patients in health care facilities or receiving home care;
- visitors to health care facilities;
- workers in support services within health-care facilities, such as laundries, waste handling, and transportation;
- workers in waste treatment disposal facilities, including scavengers
- people near unsafe treatment facilities
- people who consume contaminated products

2.4.2 Public health impact of HCW

Regarding the health impact of medical waste, the WHO (2004a), stated that medical waste, especially infectious or highly infectious, can be a medium for transmitting infectious diseases, which are called blood-borne diseases, like hepatitis B, hepatitis C, and HIV/AIDS. They can be transmitted via contaminated sharps. However, these diseases are few, compared to the numerous other medical waste related diseases, shown in Table 2-1.
Table 2-2 Examples of infections caused by exposure to HCW, causative organisms, and transmission vehicles

<table>
<thead>
<tr>
<th>Type of infection</th>
<th>Example of causative organisms</th>
<th>Transmission vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gastroenteric infections</td>
<td>Enterobacteria, e.g. Salmonella, <em>Shigella</em> spp.; <em>Vibrio cholerae</em>; helminths</td>
<td>Faeces and/or vomit</td>
</tr>
<tr>
<td>Respiratory infections</td>
<td><em>Mycobacterium tuberculosis</em>; measles virus; <em>Streptococcus pneumoniae</em></td>
<td>Inhaled secretions; saliva</td>
</tr>
<tr>
<td>Ocular infection</td>
<td>Herpesvirus</td>
<td>Eye secretions</td>
</tr>
<tr>
<td>Genital infections</td>
<td><em>Neisseria gonorrhoeae</em>; herpesvirus</td>
<td>Genital secretions</td>
</tr>
<tr>
<td>Skin infections</td>
<td><em>Streptococcus spp.</em></td>
<td>Pus</td>
</tr>
<tr>
<td>Anthrax</td>
<td><em>Bacillus anthracis</em></td>
<td>Skin secretions</td>
</tr>
<tr>
<td>Meningitis</td>
<td><em>Neisseria meningitidis</em></td>
<td>Cerebrospinal fluid</td>
</tr>
<tr>
<td>Acquired immunodeficiency syndrome (AIDS)</td>
<td>Human immunodeficiency virus (HIV)</td>
<td>Blood, sexual secretions and secretions and blood</td>
</tr>
<tr>
<td>Haemorrhagic fevers</td>
<td>Junin, Lassa, Ebola, and Marburg viruses</td>
<td>All bloody products</td>
</tr>
<tr>
<td>Septicaemia</td>
<td><em>Staphylococcus spp.</em></td>
<td>Blood</td>
</tr>
<tr>
<td>Bacteraemia</td>
<td>Coagulase-negative <em>Staphylococcus spp.</em>; <em>Staphylococcus aureus</em>; <em>Enterobacter</em>, <em>Enterococcus</em>, <em>Klebsiella</em>, and <em>Streptococcus spp.</em></td>
<td></td>
</tr>
<tr>
<td>Candidaemia</td>
<td><em>Candida albicans</em></td>
<td>Blood</td>
</tr>
<tr>
<td>Viral hepatitis A</td>
<td>Hepatitis A virus</td>
<td>Faeces</td>
</tr>
<tr>
<td>Viral hepatitis B and C</td>
<td>Hepatitis B and C viruses</td>
<td>Blood and body fluids</td>
</tr>
</tbody>
</table>

Source: Prüss et al. (1999)

In developed countries, where disease and injury surveillance programs exist, the incidence of waste related diseases and injuries are well documented. Prüss et al. (1999) provided data from Japan, regarding estimated risk of blood-borne diseases after hypodermic needle puncture, including HIV, HBV, and HCV (Table 2-2).

Table 2-3 Risk of infection after hypodermic needle puncture

<table>
<thead>
<tr>
<th>Infection</th>
<th>Risk of infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIV</td>
<td>0.3%</td>
</tr>
<tr>
<td>Viral hepatitis B</td>
<td>3%</td>
</tr>
<tr>
<td>Viral hepatitis C</td>
<td>3–5%</td>
</tr>
</tbody>
</table>

Source: Prüss et al. (1999).

In USA, for example, the infections caused by occupational injuries are available and they can be viewed in Table 2-3.
Table 2-4 Viral hepatitis B infections caused by occupational injuries from sharps (USA)

<table>
<thead>
<tr>
<th>Professional category</th>
<th>Annual number of people injured by sharps</th>
<th>Annual number of HBV infections caused by injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nurses in hospital</td>
<td>17700–22200</td>
<td>56–96</td>
</tr>
<tr>
<td>outside hospital</td>
<td>28000–48000</td>
<td>26–45</td>
</tr>
<tr>
<td>Hospital laboratory workers</td>
<td>800–7500</td>
<td>2–15</td>
</tr>
<tr>
<td>Hospital housekeepers</td>
<td>11700–45300</td>
<td>23–91</td>
</tr>
<tr>
<td>Hospital technicians</td>
<td>12200</td>
<td>24</td>
</tr>
<tr>
<td>Physicians and dentists in hospital</td>
<td>100–400</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Physicians outside hospital</td>
<td>500–1700</td>
<td>1–3</td>
</tr>
<tr>
<td>Dentists outside hospital</td>
<td>100–300</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Dental assistants outside hospital</td>
<td>2600–3900</td>
<td>5–8</td>
</tr>
<tr>
<td>Emergency medical personnel (outside hospital)</td>
<td>12000</td>
<td>24</td>
</tr>
<tr>
<td>Waste workers (outside hospital)</td>
<td>500–7300</td>
<td>1–15</td>
</tr>
</tbody>
</table>

Source: Prüss et al. (1999).

Regarding liquid waste, health care establishments produce considerable amounts of effluents, which usually contain significant concentrations of antibiotics, cytostatic agents, and other pharmaceutical products (Chitnis et al., 2004; Emmanuel et al., 2005; Mahnik, Rizovski, Fuerhacker, & Mader, 2006; Duong et al., 2008). Most of them are usually discharged into municipal sewers, and even, into water bodies without pre-treatment where municipal sewers are not common in some parts of developing countries like India (Chitnis et al., 2004).

Surprisingly, some Indonesian people continue to use amphenicols, which is a group of antibiotics for curing respiratory tract, or gastrointestinal, infections. This is restricted in many countries as some bacteria are resistant to it (Hadi et al., 2008). The continued use of an antibiotic in the presence of resistance, allows those resistant bacteria to survive, and become dominant within the bacterial flora. Once this antibiotic gets in wastewater and is incorporated into the aquatic environment, it could cause subtle effects to aquatic life, and human health, via the food web (Doerr-MacEwen & Haight, 2006).

However, there is no comprehensive study concerning the occurrence of antibiotics in wastewater in Indonesia. It will be a challenge for environmental health specialists to carry out such a study that will help determine the fate and occurrence of antibiotics in Indonesia. Considering that proper sanitation is still low, the concentration of antibiotics in the environment could be safely estimated to be high.
Several studies indicate that health care wastewater cannot totally be removed by conventional wastewater treatment plants (Chitnis et al., 2004; Allen, 2006). Mahnik et al. (2006) revealed that anthracyclines for cancer therapy are found in hospital effluents. The possible environmental pollution can be attributed to different sources of emissions from production sites or direct disposal of pharmaceuticals in households, but the main source of cytotoxic compounds in waste water, or the environment, are excretions (urine and faeces) of patients under treatment (Mahnik et al., 2006). However, the most frequently found compounds in health care wastewater are antibiotics (Auerbach, Seyfried, & McMahon, 2007; Teixeira, Delerue-Matos, Alves, & Santos, 2008).

Auerbach et al. (2007) also found tetracycline resistance genes in activated sludge in WWTP. They state that ultraviolet disinfection did not reduce the number of detectable tetracycline resistant determinants (tet\(^R\) gene types), and it was unlikely to reduce the concentration of \(tet\) (Q) and \(tet\) (G) in treated effluent (Auerbach et al., 2006). Emmanuel et al. (2005) also found glutaraldehyde and surfactants in hospital wastewater that are from the disinfectants and detergent used for cleaning in hospitals. A study on the mixture of glutaraldehyde and surfactants done by Boillot et al. (2008b), found the additive effects between the two substances.

Hence, there is clearly a need for preliminary treatment of health care effluents, to prevent urban collectors releasing them with potentially hazardous substances to the aquatic environment; and, since little is known about their health risks, it is wise to employ the precautionary principle (Brown et al., 2006; Gómez et al., 2006).

Another study that investigated the occurrence of absorbable organically bound halogens (AOX) in six German hospitals revealed that AOX were found in a medical department’s laundry, kitchen, and laboratory (Kümmerer, Erbe, Gartiser, & Brinker, 1998). Absorbable organically bound halogens are usually found in chemical substances used for X-ray contrast media, in medicine, and bleaching in laundries and kitchens (Kümmerer et al., 1998). These halogens are mostly persistent in the environment and accumulate in the food chain (Kümmerer et al., 1998). Therefore, further studies are necessary to determine the occurrence and measures of control to minimise their emission into the aquatic environment.

Health care industries also generate considerable hazardous waste from EEE. Unfortunately, there is no accurate data regarding generation of such waste, and
therefore, the magnitude of the problem is not yet determined. Herat (2008a; 2008b) pointed out that e-waste is becoming a major concern, as about 20-50 million tonnes of such waste, is produced around the world. It is evident that there will be environmental and health risks due to the existence of toxic materials in the waste stream, such as lead and other heavy metal pollutants (Herat, 2008b).

2.4.3 Public health impact of incinerators

Despite the advantages of an incinerator in treating waste, it can release pollutants to the atmosphere in stack gases, particulate matter, and ashes. The chemicals present in the stack gases include dioxins, PCBs, polychlorinated napthalenes, chlorinated benzenes, polyaromatic hydrocarbons (PAHs), numerous volatile organic compounds (VOCs), and heavy metals, including lead, cadmium and mercury (Allsopp et al., 2001; Kulkarni, Crespo, & Afonso, 2008).

Dioxins are a class of structurally and chemically related polyhalogenated aromatic hydrocarbons that mainly include PCDDs/dioxins, PCDFs/furans, and ‘dioxin-like’ biphenyls (Kulkarni et al., 2008). Several adverse health effects have been associated with dioxins, including soft tissue, sarcomas, lymphomas, skin lesions, stomach cancer, biochemical liver-test abnormalities, elevated blood lipids, fatal injury, immune system and neurological effects (Allsopp et al., 2001; Mitrou, Dimitriadis, & Raptis, 2001).

Many studies have been conducted to determine the health effects of municipal waste incinerators, including exposure studies, epidemiological studies, and risk assessments. However, there is no specific study of health effects of incinerators for medical waste, only. These studies targeted three different populations at risk; i.e., health workers, people living near incinerators, and environmental contaminants.

Studies on workers at incinerator plants, and populations residing near incinerators, identified a wide range of associated health effects, even though only a few of them met rigorous scientific standards. The same findings applied to environmental contaminants, too, as the data were very limited. Nonetheless, more relevant studies should be carried out to update the health impacts of incinerators, particularly incinerators used for treating medical wastes. More importantly, waste minimisation is imperative to minimise the risks of HCWs.
2.5 INFECTION CONTROL

An infection control program includes activities or measures in health care establishments to prevent the spread of infections via multiple media and routes that are known as HAI (Tweedy, 2005; Blenkharn, 2006; Siegel, Rhinehart, Jackson, & Chiarello, 2007). An effective ICP should include the following the important considerations to reduce the incidence of HAI (Tweedy, 2005, p. 326):

- Placement evaluations
- Personnel health and safety education
- Immunisation programs
- Protocols for surveillance
- Management for job-related illnesses
- Exposures to infectious diseases
- Counselling regarding infection risks
- Guidelines for work restrictions due to infections
- Maintenance of health records

Applied to providing care for patients and a healthy workplace for workers, these considerations can help minimise the occurrence of HAI, which prolongs the LOS of patients, and in turn, increases the health care expenditures.

In line with the steps to achieve healthy hospitals by establishing ICPs, there are two important aspects that need to be discussed: 1) UP, and 2) HAI. The first is closely related to the spread of infections within health care settings; and, the second is the outcome of the practices of the former. In other words, the higher the adoption of UP, the lower the occurrence of HAI. In practice, UP can be implemented by using appropriate PPE and SOPs, dealing with infected patients, blood, and other body fluids. The two aspects will be further explained in the following sub-sections, with the addition of the third important issue: blood-borne pathogens, since it is related to infectious waste management.

2.5.1 Universal precautions

Universal precautions or standard precautions are designed to minimise the risk of transmission of microorganisms from both recognised and unrecognised sources of infection in health care settings (Tweedy, 2005). With the various, possible routes of
transmission of infections, health care workers should choose appropriate PPE to protect them from contracting diseases. There are three important precautions, namely, airborne precautions, droplet precautions, and contact precautions (Tweedy, 2005).

**Airborne precautions**

Airborne precautions reduce the risk of airborne transmissions of infectious agents, disseminated by small-particle residue 5µm or less, evaporated droplets that may remain suspended in the air for long periods of time, or dust particles, containing the infectious agent. Airborne precautions apply to patients known or suspected to be infected with pathogens that can be spread by air, such as, measles, varicella, and tuberculosis (Tweedy, 2005).

**Droplet precautions**

Droplet precautions reduce the risk of droplet transmission of infectious agents. This transmission involves contact of the conjunctive or mucous membranes of the nose or mouth of a susceptible person with large particle droplets (larger than 5µm). The droplets contain microorganisms released from an infected person or a carrier of the microorganism. Droplets are usually released from the source person during coughing, sneezing, talking, or during the performance of certain procedures, such as, suctioning and bronchoscopy. The diseases that can be transmitted by infectious droplets are meningitis, pneumonia, sepsis, diphtheria, *Mycoplasma pneumonia*, pertussis, streptococcal (group A) pharyngitis, scarlet fever, *Rubella*, and pneumonic plague (Tweedy, 2005).

**Contact precautions**

Contact precautions reduce the risk of transmission of epidemiologically important microorganisms by direct or indirect contact. Direct contact transmission involves skin-to-skin contact or the physical transfer of microorganisms to a susceptible person. This can occur when health care workers turn patients, bathe patients, or perform other patient-care activities, requiring physical contact. Indirect contact transmission involves contact of a susceptible person with a contaminated intermediate object. Contact precautions are used for hepatitis A, contagious skin infections, herpes simplex virus, scabies, and viral or haemorrhagic conjunctivitis and infections (Tweedy, 2005).
2.5.2 Health care-acquired infections

Health care-acquired infections pose significant risks for patients and health care workers. The Centers for Disease Control and Prevention (CDC) predict that 2 million persons acquire an infection, every year, while being cured in hospitals for other diseases or injuries (Tweedy, 2005). The previous terminology of those diseases was nosocomial diseases. However, the term ‘nosocomial’ is now limited to infections acquired in hospitals (Siegel et al., 2007). HAI is used to refer to diseases associated with health care delivery in any setting, such as hospitals, long-term care facilities, ambulatory settings, and home care (Siegel et al., 2007).

In addition to the considerations of ICP, there are several elements to preventing transmission of infectious agents in health care settings: UP, surveillance, health education, hand hygiene, PPE, safe work practices, patient placement, transport of patients, environmental measures, patients’ care equipment, instruments/devices, textile and laundry, solid waste, dishware and eating utensils, and adjunctive measures (Tweedy, 2005; Siegel et al., 2007).

The efficacy of ICP in reducing HAI has been well established in high income countries. US studies estimated the cost of HAI, annually, to exceed $6.5 billion in 2004. Therefore, it is evident that an effective ICP is the best way to minimise these costs. For example, the Study on Efficacy of Nosocomial Infection Control (SENIC) carried out in the 1970s, established an association between intensive infection control and surveillance programs with a reduction of HAI by 32%, and subsequent health care costs (Zimmerman, 2007).

The WHO launched the World Alliance for Patient Safety (WAPS) in October 2004 and its fundamental priority was the “First Global Patient Safety Challenge” (GPSC), aiming at implementing several activities to reduce HAI worldwide (Allegranzi et al., 2007). Patient safety is defined as “the absence of the potential for or occurrence of health care-associated injury to patients; created by avoiding medical errors as well as taking action to prevent errors from causing injury” (Tweedy, 2005, p. 369).

The Alliance addressed some of the risk conditions leading to HAI, such as, blood products and their use, injection practices and immunisation, safe water, basic sanitation and waste management, clinical procedures, particularly at first-level and emergency care (Allegranzi et al., 2007). As the pilot phase to test the implementation of the
strategy and practical tools is currently ongoing, the results have not been obtained yet. However, this is an important step to raise awareness among stakeholders to improve the quality of care and patient safety (Allegranzi et al., 2007).

A similar study in Japanese hospitals also found that dedicated and full-time health care workers could significantly increase patient safety (Fukuda, Imanaka, Hirose, & Hayashida, 2008). They also concluded that hospitals with increased resources had more extensive patient safety and ICP, so that allocating more resources to hospitals will improve patient safety as a commitment to the WHO GPSC (Fukuda et al., 2008).

In comparison, several developing countries which attempted to establish ICP, based on the same guidelines, had varying degree of success, mainly because of different physical, environmental and socioeconomic factors (Zimmerman, 2007). Rhinehart, Goldman, and O’Rourke (1991) also revealed that several factors hindered the adoption of CDC guidelines in a paediatric intensive care unit in Jakarta, including a lack of hand washing basins and tap water, unreliable and inappropriate supply of equipment and supplies, lack of awareness of the importance of infection control, and lack of managerial support and the hierarchical relationship between physicians and nurses. Therefore, Rhinehart et al., (1991, p. 219) offered strategies to adapt available guidelines to the developing countries’ context. These include:

- Assessing the existing situation through interviews, site visits, and practice observation
- Adopting a flexible approach to implement or to reinvigorate ICP
- Instituting a broadly representative infection control committee with strong leadership support
- Appointing and training dedicated health care workers to become infection control professionals
- Establishing simple surveillance mechanisms where indicated, focusing on high-risk areas
- In collaboration with local health care workers, reviewing and modifying available guidance, such as that from CDC, to suit local conditions, practice, and resources, using a low technology, low-cost approach.
Duerink et al. (2006) also conducted a study related to nosocomial infections in an Indonesian teaching hospital. They found that low adherence to standard precaution guidelines is considered to be attitudinal, and even mean underlying behavioural problems. This is coupled with the absence of adequate facilities, such as, hand washing basins and PPE. They also observed that there was a shortage of single-use gloves and containers for safe containment of sharps waste. The study was adequate in terms of methods employed, especially for assessing hygiene behaviour with shadow observation, where the results were objective enough to describe practices among health workers in their adherence to UP.

In addition to the sharps waste management, there are no reliable data from Indonesian hospitals on occupationally-acquired sharps injuries and musculo-cutaneous exposure. Sasimartoyo (2004) revealed that health care workers were reluctant to answer whether they have experienced puncture by used needles. He also failed to find any recorded data concerning sharp-related injuries from Indonesian health care institutions.

In contrast, researchers in a 6-year retrospective study conducted in a teaching hospital in Australia (Bi, Tully, Pearce, & Hiller, 2006) found that among health care workers, medical staff experienced the highest proportion of sharp injuries (10.4%), and hollow-bore needles were implicated in 51.7% of all precutaneous injuries. Most incidents occurred during sharp use (40.4%), or after use but before disposal (27.1%). Nursing staff experienced 68.5% of reported mucocutaneous exposure. Many such exposures occurred when gloves were not used. These findings are certainly evident of the importance of PPE to reduce waste-related injuries among health care workers.

Talaat et al. (2006) conducted an experimental study on the implementation of infection control in Egypt. They found it difficult gaining advocacy and political support in the beginning of the program, as it was an interdisciplinary activity that involved all sectors of the health care system. Competing priorities in the health care sector is also a significant problem, since many hospitals had little motivation to invest in ICP. However, after getting strong political support, within two years, to develop necessary activities, the ICP has become an integral component in the health care sector.

Indonesian hospitals face the challenge of replicating Egypt’s experience. They share similar conditions of political support and basic resources for implementing ICP. In 2007, the MoH established an ICP in 100 hospitals. The first step was capacity building
using a sentinel approach, where higher-class hospitals were responsible for the relevant activities. Hopefully, this program would be sustained, and be integrated with programs like HCWM in hospitals, so that they can establish the parameters for minimum risk of HAIs. The outcomes of the programs have not been identified yet, since the training and provision of relevant guidelines are ongoing. Nevertheless, this initial program could record the preliminary activities required to implement quality improvement of health care services in Indonesian hospitals.

The Indonesian MoH data for 2006 (MoH, 2007) shows there were several HAI cases in general hospitals, including urinary tract infections (1.70%), post surgical infections (1.61%), hospital-acquired pneumonia (0.35%), phlebitis—primary blood clot infection (2.79%), decubitus ulcer (0.45%) and sepsis (0.08%), on an average of 0.95%.

Data from a class A hospital in 2010-2011 found that phlebitis was only 0.006% in semester 1 of 2010, and 0.01% in semester 1 of 2011, post surgical infections in the same periods, were 2.31% and 1.90%, urinary tract infections were 1.9% and 1.90%, and ventilator associated pneumonia were 5.35% and 2.17% (Fatmawati Hospital, 2012). These data cannot be compared, as they are from different periods. Dealing with occupational exposures in Indonesian hospitals, there is no quantitative data available currently, to determine the magnitude of occupational illnesses related to blood and body fluids.

2.5.3 Blood-borne pathogens standard

The blood-borne pathogens standard was set by the Occupational Safety and Health Administration (OSHA) in 2000, consisting of the requirements for employers with workers exposed to blood or other potentially infectious agents (Tweedy, 2005). In order to reduce or eliminate the risks of occupational exposure, an employer must apply an exposure control plan for the workplace, with details on personnel protection measures. The plan must include how the employer will use a combination of engineering and work practice procedures, to ensure the use of PPE, provide training, medical surveillance, hepatitis B vaccinations, and signs and labels and other necessary provisions.

The standard emphasises the importance of engineering control as a primary means of eliminating personnel exposure to the potential hazards. These include the use of safer
medical devices, like needleless devices etc. In spite of the availability of advanced technology in injury prevention, needle-sticks and other sharp injuries remain a concern, due to their high occurrence and severity of health effects. The CDC estimates that health care personnel sustain nearly 600,000 percutaneous injuries caused by contaminated sharps, annually (Tweedy, 2005).

2.6 HEALTH PROMOTING HOSPITALS

Health promotion programs aim at improving the quality of health by making changes in health determinants or modifiable risk factors (Johnson & Baum, 2001). The changes could be directly attributed to individual behaviour or environmental exposures. These programs can be implemented in any setting, like workplaces, schools, and hospitals.

Health promoting hospitals have emerged in many European countries since the Budapest Declaration on HPH in 1991 (WHO-Europe, 2007). In this context, hospitals are encouraged to broaden their roles from curative activities towards promotive ones, since health determinants should be seen from a whole perspective to bring about the quality of life and well-being (Aujoulat, Le Faou, Sandrin-Berthon, François, & Deccache, 2001; Pelikan, Krajic, & Dietscher, 2001). Therefore, the aim of the HPH is to adjust the orientation of current health services in the hospital from solely curative services to more comprehensive services based on the principles of health promotion. HPHs have been around for more than 20 years, and more than 650 hospitals have been involved in the International HPH Network (McHugh, Robinson, & Chesters, 2010).

The conceptual framework of the HPH program provides for a general statement concerning the specific mission of a HPH: “A HPH incorporates the concepts, values and standards of health promotion into its organisational structure and culture by means of organisational development” (Aujoulat et al., 2001; Glickman, Baggett, Krubert, Peterson, & Schulman, 2007; WHO-Europe, 2007). Moreover, Aujoulat et al. (2001) stated the targets of HPH as “the health of individuals (patients, staff, and community), and organisation, in the sense of creating a sustainable organisation, capable of learning and adapting to changing environments, combining the need to adapt with the aim of maximising health gain.”

The importance of HPH stems from hospitals being unique workplaces with so many professionals, both general practitioners and specialists, on the one hand, and their being
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assets of health care and public health systems. Therefore, utilising hospitals by understanding their management perspective for improving health status is of paramount importance (Glickman et al., 2007). On the other hand, because of their elite position within their environments, hospitals have been hard to reach, and their internal hierarchical positions could be barriers to implementing HPH. Wright et al. (2002) argued that it is time to address the absence of hospitals as secondary or tertiary health services, to move beyond their traditional environment as being the antithesis of community health, and to become an essential component of a public health strategy.

A number of studies were conducted to evaluate the concept of HPH; some found that the concept was acceptable and feasible to develop within hospitals with the variety of the health system. However, there were also barriers to the implementation of the concept in many hospitals. In Australia, for instance, the development of HPH is slower, compared to the progress in European countries, since only 11 hospitals are registered as members of the International Network of HPH (McHugh et al., 2010).

Despite the slow progress of the development of HPH across Australia, the development of a HPH in Queensland has been recognised. For example, in 1992, Queensland Health, Australia, developed a model which was called the “Queensland Model” (Gorey, 1994), which began to address the hospitals’ impacts on the environment, by launching the Green Hospital Award Scheme to encourage public hospitals to implement policies and practices that reduce these impacts on the environment, and to create a supportive social and physical environment for workers and patients (Gorey, 1994). However, no further evaluation of the progress of the program, has been forthcoming.

Furthermore, there is little evidence of the success of HPH in developing countries. The success stories of health promotion in these countries are usually health promotion in other settings, such as, health promotion in schools and workplaces, since these settings are simpler in terms of institutional characteristics and nature of aggregation. Wright et al. (2002) raised the issue about the implementation of HPH by arguing “why do we attempt to establish health promotion in such a place that is more difficult from other settings?” The possible answer would be that health promotion is a strategy to change existing conditions, regardless of the level of those conditions, by modifying the elements that could be changed as a predisposing factor. Therefore, the emphasis will be
on advocacy and capacity building, by utilising the existing resources. Wright et al. (2002) also pointed out that the concept of HPHs should also encompass better health for staff, and a healthier workplace.

Workplace improvement programs can be effective in reducing the risk factor, since hospitals are a workplace for a significant numbers of professional people who can be showcased as healthy workers. Health professionals in hospitals may be powerful messengers, not only among their own community, but also among the whole community. As opinion leaders and empowered experts, they also have important roles as advocates for local public health initiatives.

In implementing HPH, an intervention study was conducted in Beijing (Guo et al., 2007). They adopted the principles of HPH from the WHO, and came up with the Beijing Committee for Disease Prevention Guidelines for HPH, which include the elements of policy making, environment building, re-orientation of health services, health skills, and community. The study found a significant difference between the pilot and control hospitals in their degree of commitment as was seen from the availability of long-term plans and budgets for health promotion. This case can be adopted by Indonesian hospitals for its principles and strategy.

The understanding of the conceptual model of HPH and the salient features of its practical implementation should be disseminated throughout the health care system by responsible policy makers. Thus, HPH will underpin the overall services of health care institutions, and make them more effective through the provision of healthy outcome focused services, and achieve quality assurance (WHO-Europe, 2007). The WHO-Europe (2007) also provides standards for HPH to ensure the quality of health care services, as the existing standards have yet to facilitate the systematic integration of health promotion into hospital services.
2.7 SUMMARY

From the literature review, the researcher identifies that:

- The development of health care systems varies amongst developed and developing countries. The health care systems in developed countries, with their better resources and budget allocation from their GDPs, readily accommodate the health care needs of their citizens and provide universal coverage, resulting in a better health status than that of developing countries. In the case of Indonesia, its health care system has seen many reforms, but is still inadequate, due to the limited budget allocation and resources to provide high quality health care. Consequently, the health status of Indonesian people has been below their neighbouring countries, such as, Malaysia and Vietnam.

- The health impacts of unsafe HCWM, could clearly force the implementation of safe HCWM, to a degree, by emphasising the implementation of 3Rs concept, while promoting occupational health and safety and the health of the population as a whole.

- Evidently, other countries have implemented sustainable HCWM even with limited resources.

- Several technologies for waste treatment and disposal are available to select after balancing the risks and their advantages.

- It is important to determine the driving factors for implementing sustainable HCWM with a realistic and practical policy.

- Little attention is paid to the importance of a suitable policy framework for sustainable HCWM, in Indonesia, utilising the examples of environmental management and policy with regard to sustainable development, covering several environmental principles.

- Other programs such as ICP and HPH are available within the hospitals to be integrated with HCWM, as the ultimate goal is the same.
It is necessary to develop a policy framework for sustainable HCWM, based on scientific evidence for its improvement in Indonesia, to bring about the reduction of HAI and other waste related diseases and injuries.
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3. METHODOLOGY

3.1 INTRODUCTION

This chapter describes the methodology used for the study based on research questions within the conceptual framework to answer the objectives set in Chapter 1. This includes research design, studied population and samples, study locations, data collection and management, as well as, criteria, and ethical clearance, for conducting the study. Subsequently, this chapter will also present statistical techniques and hypothesis testing, for determining the predictors of HCWM, which will articulate the scope of the proposed policy framework.

3.2 CONCEPTUAL FRAMEWORK AND RESEARCH QUESTIONS

3.2.1 Conceptual framework

In order to implement safe and sustainable HCWM, several aspects should be considered in properly assessing the progress and outcomes. Townend and Cheeseman (2005) offered guidelines for assessing wastes and resources management, including, general management, social aspects, health and safety, energy and water use, and purchasing and supply. They elaborate each aspect of these considerations and categorise them into five levels, from the lowest performance to the highest outcomes, so that each level can be followed to establish waste management plans and evaluations.

In terms of the comprehensive scope of sustainable HCWM, Ananth et al. (2010) point out the importance of the roles of actors within and outside the health care settings for sustainable HCWM, and several components they should consider for successful implementation of HCWM, namely, exclusive regulatory and policy framework, assigned departments and officials with clear roles and responsibilities, establishment of HCWM system which complies with WHO guidelines and promote resource recovery, and regular capacity building programs. In relation to those essential elements, Tudor (2007) emphasises the importance of a measurement unit for health care production and the practices of waste avoidance, as without them, sustainable HCWM could not be successfully implemented.
Several factors are understood to influence the effectiveness and efficiency of sustainable HCWM in Indonesia. These can be categorised into those that belong outside of the health care facility system, and those belonging within that system. Factors outside the system include, availability of regulations relating to wastes, international principles and conventions on environmental management, national policy on MSWM and hazardous and HCW, and the national policy on ICP and HPH being introduced as programs that will be implemented in every health care facility.

Factors within the health care system include, a master plan of programs for hospitals that engage HCWM, organisational unit, capacity building, adequate personnel, budget, facilities and infrastructure, guidelines and SOP, and other programs influencing HCWM, such as, ICP and HPH.

To elucidate more information regarding the above mentioned factors within the conceptual framework, there is a need for a study with materials and methods that will be explained in the methodology chapter. These factors are intertwined and their relationship can be summarised in Figure 3-1 on the following page.

A likely outcome will be a suitable policy framework for the improvement of HCWM, with features of integrated HCWM and ICP, Sustainable WMH, and CP, that are driven by HPHs.
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Figure 3-1 Conceptual framework of the study
3.2.2 Research question

Main research question

What is a suitable policy framework for the improvement of HCWM in Indonesia?

Focus research questions

- What are the examples of best practices in HCWM to be learned from the Queensland experience?
- What is the current status of HCWM in Indonesia?
- What are the existing policies related to HCWM and why are they not suitable for safe HCWM?
- Who are the key stakeholders who have significant roles in HCWM in Indonesia?
- What are the perceptions and expectations of key stakeholders about the current HCWM practices in Indonesia?
- How do the key stakeholders plan to improve HCWM in Indonesia?
- Are there any factors which are significantly important for formulating a suitable policy framework for the improvement of HCWM in Indonesia?

The research questions are essential to determine the significant factors influencing the success of HCWM in Indonesia, as these factors can be useful for formulating a suitable policy framework that guides, directs and governs all elements of HCWM. This framework will also underpin waste and resources, and provide a clear mechanism for such management, if it is formulated using appropriate research-based knowledge.
3.3 RESEARCH DESIGN

The design of research was concurrent mixed methods research, consisting both of quantitative and qualitative approaches, to strengthen the overall results of either quantitative or qualitative research, alone (Creswell, 2009). The quantitative approach will direct the tests of association among variables of HCWM from a set of data obtained from structured questionnaires. The results can be used to generalise the important findings to represent population in which the sample has been investigated (Fuller, 2009). On the other hand, the qualitative method through the case study in selected hospitals and HCs will explore the explanation of the relationship among significant variables of HCWM, and other variables, that could not be easily defined to emphasise the quantitative research findings (Creswell, 2009). Thus, each method will contribute equally to answer the focus research questions. In terms of timing, the two methods will be employed concurrently, to meet the set objectives of the study.

3.4 RESEARCH LOCATIONS AND DURATION

The qualitative study and waste audits were conducted in five provinces: North Sumatera, Lampung, West Java, East Java, and South Sulawesi. The provinces were selected on the basis of the number and density of general hospitals available within each province, and the existence of all classes of hospitals. These selected provinces or islands also represent three regions of Indonesia, namely, Western, Central and Eastern. Sumatera and Java islands have the largest number of general hospitals, compared to other islands. Class A general hospitals were only available in North Sumatera, East Java and West Java provinces, while class B hospitals existed in all five provinces.

The quantitative study used structured questionnaires to collect data. These were mailed to randomly selected hospitals across Indonesia, according to the number of samples determined and presented in the sub-chapter on population and samples, after being tested in a hospital that was not selected as a sample unit.

The duration of the study was 12 months in total, consisting of 6 months for preliminary data collection and preparation, or pilot, and another 6 months for data collection, including follow-up of non-responsive hospitals. The preliminary study was carried out from April to October 2009, and the data collection was from June to December 2010.
3.5 POPULATION AND SAMPLE

To fulfil the research design, population, sample size, and location of study, were determined in the following paragraphs. The population of the study was 613 general hospitals in Indonesia that are owned by the central government, regional and local governments, the military/police departments, and state enterprises that fall within classes A, B, C, and D (MoH, 2009). The researcher focuses only on the general hospitals, to fulfil the assumption of homogeneity, where the general hospitals in the same class usually generate similarly characterised medical wastes, as they provide similar health care services.

The variability of waste characteristics was determined, mainly, by the different classes of hospitals and the degree to which their HCW was being managed. Moreover, a simple random sampling technique was used, without replacement, for a finite population, so that the study had the basis for knowing the degree to which the study represented the studied population of all general hospitals in Indonesia (Mangione, 1995; Thompson, 2002). Regarding random sampling from a finite universe, Fuller (2009) states that the importance of drawing a sample using probability sampling, is to avoid biased estimators of a finite population, based on its sample. Therefore, the findings of the study can be used to determine predictors of the current status of HCWM in general hospitals in Indonesia.

The researcher used sample size formula from Raosoft Inc (2004) as follows,

$$SS = \frac{Z^2 + (p)(1-p)}{(CI)^2}$$

Where:

- $Z$ = Z value (i.e. 1.96 for 95% confidence level)
- $p$ = Percentage picking a choice, expressed as decimal (.5 used for sample size needed)
- CI = Confidence interval

**Correction for Finite Population**

$$New\ SS = \frac{SS}{1 + \frac{SS-1}{pop}}$$
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Where:

\[
SS = \text{Sample size} \\
\text{pop} = \text{Number of population}
\]

The number of samples was calculated using sample calculator (Raosoft Inc., 2004), with following criteria: the sample population was 613 hospitals, 5% margin of error, 95% confidence level, and 50% response distribution, resulting in a final number of samples of 237 hospitals. Therefore, the sampling frame was the list of 237 general hospitals’ names, which were randomly selected, using a manual sampling procedure. To obtain the total sample size within the time frame and the possibility of non-response from all selected hospitals to the mailed questionnaire, the questionnaires were then mailed to all population hospitals. This will not influence the results, since a simple random sampling was applied to obtain a snapshot data from 237 hospitals. Each hospital had the same opportunity to be selected, regardless of their class, since the focus of the study was to determine a suitable policy framework.

Waste audits and in-depth interviews were conducted in eight hospitals selected purposively, using a number of criteria, such as, geographical locations, density of general hospitals across three major regions in Indonesia, and the types of waste streams. This selection of qualitative sampling was based on criterion sampling that meet some set of criteria to answer research questions set, which could not be answered by the quantitative method. Waste audits were carried out at Class A and B hospitals, which typically have more types of waste streams, since they have more types of medical services. Therefore, it could be predicted that the study will reveal more types of medical wastes.

Since the in-depth interview is a method of qualitative study, using an inductive approach, there is commonly no requirement to meet a minimum sample size, as it usually applies only to a quantitative study (Creswell, 2009). Moreover, a qualitative research focuses on interpreting the participants’ perspectives and their articulateness and experience in the research setting, such as, hospitals (Gay, Mills, & Airasian, 2009). The quantitative method through mailed survey was to answer the quantitative nature of the inquiry, and the qualitative one was to answer the research questions which could not be answered by the mailed survey (Thomas, 2003; Gay et al., 2009). Nonetheless, the two approaches will be blended to bring out the most comprehensive results of the
study. In terms of the research method selected in this study, Padgett (2012) highlights the important process of data analysis, since the researcher should give equal attention to both quantitative and qualitative data to bring about rigorous results.

The details of the selected samples for qualitative study are outlined below:

- There were four class A hospitals selected from North Sumatera, West Java, East Java, and South Sulawesi;
- There were four class B hospitals in North Sumatera, Lampung, East Java, and West Java;
- There were five HCs with in-patient care from five provinces, being the same as the locations of selected hospitals for in-depth interviews.

Waste audits were also carried out in the same eight hospitals above, to determine the characteristics and quantity of medical wastes from selected major wards.

3.6 INCLUSION AND EXCLUSION CRITERIA OF RESEARCH

The inclusion criterion was all general hospitals owned by governments across Indonesia, whereas the exclusion one was all private hospitals, and special hospitals owned by the governments, such as, mental hospitals and cancer hospitals, since the type of hospital will influence the characteristics and the amount of medical wastes generation. These criteria were based on the assumption that there would be differences between general hospitals and special hospitals, in terms of characteristics and quantities of wastes generation, as the types of medical services were different.

3.7 RESEARCH VARIABLES

The details of research variables collected are as outlined below:

- Management aspect within the hospital: class of hospital, BOR, organisational unit, master plan documents, minimisation programs, personnel, budget, on-site policy, facilities, infrastructure, and implementation of ICP.
A Policy Framework for the Improvement of Health Care Waste Management in Indonesia

- Technical aspect in the operation of HCWM: segregation, collection, transportation, on-site storage, management, off-site storage, transport and final disposal.
- Other related programs, including infection control and health promotion: availability, guidelines, activities, and other resources.
- Waste streams, waste volumes or weights and the characteristics of medical wastes.
- Aspects of occupational safety and health.
- Stakeholder aspects: commitment, roles, available regulations, common policy, mechanisms of coordination, selection of technology used for management and disposal of wastes.

The total variables of the study were 194, which can be seen from the structured questionnaire. The variables then were categorised into independent and dependent variables for further analytic purposes.

3.8 DATA COLLECTION

3.8.1 Mailed questionnaires
The research variables for quantitative study were composed in the form of questions in a structured questionnaire (Appendix 1). Most of the variables refer to WHO’s questionnaires for rapid assessment (WHO, 2006), and the structured questionnaire that was used for a previous study by Sasimartoyo (2004). However, the selected variables will be suited to the research questions of the study. All the questionnaires were pretested and revised accordingly for each question to strengthen internal validity before being used. The revised questionnaires for quantitative data were then mailed to the hospitals along with an information sheet, and inform consent form, and return envelopes. Of the first mailed questionnaires only 20% were returned. A follow-up was conducted by mailing the questionnaires to the non-responsive hospitals and other hospitals which were not selected as a member of the sample size. This would allow the researcher to obtain at least a 50% response rate within the time frame, from the 237 hospitals sample. Therefore, the result would not be biased as each general hospital has an equal chance to be selected.
3.8.2 Waste audits

Each hospital will be audited for a week in areas estimated to produce a large amount of medical wastes, such as, emergency room, internals, obstetrics and gynaecology, paediatrics, operating rooms, isolation rooms, laboratories, and pharmacy.

The procedures of waste audits are as follows:

All wastes generated at each of the selected wards were segregated daily, for a week, into six types of medical and general wastes: namely, infectious, sharps, chemical, pharmaceutical, cytotoxic, and general wastes. These six categories were contained in colour coded bags or containers, provided by the researcher, and weighed on a scale solely for medical wastes. After being weighed, the medical wastes were handled according to the existing methods available in each hospital for further treatment and disposal. Therefore, the waste audits would not impact the usual hospital waste management. Waste audit checklists were provided to record the weight of each type of waste. The waste weighing was conducted by the researcher with the assistance of each hospital’s environmental health unit staff who had been briefly trained to be ad hoc research assistants.

Health and safety matters with regard to UP being of paramount importance, all personnel involved in the waste audits had relevant PPE to prevent the risk of contamination. They had all consented to voluntarily handle the medical waste for the study. The numbers of in-patients from selected wards were also recorded to determine the amount of medical waste per occupied bed per day from each selected ward (in kg/occupied bed/day).

3.8.3 In-depth interviews

In-depth interviews being the instrument chosen for the qualitative study of the research, the researcher prepared a semi-structured questionnaire to guide the interview process. The questionnaires dealt with the organisational and managerial aspects of the existing policy on waste management within the sample hospitals, current practices of HCWM and ICP, the roles of key stakeholders, and mechanisms of collaboration in HCWM. When asked at the end of the interviews, the interviewees commented on their expectations and suggestions for achieving the aim of the study. The interviewees confirmed the accuracy of contents of their interview’s transcripts at the end, which also enhanced efficiency of data collection times.
Six types of in-depth interviews were conducted with six types of interviewees from four institutions/associations, selected as key stakeholders of the study. The researcher interviewed them after obtaining their consent via telephone or facsimile. The interviewees could select the venues to their convenience, and the process was recorded to avoid misjudgement or mistypes of the interview contents. Written confirmations were sought after explanations of information and at conclusion of interviews.

The interviewees or informants were considered policy makers or decision makers by the institutions dealing with HCWM at District local levels or national level. They represented the MoH (two persons), MoE (one person), CRTT (one person), IHA Committee (one person), eight A and B class hospitals (eight managers), and HCs (five sanitarians from five provinces). The researcher used semi structured questionnaires for the interviews with different participants, as a guide only, since the actual instrument was the researcher as interviewer. Also, the interview technique depended on the actual process of each interview. The interviews used ‘Bahasa Indonesia,’ the official language in Indonesian institutions. The in-depth interview questionnaires are presented in Appendices 2A-2G.

3.8.4 On-site visits and observations

The researcher visited eight hospitals and five HCs at least twice, for data collection, performing waste audits, and conducting in-depth interviews, in five provinces in Indonesia. The researcher also visited and undertook an internship at The Royal Brisbane and Women’s Hospital (RBWH) in Queensland. The first was a two day visit, and the second was for five days as part of an internship program for Australian Leadership Awards Scholarship recipients. In Queensland, the researcher also visited a private company operating HCW treatment by incineration.

During the visits, the researcher also observed the process of on-site HCWM in all hospitals and HCs, interviewing designated waste operators, medical doctors and nurses, and staff of waste management divisions.
3.9 DATA ANALYSIS AND INTERPRETATION

3.9.1 Quantitative data

Data coding, entry and checking

All 237 hospitals returned the questionnaires. They were checked for completeness and clarity, and were further processed in IBM SPSS program versions 19 and 20. The variables from the questionnaires were identified and grouped into independent and dependent variables for descriptive and inferential analysis. According to Gray and Kinnear (2012), a variable is a characteristic or property of a person or unit of analysis comprising a set of different values.

In terms of scaling, there are two types of variables, namely quantitative and qualitative variables. The quantitative variables can be expressed in units on a scale. Qualitative variables, cannot be expressed in units, and can only be counted as cases in various categories.

Each variable was coded for assigning numbers to their values or levels, and they were entered into the SPSS Statistics Data Editor. Morgan, Leech, Gloeckner, and Barrett (2011) specify that all data should be numeric, making them desirable for statistics, and all values or codes for a variable must be mutually exclusive, that is, only one value or number should be recorded for each variable.

All the data obtained were then categorised into nominal, ordinal, interval and ratio, as levels of measurement. The categorisation was important for selecting appropriate statistical analysis techniques as different types of data categories will have different types of statistical techniques (Morgan et al., 2011; Gray & Kinnear, 2012).

Measurement for descriptive statistics

Data sets obtained from data entry can be classified into univariate, bivariate and multivariate variables, depending on the objective of the study or research questions set for the study (Gray & Kinnear, 2012). In a univariate data set, there are only data referring to one variable. The study consists of 194 univariate variables for descriptive statistics. A number of important variables were selected to be presented in tables and graphs.
Hypothesis for inferential statistic analysis

The researcher also selected a number of important variables for multivariate analysis, comprising three or more independent variables against a dependent variable (Sheskin, 1997; Härdle & Simar, 2007). E.g., independent variables were location of hospitals, hospital classes, and type of waste segregation at source; whereas, the dependent variable was the amount of medical waste generated. Some hypotheses were formed for multivariate analysis or parametric analysis, since the researcher used a ratio scale for testing the dependent variable. Overall, data processing and analysis followed the instructions available in the SPSS program, and the chosen statistical analysis techniques were based on relevant statistical theories of the current knowledge and theory of HCWM, obtained from the literature review.

3.9.2 Qualitative data

Data preparation for statistical analysis

All qualitative data from in-depth interviews were transcribed in Bahasa Indonesia, and they were classified by type of interviewees/informants. E.g., the interviews with hospitals managers were filed in one group for analysis. Therefore, there were four groups of qualitative data: a group of hospital managers, a group of leaders from key institutions, an Indonesian hospital association, and a group of HC’s sanitarians.

Data coding

The interview results from each group were coded using the open coding style, to segment data into fragments that can be called as codes that were obtained from the interviews, to make up a group of fragmented data (Boeije, 2010). Comparing the different interviews, the researcher decided to put all fragments relating to the same theme, together.

Integrating segmented data

All groups of segmented data were then reassembled, by similar categories, to formulate a meaningful set of phenomena of current HCWM. The researcher translated the data into English, once it was all integrated into a number of narrative data sets. To a certain degree, there were difficulties in finding equivalent words in English, bearing the precise meaning as the Bahasa Indonesia words. However, the researcher believed that there will be no loss of meaning, if the translation was based on the context of the
phrases commonly used in HCWM. The integrated data include an explanation of the way the HCW in the hospitals studied, were managed from source to final disposal. The study also determined how hospital managers perceived the existing regulations and policies on HCWM. Were they suited to their capability to manage their wastes, or what prevented their compliance with the regulations?

**Constructing arguments for qualitative findings**

After completing the qualitative data analysis of the interview data, which resulted in a number of narrative explanations, the researcher provided relevant arguments obtained from current theory and phenomena related to HCWM. The arguments were then compared, as much as possible, to quantitative findings. When quantitative data could not be compared to qualitative findings, the latter were used to answer research questions that were relevant to them.

**3.9.3 Triangulation findings**

Data obtained from the above two methods, were analysed, using concurrent triangulation strategy, as suggested by Creswell (2009) and Boeije (2010). Therefore, qualitative data from in-depth interviews were used to confirm and cross-validate the findings of the quantitative part. Moreover, the qualitative part was complementary to quantitative results, and it was also utilised to answer the research questions that quantitative data could not (Hammersley, 2008). Cumulatively, the findings of the mixed methods answered all research questions, as much as possible, to generate information, important for formulating a policy framework for sustainable HCWM in Indonesia. The detailed results of the triangulation will be presented in Chapter 6.

**3.10 ETHICAL CLEARANCE**

The researcher completed the Griffith University Research Ethics Scope Checker and Expedited Human Research Application, so that the Griffith University Human Research Ethics Clearance was granted, in accordance with the National Statement on Ethical Conduct in Human Research 2007 (ENG/07/10/HREC), on 24 June 2010.

Other ethical clearances were obtained from the Ethics Committee at NIHRD, Indonesian MoH (LB.03.02./KE/6323/2010), and from the Dr Sutomo hospital/the University of Airlangga, Surabaya (105/Panke.KKE/23/IV/2010), as it is owned by a
local government. Informed consents from selected hospitals were obtained by returning the mailed questionnaires, or by allowing the researcher to conduct in-depth interviews and on-site visits for field observation.

3.11 LIMITATIONS OF THE STUDY

The limitations of the study were mainly due to the moderate response rate of mailed surveys and time constraint for waste audits that did not consider seasonal factors of waste generation, which would influence disease patterns. A 50% response rate was quite good for this study, which, by its nature, makes it ‘a sensitive inquiry,’ despite the researcher assuring the informants of confidentiality. Under no circumstances, will the identity of sample hospitals be disclosed, either in this thesis, or, for future publication.

Another cause of non response was that the sample hospitals had the opportunity to voluntarily fill in the questionnaires, as stated in the information sheet of informed consents sent to them, as mandated by ethical clearance procedures. Therefore, a number of sample hospitals were reluctant to return the mailed questionnaires.

Another limitation was that the in-depth interview with selected policy makers was carried out once only per person, which should ideally have been at least twice per person (Padgett, 2012). This was due to the limited time available, and the difficulty of arranging interviews with policy makers. However, after completing each interview, the researcher requested confirmation of their contents, and, in fact, two out of eight hospitals were very difficult to approach as they were afraid of their performance being assessed, considering the researcher being a senior researcher at the Indonesian MoH. This was in contrast to the two Queensland hospitals which were very enthusiastic to explain their HCWM and provide adequate information to the researcher.

These limitations were minimised by the following actions:

- Composing structured questionnaires which heavily contained closed-ended questions, starting with easier topics to the most difficult one, and using common official language which was self explanatory
- Pre-testing questionnaires prior to mailing them to the sample hospitals
Accompanying each mailed questionnaire with an official letter from the MoH, to encourage the hospital to answer the questionnaire and participate in the study for future improvement of its hospital

Protecting the confidentiality of the identity of each sample hospital, including in the publication of the study results

Sending the semi-structured questionnaires along with an official letter from NIHRD, the MoH, and the information sheet, to all informants, prior to interviews, so that, the informants would be well informed, and also, enabling them to be better prepared to discuss the topic being studied. This also avoids misperceptions among them, given the possibility of the research being classified as sensitive, especially for those who were in charge as health care providers.
4. HEALTH CARE AND HCWM IN THE STATE OF QUEENSLAND

4.1 INTRODUCTION

This chapter briefly describes the current HCWM in the state of Queensland, Australia. A literature review and on-site visits and observation in the RBWH in Brisbane, are the main sources of information. Prior to describing HCWM in the selected hospital, this chapter glances over the health care services in Australia, and the state of Queensland, in particular, to provide a linkage between health care services with the primary duty as health care providers, and health care facilities as waste generators. This can be used as lessons learned of best practice of Queensland government in HCWM, and protecting their patients and health care workers, through an occupational health and safety program. This also highlights the availability of regulations, policies and strategies in the implementation of HCWM.

4.2 HEALTH CARE SERVICES IN AUSTRALIA

4.2.1 Hospital services

Hospitals in Australia play significant roles in providing health services to Australians. Hospital expenditure increases faster than inflation, each year — an estimated Australian $41.8 billion in 2008-2009, it was about 3.3% of Australia’s domestic product, or about Australian $1,922 per person (Australian Institute of Health and Welfare [AIHW], 2010). Between 2004-2005 and 2008-2009, the expenditure rose, on average, by 5.1% each year. Australians are very concerned about health care services as an important aspect of social welfare. Therefore, their quality, funding, management, and access, are constantly under public scrutiny.

In terms of ownership, there are two types of hospitals in Australia: public hospitals and private hospitals. The former, are managed by State and Territory governments, and the latter, are managed and owned by private organisations, either for-profit companies, or not-for-profit, non-government organisations. Similar to public hospitals, the private ones also provide services on a day-only basis and overnight care.
According to the AIHW (2012), the numbers of hospital beds vary, considerably, across the states and territories, and are a better indicator of the availability of hospital services than are the numbers of hospitals. Chairs used for same-day treatments, like chemotherapy, are also counted as hospital beds.

The number of hospital beds rose by 3.3% between 2005–2006 (80,828 beds) and 2009–2010 (84,938 beds) with an average, annual increase of 1.2%. The increases were larger in private hospitals than public hospitals. In 2009-2010, there were 54,812 beds in public acute hospitals, 2,088 beds in public psychiatric hospitals, 2,260 beds in private day-only hospitals, and 25,778 beds in other private hospitals. In contrast, there was a significant decrease in the number of beds in public psychiatric hospitals, due to the changing face of mental health services.

However, the number of hospitals between 2005-2006, and 2009-2010 were stable. Australia has 1,326 hospitals comprising 736 public acute hospitals, 17 public psychiatric hospitals, 293 private day-only hospitals, and 280 other private hospitals. Of 1,326 hospitals, Queensland State has 276 hospitals; ranking second amongst eight states and territories.

Regarding accreditation through assessment of quality performance and effectiveness, 637 public hospitals (93% hospital beds) were accredited in June 2010, and 543 private hospitals, covering 93% of hospitals, or 97% of hospital beds in 2009-2010. Hospitals can be accredited through organisations like the Australian Council of Health Care Standards (ACHCS), Business Excellence Australia, and the Quality Improvement Council, or through ISO 9000 quality family (AIHW, 2012) certification.

There are various sources of funds for public and private hospitals, reflecting the types of patients and services. Governments mainly fund emergency departments and outpatient services, whereas, admitted patient services are commonly funded by private (non-government) sources, as well as, government sources.

The Australian Government funds public hospitals via the Australian Health Care Agreements, even though the funds are provided to state and territory governments for their spending on public hospitals. Similarly, the Australian Government funds the contributions to private hospitals via the private health insurance premium rebates, even though the funds are provided through health insurance funds and their members.

Australia reformed its national health system, and produced the National Health Reform Agreement (NHRA), agreed to by all states and territories on 2 August 2011, covering eight streams of work, including hospitals, GPs, primary care, aged care, mental health, national standards and performance, workforce, prevention and e-Health.

According to the Department of Health and Ageing (DoHA, 2011) annual report 2010-2011, the Australian Government, subsequently, selected 63 projects to receive funding to improve access to essential health services, for Australians living in rural, regional and remote areas. In addition, since June 2010, nearly $1 billion was provided under the Agreement for more than 340 projects, in more than 145 hospitals, across Australia. These projects include extending emergency departments, buying equipment to improve surgeries, and expanding the workforce to deliver better care.

4.2.2 Other health care services
Health care services are also provided by other institutions, or organisations, in the form of residential care, GP clinics, doctors’ rooms and the like. They are considered to be primary health care services. In terms of performance quality, their services are similar to the hospitals’, including compliance with regulations and policies, particularly in relation to HCWM policies and practices.

4.3 REGULATION, POLICY AND STRATEGY

4.3.1 Regulations and policies related to HCWM
Several regulations and policies cover HCWM in Queensland. These include the regulations and policies on solid waste and regulated wastes (clinical and related wastes), and other regulations governing health care related activities. Since 2009, all regulations regarding waste management like Environmental Protection (Waste Management) Regulation, 2000, and Environmental Protection (Waste Management) Policy, 2000, are administered by the Department of Environment and Resource
Management (DERM), which were previously administered by Queensland Environmental Protection Agency (EPA) separated from DERM.

Queensland Environmental Protection Act 1994

This Act came into force on 5 April 2012, and it includes all amendments up to 5 April 2012. It provides regulation-making power. The Act defines waste in relation to its management and disposal, and in relation to Waste Reduction and Recycling Act, 2011.

The definition of waste is follows:

(1) Waste includes anything, other than a resource approved under the Waste Reduction Act, chapter 8, that is—
   (a) left over, or an unwanted by-product, from an industrial, commercial, domestic or other activity; or
   (b) surplus to the industrial, commercial, domestic or other activity generating the waste.

Example of paragraph (a)—Abandoned or discarded material from an activity is left over, or an unwanted by-product, from the activity.

(2) Waste can be a gas, liquid, solid or energy, or a combination of any of them.

(3) A thing can be waste whether or not it is of value.

Waste Reduction and Recycling Act 2011

This Act came into force on 1 December 2011, consolidating all amendments until 1 December 2011. It addresses all matters regarding waste reduction and recycling in Queensland, and provides the detailed requirements in Waste Reduction and Recycling Regulation, 2011.

Queensland Waste Reduction and Recycling Regulation 2011

This regulation came into force one day after Waste Reduction and Recycling Act, 2011, and provides all regulatory requirements regarding the implementation of waste reduction and recycling, as mandated by the Act.
Queensland Environmental Protection (Waste Management) Regulation 2000

This regulation came into force on 1 December 2011, consolidating amendments until 1 December 2011. It addresses waste issues not dealt with, or not clearly defined, under previous legislation, and provides clarification to waste producers and state and local governments on:

- Offences for littering and waste dumping
- Waste tracking system
- Clinical and related waste management planning, segregation of infectious wastes, appropriate on-site storage and proper disposal
- Managing and ultimately phasing out certain polychlorinated biphenyls
- Design rules for waste equipment and toilets

Queensland Environmental Protection (Waste Management) Policy 2000

This policy, released in January 1996, sets the waste management strategy for Queensland, based on the following principles (Queensland Government, 2001):

- Integration of waste management from the point of generation to final disposal
- ‘Polluter pays’ and ‘user pays’
- Waste generators and product designers have a responsibility
- Waste management should be based on the hierarchy of prevention, recycling, treatment and finally disposal.

The policy also outlines requirements for state and local governments to prepare and implement strategic waste management plans, and introduces the WMH into legislation (DERM, 2010b).

Work Health and Safety Act 2011 (Act no.18 of 2011)

The most important part in this Act in relation to HCWM is the duty cast on workers to immediately notify their regulators after becoming aware that a notifiable incident occurred in the workplace by any means, and to preserve the incident site and minimise the risk of a further notifiable incident. The details of requirements and duties are available in Work Health and Safety Regulation, 2011.
Work Health and Safety Regulation 2011

This regulation is in force since 1 January 2012, consolidating all amendments until 1 January 2012. The importance of this regulation in relation to HCWM is the obligation of workers to maintain health and safety in the workplace, including performing work properly, wearing relevant PPE, and other requirements in the workplace, including hospitals. The details of this regulation can be seen in the workplace health and safety standards.

4.3.2 Waste management and its strategy

Waste management

Queensland generates considerable waste and, as reported, the amount of waste generated in 2008 from various streams was 32.6 million tonnes. Depending on the ways of waste management, an estimated 10.3 million tonnes was generated by households and businesses (DERM, 2010b). In comparison with other states and territories, Queensland’s waste generation per capita ranked third, after West Australia and South Australia, with 27% of waste recycled, and the remainder, disposed of at the landfills. However, waste generation per capita was higher than the national average, 1.9 tonnes compared to 1.1 tonnes (Total Environment Centre [TEC], 2007).

In terms of the amount of recycled waste, Queensland’s was below the national average. Therefore, this presents future challenges for major improvement in resource recovery, considering the possibility of increasing recyclable waste by changing the waste management strategy, favouring the 3Rs approach.

The Queensland Government faces a number of constraints in managing its waste. These include: population growth, the limitation of space for landfills, compounded by the technical difficulties to increase recycling rates, such as, contamination in kerbside recycling systems, and stringent quality requirements for feedstock materials. Another barrier is that Queenslanders are the third highest waste generators and the second lowest recyclers in Australia. Hence, a comprehensive waste strategy, combined with legislative reform, should be formulated to reduce waste generation, and increase resource recovery.
Waste management strategy

In December 2010, the Queensland Government, through DERM, introduced the new Queensland Waste Reduction and Recycling Strategy, 2010-2020, to achieve the goal of ‘zero waste.’ This replaced the previous one of 1996.

The new strategy covers sustainable environmental management principles, including resource efficiency, sustainability, engagement, and capacity building. Therefore, the aims of the strategy are:

- Reduce waste
- Optimise recovery and recycling
- Develop sustainable waste industries and jobs

The strategy has the following five parts:

- Targets and priorities
- Price signal – waste disposal levy
- Stronger legislation
- Programs and actions
- Partnerships to deliver change

The targets within the timeframe are set in Table 4-1 below.

Table 4-1 Key targets and dates of Queensland’s waste reduction and recycling strategy 2010-2020

<table>
<thead>
<tr>
<th>Target</th>
<th>2008 baseline</th>
<th>By 2014</th>
<th>By 2017</th>
<th>By 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce waste disposal to landfill, compared to business-as-usual projections</td>
<td>Business-as-usual-no strategy</td>
<td>Reduce landfill disposal by 25% - 4.6 million tonnes of avoided landfill disposal since 2010.</td>
<td>Reduce landfill disposal by 40% - 9.9 million tonnes of additional avoided landfill disposal since 2010.</td>
<td>Reduce landfill disposal by 50% - 16.3 million tonnes of additional avoided landfill disposal since 2017.</td>
</tr>
<tr>
<td>Increase recycling of construction and demolition waste</td>
<td>35%</td>
<td>50%</td>
<td>60%</td>
<td>75%</td>
</tr>
<tr>
<td>Increase recycling of commercial and industrial waste</td>
<td>18%</td>
<td>40%</td>
<td>50%</td>
<td>60%</td>
</tr>
</tbody>
</table>
Table 4-2 Key targets and dates of Queensland’s waste reduction and recycling strategy
2010-2020 (continued)

<table>
<thead>
<tr>
<th>Target</th>
<th>2008 baseline</th>
<th>By 2014</th>
<th>By 2017</th>
<th>By 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase recycling of MSW</td>
<td>23%</td>
<td>50%</td>
<td>55%</td>
<td>65%</td>
</tr>
<tr>
<td>Target 150: Increase recycling of household waste to 150 kg per person</td>
<td>64 kg per person per year</td>
<td>80 kg per person per year</td>
<td>100 kg per person per year</td>
<td>150 kg per person per year</td>
</tr>
<tr>
<td>person per year</td>
<td>5% reduction</td>
<td>10% reduction</td>
<td>15% reduction</td>
<td></td>
</tr>
<tr>
<td>Reduce generation of waste</td>
<td>2.4 tonnes per person per year</td>
<td>2.3 tonnes per person per year</td>
<td>2.2 tonnes per person per year</td>
<td>2 tonnes per person per year</td>
</tr>
</tbody>
</table>

Source: DERM (2010b, p. 6).

The new strategy provides a vision and the means to achieve a low-waste Queensland, and sets clear targets in waste management plans, under a strong legislative framework. Application of the strategy towards greater resource recovery will significantly reduce the environmental, social, economic, and health impacts of waste, and in turn, enhance sustainability. The legislative reform empowers the Queensland Government to deliver improved outcomes and resource management, consistent with the framework applied by other states and territories. The new Act introduced the waste levy, applicable at the point of disposal. Hence, this system encourages waste generators to implement waste reduction system. The application of a waste levy is to provide (DERM, 2010b, p. iii):

- A price signal to waste generators to encourage waste avoidance and resource recovery behaviour, and discourage disposal to landfill as the first option
- A source of funding for programs to assist local government, business and industry establish better resource recovery, and improve overall waste management practices
- A source of funding to support Queensland Government and local government environmental initiatives
- An incentive for industry investment in resource recovery infrastructure
- A disincentive for disposal of interstate waste in Queensland.

Overall, the new waste strategy, helps address various challenges to accomplish the vision of a low-waste Queensland, and a more resource-efficient society.
4.3.3 Management of clinical and related wastes

A fraction of HCW that need to be regulated, include clinical and related wastes, as stated in the Queensland Environmental Protection (Waste Management) Regulation 2000 (DERM, 2010a). The definitions below will instruct the segregation process prior to waste treatment and disposal, to prevent negative health risks.

- **Clinical waste** is waste that has the potential to cause diseases including animal waste, discarded waste, human tissue waste and laboratory waste and associated waste directly resulting from the processing of specimens.
- **Related wastes** are wastes including chemical, cytotoxic, human body parts, pharmaceutical and radioactive wastes.

DERM, 2010a, p. 38.

The above regulation (DERM, 2010a), directs clinical and related wastes to be contained in colour-coded bags and stored in leak-proof containers in secure spaces, to prevent generating an environmental nuisance, and being reached by unauthorised persons. Moreover, clinical and regulated wastes should be packaged properly before being transported to treatment and disposal facilities, to prevent being accidentally opened, and released to the environment.

Development approvals are required to transport regulated waste weighing more than 250 kg in a load for fee or reward. Clinical waste, being transported both on-site and off-site, must be accompanied by a report, to track their movement. The DERM also recommends for onsite transportation of clinical waste (DHP, 2010, p. 2) as follows:

- move waste in rigid-walled, leak-proof, puncture resistant containers;
- avoid moving waste in plastic bags;
- do not use waste disposal chutes;
- minimise exposure to waste (e.g. avoid moving waste during visiting hours and meal times, or through public areas); and
- avoid overfilling containers.

For safe off-site transportation of clinical waste, the DHP (2010, pp. 2-3) suggests as follows:

- transport waste in rigid-walled, leak-proof, puncture resistant containers;
do not use plastic bags;
fit secure lids to containers;
ensure reusable containers are in good condition;
preferably use vehicles kept solely for transporting clinical waste;
keep the driver’s area segregated; and
use a vehicle that is easy to load and clean, and is fitted with a method of securing containers, to prevent containers falling in transit.

Table 4-3 Colour and symbol coding for clinical and related wastes

<table>
<thead>
<tr>
<th>Waste</th>
<th>Container colour</th>
<th>Label colour</th>
<th>Symbol</th>
<th>Labelling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical</td>
<td>Yellow (vivid yellow Y13)</td>
<td>Black</td>
<td>(Biohazard symbol)</td>
<td>Clinical waste</td>
</tr>
<tr>
<td>Cytotoxic</td>
<td>Lilac (lilac P23)</td>
<td>White</td>
<td>(Cell in telophase)</td>
<td>Cytotoxic waste</td>
</tr>
<tr>
<td>Radioactive</td>
<td>Red (scarlet R12)</td>
<td>Black</td>
<td>(Radioactive symbol)</td>
<td>Radioactive waste</td>
</tr>
</tbody>
</table>

Furthermore, all clinical and related wastes should be treated appropriately, according to the regulation. Several technologies are available for the treatment and disposal of the above wastes to minimise their risk to the environment and human health. The technologies are listed below, and details of the treatment technology options can be seen in Table 4-3:

- incineration;
- autoclaving and shredding;
- chemical disinfection using hypochlorite, and shredding;
- chemical disinfection using peroxide and lime, and shredding; or
- microwave disinfection and shredding.

The Environmental Protection (Waste Management) Regulation 2000 lists the following important things dealing with proper treatment and disposal of clinical and related waste:
➢ Cytotoxic waste must be incinerated before disposal to landfill
➢ Human body parts must be incinerated or treated by chemical disinfection processes using peroxide and lime, and shredded before disposal to landfill
➢ Radioactive waste must be managed under the requirements of the Radiation Safety Act 1999. A person must not dispose of radioactive material unless:
  • the concentration or activity of a radionuclide in the material is not more than the maximum concentration; or
  • activity prescribed under a regulation; or
  • the person holds an approval to dispose of the material, and disposes of it as required under the approval.
➢ Pharmaceutical waste must be incinerated before disposal to landfill
➢ Compaction of human body parts, animal carcasses, cytotoxic waste, chemical waste, radioactive waste, pharmaceutical waste and sharps is not considered appropriate.

The above demonstrates how the Environmental Protection (Waste Management) Regulation 2000 encourages management of clinical and related wastes and guides all waste generators to comply with its regulations. Subsequently, all stakeholders involved are directed to perform their duties and responsibilities at every level of management, and aim at reaching the target set in the Waste Reduction and Recycling Strategy.
### Table 4-4 Treatment and disposal methods of clinical and related wastes based on schedule 5 of Environmental Protection (Waste Management) Regulation 2000

<table>
<thead>
<tr>
<th>Waste type as segregated</th>
<th>Incineration</th>
<th>Autoclaving and shredding</th>
<th>Chemical disinfection using hypochlorite and grinding/shredding</th>
<th>Chemical disinfection using peroxide, lime and grinding/shredding</th>
<th>Microwave disinfection and shredding</th>
<th>Compaction</th>
<th>Landfill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical</td>
<td>✓ (if registered)</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Cytotoxic</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Human body parts</td>
<td>✓ (1)</td>
<td>✗</td>
<td>✗</td>
<td>✓ (1)</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Pharmaceuticals</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Radioactive</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Clinical</td>
<td>✓ (1)</td>
<td>✓ (1)</td>
<td>✓ (1)</td>
<td>✓ (1)</td>
<td>✓ (1)</td>
<td>✓ (1)</td>
<td>✓</td>
</tr>
</tbody>
</table>

(1) Alternative treatment methods

Source: DEHP (2010, p. 3).
4.4 HCWM IN RBWH

4.4.1 Overview of RBWH

The Royal Brisbane and Women’s Hospital is the largest tertiary hospital in Queensland and since 2008, it is part of Metro North Health Service District, providing medical services for Queensland, as well as, serving patients from northern New South Wales and the Pacific Rim. It is a teaching hospital located in Herston area comprising 53 buildings and 929 beds with the occupancy rate of 86.77% in 2010, and providing an array of medical services including Surgical and Peri-operative Services, Internal Medicine Services, Women and Newborn Services, Nursing Services, Corporate Services, Medical Services, Critical Care and Clinical Support Services, Allied Health, Cancer Care Services, Mental Health Services, and Oral Health Services (Queensland Health, 2012).

Historically, the hospital’s name was the Brisbane Hospital, and since 1867, has been located at Herston campus. In 2012, the RBWH thus celebrated 145 years of world-class care of Queenslanders. Of the 53 buildings in Herston campus, there are seven main buildings, named as follows:

- Royal Women’s Hospital
- Royal Brisbane Hospital
- Royal Children’s Hospital
- Mental Health Building
- Department of Anatomical Pathology
- Queensland Radium Institute
- Queensland Institute for Medical Research Bancroft Centre

In providing high quality health care, the RBWH has a vision “to be a world-class, academic tertiary and quaternary health centre taking care of our community” and the mission of “Knowledge-led, world-class care, education, training and research.” The hospital adopts the following eight key principles to achieve the above mission (Queensland Health, 2012, p. 2):

- patient-centred care
- evidence based practice
- Capable staff
- Governance
education and training  Leadership
partnerships  Efficiency

In terms of environmental performance, it is the first hospital in Queensland to introduce an integrated waste tracking system, internally, and to reduce energy consumption, and introduce a waste recycling system. The hospital has also implemented a sharps waste reduction and safety program to minimise the risk of needle-stick injuries and reduce sharps waste management costs as included in Clinical and Related Waste Management Plan 2007-2012 (Queensland Health, 2006).

The following description of the waste management system at the RBWH is based on in-depth interviews with the Environment and Waste Coordinator, Manager and staff, and onsite observations during internship as an Australian Leadership Award Scholarship recipient from 9-10 September 2008, 19-20 October 2010, and 25-27 October 2010.

4.4.2 Solid waste generation and segregation

The hospital implements waste minimisation management, in accordance with the WMH, preferring waste avoidance and 3R practices, over waste treatment and disposal. The hospital manages its waste that is inevitably produced, by emphasising segregation at source into four major wastes, seeking to save natural resources and reduce the cost of treatment and disposal. The four major types of wastes generated by the RBWH are:

- Clinical and related wastes
- Cytotoxic waste
- Recyclable wastes
- General wastes

All these wastes are segregated, using the colour code determined by EPA (Waste Management) Regulation and Policy 2000, as seen in Figure 4-1. Examples of clinical and related wastes are human pathological waste, human blood products - serum, plasma tubing and drainage bags containing free-flowing blood or body fluids, oxygen and nebuliser masks and tubing, and intravenous giving sets. Clinical wastes are identifiable where blood, blood products or body fluids is flowing, dripping, oozing, liquid or expressible from material, and containers of blood or free flowing body fluids, e.g. urine bags, tubing, suction canisters, and sputum mugs. Moreover, material that is
not saturated or dripping blood or body fluid is general waste, unless it is waste from Isolation Rooms in use by infectious patients.

Figure 4-1 Segregation and waste colour-codes at RBWH

Wastes are categorised as sharps if the wastes have sharp points, protuberances or cutting edges, capable of causing a penetrating injury to humans, such as, syringes with needles attached, scalpel blades, needles, pasteur pipettes, drawing up containers, razors, broken glass/vials and cannulas.

Wastes generated from each ward are sorted there and collected in small bins, according to the waste type. Generally, the three types of small bins with relevant colour coded plastic bags are placed underneath the sinks. The green bins with transparent bags are for general wastes, and the yellow bins with yellow bags are for clinical wastes. For sharps wastes, a yellow bin is usually hung on the wall of each ward, which is high enough to avoid contact by children.

There are two kinds of sharps containers; the old one is a yellow box with a lid that could be manually closed every time the waste is collected. The new one is the sealed sharps container which is more effective in avoiding overfills as it is automatically shut off after reaching the optimum or full capacity (Figure 4-2). In contrast, the old design is less effective, increasing the risk of sharps injuries, if overfilled. More importantly, the use of the new model is more efficient as they are reusable too, significantly reducing the costs of provision of sharps containers.
When handling hospital wastes, waste collectors should observe UP by wearing disposable gloves and close bin liners prior to removing from containers. More importantly, they should avoid coming in contact with wastes by keeping containers away from their bodies when transferring waste bags, and washing hands afterward.

The generation of each type of waste varies, and it is estimated that the proportion of clinical and related wastes is about 20-25% and the remainder is recyclable and general wastes. The generation of clinical wastes is about 20-30 bins daily, which is collected by an assigned contractor, thrice per day. The production of sharps wastes is about 60 boxes, and the contractor collects these, twice a week.

### 4.4.3 Solid waste collection, containment, on-site transport and storage

Wastes which have already been collected in ward bins according to the wastes types are collected by designated cleaning staff using wheelie bins, to be put in similar but larger bins, in a disposal/holding area, located on each floor of the hospital. The wastes are usually collected 3-4 times in a day shift, and three times in a night shift.

There are six types of larger bins in the holding areas on each level, to accommodate the wastes generated from the wards. Sorting of recyclable wastes is done in the holding areas. The additional bins in the holding areas are for plastic bottles and cardboards. Cytotoxic wastes are contained in purple bins with the symbol of a cell in telophase.

*Figure 4-2 New model of sharps containers*
Different waste collectors are assigned to replace the full bins in the holding areas with empty bins, and take the full ones to the loading dock in another area, which can be accessed by the assigned contractor staff for off-site bin cleaning, recycling, treatment and disposal (Figure 4-3).

Figure 4-3 Various types of waste bins at RBWH

According to Gregg Butler (personal communication, October 19, 2010), the hospital hires four contractors for different assignments like incineration, and disposal of infectious and related wastes, recyclable waste recycling, sharps waste treatment and reuse of sharps containers, and disposal of general waste.

The hospital hires four certified contractors. Ace Waste is for clinical and related wastes treatment, Trans Pacific Cleanaway is for general and other recyclable wastes, Daniels Group is for cleaning sharps waste containers, and ISS World Australia for cleaning services. All contractors have responsibilities for providing quality services to comply with Environmental Protection (Waste Management) Regulation and Policy 2000. Therefore, they are also liable to supply the cleaned bins and clean the used bins at their own costs and risks, as stated in their contract agreements.

The costs of waste management are charged to each building, according to the record of each waste-bin equipped with bar codes. The cost of infectious waste and cytotoxic wastes treatment per kilogram is approximately AUD 76 cents (see Figure 4-4).
However, the hospital is not charged for cardboards and papers, as these are recycled by the contractor for economic benefit. Other recyclable wastes like plastic bottles are managed the same as cardboards and paper.

The general waste that cannot be recycled in the hospital is collected once a day by the assigned contractor and are disposed of in the sanitary landfills after further sorting for segregation of valuable material. About 40-50 bins of general wastes are collected per day from the hospital.

The hospital also generates pathological wastes containing human body parts and tissues, particularly from emergency and operation rooms, and from the laboratory. The pathological waste is collected in separate bins and kept refrigerated until collected by assigned contractor for incineration.

![Figure 4-4 Infectious (yellow) and cytotoxic (purple) waste bins](image)

The liquid clinical waste like blood samples and body fluids from dialysis rooms will be incinerated along with other clinical wastes.

Pharmaceutical wastes, which are expired medicines and other unused drugs, are also collected by the same contractor to be incinerated.

Mercury waste, generated by the hospital from medical devices and from used lightings, is collected by the contractor for further treatment. There is a special device for catching the mercury from unused lights so as to avoid mercury spills. However, the hospital provides mercury spill kits for cleaning any accidental mercury spills.
Radioactive wastes are also managed in accordance with the regulation by storing and shielding the wastes in a secure room to achieve their complete decay process depending on their half lives. The radioactive wastes are by-products of diagnostic and therapeutic medicines (see Figure 4-5).

![Secured radiological wastes room](image)

**Figure 4-5 Secured radiological wastes room**

### 4.4.4 Solid waste tracking system

The RBWH has implemented an electronic waste tracking system since 1 July 2003, to responsibly comply with the Environmental Protection (Waste Management) Regulation 2000, as the hospital is a regulated waste generator.

The hospital must provide prescribed information to the assigned contractor as transporter, and to the Queensland EPA (within the DERM), on the approved form, or in a prescribed way, and be subject to the application of the polluter pays principle. Therefore, all costs resulting from waste management are borne by the hospital.

The regulation also states that waste handlers, consisting of generators, transporters and receivers, have waste tracking responsibilities. The regulation also defines a generator as a commercial or industrial organisation, which produces, or stores, trackable waste, and arranges for this waste to be sent for storage, recycling, treatment or disposal, at another location via an authorised transporter.

According to schedule 2 of the regulation, the prescribed information includes:

- *the generator’s name, address, local government area and contact details*;
• generator identification number;
• the name, address and contact details of the person to whom the waste is to be transported;
• the day and time the generator gives the waste to the transporter for transporting;
• the load number;
• for a load of waste transported into or out of Queensland, the consignment number for the load;
• the type and number of containers if the waste is dangerous goods;
• the following details of the waste:
  • the type of waste;
  • the amount in kilograms or litres;
  • its physical nature (solid, liquid, paste or gas);
  • its waste code;
  • its UN number (if any)*;
  • its packaging group designator (if any)*;
  • its dangerous goods class and any subsidiary risk (if any)*; and
• the waste origin code for the activity that produced the waste.

Under the regulation, the hospital is required to record and keep the record for at least five years of the following:

• the information mentioned in the above section;
• the transporter's name, address and contact details;
• the transporter’s licence (environmental authority) number; and
• the registration number of the vehicle (if a motor vehicle) used to transport the waste.

The prescribed tracking system assigns a unique load number to each load transported by the waste transporter, and the transporter must carry a document containing the information received from the generator. The document can be an electronic record (Figure 4.6).
To fulfil the above requirements of the regulation, the hospital implements a waste tracking system as follows:
Each bin in each loading area located in each level of the hospital is bar coded, so it can be scanned and its weight recorded. The wastes in each bin then can be traced back if needed for monitoring or audits.

All waste bins will be moved to loading dock and they are scanned again and the weight of the waste is recorded.

All recording of the bins will be sent to the EPA on-line so that the EPA can monitor the wastes generated in real time.

After weighing at the hospital loading dock, the waste bins will be taken by the assigned contractor to the incinerator owned by Ace Waste. Once the bins reach the Ace Waste incinerator located in Willawong, Queensland, the bins will be scanned and recorded. If the weight of the bins recorded from the hospital does not match with the weight sent to the incinerator, the system will send an alert signal to be followed up.

4.4.5 Reduce, reuse and recycle system

The hospital has implemented the 3R system, as directed by Queensland Government through DERM, to reduce the costs of waste management and preserve natural resources. To achieve an effective 3R program, the hospital provides an on-site policy, guidelines, and standard operating procedures (SOP), combined with necessary facilities, regular training, and induction program, so that each hospital personnel will be aware of the duty to be responsible for appropriate waste handling and management.

The researcher observed the implementation of the 3R policy, during visits, especially the practices of waste segregation and the displays in each room at each level, emphasising the importance of safe HCWM (see Figure 4-7). The Waste and Environment Unit within the hospital importantly, provides regular consultation in case of inquiry, or to support decisions in cases of doubt about proper segregation of certain types of wastes, etc. Therefore, doctors, nurses or any other hospital personnel are enthused to be involved in the 3R program.
Figure 4-7 Examples of 3R application

The provision of transparent/white plastic bags for general waste in each room/ward has also increased the good practices of hospital staff in segregation, as mistakes like disposing clinical wastes in the plastic bags, can be traced back to the offending department/ward.

According to Butler (personal communication, October 25, 2010), the implementation of 3R system has significantly reduced the wastes generated, and the incidence of sharps injuries among hospital staff, so that the system produces economic benefit by reducing the costs of waste management and the reduction of occupational injuries.

An example of the efficiency resulting from the 3R system is the reduction of waste handling costs of drink containers and cardboard boxes of about 200,000 dollars annually, by providing compactors.

Since 2000, the RBWH performed remarkably in managing its wastes, and it received “the ACHCS” awards in 2003, for its efforts. Its dedicated Waste Management Team has successfully set a benchmark in hospital waste management through segregation and recycling. The same awards have been received by the hospital repeatedly, thereafter, by maintaining its performance in HCWM.

The hospital has also received other awards related to efficiency in the use of natural resources, such as, water and energy (G. Butler, personal communication, October 24, 2010). The achievement in waste management and resource recovery has reduced 30%...
of clinical wastes generation, and increased the volume of recyclables by 50% (G. Butler, personal communication, October 24, 2010).

4.4.6 Solid waste treatment and disposal
Solid wastes from the hospital are required to be treated and disposed of in accordance with the available regulations, as mentioned in Table 4.3 above. In this, the hospital hires Ace Waste for treatment and disposal of its clinical and related wastes, through the mechanism provided in the regulation.

The hospital also continues to improve its waste management plan. It works at achieving efficiency and effectiveness in hospital waste management, by conducting regular waste audits, and establishing a monitoring system to ensure that its wastes are properly managed in accordance with relevant regulations.

4.4.7 Wastewater treatment
The hospital also generates wastewater from its daily activities, including storm water and sewage water. All the wastewaters flow into the sewer system and are treated off-site, along with municipal wastewater. To prevent the discharge of pharmaceutical wastes into the sewer system, the hospital must comply with the EPA (waste management) Regulation, 2000, that only allows discharge of vitamins and intravenous solutions containing glucose, saline solutions, liquid food preparations, and electrolytes, into the sewer system.

4.4.8 Occupational health and safety
As hospitals are potentially hazardous workplaces, the RBWH implements occupational health and safety to prevent its workers from contracting HAI and injuries, and to provide a safe workplace for delivering high quality health services. As such, the hospital follows codes and practice to achieve standards required under the Workplace Health and Safety Act 2011. In line with the codes of practice, Queensland Health has established a surveillance program to recognise the existence of HAI, and to address the infection problems, accordingly (Queensland Government, 2011).

The surveillance system will be useful to determine the trend of infection rates, antimicrobial resistance and nosocomial pathogens. Therefore, the system enables the hospital to measure the extent of occupational exposure to blood and other potentially
infectious substances, among health care workers. It also measures occupational exposure to HIV, HBV and HCV and establishes risk factors like exposure to blood and body fluids among health care workers.

The provision of sealed sharps containers, PPE, relevant guidelines, SOP of safety injections, and regular training of infection control are among the preventive actions of the hospital in protecting its workers and patients from HAI and waste related diseases and injuries.

4.4.9 Leadership in HCWM

To implement a best practice HCWM, the RBWH, through its dedicated waste management team, established a leadership project in Hospital Waste Management and Resource Recovery with the slogan “know which bin to throw it in” across the Herston Complex, underlying the importance of waste segregation at point of generation.

The project includes monitoring, assessment, action, evaluation, feedback, customer focus and quality outcomes. The details of the actions are as follows:

- Monitoring has been conducted using visual waste audits of bins in wards, holding area/disposal area, and at the dock area on a daily basis, and full-scale waste audits, including physically separating every bag of waste over a twenty-four hour period. A random monitoring of on-site contractors was also done to ensure compliance with environmental standards as stated in the regulation.
- An assessment of the waste audits has provided accurate information on weight of each type of wastes, determining the failure of incorrect disposal practices in each ward or room, and assessing methods of obtaining correct disposal from staff, patients and visitors.
- Action consists of the provision of colour coded bins, signage, education of personnel, use of 660 litre wheelie bins, audit and assessment of waste categories and expansion of the existing recycle program.
- Evaluation to determine the success of the segregation program was conducted by communication with all categories of staff in the wards and the departments, daily monitoring using visual waste audits, and a follow up full scale waste audit after three months’ implementation.
Feedback was obtained from the staff on the segregation bins located at each ward close to the hand basin, and feedback on the “know which bin to throw it in” signage program.

Customer focus with the three values of honesty, integrity and trust has been achieved as the values provide waste generators within the hospital with deadlines to follow up audit, and an honest feedback, and they are kept confidential to ensure they are not being victimised or judged.

Leadership and commitment from the managerial levels within the hospital has allowed for further success by continuous improvement, based on regular assessment and involvement of communication on a number of levels, utilising the leadership approach performed by the leaders of the hospital.

4.5 SUMMARY

Chapter four provides sufficient information regarding the health care system in Australia, particularly in Queensland, including the best practice of HCWM being achieved by the RBWH. More importantly, the provision of comprehensive regulations combined with a policy framework for managing HCW, brings about the success of HCWM, utilising the expertise and dedication of all stakeholders, under the leadership and commitment of the managerial level. It is understandable that implementing HCWM is not an easy task as health care facilities, particularly hospitals, are complex workplaces which provide health care services for a number of sick and susceptible persons by different kinds of health care professionals and personnel. The awareness that hospitals are potentially hazardous workplaces is paramount; as such, provision of proper preventive measures is vital to ensure the health and safety of hospital communities, including patients and visitors. Therefore, the provision of health care services does not pose health impact resulting from wastes as by-products of the services, and in turn, the incidence of HAI and waste related injuries can be minimised.

The continuous improvement of SWM in Queensland, including HCWM, with emphasis on the spirit of zero waste, and resource recovery, can be regarded as the correct pathway to achieve sustainable development. In this effort, all stakeholders concerned are required by law to be actively involved in meeting the set target, such as, Queensland’s Waste Reduction and Recycling Strategy 2010-2020.
Overall, this chapter provides evidence from the experience of Queensland, that safe HCWM practices can be adopted through relevant regulations and a sound, policy framework. Moreover, the example of HCWM model implemented by the RBWM, while strictly complying with the regulations, qualifies as a best practice of HCWM in Australia.
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5. CURRENT STATUS OF HCWM IN INDONESIA

5.1 INTRODUCTION

This chapter describes all necessary variables underlying the current status of HCWM in Indonesia, as it includes an adequate sample size of 237 general hospitals, ranging from A to D class hospitals owned by the Central and Local Governments, across 27 provinces out of 33 provinces. The important variables of HCWM, are regulation and policy, characteristics of hospitals, resources and training, combined with variables of other programs related to HCWM, such as, infection control and HPH.

The presentation of the variables elucidated from the mailed survey was divided into two sections: namely, descriptive statistical data, and inferential statistical data. The first section presents each variable in proportions or percentages in the form of charts and tables, whereas, the second one presents the statistical association between several independent variables and one dependent variable, using multivariate analysis, to determine the predictors of hospital waste generation.

This chapter also provides descriptive data of medical waste generation per occupied bed per day from waste audits, instead of the same variable from the mailed survey. Subsequently, the relevant variables of HCWM also presented qualitatively from in-depth interviews. Therefore, the results of the study can be categorised as a comprehensive study of HCWM in Indonesia, as this applied mixed methods of inquiry.

5.2 BACKGROUND INFORMATION OF THE STUDY

5.2.1 Location of the study

There were 237 general hospitals selected in the study from 27 provinces out of 33 provinces across Indonesia. The locations of the study were in six large islands as seen in Figure 5-1. The largest number of hospitals was from Java Island (49.40%), followed by Sumatera (28.70%), Kalimantan (10.12%), Bali and Nusa Tenggara (5.90%), Sulawesi (4.60%), and Papua (1.3%). These numbers of selected hospitals indicate that more hospitals existed in islands with more people. E.g., about 67% of total population of Indonesia live in Java Island.
5.2.2 Ownership of study hospitals
As mentioned earlier, the study only used hospitals owned by Central and local governments, as sample hospitals, representing about half of total general hospitals. As seen in Figure 5-2, the local government hospitals dominated the number of sample hospitals of the study with the proportion of 89.45%, whereas, the Central government hospitals were only 10.55%. This also indicates that in the decentralisation era, more hospitals are owned by local governments.

5.2.3 Characteristics of study hospitals
There were several important variables considered as characteristics of study hospitals, including class of hospitals, number of beds, BOR, and numbers of inpatients and outpatients. These characteristics will influence waste generation, to some degree.
All classes of hospitals, A, B, C and D, were selected, including their equivalent classes from other owners, as the hospitals administered by Police/Army were categorised by different names. Figure 5-3 shows 130 class C hospitals (54.90%), randomly selected as sample, followed by class B (36.30%), class A (5.50%) and the least number was class D (3.40%). These numbers also represent the availability of each class hospital in the population of study.

Figure 5-3 Class of study hospitals

Figure 5-4 presents the number of beds of all sample hospitals in class interval as to be easier to read in the graph. Hospitals with less than 150 beds dominated the number of sample hospitals with 41.80%, and hospitals with the number of beds ranging from 151 to 300 ranked second (39.70%). In contrast, more than 900 beds were only a few from class A hospitals.

Figure 5-4 Number of beds in 2009 by class interval
The next characteristic was BOR (see Figure 5-5), which was very important as it indicated the utilisation of health care services in a given country. Surprisingly, there were two sample hospitals with BOR of less than 20%. This meant that the hospitals did not treat many inpatients during 2009, as only 20% of their beds were occupied. In contrast, the highest recorded BOR was in the range of 60%-70%.

Even though BOR is a good indicator of hospital utilisation, the researcher cannot assume that the low BOR in many hospitals would indicate that the health status of Indonesians was better, as there are several other indicators needed to determine the health status.

According to the MoH (2011), BOR during the last few years was on an upward trend, indicating that hospital utilisation had increased. Of several reasons for this increased demand for health services, enhanced health insurance stood out, as poor people have received free hospital services from community health insurance since 2005.

![Figure 5-5 BOR by class interval in 2009](image)

Patients admitted to hospitals for a minimum of one day, are considered to be inpatients. In Figure 5-6, 114 hospitals are shown to have had between 1 and 10,000 inpatients (48.10%). Second are the hospitals with between 10,000-20,000 inpatients (35.90%). On the other hand, hospitals which had more than 30,000 inpatients were only 16 hospitals (16.00%). The number of inpatients is estimated to be a determinant of HCWM.
The last characteristic of study hospitals was the number of outpatients. Outpatients are people who attend hospitals seeking medical services, without staying overnight, as their illnesses are usually considered not severe. In Figure 5-7, the hospitals with the highest number of outpatients were only four, or 1.70%, whereas the hospitals with the lowest number of outpatients were 46.80%. These data indicate that the sample of the study were mainly small hospitals, with total outpatients in 2009 of less than 50,000.

5.3 REGULATIONS AND POLICIES

5.3.1 Regulations and policies at national and local levels

Regulations and policies are very significant elements in achieving safe HCWM. These variables were also researched in order to develop a suitable framework for countries
which are considered as lacking in sustainable HCWM, like Indonesia. These regulations and policies provide direction and requirements to manage HCW, in a sustainable way, without compromising the health and safety of the health care community, including staff, patients, and visitors, as well as, people living nearby the health care facilities.

In Indonesia, regulations and policies on any subject, are available at the central and local levels. Figure 5-8 provides data on the availability of HCWM policies at central level, which could be from the MoH, MoE or other ministries and agencies. 75.50% of 237 hospitals confirmed that a written policy was available from the Central Government, and the remaining 24.50% stated that they did not have a policy from the same source.

This figure indicates that many hospitals did not have HCWM regulations and policies from the central level that can be referred to, in implementing safe HCWM. This could also mean that regulations and policies, to some extent, are not regarded as important aspects of HCWM, or that many hospitals were reluctant to manage their wastes in accordance with relevant regulations and policies.

![Figure 5-8 Availability of policy from Central Government](image)

Regarding completeness and clarity of the above policies, 152 (84.92%) out of 179 hospitals confirmed that the policies were complete and clear enough to understand. Figure 5-9 presents the proportions of hospitals which commented on the availability and clarity of HCWM policies from the centre. This figure is very interesting as many hospitals confirmed that the available regulations and policies from the central level...
A Policy Framework for the Improvement of Health Care Waste Management in Indonesia

dealing with HCWM were clear and complete enough. However, this perception will need to be compared with the results from in-depth interviews to understanding the context of completeness and clarity of such regulations and policies.

![Figure 5-9 Completeness and clarity of Central Government policy](image)

Guidelines for HCWM are very important for its implementation, as they cover all aspects of HCWM, the roles and responsibilities of each stakeholder concerned, and mechanisms for complying with relevant regulations. From the sample of 237 hospitals, 197 (83.12%) confirmed that there were HCWM guidelines available, and the remaining hospitals denied the availability of such guidelines (16.88%). It seems the majority of hospitals had guidelines to follow to implement HCWM (Figure 5-10).

![Figure 5-10 Availability of guidelines for HCWM implementation](image)

Green hospital initiative is a relatively new approach in Indonesia, as a similar approach that was applied in other industries, used the more popular term ‘cleaner production.’ This was an initiative by the Indonesian Hospital Association (IHA). This approach emphasises the importance of preserving natural resources and P2 in hospitals, including waste minimisation.
Figure 5-11 shows that only a few hospitals (19.83%) confirmed the availability of a green policy within their hospitals. In contrast, the large proportion of hospitals did not have/were unaware of such a policy. This is evidence that many Indonesian hospitals did not implement P2, as they were not familiar with the policy on green hospitals.

Many institutions provided guidelines for HCWM. In Table 5-11, the sample hospitals were asked the names of institutions providing HCWM guidelines, and the answers ranged from 1 to 16 institutions.

As these numbers are obtained from a question with multiple answers from the structured questionnaire, the cumulative percentages of each institution will be on the row of the graph, while the total frequency of all hospitals will be on the column. One hundred and ninety six (82.70%) hospitals filled in the questionnaires regarding the institutions providing such guidelines and 40 (16.90%) hospitals were reluctant to answer.

As for the proportion of each institution, the MoH was the highest preference with 79 hospitals (33.30%) and the second preference was guidelines from both the MoH and MoE (10.50%). The third rank was for guidelines from the combination of MoH, MoE and Governor. Interestingly, only one hospital stated that it had a guideline from the MoH and WHO. These results indicate that the HCWM guidelines were mainly from the Central Government, namely MoH and MoE, as the key stakeholders in waste management and policy. Moreover, these data also provide evidence that 40 sample hospitals did not have HCWM guidelines and it can be assumed that many hospitals in their population did not manage their wastes properly.
Table 5-1 Availability of HCWM guidelines from various sources

<table>
<thead>
<tr>
<th>No.</th>
<th>Type of Sources of Hospital Guidelines on HCWM</th>
<th>Yes</th>
<th>%</th>
<th>No</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MoH</td>
<td>79</td>
<td>33.3</td>
<td>158</td>
<td>66.7</td>
</tr>
<tr>
<td>2</td>
<td>MoE</td>
<td>16</td>
<td>6.8</td>
<td>221</td>
<td>93.2</td>
</tr>
<tr>
<td>3</td>
<td>Governor</td>
<td>8</td>
<td>3.4</td>
<td>229</td>
<td>96.6</td>
</tr>
<tr>
<td>4</td>
<td>Provincial and District Health Services</td>
<td>12</td>
<td>5.1</td>
<td>225</td>
<td>94.9</td>
</tr>
<tr>
<td>5</td>
<td>MoH and Governor</td>
<td>6</td>
<td>2.5</td>
<td>231</td>
<td>97.5</td>
</tr>
<tr>
<td>6</td>
<td>MoH and MoE</td>
<td>25</td>
<td>10.5</td>
<td>212</td>
<td>89.5</td>
</tr>
<tr>
<td>7</td>
<td>MoH and WHO</td>
<td>1</td>
<td>0.4</td>
<td>236</td>
<td>99.6</td>
</tr>
<tr>
<td>8</td>
<td>Consultant on Planning and Design</td>
<td>3</td>
<td>1.3</td>
<td>234</td>
<td>98.7</td>
</tr>
<tr>
<td>9</td>
<td>SOP based on Health Ministerial Decrees</td>
<td>1</td>
<td>0.4</td>
<td>236</td>
<td>99.6</td>
</tr>
<tr>
<td>10</td>
<td>MoH and Provincial &amp; District Health Services</td>
<td>11</td>
<td>4.6</td>
<td>226</td>
<td>95.4</td>
</tr>
<tr>
<td>11</td>
<td>MoH, MoE and Governor</td>
<td>16</td>
<td>6.8</td>
<td>221</td>
<td>93.2</td>
</tr>
<tr>
<td>12</td>
<td>MoH, MoE, and Provincial &amp; District Health Services</td>
<td>8</td>
<td>3.4</td>
<td>229</td>
<td>96.6</td>
</tr>
<tr>
<td>13</td>
<td>MoH, MoE, Governor, and Provincial &amp; District Health Services</td>
<td>4</td>
<td>1.7</td>
<td>233</td>
<td>98.3</td>
</tr>
<tr>
<td>14</td>
<td>MoH, Governor, and Provincial &amp; District Health Services</td>
<td>2</td>
<td>0.8</td>
<td>235</td>
<td>99.2</td>
</tr>
<tr>
<td>15</td>
<td>MoH, WHO, and Provincial &amp; District Health Services</td>
<td>2</td>
<td>0.8</td>
<td>235</td>
<td>99.2</td>
</tr>
<tr>
<td>16</td>
<td>MoE and Governor</td>
<td>3</td>
<td>1.3</td>
<td>234</td>
<td>98.7</td>
</tr>
<tr>
<td>17</td>
<td>No answer</td>
<td>40</td>
<td>16.9</td>
<td>197</td>
<td>83.1</td>
</tr>
</tbody>
</table>

There is a Health Ministerial Decree No.1204/2004 concerning Hospitals’ Environmental Health Standards, which provides a code of practice of HCWM for hospitals. This includes the stages of WMH from waste avoidance, reuse, recycling to disposal. This decree also provides guidelines for waste segregation with colour-coded bins and bags and health and safety procedures.

Figure 5-12 presents the proportions of hospitals, according to three variables, that comply with the decree. The majority of hospitals confirmed that they partly comply with the decree (77.20%), while 22.40% hospitals claimed to fully comply with the decree. The data also showed that only one hospital did not know that there was a decree for its hospital to comply with. One of the reasons was the limited resources available.
5.3.2 Policies within health care institutions

The availability of HCWM policies is a prerequisite for its proper implementation of in hospitals. This section will describe all types of policies and guidelines formulated by hospital managers to translate policies from higher levels to guide the implementation of HCWM. These policies vary, comprising hospital manager decrees, guidelines, SOPs, and action plans, and other conditions, according to the perception of environmental health/sanitation units, which manage hospital wastes. There are five figures presenting the on-site policies and related guidelines, as well as, plan of actions in 237 sample hospitals, including three figures in Section 5.3.3.

Figure 5-13 shows the percentages of available on-site policies on HCWM. One hundred and fifty one (63.71%) hospitals out of 237 pointed out that they had on-site HCWM policy and 36.29% did not have such policy. The high proportion of unavailable on-site policy was also an indication of a neglect of proper HCWM.

Figure 5-12 Implementation of Health Ministerial Decree No. 1204/2004
Figure 5-14 presents the proportions of sample hospitals about their perception, regarding the conditions of available HCWM policy within their hospitals. Out of 151 hospitals which had a policy, 131 (86.75%) stated that the policy was complete and understandable to follow, and some 20 (13.25%) hospitals perceived that the policy was neither clear nor complete to comply.

![Figure 5-14 Completeness and clarity of Manager’s policy on HCWM](image)

### 5.3.3 Hospital waste management plans and SOPs

The availability of HCWM plans, including reduction plans, in hospitals, is very essential to determine the resources needed, targets to achieve, and instruments to evaluate the process and the outcome, for a period of time. Moreover, the plans should be quantitatively measured, based on available strategies to minimise waste generation.

In order to implement the prescribed actions plans, SOPs will be required to guide all stakeholders involved, within the hospitals, in every stage of the WMH.

There are three figures below showing the proportions of hospitals which had written waste management plans, waste minimisation plans and their SOPs from the total of 237 hospitals.

Figure 5-15 describes the percentage of sample hospitals having HCWM plans to be followed by all personnel within the hospital, depending on their roles, on a daily basis. About three quarters of sample hospitals confirmed that they had such plans for implementing HCWM. Meanwhile, the remaining 58 (24.47%) hospitals did not have HCWM plans.
From the total of 179 hospitals which had HCWM plans, 157 (87.71%) hospitals had such plans to reduce waste production and to minimise the cost of waste management and the risks of waste related diseases. Only 22 hospitals did not provide their staff with waste minimisation plans as can be seen in Figure 5-16.

Figure 5-16 Availability of waste minimisation plans

Figure 5-16 shows those hospitals that follow waste management plans, while Figure 5-17 shows that 95% have SOPs for carrying out waste reduction actions. Only 5% of hospitals mentioned that they did not have a SOP for waste reduction, and, therefore, they did not perform any activity to reduce their wastes.
5.4 SOLID WASTE STREAMS, GENERATION, COLLECTION AND TRANSPORT

5.4.1 Solid waste stream and generation

There are variations in waste streams from hospitals, depending on their class, since the classes determine the types of medical services, types of specialities, and the numbers of beds. Class D hospitals, which are the lowest class, typically have four types of specialist services, namely, paediatric, obstetrics & gynaecology, internist, and surgery. Waste streams can also be determined by disease patterns and treatment methods, and the LOS. The details of waste streams can also be seen in Table 5-2.

In terms of waste generation, hospital produced wastes include, general waste with characteristics similar to municipal waste, and medical waste, comprising infectious, chemical, pathological, radioactive, cytotoxic and other hazardous wastes.

In the following figures, the generation of hospital wastes will be divided into two categories, i.e., general and medical wastes. The following paragraphs also describe the daily average of medical waste produced by hospitals that weighed their wastes.

Figure 5-18 shows the weights of general waste (non medical waste) in 10 groups from 218 hospitals that weighed their wastes, daily. The weights were already adjusted to the occupied beds, based on the BOR. Hospitals generating 1.41-2.10 kg/bed/day (25.30%) formed the highest proportion, while a single hospital producing more that 6kg/bed/day was the lowest percentage.
It can be predicted that the hospitals generating a higher amount of wastes are those with a higher number of beds and specialities, and they are, typically, class A or B hospitals. It is also possible that small hospitals producing more medical wastes do not segregate their wastes at source, so that, the wastes become infected and are categorised as medical wastes. Thus, to what extent the hospital manages their wastes will also influence the amount of medical waste generated.

**Figure 5-18 Daily generation of general wastes per occupied bed**

Figure 5-19 presents the production of medical wastes from sample hospitals. The figures are adjusted to the occupied beds of the same day. From 237 hospitals, 221 (93, 20%) hospitals weighed their medical wastes, and only a small proportion of hospitals did not calculate their wastes. The highest proportion was hospitals that produced 0.21-0.40 kg/bed/day (39.80%) of medical wastes, followed by 53 (24.00%) hospitals that produced 0.41-0.60kg/bed/day. Only 2 hospitals generated more than 1.60kg/bed/day of medical wastes.

**Figure 5-19 Generation of medical wastes per occupied bed daily**
The data from Figure 5-19 shows the daily average of medical waste generation per bed to be 0.4395 kg. Using this number to determine the proportion of hospitals, 137 (57.81%) hospitals produced below the daily average, weight of medical wastes (Figure 5-20). These numbers are very useful for planning waste management, including numbers of containers and plastic bags, storage, personnel, capacity of treatment technology for onsite treatment, needed.

![Figure 5-20 Proportion of medical waste generation based on its average](image)

Table 5-2 presents the daily average generation of medical wastes from selected wards. Based on the types of wards, the number of hospitals that weighed their wastes varied from 4 to 70 hospitals. This indicates that less than 30% of hospitals weighed their wastes of each waste stream. The majority of hospitals weighed their wastes in their storage room or other place.

The dental clinics, from amongst selected wards, was where the least medical wastes, with an average 1.5927 kg, were produced. In contrast, the operating theatres produced the highest amount of medical wastes with an average of 16.6043 kg/day.

<table>
<thead>
<tr>
<th>No.</th>
<th>Wards</th>
<th>N</th>
<th>Min</th>
<th>Max</th>
<th>Range</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Outpatient Room</td>
<td>63</td>
<td>0.13</td>
<td>148</td>
<td>147.88</td>
<td>8.9143</td>
</tr>
<tr>
<td>2.</td>
<td>Emergency Room</td>
<td>69</td>
<td>0.50</td>
<td>170</td>
<td>169.50</td>
<td>13.9497</td>
</tr>
<tr>
<td>3.</td>
<td>Ob &amp; Gen Room</td>
<td>70</td>
<td>0.25</td>
<td>290</td>
<td>289.75</td>
<td>14.6507</td>
</tr>
<tr>
<td>4.</td>
<td>Surgery Room</td>
<td>60</td>
<td>0.50</td>
<td>200</td>
<td>199.50</td>
<td>14.8338</td>
</tr>
<tr>
<td>5.</td>
<td>Operation Theatre</td>
<td>70</td>
<td>0.50</td>
<td>260</td>
<td>259.50</td>
<td>16.6043</td>
</tr>
<tr>
<td>6.</td>
<td>ICU Room</td>
<td>65</td>
<td>0.50</td>
<td>45</td>
<td>44.50</td>
<td>4.7225</td>
</tr>
<tr>
<td>7.</td>
<td>Internist Room</td>
<td>61</td>
<td>0.50</td>
<td>200</td>
<td>199.50</td>
<td>12.1236</td>
</tr>
</tbody>
</table>
Table 1. No. of Wards and Weight of Wastes

<table>
<thead>
<tr>
<th>No.</th>
<th>Wards</th>
<th>N</th>
<th>Min</th>
<th>Max</th>
<th>Range</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Pathology Room</td>
<td>28</td>
<td>0.40</td>
<td>60</td>
<td>59.60</td>
<td>7.0650</td>
</tr>
<tr>
<td>9</td>
<td>Pharmacy Room</td>
<td>30</td>
<td>0.10</td>
<td>25</td>
<td>24.90</td>
<td>2.7483</td>
</tr>
<tr>
<td>10</td>
<td>Isolation Room</td>
<td>35</td>
<td>0.20</td>
<td>30</td>
<td>29.80</td>
<td>3.5471</td>
</tr>
<tr>
<td>11</td>
<td>Oncology Room</td>
<td>4</td>
<td>0.50</td>
<td>15</td>
<td>14.50</td>
<td>7.5000</td>
</tr>
<tr>
<td>12</td>
<td>Radiology Room</td>
<td>29</td>
<td>0.10</td>
<td>20</td>
<td>19.90</td>
<td>2.7259</td>
</tr>
<tr>
<td>13</td>
<td>Dental Clinics</td>
<td>41</td>
<td>0.20</td>
<td>17</td>
<td>16.80</td>
<td>1.5927</td>
</tr>
<tr>
<td>14</td>
<td>Dialysis Room</td>
<td>21</td>
<td>0.50</td>
<td>198</td>
<td>197.50</td>
<td>20.7357</td>
</tr>
<tr>
<td>15</td>
<td>Laboratory</td>
<td>65</td>
<td>0.09</td>
<td>40</td>
<td>39.91</td>
<td>4.2272</td>
</tr>
</tbody>
</table>

Figure 5-21 shows the percentages of hospitals that weighed their electronic, sharps, radiological, and pharmaceutical wastes. Although hospitals generate considerable amounts of electronic waste, only 7 (2.95%) out of 237 hospitals weighed them.

Regarding sharps wastes, only 33 (13.92%) out of 237 hospitals weighed their sharps wastes. The weights varied from 0.30 kg/day to 127kg/day. This indicates that the majority of hospitals mixed their sharps wastes with other infectious wastes, increasing the risk of injuries. Note that the containers for infectious wastes are different from those for sharps wastes. Considering their sharp properties, they can puncture unprotected waste handlers, when they are not appropriately segregated.

The presence of radiological wastes indicates that the hospital provided radiological diagnostics or therapy for the general public. As seen in Figure 5-21, only about 7 (2.95%) hospitals weighed their radiological wastes. One reason why a majority of hospitals did not weigh them was because they were not needed to be sent to off-site treatment, but were stored onsite, for natural decay. Another reason was, not all sample hospitals provide radiological diagnostics or therapy, so that they did not produce radiological wastes. The production of radiological wastes was from 1.50kg/day to 20kg/day, depending on the types of radiological services and the number of patients.

The proportion of hospitals which weighed their pharmaceutical wastes was only 15 (6.33%). This percentage indicates two possibilities: 1) the majority of hospitals have well-planned pharmaceutical supply and demand, based on disease patterns, so that they did not generate expired pharmaceutical products; and 2) that the pharmaceutical wastes were mixed with other wastes. Thus only few hospitals collected and weighed their pharmaceutical wastes separately. It is interesting to note that the pharmaceutical wastes...
generated, varied from 0.10kg/day to 540kg/day. The highest number could be from a hospital in a disaster affected area, which had not disposed of its expired pharmaceutical products from foreign donations.

![Diagram showing the proportions of hospitals segregating several types of wastes](image)

**Figure 5-21 Weighing of electronic, sharps, radiological and pharmaceutical wastes**

### 5.4.2 Solid waste segregation, collection and containment

Waste segregation, collection and containment at source are the most important stages of WMH, when waste generation cannot be avoided. The following figures show the percentages of hospitals practising segregation, storage and containment of wastes, based on the relevant regulations.

Figure 5-22 shows the proportions of hospitals segregating several types of wastes, based on their characteristics, to accommodate the appropriate treatment methods available. More than half of the sample hospitals segregated their wastes into two types of waste: general and medical wastes. Only two hospitals mixed their general and medical wastes together, failing to segregate waste, at all. The remaining hospitals sorted their wastes into three or more categories.
A Policy Framework for the Improvement of Health Care Waste Management in Indonesia

Figure 5-22 Categories of solid waste segregation at source

The implementation of good segregation practices is seen in Figure 5-23. Good practices, grouped from three categories and more, were seen in 48.10% or 114 hospitals that were already separating their wastes into general, sharps and infectious wastes. The best practices were performed by four hospitals only (see Figure 5-22).

Figure 5-23 Quality of segregation practices of solid wastes

All hospital staff should be responsible for waste segregation, at source of generation, during their activities. Figure 5-24 presents the proportions of different types of hospital staff who segregated the wastes into appropriate containers. Staff who collected wastes at the point of generation was less than half (48.52%), whereas cleaning workers was 18.14%, and the remaining 33.33% performed both tasks. These numbers indicate that hospitals still rely on cleaning workers, who, in fact, did not perform health services generating waste.
Figure 5-24 Types of personnel dealing with solid waste segregation

Another important aspect of segregation at source is the availability of SOPs to guide staff responsible for segregation and containment of wastes, appropriately. Figure 5-25 presents the percentage of SOPs at each room of the hospitals. About three quarter of hospitals confirmed they had SOPs at each room/ward.

Figure 5-25 Availability of SOP for waste segregation and collection

According to available guidelines, such as, Health Ministerial Decree No.1204/2004, hospital wastes should be segregated at source and collected in colour-coded plastic bins with corresponding plastic lids. Figure 5-26 presents the proportion of hospitals and how they respond to the decree. Only 79 (33.33%) hospitals confirmed that they fully complied with the decree, and collected waste in colour coded containers. 84 (35.44%) hospitals partly complied with the decree, and the remaining 31.22% of hospitals did not provide such containers.
Figure 5-26 Compliance of solid waste containment and labelling according to Health Ministerial Decree No 1204/2004

Figure 5-27 shows the proportions of hospitals providing colour coded containers as required by the decree. More than half, or 68.78% provided correct colour coded bins.

Figure 5-27 Quality of colour-coded waste bins

The reasons why hospitals did not comply and provide colour coded bins are presented in Figure 5-28. Most confirmed that colour coded bins and plastic lids were rare and expensive. Others significantly stated that they only separated their wastes into two categories, and so, did not provide their rooms with correct colour coded containers, and that there was no budget available for those requirements.
Another important aspect of waste containment and labelling of sharps wastes is protection of waste handlers from sharps injuries. For this, the sharps containers should be puncture proof, as sharps are objects or devices having sharp points, protuberances or cutting edges, capable of causing penetrating injuries to humans.

Figure 5-29 shows the percentages of different types of sharps containers used in Indonesian hospitals. Most sample hospitals (46.0%) utilised plastic containers for their sharps wastes, followed by safety boxes (33.3%), and plastic bags, separated from other infectious wastes.
Figure 5-30 presents the proportion of hospitals using needle cutters for cutting the needles from plastic syringes to recycle the plastics for economic reward. About 35.4% hospitals cut needles.

![Figure 5-30 Application of needle cutting](image)

There are several ways the cut needles are treated, as can be seen in Figure 5-31. Only 99 hospitals treated their needles waste by disinfecting and incinerating them, or burying them. The majority of hospitals incinerated needles after cutting them from their plastic syringes and recycled the plastics. A few disinfected the needles to prevent waste handlers from contamination.

![Figure 5-31 Further treatment after needle cutting](image)

Figure 5-32 presents the ways of containment after needle cutting by sample hospitals. More than 60.00% hospitals confirmed that they contained cut needles in a separate container.
5.4.3 On-site solid waste transport and storage

After being segregated and collected in waste bins or containers, the hospital wastes are kept in designated rooms for temporary storage, before removal for further treatment onsite, or offsite. There are certain requirements and equipment for moving wastes from their points of generation, such as, using waste trolleys, or whee-lib bins, to prevent contamination and unexpected accidents.

The following figures describe onsite waste transport and storages, and proportions of hospitals owning special equipment, the ways of delivering the wastes from wards, frequency of waste collection, per day, and who is in charge of transporting the wastes.

Figure 5-33 presents the existence of waste transport vehicles. More than a three quarter of hospitals confirmed that they had special vehicles for waste transport to temporary storages or to onsite treatment plants.
Several ways of transporting solid wastes to temporary waste storages can be seen in Figure 5-34. A majority of hospitals stated that their staff carry HCW by hands (77.05%), and only about 14.75% use wheelie waste bins. This data shows that there is a considerably high risk of waste leakage, or spilling over, when many hospitals still use unsecured waste buckets.

**Figure 5-34 Ways of onsite transport of solid waste**

Of hospital staff performing onsite waste transport, cleaning service workers were the highest percentage. The other three types of staff were namely, incinerator operators, nurses, and other staff, comprising 16.88%, 1.69%, and 0.42%, respectively (Figure 5-35).

**Figure 5-35 Types of personnel onsite transporting solid waste**

There were variations in frequency of onsite waste transport among study-hospitals, ranging, from once per day to uncertain times, as the hospitals did not record the frequency. Figure 5-36 shows that once and twice per day were the highest frequencies
of waste transport and storage. Interestingly, a considerably high proportion of hospitals did not know their frequency of waste storage. This indicates that there were no waste audits to determine the daily waste generation, and, therefore, they did not know the exact frequency of waste transport within the hospitals.

![Frequency of waste transport daily](image)

**Figure 5-36 Frequency of waste transport daily**

Hospital wastes should be stored in a secure place to prevent access by unauthorised people, considering the risks of contamination and injuries. Figure 5-37 presents the percentages of hospitals with different types of medical waste storages. Almost half of them confirmed that they had medical waste storages, and 37.97% hospitals stored them together with general waste. The lowest percentage of hospitals did not have medical waste storages and they loaded them directly to incinerators.

![Availability of waste storage](image)

**Figure 5-37 Availability of waste storage**

Figure 5-38 presents the different conditions of waste storage in hospitals that had waste storages as shown in Figure 5-34. 67.40% hospitals stated that they had secure
temporary waste storages, preventing access by unauthorised persons. The remaining proportion confirmed that their storages could be accessed easily by any person.

![Pie chart showing conditions of solid waste storage](image)

**Figure 5-38 Conditions of solid waste storage**

Data regarding waste management records are presented in Figure 5-39, which shows that the percentages of hospitals with, and without, waste management records, were almost equal.

![Pie chart showing availability of waste records](image)

**Figure 5-39 Availability of waste records**

### 5.5 IMPLEMENTATION OF 3R APPROACH

The important strategy of reduce, reuse and recycle, helps reduce the negative impact of hospital wastes on the environment and human health, and waste management costs. However, the implementation of this approach has not yet been well determined, since there are no systems and waste reduction activities in place, in health care settings. On
the other hand, reuse and recycle have been practised in some ways that are not officially recognised by the hospital authorities.

5.5.1 Waste reduction
Systematic waste reduction in hospitals has not been implemented, since there is no data regarding this activity and its outcome in the sample hospitals.

5.5.2 Waste reuse and recycling
Even though there is no system available for waste reuse and recycle, the hospitals confirmed that these occurred within the hospitals as shown in the following figures.

Figure 5-40 shows the percentage of hospitals which reused general wastes. Only 11.39% hospitals reused a few types of general wastes, like used packages of medical devices and supplies.

![Figure 5-40 Reuse of general wastes](image)

Regarding different types of reused general wastes, Figure 5-41 presents the percentages of cardboards and plastic containers, without description of the re-usage purposes. It can be seen that carton boxes make up 85.19% of used general wastes, and plastic containers, only 14.81%.
Figure 5-41 Types of reused of general wastes

Figure 5-42 shows the percentages of hospitals that reuse, recycle and pre-treat medical wastes. Only 16 (6.80%) hospitals reused their medical wastes like intravenous plastic bottles and medicine bottles or glasses. They disinfect the wastes prior to reuse if they were visibly contaminated. 27 (11.40%) hospitals disinfect their medical waste prior to disposal.

Eighty one (34.20%) hospitals confirmed that they recycled their medical wastes, but it was outside the hospital premises. The types of recycled medical wastes were similar to the reused wastes, but some hospitals did not mention them.
5.6 USE OF WASTE TREATMENT TECHNOLOGY

5.6.1 Medical waste treatment technology

Once wastes are generated, they should be handled and treated in appropriate ways to eliminate their likely harmful impacts on human health and the environment. There are many types of waste treatment technologies described in the literature review that can be chosen, depending on several considerations of the preservation of the environment and protection of human health.

In the following figures, several variables of medical waste treatment technology applications are presented, including non-incineration and incineration.

Figure 5-43 presents types of treatment technology methods used by the sample hospitals. Single treatment of incineration was the most popular, being used by 194 (92.40%) hospitals, from 210 sample hospitals, which confirms that they treated their medical wastes. Other treatment methods like disinfection, encapsulation, autoclaving and microwaving, or combinations of them, were only used by a few hospitals.

![Figure 5-43 Types of treatment technology used for medical waste](image)

Figure 5-44 presents the different proportions of 27 hospitals which did not treat their medical wastes. Ten buried medical wastes in their backyards, nine kept the wastes in their premises, and six hospitals disposed of them in municipal waste disposal sites. Surprisingly, two hospitals confirmed that they gave their medical wastes to scavengers, posing a high risk of contamination.
Figure 5-44 Destination of untreated medical wastes

5.6.2 Incineration

Incineration was the commonest waste treatment technology used by hospitals as seen in Figure 5-43 above. The types of wastes incinerated should follow the criteria given by Prüss et al. (1999) and Vallero and Peirce (2003) to achieve effective waste combustion and reduce the chemical pollutants produced.

However, the incineration practices in sample hospitals did not completely fulfill the requirements of effective combustion, to comply with the available regulations and policies.

Figure 5-45 presents the types of medical wastes incinerated by 210 hospitals. The majority of hospitals incinerated all types of medical wastes such as sharps, infectious wastes, pharmaceutical wastes, and pressure containers. Pressure containers should be recycled or returned to the producers, as they must not be incinerated, to avoid explosions that may destroy the incinerator. Moreover, pharmaceutical wastes will be effectively treated only in high-temperature incinerators, and in small amounts.
There are two typical places for incineration of medical waste: onsite, and offsite, the hospital premises. Figure 5-46, shows that 87.89% of hospitals treated their medical wastes outside their premises, and the remaining 12.11% used onsite incinerators or their own incinerators.

Of incinerator models, 52.91% of hospitals used one-burner incinerators, 46.12% used two-burner incinerators, and less than 1% used the cylinder model (see Figure 5-47 below).
An appropriate incinerator should be equipped with air pollution control devices, in accordance with relevant regulations, including fly-ash trapping devices. Figure 5-48 presents that 43.20% of 206 hospitals had such devices in their incinerators, which means that more than half of the hospitals did not have them.

Figure 5-49 shows the ages of hospital incinerators. 213 hospitals answered the question about incinerators’ ages. The highest number of hospitals used incinerators that were 4-6 years old. 33 (15.5%) hospitals used incinerators more than 12 years old.
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Figure 5-49 Age of incinerator being used

Figure 5-50 presents the different incinerator capacities, expressed in kgs. Capacities ranged from 10 to 1,000kgs in a total of 155 hospitals. These capacities suitably accommodated the daily waste generations and treatments.

Figure 5-50 Capacity in Kilogram

Figure 5-51 presents the quality of incinerators used, based on the achievement of minimum temperature and retention time of waste combustions. In this figure, the minimum temperature of 800°C was considered adequate for a small-scale incinerator. Only 206 hospitals responded to the question about operational incinerator temperature.
144 (69.90%) hospitals operated their incinerators at the minimum temperature, and the others (30.10%), at less than 800°C.

![Figure 5-51 Temperature and duration of operating incinerators](image)

Still on the temperatures of incinerators, figure 5-52 presents the percentages of hospitals meeting the minimum operating temperatures of incinerators. Only 108 hospitals, or about half of them, confirmed that their incinerators always operated at the minimum temperature. About 39.91% of hospitals stated that they sometimes met the minimum required temperature, and 9.39% did not meet the requirement at all times.

![Figure 5-52 Achievement of optimum temperature of incinerators](image)

Figure 5-53 presents the types of medical wastes incinerated, including infectious, sharps, pharmaceutical, heavy metals, pathological, chemical, radiological and pressure container wastes.

The majority of hospitals incinerated their infectious (non-sharps) wastes (91.20%), sharps (92.60%), pharmaceutical and pathological wastes (60.60%). There were also
several types of wastes that should not be incinerated, including heavy metals, chemicals, radiological and pressure container wastes, as they can pollute the environment, and also, explode.

Operating incinerators could harm human health and the environment by emitting air pollutants, when they do not meet several requirements, including minimum temperatures, adequate retention times, and air pollution control devices. Therefore, such incinerators should be operated at safe distances from residential areas. Figure 5-54 provides percentages of incinerator distance from residential areas, in six groups. Five groups of existing incinerators were located within 100 meters (62.70%), and one group, outside 100 metres (37.30%), of residential areas.
Figure 5-54 Distance between incinerators and residential areas

Figure 5-55 shows the percentages of existing incinerators’ distance from public roads, in six groups, ranging from less than 10 metres, to more than 100 metres. The percentage of incinerators located less than 100 metres (53.10%) from public roads was higher than those placed further than 100 metres (46.90%).

Figure 5-55 Distance between incinerators and public roads

The regular inspection of incinerator emissions is imperative to detect the likely failure of operational incinerators in meeting air pollution standards. Figure 5-56 presents the percentages of hospitals that monitor gas emissions regularly. Only 55 (25.82%)
hospitals checked the gas emitted from their incinerators, at least, once a year. However, there was no information about outcomes of the monitoring.

![Figure 5-56 Regular checking of incinerator gas emissions](image)

Figure 5-56 shows the perception of hospitals regarding the cost of medical wastes treatment. More than half of the hospitals confirmed that the cost of medical wastes incineration is relatively expensive.

![Figure 5-57 Perception of hospitals regarding costs of incineration](image)

5.6.3 Non incineration

Instead of the incineration method (above), there are several other medical wastes treatment technologies, using non combustion systems, available worldwide, including in the developing world. In Indonesia, those methods are less popular in health care settings. The following describes the use of such methods in the sample hospitals.

Figure 5-58 shows the percentages of four types of non incineration methods of medical wastes treatment. Disinfection was the most popular among the four methods, followed
by autoclaving, which was the same as encapsulation, whereas microwaving was the least popular option. The reason is that disinfection is a common method not only for eliminating biological contamination of wastes, but also of any object or devices in the hospital premises.

![Figure 5-58 Non incineration technology used for medical waste treatment](image)

### 5.7 WASTEWATER MANAGEMENT AND TREATMENT OPTIONS

As mentioned earlier, hospitals also generate huge amounts of wastewater, which are categorised as grey water, and black water, including medical wastewater. In order to prevent wastewater contamination of the environment, hospitals are required to treat their wastewater in accordance with the Environment Ministerial Decree No.58/1995 on Wastewater Effluent Standards.

Hospital wastewater management, in terms of treatment methods, availability of pretreatment facilities, and disposal of untreated wastewater, costs of treatment, compliance and constraints being encountered will be discussed below. Wastewater treatment technologies include three types of plants, namely, primary, secondary, and tertiary treatment plants. The first type is considered the simplest one, and the third is the most comprehensive method, as it consists of advanced physical, biological and chemical processes. 194 (81.90%), out of 237, hospitals used WWTP for wastewater treatment.
Figure 5-59 presents the percentages of hospitals using the three types of wastewater treatment technologies. Seventy four (40.66%) hospitals of 182 confirmed that they had tertiary WWTP to treat their liquid wastes, whereas 32.42% of the others used secondary, and 26.92%, primary WWTP, respectively.

![Figure 5-59 Types of wastewater treatment facilities](image)

Figure 5-59 Types of wastewater treatment facilities

Figure 5-60 shows the hospitals’ ways of disposing of their untreated wastewater. 55 hospitals used seven ways to dispose of their liquid wastes, and all of them are considered to be unsanitary methods, since they cannot decompose inorganic and organic materials contained in hospital wastewater, to meet the required effluent standards. 23 (41.80%) hospitals used dug wells as a means of wastewater disposal on-site, followed by septic tanks used by 20.00%.

![Figure 5-60 Disposal facilities for untreated wastewater](image)
Separation of medical wastewater from general wastewater generated by hospitals is intended to perform pre-treatment of medical wastewater. Figure 5-61 shows the percentage of hospitals which did not separate their medical wastewater from general sewage. Out of 182 hospitals which had WWTP, only 41.76% separated their medical wastewater from sewage.

![Figure 5-61 Separation of medical wastewater and general wastewater](image)

**Figure 5-61 Separation of medical wastewater and general wastewater**

Figure 5-62 presents the proportions of hospitals providing pre-treatment facilities of their medical wastewater. Only 39.47% hospitals confirmed that they performed pre-treatment of medical wastewater before it enters WWTP to disperse and filter it to achieve effective disinfection when it gets mixed with sewage in the WWTP. This is done as medical wastewater usually contains gross solids and faecal matter that will hinder the disinfection process in the WWTP without pre-treatment.

![Figure 5-62 Availability of pre-treatment facilities of medical wastewater](image)

**Figure 5-62 Availability of pre-treatment facilities of medical wastewater**

Figure 5-63 shows the percentage of hospital conducting regular examination of their wastewater effluents to fulfil the requirements of relevant regulations. Some 172
(72.57%) out of 237 sample hospitals fulfilled the requirements by conducting regular examinations.

Figure 5-63 Regular examination of wastewater effluents

Figure 5-64 presents the frequencies of hospitals carrying out regular examination of their wastewater annually. 44.19% of hospitals confirmed that they conducted such examinations more than three times per year, while 12 (6.98%) hospitals admitted that they did it once a year.

Figure 5-64 Frequency of examination of wastewater effluents per year

Figure 5-65 shows the proportions of hospitals complying with effluent standards required by the Environment Ministerial Decree No. 58/1995. More than half of the hospitals confirmed that they always complied with the above Decree, and only 2 (1.16%) hospitals did not comply, whereas 65 (37.79%) hospitals sometimes met the minimum requirement of effluent standards.
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Figure 5-65 Compliance with wastewater effluent standards

Figure 5-66 shows the types of constraints faced by hospitals that hinder fulfilling the requirements of WWTP, as mandated by the regulations. The operational cost of the WWTP was the highest constraint faced by 40.93% of hospitals, followed by investment cost to buy and install the WWTP. The other constraints encountered by several hospitals were equipment, expertise and location.

Figure 5-66 Constraints of hospitals in providing WWTP

5.8 AVAILABILITY OF HCWM RESOURCES AND TRAINING

5.8.1 Resources

Resources and records are considered important elements of establishing sustainable HCWM, as they include waste management units, routine budgets for planning, procurement of equipment and supplies, hiring personnel, monitoring and surveillance, as well as, for investing and maintaining the whole process of HCWM. The following figures will describe the importance of each element in HCWM systems.
The availability of an environmental health/sanitation unit in a hospital is a prerequisite, since this unit is structurally assigned to perform HCWM functions, as part of the hospital’s environmental health activities in accordance with relevant regulations. The name of the unit can vary, depending on the ownership of the hospital, e.g., environmental health installation, environmental sanitation installation, sanitation installation, or waste management unit. As for hospitals with no such unit, HCWM is usually within the unit handling equipment and supplies.

Figure 5-67 shows that the 79.32% hospitals had units for HCWM functions, and 20.68% did not.

![Figure 5-67 Availability of Environmental Health/Sanitation Unit](image)

Figure 5-68 shows the percentages of sample hospitals vis-a-vis the availability of routine funds for operating the whole process of WMH. The majority of hospitals had routine budgets for HCWM systems, and only 34 (14.35%) hospitals did not have such funds. Less than half of the hospitals (46.80%) did not have enough funds for operational costs of HCWM.

![Figure 5-68 Availability of Routine Funds](image)
Figure 5-68 Availability of routine budget for HCWM

Figure 5-69 presents the percentages of hospitals hiring personnel from third parties for operating HCWM systems. Only 37 (15.61%) hospitals did not have sufficient staff to operate daily management of their wastes, prompting them to hire from third parties. The majority of the other hospitals utilised their permanent staff for the purpose.

Figure 5-69 Outsourcing to, or Hiring from, Third Parties for HCWM Operations

Regarding the adequacy of personnel for HCWM, Figure 5-70 reveals that less than half of the sample hospitals had sufficient HCWM personnel. These percentages do not differentiate between permanent and hired staff.

Figure 5-70 Adequacy of HCWM personnel

Availability of HCWM recording is essential for establishing sustainable HCWM, as it is used for planning, monitoring, and evaluation processes. The recording system should completely record all resources available, and daily waste production and characteristics. This data should result from comprehensive waste audits that also consider waste minimisation, including 3R practices.
Figure 5-71 shows the percentages of hospitals having such HCWM records. More than half (57.81%) of the hospitals recorded only some activities related with HCWM, from generation to disposal stages. Only a quarter of them (25.74%) had complete records of HCWM. This indicates that no sustainable HCWM is practised in hospitals that did not have accurate data of their waste management (16.46%).

![Figure 5-71 Availability of HCWM recording system](image)

As explained earlier in the literature review, hospital wastes could pose significant health risks, which emphatically warrants all occupational injuries related to hospital wastes be recorded for designing preventive and curative measures.

Figure 5-72 shows the proportions of hospitals with recording systems to determine the magnitude of waste related injuries and diseases. Only 13.50% hospitals were found to record such accidents completely. The others did not have such systems, and 17.30% of the total hospitals stated that such accidents had never happened.

![Figure 5-72 Reporting and recording of injuries caused by wastes and injections](image)
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Related to the figures on recording systems, Figure 5-73 talks of annual HCWM reports. About 43.04% hospitals had annual HCWM reports, 29.54% had no regular reports, and 27.43% had no reports at all, underlining the requirement to formalise recording and reporting systems in order to establish safe HCWM.

![Figure 5-73 Availability of annual report on HCWM](image)

Table 5-3 informs the current condition of seven selected elements of HCWM. These were sieved from responses of the 237 hospitals. A lack of facilities topped the list of problems, followed by lack of funds, and lack of trained officers to implement HCWM. Interestingly, only 69 hospitals mentioned lack of policy and regulation.

<table>
<thead>
<tr>
<th>No.</th>
<th>Specific Constraints on HCWM Implementation</th>
<th>Yes</th>
<th></th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>1</td>
<td>Lack of Implementing Officers</td>
<td>130</td>
<td>54.9</td>
<td>107</td>
</tr>
<tr>
<td>2</td>
<td>Lack of Trained Officers</td>
<td>147</td>
<td>62.0</td>
<td>90</td>
</tr>
<tr>
<td>3</td>
<td>Lack of Facility</td>
<td>164</td>
<td>69.2</td>
<td>73</td>
</tr>
<tr>
<td>4</td>
<td>Lack of Funds</td>
<td>155</td>
<td>65.4</td>
<td>82</td>
</tr>
<tr>
<td>5</td>
<td>Lack of Technology</td>
<td>78</td>
<td>32.9</td>
<td>159</td>
</tr>
<tr>
<td>6</td>
<td>Lack of Policy and Regulation</td>
<td>69</td>
<td>29.1</td>
<td>168</td>
</tr>
<tr>
<td>7</td>
<td>Lack of Management Support</td>
<td>71</td>
<td>30.0</td>
<td>166</td>
</tr>
</tbody>
</table>

5.8.2 Training

Training of hospital staff and other stakeholders in HCWM is necessary to empower them to handle and manage wastes appropriately. This will help them be effective and efficient in their work, and also protect them from contamination/infection/injury, as these wastes are categorised as infectious and hazardous. The following figures and tables show various aspects of HCWM related training, as the study revealed.
Figure 5-74 presents the availability of HCWM induction programs. Not all HCWM staff were inducted formally to the essential procedures and codes of conduct for safe HCWM. 160 of the 237 hospitals (67.51%), confirmed the availability of HCWM induction programs, while the remaining number (32.49%) did not have such programs.

![Figure 5-74 Availability of induction program of HCWM personnel](image)

Figure 5-74 Availability of induction program of HCWM personnel

Figure 5-75 shows the availability of HCWM trained groups of hospital personnel. 57.81% of hospitals had less than 30% staff trained in HCWM, and 40 hospitals (16.88%) confirmed that more than 60% of their staff had been trained.

![Figure 5-75 Percentage of trained HCWM personnel](image)

Figure 5-75 Percentage of trained HCWM personnel

Figure 5-76 shows the number of hospitals receiving HCWM training from several institutions for their staff. 49.10% of hospitals received training from one institution only, while 33.90% received HCWM training from two institutions.
Figure 5-76 Number of institution providing HCWM trainings

On institutions providing HCWM training, Table 5-4 shows the percentages of training received from various sources, ranging from government institutions, to international agencies. Provincial and District Health Offices were regarded as the main institutions providing such training, followed by the MoH and MoE. Government institutions evidently dominate HCWM training for hospital staff.

<table>
<thead>
<tr>
<th>No.</th>
<th>Institution Providing Training on HCWM</th>
<th>Yes</th>
<th>%</th>
<th>N</th>
<th>No</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MoH</td>
<td>79</td>
<td>46.7</td>
<td>90</td>
<td>53.3</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>MoE</td>
<td>53</td>
<td>32.7</td>
<td>109</td>
<td>67.3</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Provincial and District Health Offices</td>
<td>96</td>
<td>59.3</td>
<td>66</td>
<td>40.7</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Various International Agencies (WHO-ADB-ETLog Health)</td>
<td>11</td>
<td>6.4</td>
<td>160</td>
<td>93.6</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Various National Organizations (IHA-SANIPLAN-NAVY)-UGM-MIGAS-TR)</td>
<td>25</td>
<td>14.6</td>
<td>146</td>
<td>85.4</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>BTKL Institution (EH Technical Lab)</td>
<td>5</td>
<td>2.9</td>
<td>166</td>
<td>97.1</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Private Training Foundation Board</td>
<td>19</td>
<td>11.1</td>
<td>152</td>
<td>88.9</td>
<td></td>
</tr>
</tbody>
</table>

5.8.3 Occupational health and safety

Occupational health and safety is an essential program in hospitals, dealing with the health and safety of staff, patients and visitors. Outcomes of safety & health programs are a hospital’s key performance indicators.
The following figures describe the outcome of the study related to health and safety programs, such as, the provision of PPE, PEP, immunisation, and occurrence of needle injuries and types of syringes used for injections.

Figure 5-77 presents the proportions of hospital staff using PPE while performing their duties to protect them from injuries at work. 213 hospitals responded to the question on PPE use. More than half confirmed that their staff always wore PPE, while handling wastes, and about 37.56% wore PPE sometimes, and 8.92% did not use PPE at all.

![Figure 5-77 Use of PPE by waste handlers](image)

Provision of relevant vaccines for workers at risk in hospitals is necessary to protect them from contracting contagious diseases, such as hepatitis B. Waste handlers are among hospital staff that are at risk of such diseases, therefore, they need to be immunised accordingly.

Figure 5-78 shows the proportion of hospitals providing hepatitis B immunisation for their waste handlers. Of 214 hospitals, 80 (37.38%) stated that they provided HCWM workers with hepatitis B immunisation as they were at risk of blood-borne diseases. Therefore, there was a considerable proportion of HCWM workers who were not protected from such risk.
A significant proportion of hospitals confessed that the staff suffered from needle punctures (67.09%). The rest of the hospitals confirmed that they did not experience such incidents.

Hospital staff who are accidentally punctured by needles should be given PEP to minimise getting infections that maybe caused by contaminated syringes. Figure 5-80 presents the ways to minimise likely infections from needle-stick punctures among hospital staff. Of 154 hospitals, the highest percentage provided anti tetanus serum to victims, and the second, only cleaned the wounds, and a small number were given PEP. Surprisingly, the rest of the hospitals stated that their staff did not report such accidents, thus leaving them at risk of blood borne infections without any treatment.
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Figure 5-80 Ways of handlings of occupational injuries

Figure 5-81 shows that all hospitals used disposable and auto disable syringes or combinations of them. This prevents cross-contamination among patients, as there is no reuse of syringes. However, this cause a higher generation of sharps wastes from disposable syringes.

Figure 5-81 Types of syringes and needles for daily injections

5.8.4 Use of third parties in medical waste treatment and disposal

Figure 5-82 presents the percentage of hospitals dealing with medical waste treatment and disposal by using third parties as required by the relevant regulations. The majority of hospitals had a contract with private companies or other health care institutions
provided medical waste treatment and disposal. Only 10.00% hospitals did not have such a contract, regardless of the locations of their medical waste treatments.

![Figure 5-82 Availability of written contract between hospitals and waste contractors](image)

### 5.9 INFECTION CONTROL PROGRAM

An infection control program is essential in health care settings, to manage hazards and prevent accidents or injuries and the spread of communicable diseases among patients, workers, and visitors.

In controlling infections at health care settings, hazards identification is the first step to anticipate a hazardous situation requiring intuition, training, and awareness of relevant hospital staff. Hence, the trained staff can identify hazards by conducting self-inspections, regular safety surveys and safety audits.

Training on infection control for personnel in Environmental Health /Sanitation Division of the hospital is also necessary, since their work is related to hazardous materials and wastes, and a hazardous workplace.

Figure 5-83 presents the percentages of hospitals providing training on infection control for environmental health staff. About 133 (56.12%) hospitals stated that they had provided infection control training to their environmental health workers.
Figure 5-83 Training on infection control for personnel in Environmental Health Division

Table 5-5 shows the percentages of hospitals which gave infection control training to environmental health staff, on seven topics, ranging from UP to waste segregation at source. Of the seven topics covered, proper hand washing and the use of PPE were the most commonly provided to the relevant staff (88.88%); the second was training in waste segregation at the point of generation (78.40%), followed by UP (67.90%), and safe injection, including recapping of used syringes (53.70%). PEP was the least popular topic of infection control training.

Table 5-5 Materials covered in infection control training

<table>
<thead>
<tr>
<th>No.</th>
<th>Training materials provided on infection control</th>
<th>Yes</th>
<th>%</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>UP</td>
<td>91</td>
<td>67.9</td>
<td>43</td>
<td>32.1</td>
</tr>
<tr>
<td>2</td>
<td>Safe injection including recapping</td>
<td>72</td>
<td>53.7</td>
<td>62</td>
<td>46.3</td>
</tr>
<tr>
<td>3</td>
<td>Wastewater spillage including blood and other body secretion</td>
<td>63</td>
<td>47.0</td>
<td>71</td>
<td>53.0</td>
</tr>
<tr>
<td>4</td>
<td>Proper hand washing and use of PPE</td>
<td>119</td>
<td>88.8</td>
<td>15</td>
<td>11.2</td>
</tr>
<tr>
<td>5</td>
<td>Recording on contamination and sharp injuries</td>
<td>55</td>
<td>41.0</td>
<td>79</td>
<td>59.0</td>
</tr>
<tr>
<td>6</td>
<td>PEP</td>
<td>37</td>
<td>27.6</td>
<td>97</td>
<td>72.4</td>
</tr>
<tr>
<td>7</td>
<td>Medical wastes segregation at source</td>
<td>105</td>
<td>78.4</td>
<td>29</td>
<td>21.6</td>
</tr>
</tbody>
</table>

Figure 5-84 shows the proportion of hospitals providing PEP to their staff who worked in a hazardous environment and with hazardous materials. More than half of the sample hospitals (59.07%) confirmed that they had PEP for their staff, suffering from accidents or injuries, at the hospital.
An effective ICP in the hospital focuses on sound personal hygiene, monitoring and surveillance of communicable infections that can potentially expose the health care community. The program also emphasises the importance of preventing infectious diseases, providing measures for occupational illnesses and eliminating unnecessary procedures.

Figure 5-89 shows the proportion of hospitals which had designated infection control officers to perform leadership roles in ICP. Less than half of 237 hospitals had designated infection control officers (40.08%).

Moving from Figure 5-83, which covered infection control training for environmental health staff, Figure 5-86 shows the hospitals which involved the above staff in performing ICP. About 60.87% hospitals already involved the environmental health staff in ICPs to make them effective in controlling potential risks in the hospital’s
environment, and providing preventive measures to reduce HAI among the hospital community.

Figure 5-86 Involvement of Environmental Health Unit in ICP

5.10 HEALTH PROMOTING HOSPITALS

The concept of ‘health promoting hospitals,’ already explained in the literature review, is a public health approach to enhance the functions of hospitals that currently deal with curative measures and focus on promotive and preventive measures, utilising the strengths of available resources. The HPH will improve not only the functions of hospitals in delivering health services, but also the outcomes of hospitals with regard to ecological public health and the reduction of HAI.

Figure 5-87 presents the proportion of hospitals that implement HPH principles. Surprisingly, many hospitals confirmed that they already implemented them, since the MoH introduced HPH, early this year. This explains the confusion between HPH and health education at hospitals, since the latter had been established more than three decades ago. It is true that health education is part of HPH, but, HPH is more comprehensive in terms of its philosophical approach and scope.
5.11 DETERMINANTS OF HCWM

This section describes the inferential statistical analysis to determine significant variables of HCWM from selected variables of the study, which theoretically, relate to each other. The researcher has chosen multiple regression and logistic regression analyses, based on the nature of dependent variables of the study. Multivariate regression is used to analyse the influence of more than one independent variable against a dependent variable, which is classified as a ratio or interval scale. On the other hand, logistic regression is to analyse the influence of more than one independent variable against a dependent variable, which is classified as a categorical or nominal scale.

5.11.1 Multivariate linear regression

In this multiple linear regression, two models will be analysed, based on dependent variables, including generations of general and medical wastes, as follows.

*Dependent variables:*

- Model 1: General waste (kg/day/bed)
- Model 2: Medical waste (kg/day/bed)

Both of the dependent variables have been adjusted for the occupied bed. It is calculated by

\[ WASTE_i = \frac{\text{Generated waste}_i}{BED_i \times BOR_i} \]
Where $WASTE_i$ can be $GENW_i$ or $MEDWi$; $BED_i$ is number of beds in the $i^{th}$ hospital and $BOR_i$ is the bed occupancy rate of the $i^{th}$ hospital.

The hypothesis of all inferential statistics is presented in Table 5-6.

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Label of Variable</th>
<th>Variable Name</th>
<th>Used in Model</th>
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<tbody>
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<td>The generation of general waste is influenced by number of inpatients.</td>
<td>Number of inpatients per day</td>
<td>NIP</td>
<td>1 &amp; 2</td>
</tr>
<tr>
<td>The generation of medical waste is influenced by number of inpatients.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The generation of general waste is influenced by number of outpatients.</td>
<td>Number of outpatients per day</td>
<td>NOP</td>
<td>1 &amp; 2</td>
</tr>
<tr>
<td>The generation of medical waste is influenced by number of outpatients.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The generation of general waste is different in a hospital that has routine budget for HCWM.</td>
<td>Availability of routine budget (dummy variable)</td>
<td>DWMBUDGET</td>
<td>1 &amp; 2</td>
</tr>
<tr>
<td>The generation of medical waste is different in a hospital that has routine budget for HCWM.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>The generation of general waste is different in a hospital that is located in Java or Bali islands.</td>
<td>Hospital location by island, Java and Bali islands vs. outer Java and Bali islands (dummy variable)</td>
<td>DLOC</td>
<td>1 &amp; 2</td>
</tr>
<tr>
<td>The generation of general waste is different in a hospital that is located in Java or Bali islands.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The generation of general waste is different in a hospital that has a written central policy applied to HCWM.</td>
<td>Existence of written central policy applied to HCWM (dummy variable)</td>
<td>DCEPOL</td>
<td>1</td>
</tr>
<tr>
<td>The generation of general waste is different in hospitals that have written plans on HCWM implementation.</td>
<td>Having written plan on HCWM implementation (dummy variable)</td>
<td>DWPLAN</td>
<td>1</td>
</tr>
<tr>
<td>The generation of medical waste is different in a hospital that owns a sanitation unit or installation.</td>
<td>Existence of sanitation unit or installation in the hospital management (dummy variable)</td>
<td>DWMUNIT</td>
<td>2</td>
</tr>
<tr>
<td>The generation of medical waste is different in a hospital that provides training for personnel to perform HCWM.</td>
<td>Provision of pre-training for personnel to perform HCWM (dummy variable)</td>
<td>DTRAIN</td>
<td>2</td>
</tr>
</tbody>
</table>
The explanatory variables comprise both nominal and categorical (dummy) variables. The quantitative variables are:

- Number of inpatients (annual) (NIP) $\rightarrow$ Divided by 365 $\rightarrow$ Number of inpatients (daily).
- Number of outpatient (annual) (NOP) $\rightarrow$ Divided by 313 $\rightarrow$ Number of outpatients (daily).

The indicator variables are:

The type of dummy variable used in this study is an intercept dummy. Adding the indicator variable to the regression model, along with a new parameter $\delta$ would result in

$$y_i = \beta_1 + \delta D_i + \beta_2 x_i + e_i$$

Provided that the equation above is correctly specified, the effect of including a dummy variable is

$$E(y_i) = \begin{cases} 
(\beta_1 + \delta) + \beta_2 x_i & \text{when } D = 1 \\
\beta_1 + \beta_2 x_i & \text{when } D = 0 
\end{cases}$$

- Level of hospitals or class (Dummy Variable)
  
  $DCLASS = \begin{cases} 
1, \text{ if the class of hospital is A or B} \\
0, \text{ if the class of hospital is C or D}
\end{cases}$

- Location (DV)
  
  $DLOC = \begin{cases} 
1, \text{ if the hospital is located in Java or Bali Island} \\
0, \text{ if the hospital is located outside of Java and Bali Islands}
\end{cases}$

- Policy Variables 1 (Central/Off-site policy)
  
  $DCEPOL = \begin{cases} 
1, \text{ yes} \\
0, \text{ no}
\end{cases}$

- Policy Variables 2 (On-site policy)
  
  $DHOSPOL = \begin{cases} 
1, \text{ yes} \\
0, \text{ no}
\end{cases}$

- Waste Management Plan
  
  $DWMPLAN = \begin{cases} 
1, \text{ yes} \\
0, \text{ no}
\end{cases}$
• Training

\[ D_{\text{TRAIN}} = \begin{cases} 
1, \text{yes} \\
0, \text{no}
\end{cases} \]

• Availability of Routine Budget

\[ D_{\text{WMBUDGET}} = \begin{cases} 
1, \text{yes} \\
0, \text{no}
\end{cases} \]

• Availability of Sanitation Unit

\[ D_{\text{SATUNIT}} = \begin{cases} 
1, \text{yes} \\
0, \text{no}
\end{cases} \]

**Functional form**

To determine the functional form, first, the researcher needs to plot the dependent variables against the continuous explanatory variables. Figure 5-88 presents the scatter plot between general waste, and medical waste, generation, against the number of inpatients per day, and number of outpatients per day. It can be seen from the figure that the relationship between general waste and number of inpatients and number of outpatients is non-linear. The relationship between medical waste and number of inpatients and number of outpatients is also non-linear.
One of the ways to take into account the non-linear relationship is to use linear-log models. However, since in the next section the dependent variables (GENW and MEDW) are transformed by natural logarithm to make them normally distributed, the model becomes log-log model. The advantage of using this model is that a better fit of the data will be gained. Additionally, interpretation of the estimated parameters will be more convenient.

A log-log model is one where both the dependent and independent variables are transformed by the “natural” logarithm. The model is as follows

$$\ln(y_i) = \beta_1 + \beta_2 \ln(x_{i2}) + \ldots + \beta_K \ln(x_{iK}) + e_i$$
The parameter $\beta_2$ is the elasticity of $y$ with respect to $x$. Although the variables and the relationship are non-linear, the model is still linear in parameters. Hence, the model can still be estimated using the least squares estimation technique.

When intercept dummy variables are included in a log-log model, in general, it becomes

$$\ln(y_i) = \beta_1 + \beta_2 \ln(x_{i2}) + \ldots + \beta_K \ln(x_{iK}) + \delta_1 D_{x_{i1}} + \ldots + \delta_L D_{x_{iL}} + e_i$$

Therefore, the multiple regression models used are as follows:

- **Model 1: General Waste Model**
  $$\ln(GENW_i) = \beta_1 + \beta_2 \ln(NIP_i) + \beta_3 \ln(NOPI_i) + \delta_1 DLOC_i + \delta_2 DWMBUDGET_i + \delta_3 DwMPLAN_i + \delta_4 DCEPOL_i + e_i$$ (5-1)

- **Model 2: Medical Waste Model**
  $$\ln(MEDW) = \beta_1 + \beta_2 \ln(NIP_i) + \beta_3 \ln(NOPI_i) + \delta_1 DLOC_i + \delta_2 DWMBUDGET_i + \delta_3 DwMUNIT_i + \delta_4 DTRAIN_i + e_i$$ (5-2)

**Test of assumptions**

The assumptions of the multiple regression model are (Hill, Griffiths, & Lim, 2010, p. 173):

- **MR1.** $y_i = \beta_1 + \beta_2 x_{i2} + \beta_K x_{iK} + e_i, i = 1, \ldots, N.$
- **MR2.** $E(y_i) = \beta_1 + \beta_2 x_{i2} + \beta_K x_{iK}$. The expected (average) value of $y$ depends on the values of the explanatory variables and the unknown parameters (taken into account in the error term). Each random error has a probability distribution with zero mean. It is equivalent to $E(e) = 0$.
- **MR3.** $\text{var}(y) = \text{var}(e) = \sigma^2$. The variance of the probability distribution of $y$ does not change with each observation. Some observations on $y$ are not more likely to be further from the regression function than others. This property is known as homoscedasticity.
- **MR4.** $\text{cov}(y_i,y_j) = \text{cov}(e_i,e_j)$. Any two observations on the independent variable are uncorrelated. For example, if one observation is above $E(y)$, a subsequent observation is not more or less likely to be above $E(y)$. 

Sri Irianti
• MR5. The values of each $x_{ik}$ are not random and not exact linear functions of the other explanatory variables.

• MR6. Sometimes, it is assumed that the values of $y$ are normally distributed about their mean. That is $y_i \sim N[(\beta_1 + \beta_2x_{i2} + \ldots + \beta_ix_{ik}), \sigma^2]$, which is equivalent to assuming that the errors are normally distributed or $e \sim N(0, \sigma^2)$.

For a regression model to be valid for generalisation, its underlying assumptions must be met and have to be tested (Field, 2009).

**Homoscedasticity**

The assumption of homoskedasticity refers to assumption MR3. To check for it, it is needed to examine the residual plot of the regressions. Figure 5-89 shows the scatter plot of the standardised residuals of the regressions against the standardised predicted values from Model 1 and Model 2.

![Scatter Plot of ZRESID against ZPRED from both models](image)

It can be seen from Figure 5-90 that the points are randomly and evenly dispersed throughout the plot, which indicate that the variance of the residual terms is relatively constant. Therefore, it is assumed that both models satisfy the assumption of homoscedasticity.

**Normality of the dependent variable**

Due to the moderate response rate of the survey, it is better to make sure that the assumption MR6 is satisfied. In this case, the dependent variables (GENW and MEDW) should follow a normal distribution.
One approach to do this is to examine their histograms. Figure 5-90 shows the histograms of the dependent variables. It can be seen that both of the distributions of GENW and MEDW are positively skewed.

Another approach is to do a formal test for normal distribution. One of which is the Kolmogorov-Smirnov Test of Normality (Table 5-7), which basically compares the scores in the sample to a normally distributed set of scores with the same mean and standard deviation (Field, 2009).

The result of the test is shown in Table 5-7. Since the p-values are both below 0.05, then there is enough evidence to conclude that the distributions are significantly different from a normal distribution. This is in line with the pictorial observation of the histograms. Therefore, the dependent variables need to be normalised (transformed) in order to be normally distributed.

The transformation of the dependent variables involves two stages. First, both of the variables are transformed into their natural logarithmic form. Second, the outliers are omitted until the distribution can be assumed as normal (i.e. the null hypothesis of the Kolmogorov-Smirnov Test of Normality cannot be rejected). Table 5-8 shows the

---

**Figure 5-90 Histograms of general waste and medical waste**

---

**Table 5-7 Kolmogorov-Smirnov test of normality of the dependent variables**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Statistic</th>
<th>df</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GENW</td>
<td>0.119</td>
<td>218</td>
<td>0.000*</td>
</tr>
<tr>
<td>MEDW</td>
<td>0.173</td>
<td>221</td>
<td>0.000*</td>
</tr>
</tbody>
</table>

* Lower bound of significance

---

Note: GENW = generation of general waste (kg/bed/day); MEDW = generation of medical waste (kg/bed/day); df = degrees of freedom; accepted level of significance is 5%.
results of the test of normality in which the null hypothesis in both variables cannot be rejected. Therefore, it can be assumed that the distribution of the dependent variables is not different from normally distributed data.

Table 5-8 Kolmogorov-Smirnov test of normality of the transformed dependent variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Statistic</th>
<th>df</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNGENW</td>
<td>0.054</td>
<td>214</td>
<td>0.200*</td>
</tr>
<tr>
<td>LNMEDW</td>
<td>0.054</td>
<td>211</td>
<td>0.200*</td>
</tr>
</tbody>
</table>

* Lower bound of significance

Normality of the residuals

Assumption MR6 states that if the dependent variable is normally distributed, then the residuals from the regression should also be normally distributed. Figure 5-91 shows the histograms of the residuals from regressions of the General Waste and Medical Waste models. It can be seen from the histograms that the residuals in both models are normally distributed, indicated by the bell-shaped normal curve.

Figure 5-91 Histogram of standardised residuals from General Waste Model and Medical Waste Model
A Policy Framework for the Improvement of Health Care Waste Management in Indonesia

Multicollinearity

To satisfy assumption MR5, we need to check the presence of high multicollinearity. One approach is to examine the variance inflation factor (VIF), which is the speed with which variances and co-variances increase (Gujarati & Porter, 2009), and its formula is as follows:

\[
VIF = \frac{1}{(1 - r_{23}^2)}
\] (5-3)

Where \( r_{23} \) is the sample correlation coefficient between the values of \( x_2 \) and \( x_3 \) (explanatory variables). If the largest value of VIF exceeds 10, then there is an indication of severe multicollinearity (Bowerman & O’Connell, 1990; Myers, 1990).

Another approach is to examine the inverse of VIF, which is called tolerance (TOL). That is

\[
TOL_j = \frac{1}{VIF_j} = (1 - R_j^2)
\] (5-4)

where \( R_j^2 \) is the coefficient of determination in the regression of one explanatory variable on the remaining explanatory variables. The value of TOL below 0.2 indicates a potential multicollinearity problem (Menard, 2001). Moreover, if the average VIF is substantially greater than 1, then the regression is potentially biased (Bowerman & O’Connell, 1990).

Table 5-9 presents a summary of the collinearity statistics from both general waste and medical waste models. In both, there are no values of VIF that exceed 10; there are no values of TOL below 0.20; and the average VIFs are both not very far from 1. In conclusion, therefore, both models can be assumed to be free from severe multicollinearity.
Table 5-9 Collinearity statistics from Model 1 and Model 2

<table>
<thead>
<tr>
<th></th>
<th>General Waste Model</th>
<th>Medical Waste Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>TOL</td>
<td>VIF</td>
</tr>
<tr>
<td>LN(NIP)</td>
<td>0.32</td>
<td>3.10</td>
</tr>
<tr>
<td>LN(NOP)</td>
<td>0.28</td>
<td>3.62</td>
</tr>
<tr>
<td>DLOC</td>
<td>0.73</td>
<td>1.37</td>
</tr>
<tr>
<td>DWMBUDGET</td>
<td>0.89</td>
<td>1.12</td>
</tr>
<tr>
<td>DWMPLAN</td>
<td>0.87</td>
<td>1.15</td>
</tr>
<tr>
<td>DCEPOL</td>
<td>0.95</td>
<td>1.05</td>
</tr>
<tr>
<td>Average VIF =</td>
<td>1.90</td>
<td></td>
</tr>
</tbody>
</table>

Note: TOL = Tolerance; VIF = variance-inflating factor.

The least squares estimation procedures

Consider a multiple regression model, with \( i \) denoting the \( i^{th} \) observation

\[
y_i = \beta_1 + \beta_2 x_{i2} + \beta_3 x_{i3} + e_i
\]

(5-5)

In principle, the least squares method is the method used to find “the values of \( (\beta_1, \beta_2, \beta_3) \) that minimise the sum of squared differences between the observed values of \( y_i \) and their expected values \( E(y_i) = \beta_1 + \beta_2 x_{i2} + \beta_3 x_{i3} \)” (Hill et al., 2011, p. 174). Mathematically, this is done by minimising the sum of squares function \( S(\beta_1, \beta_2, \beta_3) \), which is a function of the unknown parameters, given the data:

\[
S(\beta_1, \beta_2, \beta_3) = \sum_{i=1}^{N} (y_i - E(y_i))^2 = \sum_{i=1}^{N} (y_i - \beta_1 - \beta_2 x_{i2} - \beta_3 x_{i3})^2
\]

(5-6)

By minimising the above, the least squares estimators yield the least squares estimates \( b_1, b_2, \) and \( b_3 \).

Furthermore, another parameter that has to be estimated in the multiple regression model is the variance of the error term, which is \( \sigma^2 = \text{var}(e_i) = E(e_i^2) \). The estimated residuals for the multiple regression model in the previous section are:

\[
\hat{e}_i = y_i - \hat{y}_i = y_i - (b_1 + b_2 x_{i2} + b_3 x_{i3})
\]
An estimator for $\sigma^2$ that utilise information from $\hat{e}_i^2$ and has good statistical properties is:

$$\hat{\sigma}^2 = \frac{\sum_{i=1}^{N} \hat{e}_i^2}{N - K} \tag{5-7}$$

where $N$ is the number of observations and $K$ is the number of parameters being estimated in the multiple regression model.

**Sampling properties of the least squares estimators**

In general, the least squares estimators $(b_1, b_2, b_3)$ are random variables; their values are different in different samples, and their values are known when a sample is collected and computed. The reliability of the estimates varies from sample to sample and this can be assessed, based on the sampling properties of the estimators (Hill et al., 2011).

The Gauss-Markov Theorem states that for the multiple regression model, if assumptions MR1-MR5 hold, then the least squares estimators are the best linear unbiased estimators (BLUE) of the parameters (Hill et al., 2011). If the further assumption is that the residuals are normally distributed, then the dependent variable will also be a normally distributed random variable. Hence, the least squares estimators will also be normally distributed as they are linear functions of the dependent variable (Hill et al., 2011).

**The variance and co-variances of the least squares estimators**

The variances and co-variances of the least squares estimators provide information regarding the reliability of the estimators $b_1$, $b_2$, and $b_3$. Given the unbiased nature of the least squares estimators, the smaller their variances, the more likely they will produce estimates close to the true parameter values. For $K = 3$ the variances and co-variances can be expressed as:

$$var(b_2) = \frac{\sigma^2}{(1 - r_{23}^2) \sum_{i=1}^{N} (x_{i2} - \bar{x}_2)^2} \tag{5-8}$$

Where $r_{23}$ is the sample correlation coefficient between the values of $x_2$ and $x_3$. Its formula is given by
For convenience, the variances and co-variances of the least squares estimators can be arranged in a matrix form, hence called the variance-covariance matrix or covariance matrix. When \( K = 3 \), the arrangement of the covariance matrix is:

\[
\text{cov}(b_1, b_2, b_3) = \begin{bmatrix}
\text{var}(b_1) & \text{cov}(b_1, b_2) & \text{cov}(b_1, b_3) \\
\text{cov}(b_1, b_2) & \text{var}(b_2) & \text{cov}(b_2, b_3) \\
\text{cov}(b_1, b_3) & \text{cov}(b_2, b_3) & \text{var}(b_3)
\end{bmatrix}
\]

The standard errors of \( b_1, b_2, \) and \( b_3 \) are given by the square roots of the corresponding estimated variances. That is:

\[
se(b_k) = \sqrt{\text{var}(b_k)}
\]

**The distribution of the least squares estimators**

Given that assumptions MR1-MR5 hold, the least squares estimators \( b_k \) is the best linear unbiased estimator of the parameter \( \beta_k \) in the model

\[
y_i = \beta_1 + \beta_2 x_{i2} + \beta_3 x_{i3} + \ldots + \beta_K x_{iK} + e_i
\]

If we further assume that MR6 – that the random errors \( e_i \) are normally distributed – hold, then the dependent variable \( y_i \) is normally distributed. Moreover, because the least squares estimators are linear functions of dependent variables, they are also normally distributed

\[
b_k \sim \text{N}(\beta_k, \text{var}(b_k))
\]

implying that each \( b_k \) has a normal distribution with mean \( \beta_k \) and variance \( \text{var}(b_k) \). By subtracting its mean and dividing by the square root of its variance, it can be transformed into the *standard normal variable* \( Z \),

\[
Z = \frac{b_k - \beta_k}{\sqrt{\text{var}(b_k)}} \sim \text{N}(0,1), \quad \text{for } k = 1, 2, \ldots, K
\]
with zero mean and a variance of 1. The variance of $b_k$ depends on the unknown variance of the error term, $\sigma^2$. When $\sigma^2$ is replaced by its estimator $\hat{\sigma}^2$, from (5-7) we obtain the $\text{var}(b_k)$ which is denoted as $\text{var}(\hat{b}_k)$. Replacing $\text{var}(b_k)$ by $\text{var}(\hat{b}_k)$ will change the $N(0,1)$ random variable to a $t$-random variable. That is:

$$t = \frac{b_k - \beta_k}{\sqrt{\text{var}(\hat{b}_k)}} = \frac{b_k - \beta_k}{\text{se}(b_k)} \sim t_{(N-K)} \quad (5-11)$$

**Interval estimation**

In addition to the point estimates of the unknown population parameters $\beta_k$ in the multiple regression model, there is interval estimation, which is a range of values where the true parameters are likely to fall. Such intervals are often called confidence intervals (CI). The general expression for a $100(1-\alpha)%$ confidence interval is:

$$(b_k \pm t_{(1-\alpha/2, N-K)} \times \text{se}(b_k)) \quad (5-12)$$

where,

- $b_k$ is the point estimate of parameter $\beta_k$
- $t$ is critical value
- $\alpha$ is the level of significance (0.05 in this study)
- $N$ is the number of observations
- $K$ is the number of parameters in the model
- $\text{se}(b_k)$ is the standard error of $b_k$

The CIs in all the models in this study will be generated by the IBM SPSS version 20.

**Hypothesis testing**

To make sure that there is evidence that the explanatory variables influence the dependent variable, the researcher needs to test the significance of each and every explanatory variable. Consider a given explanatory variable, say $x_k$, has no bearing on $y$, then $\beta_k = 0$. Hence the researcher needs to test the null hypothesis

$$H_0 : \beta_k = 0$$

against the alternative hypothesis.
The test statistic used, if the null hypothesis is true, is

$$ t = \frac{b_k}{se(b_k)} \sim t_{(N-K)} $$.  

This test statistic is reported in the SPSS output along with its p-values. Hence, the researcher rejects $H_0$ if $p \leq 0.05$ and does not reject $H_0$ if $p > 0.05$.

### Measuring goodness of fit

Goodness of fit is measured by coefficient of determination ($R^2$), which is the proportion of variation in the dependent variable explained by all the explanatory variables included in the linear model. The coefficient of determination is:

$$ R^2 = \frac{SSR}{SST} = 1 - \frac{SSE}{SST} = 1 - \frac{\sum_{i=1}^{N} \hat{\varepsilon}_i^2}{\sum_{i=1}^{N} (y_i - \bar{y})^2} $$ \hfill (5-13)

Where, $SSR$ is the variation in $y$ “explained” by the model (sum of squares regression), $SST$ is the total variation in $y$ about its mean (sum of squares total), and $SSE$ is the sum of squared least squares residuals (errors)—the portion of the variation in $y$ that is not explained by the model (Hill et al., 2011).

The notation $\hat{y}_i$ refers to the predicted value of $y$ for each of the sample values of the explanatory variables. That is,

$$ \hat{y}_i = b_1 + b_2 x_{i2} + b_3 x_{i3} + b_K x_{iK} $$

As long as the model includes a constant (i.e. $\beta_1$), the sample mean $\bar{y}$ is both the mean of $y_i$ and $\hat{y}_i$.

The problem with $R^2$, however, is that it can be made large by adding more and more variables, even if they have no theoretical justification. An alternative measure of goodness of fit is the adjusted-$R^2$, denoted as $\overline{R^2}$, and is computed as:
This measure applies a “penalty” for every additional variable, and hence, it does not always go up when a variable is added.

The least squares inference procedures

The estimated model is \( \ln(\hat{y}) = b_1 + b_2 \ln(x) \) and \( b_2 \) is the estimated constant elasticity of \( y \) with respect to \( x \). That elasticity implies that a 1% change in \( x \) is associated with \( b_2 \) change in \( y \). The intercept dummy variables, however, have different interpretations. Consider a log-log model

\[
\ln(Y_i) = \beta_1 + \beta_2 \ln(x_i) + \delta D_{X_i} + \epsilon_i
\]

where \( DX \) is an intercept dummy variable that creates a parallel shift of the log-log relationship when \( DX = 1 \). That is

\[
\ln(Y_i) = \begin{cases} 
\beta_1 + \beta_2 x_i & D_{X_i} = 0 \\
(\beta_1 + \delta) + \beta_2 x_i & D_{X_i} = 1
\end{cases}
\]

Since the dependent variable is in natural logarithmic form, the interpretation of the coefficient of the dummy variable (\( \delta \)) is as follows

\[100(e^\delta - 1)\%\]

The result can be interpreted as the parallel percentage difference of the slopes.

Testing the significance of the model

Consider again the general multiple regression model with \((K - 1)\) explanatory variables and \( K \) unknown coefficients

\[ y_i = \beta_1 + \beta_2 x_{i2} + \beta_3 x_{i3} + \ldots + \beta_K x_{iK} + \epsilon_i \]  

To examine whether the model consists of viable explanatory variables as a whole, we set up the following and alternative hypotheses:

\[ H_0 : \beta_2 = 0, \beta_3 = 0, \ldots, \beta_K = 0 \]
At least one of the $\beta_k$ is nonzero for $k = 2, 3, \ldots, K$

The null hypothesis is a joint one because it has $K - 1$ component and it conjectures that each and every one of the parameters $\beta_k$, except the intercept parameter $\beta_1$, are simultaneously zero. If this is true, none of the explanatory variables affects $y$. If the alternative hypothesis $H_1$ is true, then, at least one of the parameters is non zero, implying that it is worth including it in the model. The $F$-test is used for testing the joint null hypothesis in (5-16) and its statistic is calculated by using the following formula:

$$F = \frac{(SST - SSE)/(K - 1)}{SSE/(N - K)}$$  \hspace{1cm} (5-17)

This $F$-statistic is automatically reported by SPSS, including its $p$-value ($p$). If $p \leq 0.05$ then we reject $H_0$ and conclude that there is at least one variable that has a non-zero parameter. Otherwise, we do not reject $H_0$ and assume that it holds. The $F$-statistic can also be compared to a critical value from the $F_{(K-1,N-K)}$ distribution.

### 5.11.2 Multivariate logistic regression

Logistic regression is, in essence, a multiple regression with a categorical outcome variable. Like the ordinary multiple regression, it can also have continuous or categorical explanatory variables. Consider the usual general multiple regression model:

$$y_i = \beta_1 + \beta_2 x_{i2} + \beta_3 x_{i3} + \cdots + \beta_K x_{iK} + e_i, \ i = 1, \ldots, N$$  \hspace{1cm} (5-18)

If the dependent variable, $y$, is binary—taking the value of 1 (denoting the presence or possession of an attribute) or 0 (denoting the absence of that attribute)—then estimating using the least squares, although possible, is not free from problems. Those problems are (Gujarati and Porter, 2010, p. 387): (1) the predicted values of the dependent variable, $\hat{y}$, may not lie between 0 and 1; (2) since $y_i$ is binary, the error term in such model is also binary, which, unlike the usually assumed in the least squares estimation, follows binomial distribution; and (3) the error term is heteroscedastic.

One solution is to use logistic regression, which predicts the probability of $y$ occurring, given known values of the predictors (Field, 2009). The logistic regression equation would become:
Therefore, \( p(y) \) can be calculated with the following formula, which is a rearrangement of formula (5-20):

\[
p(y) = \frac{e^{(\beta_1 + \beta_2 x_{12} + \cdots + \beta_K x_{IK})}}{1 + e^{(\beta_1 + \beta_2 x_{12} + \cdots + \beta_K x_{IK})}}
\]  

(5-20)

where \( p(y) \) is the probability of \( y \) occurring, \( e \) is the base of natural logarithms, and the other parts are similar to those in ordinary multiple regression equation.

**Assumptions**

Logistic regression has some similar assumptions of linear regression (Field, 2009):

- **Linearity:** Since the dependent variable in logistic regression is binary, it violates the assumption of linearity in the ordinary multiple regression. However, transforming the data into its logarithmic form overcomes this problem. Therefore, in logistic regression, it is assumed that the relationship between any continuous predictors and the logit of the dependent variable is linear (Field, 2009).
- **Independence of errors:** this assumption is the same as for the ordinary multiple regression (see assumption MR4).
- **Multicollinearity:** this assumption is the same as for the ordinary multiple regression (see assumption MR5).

**Goodness of fit: Log-likelihood statistic**

Logistic regression predicts the probability of an event occurring for a given subject (i.e. hospital), denoted as \( p(y_i) \), based on observations whether or not the event did occur for that subject (this is denoted as \( y_i \), the actual outcome for the \( i^{th} \) person) (Field, 2009). Therefore, for a given hospital, \( y \) will be either 0 (the outcome did not occur) or 1 (the outcome did occur), and the predicted value, \( p(y_i) \), will be a value between 0 (there is no chance that the outcome will occur) and 1 (the outcome will certainly occur). To assess how well a logistic regression model fits the data, we can use the observed and predicted values, which are measured by the log-likelihood:
The log-likelihood is an indicator of how much information is unexplained, after the model has been fitted; thus, it follows that large values of the log-likelihood statistic indicate poorly fitting statistical models (Field, 2009).

**Goodness of fit: R and R²**

In the ordinary multiple regression, the goodness of fit is measured by the coefficient of determination, $R^2$. In logistic regression, the multiple correlation is known as the $R$-statistic, which is the partial correlation between the dependent variable and each of the explanatory variables and it varies between -1 and 1 (Field, 2009). The formula is as follows:

$$ R = \pm \sqrt{\frac{Wald - (2 \times df)}{-2 \text{LL(original)}}} $$  \hspace{1cm} (5-22)

where $-2 \text{LL}$ is the -2 log-likelihood for the original model before any predictors were entered, $df$ is degrees of freedom, and $Wald$ is the Wald statistic. A positive value of $R$ implies the likelihood of the outcome occurring increases as the explanatory variable increases. Conversely, a negative value indicates the likelihood of the outcome occurring decreases as the explanatory variable increases. A small value of $R$ means that a variable contributes only a small amount to the model.

The SPSS, however, uses Cox and Snell’s $R^2_{CS}$ (1989), which is based on the log-likelihood of the model ($\text{LL(new)}$), the log-likelihood of the original model ($\text{LL(baseline)}$), and the sample size, $n$:

$$ R^2_{CS} = 1 - e^{\frac{2}{n} [\text{LL(new)} - \text{LL(baseline)}]} $$  \hspace{1cm} (5-23)

Since this statistic never reaches its theoretical maximum of 1, Nagelkerke (1991) suggested the following modification (Nagelkerke’s $R^2_N$):
Although the calculation differs from that in the ordinary multiple regression, the interpretation is similar (Field, 2009).

**Wald Statistic**

To assess whether the variables in the model individually contributes to the model, logistic regression uses the Wald statistic, which follows the chi-square distribution. If the coefficient of a predictor variable is significantly different from zero, then it can be assumed, that the predictor is making a significant contribution to the prediction of the outcome, \( y \) (Field, 2009). The formula is as follows:

\[
Wald = \frac{b_k}{se(b_k)}
\]  
(5-25)

**The odds ratio**

An important interpretation of logistic regression is the value of odds ratio (derived by taking the exponent of \( \beta_k \)), which indicates the change in odds resulting from a unit change in the predictor. The odds of an event occurring are defined as the probability of an outcome occurring, divided by, the probability of that outcome not occurring (see equation [5-26]).

\[
\text{odds} = \frac{p(\text{outcome occurring})}{p(\text{outcome not occurring})}
\]  
(5-26)

\[
p(\text{outcome } Y \text{ occurring}) = \frac{1}{1 + e^{-(b_0 + b_1 x_1)}}
\]
\[
p(\text{outcome } Y \text{ not occurring}) = 1 - P(\text{event } Y)
\]

The odds before and after a unit change in the predictor variable can be calculated by

\[
\Delta \text{odds} = \frac{\text{odds after a unit change in the predictor}}{\text{original odds}}
\]  
(5-27)

The interpretation is as follows: a value greater than 1 indicates that the odds of the outcome occurring increases as the predictor increases. Conversely, a value less than 1
indicates that the odds of the outcome occurring decreases as the predictor increases (Field, 2009).

The logistic regression models

To answer the research questions regarding compliance of the hospitals with the relevant regulations, there are two models that will be used. The first model uses waste segregation as the dependent variable, while the second model uses colour coding as the dependent variable. The explanatory variables will be the same for both models; they are: DWMBUDGET, DWMUNIT, DWPLAN, DCENPOLICY, DMANPOLICY, DHOSPGUIDE, DROOMSOP, DHOSPCCLASS, and DLOCATION.

The description of the explanatory variables is as follows:

- Availability of routine budget for HCWM
  \[
  \text{DWMBUDGET} = \begin{cases} 
  1, \text{ yes} \\
  0, \text{ no} 
  \end{cases}
  \]

- Existence of sanitation unit
  \[
  \text{DWMUNIT} = \begin{cases} 
  1, \text{ yes} \\
  0, \text{ no} 
  \end{cases}
  \]

- Availability of HCWM plans
  \[
  \text{DWPLAN} = \begin{cases} 
  1, \text{ yes} \\
  0, \text{ no} 
  \end{cases}
  \]

- Availability of policy from Central Government
  \[
  \text{DCENPOLICY} = \begin{cases} 
  1, \text{ yes} \\
  0, \text{ no} 
  \end{cases}
  \]

- Existence of policy on HCWM by Hospital Manager
  \[
  \text{DMANPOLICY} = \begin{cases} 
  1, \text{ yes} \\
  0, \text{ no} 
  \end{cases}
  \]

- Existence of hospital guideline on HCWM implementation
  \[
  \text{DHOSPGUIDE} = \begin{cases} 
  1, \text{ yes} \\
  0, \text{ no} 
  \end{cases}
  \]

- SOP in the room on segregation
  \[
  \text{DROOMSOP} = \begin{cases} 
  1, \text{ yes} \\
  0, \text{ no} 
  \end{cases}
  \]
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- Class of hospital
  \[ \text{DHOSPCLASS} = \begin{cases} 
    1, & \text{Class A or B} \\
    0, & \text{Class C or D} 
  \end{cases} \]

- Location by island
  \[ \text{DLOCATION} = \begin{cases} 
    1, & \text{if the hospital is located in Java or Bali island} \\
    0, & \text{otherwise} 
  \end{cases} \]

The following will be the table of logistic regression models containing equations of variables involved.

### Table 5-10 Logistic regression models

#### Model 1: Waste Segregation Model

\[
\text{SEGREGATION}_i = \beta_1 + \beta_2 \text{DWMBUDGET}_i + \beta_3 \text{DWMUNIT}_i + \beta_4 \text{DWPLAN}_i + \\
\beta_5 \text{DCENPOLICY}_i + \beta_6 \text{DMANPOLICY}_i + \beta_7 \text{DHOSPGUIDE}_i + \\
\beta_8 \text{DROOMSOP}_i + \beta_9 \text{DHOSPCLASS}_i + \beta_{10} \text{DLOCATION}_i + \epsilon_i
\]

Logistic Regression Model 1

\[
p(\text{SEGREGATION}) = \frac{e^{(\beta_1 + \beta_2 x_{1i} + \cdots + \beta_K x_{Ki})}}{1 + e^{(\beta_1 + \beta_2 x_{1i} + \cdots + \beta_K x_{Ki})}}
\]

#### Model 1: Colour Coding Model

\[
\text{COLCODING}_i = \beta_1 + \beta_2 \text{DWMBUDGET}_i + \beta_3 \text{DWMUNIT}_i + \beta_4 \text{DWPLAN}_i + \\
\beta_5 \text{DCENPOLICY}_i + \beta_6 \text{DMANPOLICY}_i + \beta_7 \text{DHOSPGUIDE}_i + \\
\beta_8 \text{DROOMSOP}_i + \beta_9 \text{DHOSPCLASS}_i + \beta_{10} \text{DLOCATION}_i + \epsilon_i
\]

Logistic Regression Model 2

\[
p(\text{COLCODING}) = \frac{e^{(\beta_1 + \beta_2 x_{1i} + \cdots + \beta_K x_{Ki})}}{1 + e^{(\beta_1 + \beta_2 x_{1i} + \cdots + \beta_K x_{Ki})}}
\]

In order to be able to generalise the outcomes of inferential statistics, it is necessary to conduct a test to ensure that the models used do not suffer from severe multicollinearity, as can be seen in the following paragraphs.

### Testing for multicollinearity

The assessment of multicollinearity in logistic regression models is similar to that in the ordinary multiple regression models. Table 5-11 shows a summary of the collinearity statistics from both, Waste Segregation, and Colour Coding, models. In both, there are no values of VIF that exceed 10; there are no values of TOL below 0.20; and the
average VIFs are both not very far from 1. In conclusion, therefore, both models can be assumed to be free from severe multicollinearity.

Table 5-11 Collinearity statistics from Waste Segregation Model and Colour Coding Model (Same explanatory variables)

<table>
<thead>
<tr>
<th>Variable</th>
<th>TOL</th>
<th>VIF</th>
<th>Variable</th>
<th>TOL</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>WMBUDGET</td>
<td>0.85</td>
<td>1.17</td>
<td>HOSPGUIDE</td>
<td>0.76</td>
<td>1.32</td>
</tr>
<tr>
<td>WMUNIT</td>
<td>0.95</td>
<td>1.05</td>
<td>ROOMSOP</td>
<td>0.70</td>
<td>1.43</td>
</tr>
<tr>
<td>WMPLAN</td>
<td>0.78</td>
<td>1.28</td>
<td>HOSPCLASS</td>
<td>0.75</td>
<td>1.33</td>
</tr>
<tr>
<td>CENPOLICY</td>
<td>0.75</td>
<td>1.34</td>
<td>LOCATION</td>
<td>0.78</td>
<td>1.28</td>
</tr>
<tr>
<td>MANPOLICY</td>
<td>0.72</td>
<td>1.38</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Average VIF = 1.29

Note: TOL = Tolerance; VIF = variance-inflating factor.

5.11.3 Determinants of the generation of general wastes

The model to determine the general waste production is as follows:

$$
\ln (\text{GENW}_i) = b_1 + b_2 \ln(\text{NIP}_i) + b_3 \ln(\text{NOP}_i) + \hat{\delta}_1 \text{DLOC}_i \\
+ \hat{\delta}_2 \text{DWMBUDGET}_i + \hat{\delta}_3 \text{DMPLAN}_i + \hat{\delta}_4 \text{DCEPOL}_i
$$

(5-28)

Table 5-12 shows the list of estimated parameters of the general waste model, including the number of inpatients (NIP), the number of outpatients (NOP), the location of hospitals (DLOC), availability of routine budgets (DWMBUDGET), availability of waste plans (DMPLAN), and availability of central policy (DCEPOL). It can be seen that there were three significant variables ($p<0.05$), namely, the number of inpatients, number of outpatients, and the location of study (within Java-Bali islands, and outside Java-Bali islands).

Table 5-12 Estimated parameters of the general waste model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coeff.</th>
<th>SE</th>
<th>CI Lower</th>
<th>CI Upper</th>
<th>p-value</th>
<th>Intercept Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.79</td>
<td>0.23</td>
<td>0.32</td>
<td>1.25</td>
<td><strong>0.0009</strong></td>
<td></td>
</tr>
<tr>
<td>LN(NIP)</td>
<td>-0.37</td>
<td>0.09</td>
<td>-0.55</td>
<td>-0.19</td>
<td><strong>p&lt;0.001</strong></td>
<td></td>
</tr>
<tr>
<td>LN(NOP)</td>
<td>0.19</td>
<td>0.08</td>
<td>0.04</td>
<td>0.34</td>
<td><strong>0.0143</strong></td>
<td></td>
</tr>
<tr>
<td>DLOC</td>
<td>-0.20</td>
<td>0.10</td>
<td>-0.39</td>
<td>0.01</td>
<td><strong>0.0393</strong></td>
<td>-18</td>
</tr>
<tr>
<td>DWMBUDGET</td>
<td>0.15</td>
<td>0.13</td>
<td>-0.11</td>
<td>0.40</td>
<td>0.2636</td>
<td>16</td>
</tr>
<tr>
<td>DWPLAN</td>
<td>0.02</td>
<td>0.10</td>
<td>-0.19</td>
<td>0.22</td>
<td>0.8809</td>
<td>2</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Variable</th>
<th>Coeff.</th>
<th>SE</th>
<th>CI Lower</th>
<th>CI Upper</th>
<th>p-value</th>
<th>Intercept Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCEPOL</td>
<td>0.06</td>
<td>0.10</td>
<td>-0.13</td>
<td>0.25</td>
<td>0.5521</td>
<td>6</td>
</tr>
</tbody>
</table>

R-squared = 0.1080
Adjusted R-squared = 0.0818
F-statistic = 4.163
Prob. (F-statistic) = \( p < 0.001 \)

Note: Coeff. = coefficients; SE = standard errors; CI = confidence intervals; Dependent variable: generation of medical waste in natural logarithmic form (LNGENW); Accepted level of significance = 0.05.

Interpretations:

- The model is significant (\( p < 0.001 \)) and \( R^2 \) is 10.80%, which is the total variation in the generation of general waste that can be explained by the variation of the independent variables.
- NIP; a 1% increase in the number of inpatients is associated with a 0.37% decrease, on average, in the number of generated general waste, holding all other variables constant. It is statistically significant at the 5% level of significance.
- NOP; a 1% increase in the number of outpatients is associated with a 0.19% increase, on average, in the number of generated general waste, holding all other variables constant. It is statistically significant at the 5% level of significance.
- DLOC; a hospital located in Java or Bali islands is expected to have 18% lower generation of general waste than that of a hospital located outside of Java and Bali islands. It is statistically significant at the 5% level of significance.
- DWMBUDGET; a hospital that has routine budget for HCWM is expected to generate 16% more general waste than a hospital that does not. However, it is not statistically significant at the 5% level of significance.
- DWPLAN; a hospital that has a waste management plan is expected to generate 2% more general waste than a hospital that does not. However, it is not statistically significant at the 5% level of significance.
- DCEPOL; a hospital that has a central policy is expected to generate 6% more general waste than a hospital that does not. However, it is not statistically significant at the 5% level of significance.

5.11.4 Determinants of the generation of medical wastes

The model for predicting medical waste generation is as follows
\[ \ln(MEDW_i) = b_1 + b_2 \ln(NIP_i) + b_3 \ln(NOP_i) + \delta_1 DLOC_i \\
+ \delta_2 DWMBUDGET_i + \delta_3 DWMUNIT_i + \delta_4 DTRAIN_i \] (5-29)

Table 5-13 presents the estimated parameters of the medical waste model of the study, consisting of the number of inpatients (NIP), the number of outpatients (NOP), location of hospitals (DLOC), availability of routine budgets (DWMBUDGET), availability of waste management units (DWMUNIT), and availability of training on HCWM (DTRAIN). The study found four significant variables as determinants of medical waste generation, namely, the number of inpatients, the number of outpatients, availability of routine budgets, and availability of waste management units.

### Table 5-13 Estimated parameters of the medical waste model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coeff.</th>
<th>SE</th>
<th>CI Lower</th>
<th>CI Upper</th>
<th>p-value</th>
<th>Intercept Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.69</td>
<td>0.22</td>
<td>-1.12</td>
<td>-0.26</td>
<td>0.0019</td>
<td></td>
</tr>
<tr>
<td>LN(NIP)</td>
<td>-0.51</td>
<td>0.08</td>
<td>-0.67</td>
<td>-0.35</td>
<td>( p &lt; 0.001 )</td>
<td></td>
</tr>
<tr>
<td>LN(NOP)</td>
<td>0.29</td>
<td>0.07</td>
<td>0.15</td>
<td>0.43</td>
<td>( p &lt; 0.001 )</td>
<td></td>
</tr>
<tr>
<td>DLOC</td>
<td>-0.17</td>
<td>0.09</td>
<td>-0.34</td>
<td>0.00</td>
<td>0.0512</td>
<td>-15</td>
</tr>
<tr>
<td>DWMBUDGET</td>
<td>0.29</td>
<td>0.12</td>
<td>0.06</td>
<td>0.52</td>
<td>0.0137</td>
<td>34</td>
</tr>
<tr>
<td>DWMUNIT</td>
<td>0.19</td>
<td>0.09</td>
<td>-0.38</td>
<td>-0.01</td>
<td>0.0364</td>
<td>-18</td>
</tr>
<tr>
<td>DTRAIN</td>
<td>-0.15</td>
<td>0.09</td>
<td>-0.33</td>
<td>0.02</td>
<td>0.0841</td>
<td>-14</td>
</tr>
</tbody>
</table>

R-squared = 0.2299
Adjusted R-squared = 0.2073
F-statistic = 10.1518
Prob. (F-statistic) = \( p < 0.001 \)

Note: Coeff. = coefficients; SE = standard errors; CI = confidence intervals; Dependent variables: generation of medical waste in natural logarithmic form (LNEDW); Accepted level of significance = 0.05.

Interpretations:
- The model is significant \( (p < 0.001) \) and \( R^2 \) is 22.99\%, which is the total variation in the generation of medical waste that can be explained by the variation of the independent variables.
- LN (NIP); a 1% increase in the number of inpatients is associated with a 0.51% decrease, on average, in the number of generated medical waste, holding all other variables constant. It is statistically significant at the 5% level of significance.
• NOP; a one percent increase in the number of outpatients is associated with a 0.29% increase, on average, in the number of generated medical waste, holding all other variables constant. It is statistically significant at the 5% level of significance.

• DLOC; a hospital located in Java or Bali islands is expected to have 15% lower generation of medical waste than that of a hospital located outside of Java or Bali islands. However, it is not statistically significant at the 5% level of significance.

• DWMBUDGET; a hospital that has routine budget for HCWM is expected to generate 34% more medical waste than a hospital that does not. It is statistically significant at the 5% level of significance.

• DWMUNIT; a hospital that owns a sanitation unit is expected to generate 18% less medical waste than a hospital that does not. It is statistically significant at the 5% level of significance.

• DTRAIN; a hospital that provides training for HCWM is expected to generate 14% less medical waste than a hospital that does not. However, it is not statistically significant at the 5% level of significance.

5.11.5 Determinants of HCWM in complying with relevant regulations

This section presents a summary of results from both logistic regression models, namely, Waste Segregation, and Colour Coding, Models.

Waste Segregation Model

Table 5-14 shows the result of logistic regression of the waste segregation model.

<table>
<thead>
<tr>
<th>Variables</th>
<th>β (SE)</th>
<th>OR (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.50 (0.65)</td>
<td>-</td>
<td>0.0203</td>
</tr>
<tr>
<td>DWMBUDGET (Ref: No)</td>
<td>0</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Yes</td>
<td>1.02 (0.50)</td>
<td>2.76 (1.04-7.35)</td>
<td>0.0421</td>
</tr>
<tr>
<td>DWMUNIT (Ref: No)</td>
<td>0</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Yes</td>
<td>0.43 (0.38)</td>
<td>1.54 (0.74-3.23)</td>
<td>0.2491</td>
</tr>
<tr>
<td>DWMPPLAN (Ref: No)</td>
<td>0</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Yes</td>
<td>1.31 (0.42)</td>
<td>3.69 (1.61-8.46)</td>
<td>0.0020</td>
</tr>
<tr>
<td>DCENPOLICY (Ref: No)</td>
<td>0</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Yes</td>
<td>-1.36 (0.41)</td>
<td>0.26 (0.11-0.58)</td>
<td>0.0010</td>
</tr>
<tr>
<td>DMANPOLICY (Ref: No)</td>
<td>0</td>
<td>1</td>
<td>-</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Variables</th>
<th>β (SE)</th>
<th>OR (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent Var. = SEGREGATION (3 or more types vs. 2 types or no segregation)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.54 (0.37)</td>
<td>1.71 (0.83-3.54)</td>
<td>0.1452</td>
</tr>
<tr>
<td>DHOSPGUIDE (Ref: No)</td>
<td>0</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-1.09 (0.00)</td>
<td>0.34 (0.13-0.85)</td>
<td>0.0209</td>
</tr>
<tr>
<td>DROOMSOP (Ref: No)</td>
<td>0</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>0.71 (0.41)</td>
<td>2.03 (0.92-4.49)</td>
<td>0.0807</td>
</tr>
<tr>
<td>DHOSPCLASS (Ref: Class C or D)</td>
<td>0</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Class A or B</td>
<td>0.47 (0.33)</td>
<td>1.61 (0.84-3.08)</td>
<td>0.1536</td>
</tr>
<tr>
<td>DLOCATION (Ref: Outside of Java and Bali island)</td>
<td>0</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>In Java or Bali island</td>
<td>0.04 (0.33)</td>
<td>1.04 (0.55-1.98)</td>
<td>0.9067</td>
</tr>
</tbody>
</table>

Note: SE = standard errors; OR = odds ratio; CI = Confidence Interval; Ref. = reference category; \( R^2 = 0.1920 \) (Cox & Snell), 0.2561 (Nagelkerke). Model \( \chi^2(9) = 50.53, p<0.001 \); Accepted level of significance = 0.05.

Interpretations:

- Overall model: the overall model is significant \( (p<0.001) \). \( R^2 = 0.2561 \), which means 25.61% of the total variation in the dependent variables is explained by the variation in the explanatory variables.

- WMBUDGET; a hospital that has routine budget for HCWM was more likely to segregate waste into three types, or more, than a hospital that does not (OR = 2.76, CI = 1.04-7.35). It is statistically significant at the 5% level of significance.

- WMUNIT; a hospital that has a sanitation unit for HCWM was more likely to segregate waste into three types, or more, than a hospital that does not (OR = 1.54, CI = 0.74-3.23). However, it is not statistically significant at the 5% level of significance.

- WMPLAN; a hospital that has a waste management plan was more likely to segregate waste into three types, or more, than a hospital that does not (OR = 3.69, CI = 1.61-8.46). It is statistically significant at the 5% level of significance.

- CENPOLICY; a hospital that has a CENPOLICY was less likely to segregate waste into three types, or more, than a hospital that does not (OR = 0.26, CI = 0.11-0.58). It is statistically significant at the 5% level of significance.

- MANPOLICY; a hospital that has a MANPOLICY is more likely to segregate waste into three types, or more, than a hospital that does not (OR = 1.71, CI =
0.83-3.54). However, it is not statistically significant at the 5% level of significance.

- **HOSPGUIDE;** a hospital that has a HOSPGUIDE was less likely to segregate waste into three types, or more, than a hospital that does not (OR = 0.34, CI = 0.13-0.85). It is statistically significant at the 5% level of significance.

- **ROOMSOP;** a hospital that has a ROOMSOP was more likely to segregate waste into three types, or more, than a hospital that does not (OR = 2.03, CI = 0.92-4.49). However, it is not statistically significant at the 5% level of significance.

- **HOSPCLASS;** a hospital that is classified as Class A or B was more likely to segregate waste into three types, or more, than a hospital that is classified as Class C or D (OR = 1.61, CI = 0.84-3.08). However, it is not statistically significant at the 5% level of significance.

- **LOCATION;** a hospital that is located in Java or Bali islands was more likely to segregate waste into three types, or more, than a hospital that is located outside Java and Bali islands (OR = 1.04, CI = 0.55-1.98). However, it is not statistically significant at the 5% level of significance.

### Colour Coding Model

Table 5-15 shows the result of logistic regression of the colour coding model.

<table>
<thead>
<tr>
<th>Variables</th>
<th>β (SE)</th>
<th>OR (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-5.88 (1.08)</td>
<td>1</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>DWMBUDGET (Ref: No)</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.82 (0.65)</td>
<td>2.28 (0.64-8.07)</td>
<td>0.2020</td>
</tr>
<tr>
<td>DWMUNIT (Ref: No)</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1.16 (0.48)</td>
<td>3.19 (1.26-8.09)</td>
<td>0.0146</td>
</tr>
<tr>
<td>DWMPLAN (Ref: No)</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>-0.64 (0.47)</td>
<td>0.53 (0.21-1.33)</td>
<td>0.1740</td>
</tr>
<tr>
<td>DCENPOLICY (Ref: No)</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.25 (0.48)</td>
<td>1.28 (0.50-3.28)</td>
<td>0.6076</td>
</tr>
<tr>
<td>DMANPOLICY (Ref: No)</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.46 (0.42)</td>
<td>1.58 (0.69-3.59)</td>
<td>0.2759</td>
</tr>
<tr>
<td>DHOSPGUIDE (Ref: No)</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
### Variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>β (SE)</th>
<th>OR (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent Var. = COLCODING (Fully categorised vs. Partly categorised or not at all)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.72 (0.68)</td>
<td>2.05 (0.55-7.71)</td>
<td>0.2874</td>
</tr>
<tr>
<td>DROOMSOP (Ref: No)</td>
<td>0</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Yes</td>
<td>1.97 (0.66)</td>
<td>7.16 (1.98-25.92)</td>
<td>0.0027</td>
</tr>
<tr>
<td>DHOSPCLASS (Ref: Class C or D)</td>
<td>0</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Class A and B</td>
<td>0.91 (0.35)</td>
<td>2.49 (1.25-4.98)</td>
<td>0.0098</td>
</tr>
<tr>
<td>DLOCATION (Ref: Outside of Java or Bali island)</td>
<td>0</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>In Java or Bali island</td>
<td>1.16 (0.39)</td>
<td>3.18 (1.49-6.78)</td>
<td>0.0027</td>
</tr>
</tbody>
</table>

**Note:** SE = standard errors; CI = Confidence Interval; Ref. = reference category; \( R^2 \) = 0.2728 (Cox & Snell), 0.3789 (Nagelkerke). Model \( \chi^2(9) = 75.51, p<0.001; \) Accepted level of significance = 0.05.

**Interpretations:**

- Overall model: the overall model is significant \((p<0.001)\). \( R_N^2 = 0.3789 \), meaning that 37.89% of the total variation in the dependent variable is explained by the variation in the explanatory variables.
- WMBUDGET; a hospital that has routine budget for HCWM was more likely to fully categorise its waste stream, than a hospital that does not \((OR = 2.28, CI = 0.64-8.07)\). However, it is not statistically significant at the 5% level of significance.
- WMUNIT; a hospital that has a sanitation unit for HCWM was more likely to fully categorise its waste stream, than a hospital that does not \((OR = 3.19, CI = 1.26-8.09)\). It is statistically significant at the 5% level of significance.
- WMPLAN; a hospital that has a waste management plan was less likely to fully categorise its waste stream, than a hospital that does not \((OR = 0.53, CI = 0.21-1.33)\). However, it is not statistically significant at the 5% level of significance.
- CENPOLICY; a hospital that has a CENPOLICY was more likely to fully categorise its waste stream, than a hospital that does not \((OR = 1.28, CI = 0.50-3.28)\). However, it is not statistically significant at the 5% level of significance.
- MANPOLICY; a hospital that has a MANPOLICY was more likely to fully categorise its waste stream, than a hospital that does not \((OR = 1.58, CI = 0.69-3.59)\). However, it is not statistically significant at the 5% level of significance.
• HOSPGUIDE; a hospital that has a HOSPGUIDE was more likely to fully categorise its waste stream, than a hospital that does not (OR = 2.05, CI = 0.55-7.71). However, it is not statistically significant at the 5% level of significance.

• ROOMSOP; a hospital that has a ROOMSOP was more likely to fully categorise its waste stream, than a hospital that does not (OR = 7.16, CI = 1.98-25.92). It is statistically significant at the 5% level of significance.

• HOSPCLASS; a hospital that is classified as Class A or B was more likely to fully categorise its waste stream, than a hospital that is classified as Class C or D (OR = 2.49, CI = 1.25-4.98). It is statistically significant at the 5% level of significance.

• LOCATION; a hospital that is located in Java or Bali islands was more likely to fully categorise its waste stream, than a hospital that is located outside Java and Bali islands (OR = 3.18, CI = 1.49-6.78). It is statistically significant at the 5% level of significance.

5.12 ON-SITE OBSERVATION AND WASTE AUDITS

Waste audits in eight hospitals in five provinces did not comprehensively find the hospital waste characteristics and streams, due to some research restrictions placed by those hospitals. Nonetheless, the results of the mailed survey revealed a significant and complete outcome, confirming the evidence as sufficient to reconsider the existing HCWM policy.

5.12.1 Hospital waste streams and generation

A hospital has many waste streams, depending on medical services, its class and number of beds. Onsite visits to ten A and B class hospitals revealed a similar status of WMH, from waste segregation, collection, onsite transport, to storage and treatment.

General waste streams stem typically from ancillary facilities (non medical rooms/wards), like kitchens, offices, canteens, reception rooms, etc., where considerable amounts of general wastes are produced. General wastes comprise recyclable wastes and non recyclable wastes/organic wastes. In contrast, medical wards generate only small amounts of general waste, provided that, general and medical wastes were segregated correctly. However, the researcher found that general and medical wastes were often mixed, either in general waste bins, or in medical wastes bins, in inpatient
rooms. This amplifies the cost of waste treatment, since the mixture should be
categorised as medical wastes.

The majority of hospitals only segregated their wastes into two types, even with the
same colour coded lids and bins. Some of the hospitals only provided plastic bags,
without bins, for medical wastes, including sharps waste, leaving sharps waste
unsecured. These practices potentially harmed the hospital’s and the community’s
environment (see Figure 5-92).

![Image of hospital waste containments](image)

Source: Photo taken by the researcher during onsite visit.

**Figure 5-92 Hospital waste containments in an Indonesian hospital**

In medical waste streams, there were huge amounts of infectious wastes from wound
dressings, and at times, some pathological wastes, generated in emergency rooms and
operating theatres. Overfilled sharps wastes collected in sharps boxes were also noticed
in few hospitals, and they were located in places that could be reached by unauthorised
persons, including children. This was commonly seen in public hospitals (Figure 5-93).
Interestingly, pharmaceutical wastes found in a hospital, which was not considered to be in a disaster area where hospitals received pharmaceutical donations from foreign countries, were unused and expired. The hospital waste manager argued that he was afraid to dispose of them, and therefore, kept them in the waste storage.

Other medical wastes, categorised as hazardous, like chemicals, heavy metals, and radioactive wastes, were not found during waste audits. Radiological wastes were kept in a secure place until full decayed; some of them would be sent to the CRTT for treatment and disposal.

Waste was weighed in five selected wards of eight hospitals for a week. The wards were operating theatres, obstetrics and gynaecology wards, internist wards, emergency rooms, and laboratories. The average generation of hospital wastes from the selected hospitals is shown in the following table (Table 5-16).

Obstetrics and gynaecology rooms generated the highest amount of general wastes, averaging 2,720.60 grams, per occupied bed, per day, and laboratories were the lowest, averaging 158.43 grams, per occupied bed, per day.
Emergency rooms generated the highest amount of infectious wastes (708.71 grams), followed by operating theatres (283.62 grams), and laboratories (266.22 grams). The highest production of sharps wastes occurred in operating theatres (31.59 grams) followed by obstetrics and gynaecology rooms (31.03 grams).

Cytotoxic wastes were produced only in Internist rooms, as by-products of chemotherapy services performed on cancer patients. The internist rooms also generated pharmaceutical wastes, averaging 164.01 grams, per occupied bed, per day.

The waste audits did not find any chemical wastes in the audited rooms, since they did not use chemical substances, save those chemical-related medicines categorised as pharmaceutical, or cytotoxic, wastes.

Table 5-16 Average waste generation from selected wards per occupied bed per day

<table>
<thead>
<tr>
<th>Ward</th>
<th>General wastes (gram)</th>
<th>Infectious wastes (gram)</th>
<th>Sharps wastes (gram)</th>
<th>Cytotoxic wastes (gram)</th>
<th>Pharmaceutical wastes (gram)</th>
<th>Chemical wastes (gram)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating theatre</td>
<td>2,354.84</td>
<td>283.62</td>
<td>31.59</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Obstetrics &amp; gynaecology</td>
<td>2,720.60</td>
<td>168.60</td>
<td>31.03</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Internist room</td>
<td>1,773.72</td>
<td>122.35</td>
<td>20.17</td>
<td>105.92</td>
<td>164.01</td>
<td>-</td>
</tr>
<tr>
<td>Emergency room</td>
<td>1,433.62</td>
<td>708.71</td>
<td>22.36</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Laboratory</td>
<td>158.43</td>
<td>266.22</td>
<td>19.51</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Average</td>
<td>1,688.24</td>
<td>309.90</td>
<td>24.93</td>
<td>105.92</td>
<td>164.01</td>
<td>-</td>
</tr>
</tbody>
</table>

5.12.2 Common practices of HCWM

Waste was partially segregated in each ward, with the available waste bags and bins, and labelled as general and medical wastes, either on the walls, or the bins. The bins were usually placed under the hand washing basins, or in a corner of the room. Even in the bigger hospitals, the provisions of adequate HCWM facilities for segregation, collection, containment, transport and storage were found lacking. This, in turn, led to inappropriate waste handling and treatment practices.
The hospital waste managers often said that the prices of colour coded plastic bags and bins were relatively high, compared to the common black plastic bags. Therefore, they only provided the same plastic bags or bins for both, general and medical, wastes. The only difference was the labels identifying general and medical wastes. This caused some confusion amongst the staff in charge.

Sharps containers or boxes were only found in few hospitals, since these were provided by donors like WHO and UNICEF. When donated stocks ran out, they were replaced with plastic bags or bins, together with other infectious wastes, as the ideal facility was unaffordable. A hospital also utilised used jerry cans for sharps waste containers instead of plastic bins.

Onsite waste transport facilities were also found inadequate. Evidently, only few hospitals had waste trolleys. In all others, the wastes collected in plastic bags were manually carried by waste collectors, from each ward, to a designated temporary storage, or directly to an incineration site. The wastes from each ward were transported to available interim storages, twice a day, in the morning and afternoon, by cleaning service staff. The cleaners then report to the waste unit staff to record the amounts of wastes, usually, in volumes, or numbers of containers. Wastes were generally not weighed, as hospitals had their own incinerators. Wastes were weighed only where the hospitals sent them for offsite treatment, usually, at the incineration sites, depending on the waste service contracts.

The provision, and the use, of PPE were also limited; where, even those provided, were not worn by the waste handlers to protect them from potential contamination. Reuse of disposable gloves was common in several hospitals, reducing the numbers used, but resulting in ineffective protection and possible contamination. Some waste handlers, when asked why they were not wearing PPE, just smiled and replied they were accustomed to come in contact with wastes. When asked further about the possibility of getting punctured, they confirmed that such accidents happened, but, there were no apparent repercussions.

Several nurses informally confessed that they suffered needle punctures when they recapped used syringes, particularly when they had to provide medical treatment in times of high demand.
All selected hospitals used incinerators for treating their medical wastes, as this was believed to be the only affordable technology available, and permitted by regulations. However, only a few hospitals possessed legal permits from the MoE. Different specifications of minimum temperature and air pollution control devices of different incinerators rendered it difficult to meet the basic requirements for incineration permits. Therefore, the treatment of medical wastes, even without permits, was assumed to be better than disposal in municipal waste dump sites. An example of a hospital incinerator is as follows (Figure 5-94):

![Medical waste incinerator in an Indonesian hospital](image)

Source: Photo taken by the researcher during onsite visit.

**Figure 5-94 Medical waste incinerator in an Indonesian hospital**

Regarding the overall cleanliness of the selected hospitals, the majority of wards and offices were found to be sufficiently clean. Executive rooms and wards were especially clean, since they employed more staff, compared with the lower classes of inpatient rooms. The researcher also observed visitors occupying the hallways for resting and
smoking, even though they were not allowed. The hand wash basins which were available in some designated places were, mostly, dirty, and not equipped with hand dryers or paper wipers.

5.13 QUALITATIVE INQUIRY

5.13.1 Overview
As mentioned in the methodology, the qualitative approach will be used to answer the research questions that were insufficiently covered by quantitative inquiries. This will help make the overall outcome of the study more comprehensive to determine the current status of HCWM, and to develop an appropriate policy framework to improve it.

The data from qualitative inquiries employing in-depth interviews were classified into four groups, namely; central policy makers, hospital managers, hospital association, and health centre sanitarians. The contents of the interviews which were disaggregated into themes are presented in Table 5-17. Some sections carry data obtained from secondary data too.

<table>
<thead>
<tr>
<th>No.</th>
<th>Group</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Central policy makers (4 interviewees) (CP1, CP2, CP3, CP4)</td>
<td>Roles and responsibilities of HCWM, perceptions on availability and sufficiency of regulations and policies, HCWM system, co-ordinations within institution and with other institutions, and suggestions for improvement of HCWM.</td>
</tr>
<tr>
<td>2.</td>
<td>Indonesian Hospital Association (1 interviewee) (IHA)</td>
<td>Roles in improving hospitals’ environmental health through green hospital concept, perceptions on availability and clarity of HCWM regulations and policies, opinions on unsafe HCWM, opinion on current use of incinerators, and suggestions to improve HCWM in Indonesia.</td>
</tr>
<tr>
<td>3.</td>
<td>Hospital managers (8 interviewees) (HM1, HM2, HM3, HM4, HM5, HM6, HM7, HM8)</td>
<td>Opinions on current HCWM practices, compliance with available regulations and policies on HCWM, sufficiency of HCWM guidelines, knowledge on HCWM, opinion on implemented policy, constraints on proper HCWM implementation, availability of HCWM training and induction, availability of needle injury surveillance, sanctions for unsafe HCWM, 3R implementation, collaboration in HCWM with</td>
</tr>
</tbody>
</table>
4. Health centre sanitarians (HS1, HS2, HS3, HS4, HS5)  
   Current HCWM policies and practices, use of colour coded system, availability of medical waste storage, waste weighing, medical waste treatment, availability of local policy and guidelines, regular supply of HCWM equipment, collaboration in HCWM, liquid waste treatment, availability of HCWM training and providers, suggestions to improve HCWM practices.

5.13.2 Involvement of stakeholders

The involvement of the HCWM system’s key stakeholders is essential, since they are the primary actors with different roles and responsibilities under the current regulations designed to achieve the goal of safe and sustainable HCWM, to reduce potentially adverse health impacts of HCW generation.

Administratively, there are three levels of organisations responsible for the formulation and implementation of policy: the central level, local level, and the hospitals. The researcher includes the roles and responsibilities of the MoH in this section, since Hospital Act No. 44/2009 makes this the key arm of the central government that regulates all hospitals in Indonesia, technically and administratively.

Key stakeholders at the central level

The MoE also introduced the CP approach to the industrial sector in 1995, popularly known by the acronym ‘PROPER.’ It assesses environmental management performance as consequent to hazardous waste management, and is regarded as complementary to the existing instruments of environmental management, such as, legal sanctions (MoE, 2011).

The assessed industries are categorised into four colours: black, red, blue and green, depending on their meeting set requirements. Blue and green are more favoured, since they indicate that the required standards are met. Hospitals, classified as service industries, are also assessed. For instance, 19 hospitals were assessed in 2010, and 36, in 2011. Of these 36, one hospital that did not meet the requirements was found to be overloaded, as it treated medical wastes from a greater number of other hospitals than was permitted (MoH, 2011).

The NAAE is mainly responsible for the safe treatment of radioactive wastes from health care facilities, which need to be treated, instead of being kept at the point of generation to decay, e.g., short-lived radioactive wastes.

The MoH, has the specific responsibility of providing sufficient guidelines for the implementation of safe HCWM and other public health programs within hospitals, to ensure that they comply with relevant regulations.

Several hospitals that breached the regulations received verbal sanctions from the MoH or local governments, with no known instances of drastic sanctions, like closures, being imposed.

Similarly, the MHA is responsible for issuing relevant regulations and guidelines to local governments that have hospitals at provincial and district levels, to comply with relevant regulations of the MoE and MoH. Local governments also have the right to set norms or standards in the form of local government decrees.

**Key stakeholders at local level**

The stakeholders at local level are provincial and district governments. Their roles and responsibilities are defined in the relevant regulations, as were referred to on page 25 in Chapter 2. The details of authorisation of the hazardous waste management permit, and
the spread of control between the three levels of government, are presented in Table 5-18, below.

### Table 5-18 Authorisation of hazardous waste management permit and supervision amongst Central and local Governments

<table>
<thead>
<tr>
<th>Hazardous waste management</th>
<th>Licensing</th>
<th>Supervision</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Central</td>
<td>Provincial</td>
</tr>
<tr>
<td>Storage</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Collection</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Transportation</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Utilisation</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Treatment</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Collection from other generators</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Note: waste oil collection permit remains at the central level. 

**Key stakeholders in the MoH**

Structurally, there are two directors general (DGs) within the MoH, with direct responsibility over the provision of high quality health services, and sound HCWM systems. They are: the Director General of Disease Control and Environmental Health, and, the Director General of Health Care. The first one presides over the Directorate of Environmental Health, which formulates policies and guidelines on environmental health, including HCWM. The second has administrative responsibility for the quality services of hospitals. Good collaboration and coordination between the two DGs is, therefore, crucial.

Besides the two DGs, the MoH also has a Centre for Public Health Intervention Technology, the CPHIT, (formerly, Centre for Ecology and Health Status Research and Development - CEHSRD), whose core function is to provide reliable and accurate data and information on public health intervention technology, including appropriate technology for safe HCWM. Thus, high-level coordination among these key stakeholders within the MoH is of paramount importance for the realisation of improved HCWM.

The qualitative findings regarding current coordination and collaboration, along with constraints faced by each stakeholder, will be explained in the results of qualitative inquiries.
Key stakeholders within hospitals

There are two broad categories of internal stakeholder groups in hospitals: health, and non-health, personnel. According to the MoH (2011), of a total of 142,521 personnel who worked for 437 public hospitals, 78.58% were health personnel, and, 21.42% were non-health personnel. The health personnel included specialists, GPs, dentists, nurses, midwives, pharmacists, public health specialists, sanitarians, nutritionists, physiotherapists, and medical technicians.

Out of 111,998 health personnel, there were 7,598 specialists who worked for public hospitals with 16 specialists per hospital, on average. 6,685 GPs worked for public hospitals with of 14 GPs per hospital, on average, and 1,741 dentists, with 4 dentists per hospital, on average.

Nurses, with their vitally important roles of caring for patients, usually dominate the proportion of health personnel. In the same year, 66,701 nurses worked for public hospitals, with 128 nurses per hospital, on average. The average number of midwives was only 22 per public hospital, with their maternal health roles being more specific than nurses.

Non-health personnel serve different kinds of tasks in hospitals, and are categorised as supporting staff, since they are not directly related to medical services.

All categories of hospital personnel mentioned above are responsible for hospital waste management at different stages, depending on their specific duties. This fact underlines the importance of clear onsite HCWM policies, guidelines and SOPs, to realise the goals of safe HCWM in hospitals, reducing the burden of HAI.

The extent of the involvement of stakeholders can also be seen from the description of each variable of the study, especially in the performance of health care WMH, from segregation at source, to appropriate treatment and disposal, complying with relevant regulations.

Several external stakeholders like medical and other suppliers, and visitors, too, influence the hospitals’ performance in HCWM. Suppliers influence implementation of the hospitals’ green purchasing policy. Similarly, visitors could play a significant part in waste generation and its reduction, depending on the HCWM policy in place.
5.13.3 Privatisation in HCWM

Privatisation of medical waste treatment and disposal commenced when government introduced Regulation No. 18/1999, as amended by, No. 85/1999 on Hazardous Waste Management. Articles 9 to 26 of this regulation, mandates all industries, including hospitals, to manage their wastes in a safe manner, to prevent polluting the environment, and posing health risks to people surrounding them, or living close to treatment and disposal sites.

There are two models of medical waste management systems: onsite and offsite treatment and disposal, depending on their capacity to effect such treatment and disposal approved by the MoE. In the offsite model, hospitals send medical wastes to another hospital or a private company, which has a waste treatment permit under article 40 of the regulation. In the onsite model, a hospital with a waste treatment permit is allowed to treat medical wastes from other hospitals and its own medical wastes.

Until the end of 2011, there were only 16 private companies in 6 provinces, with licenses to treat hazardous waste commercially, offsite, from other industries, including hospitals. Apart from the offsite system, more hospitals had their own incinerators to treat their own medical wastes in 16 provinces (MoE, 2011).

Waste treatment permits are given to companies meeting all requirements under the regulations, for 5 years, and can be extended, upon application, for a similar period. The permit certificate is signed by the MoE as a ministerial decree.

The details of the requirements include: the types of medical wastes to be incinerated, technical specifications of incinerators, operational system of incinerator, recording and reporting system, emission standards monitoring, and residual disposal system.

A few local hospitals complained about the available mechanism of permit applications for waste treatment, off-site. It is felt that they must be centralised, and they suggested that the central government reconsider the existing permit mechanism, to enable a local private company to apply for a permit to a local authority, enabling hospitals owned by local governments to send their waste to the local company.
5.13.4 Knowledge of stakeholders regarding current regulations and policies related to HCWM

On the availability of HCWM regulations, all institutions at the central level (CP1-CP4) stated that Indonesia has sufficient under its umbrella of laws. One institution, CP3, stated that Government Regulation No. 18/1999, as amended by, No. to 85/1999 is enough to govern hazardous waste management, including HCWM. Therefore, all health care facilities are obliged to manage their hazardous waste accordingly. The interviewee added that Solid Waste Management Act No. 18/2008 is intended mainly, to govern MSWM, although it also defines HCW. Another institution, CP4, mentioned that government regulation no. 27/2002 regulates radioactive wastes from health care facilities and that the policies governing radioactive wastes management were clear enough.

The interviewee, CP4, stated that the problem of non-compliance with the relevant regulations was due to poor dissemination of information about the regulations and policies. CP4 added that the radioactive waste transportation and treatment tariff could also be a problem for waste generators.

Regarding the existing HCWM policy, CP2 stated that the MoH has a number of decrees and guidelines for hospitals, including HCWM: e.g., Health Ministerial Decree No.1204/2004 on Hospitals Environmental Standards, Ministerial Decree No. 129/2008 for Minimal Hospital Service Standards, Technical Guideline for Health Care Wastewater Treatment, and Guideline for Health Care Infection Control and Prevention. CP2 also felt the important aspects of HCWM are covered by the Guideline for Hospital Services, and the ministerial decree concerning World-class Indonesian Hospitals. The latter, decrees that a world-class hospital can be legally operated if safe HCWM is implemented in accordance with the relevant regulations.

Dealing with the green hospital policy, CP2 stated that their office was finalising the Environmentally-friendly Hospital Guideline, and were optimistic about hospitals accomplishing safe HCWM. CP2 ended the interview by saying that hospital accreditation was a good policy instrument to improve hospital conditions and service quality, since it required safe HCWM to be accredited.

The IHA offered some interesting comments regarding regulations and policies. They felt that there were sufficient regulations. The problem was the lack of harmonisation of
existing regulations and policies between the central and local levels. This confused hospitals about compliance with them. E.g., the governor’s decrees and the environmental ministerial decrees dealing with effluent and emission standards were different. Thus, hospitals would prefer to comply with regulations that were less stringent to follow. The importance of technical guidance and the provision of relevant facilities for hospitals to comply with the regulations were also highlighted.

Hospital Act No. 44/2009 clearly states that a requirement of the hospital permit was the availability of waste management facilities according to relevant regulations. Therefore, the central and local governments should coordinate and monitor the implementation of the Hospital Act, combining with regular guidance and technical consultations, where necessary.

In contrast with the perspective of central level policy makers, the majority of waste managers (HM2, HM3, HM5, HM7, and HM8) argued that the existing regulations were difficult to understand. The obligations relating to medical waste treatment, and what had to be incinerated offsite if a hospital did not possess a regulatory incinerator, were unclear. Moreover, they stated that even though hospitals could choose to treat waste onsite, meeting the permit requirements were considered to be ‘a difficult thing to achieve.’ Hence they choose not to apply for a treatment permit but continue operating their own incinerators. This situation is compounded when there are no private companies providing offsite waste treatment services, particularly outside Java island.

Two hospitals, HM4 and HM6, held different opinions about the existing regulations and policies. They used the relevant regulations and policies to formulate in-house waste management policies. They fully understand that these regulations, importantly, regulate medical wastes, which potentially harm the environment and adversely impact public health. However, they could appreciate that many hospitals found the regulations difficult to follow, since available resources were limited, especially, in small hospitals owned by local governments.

HM4 also stated: ‘our hospital has already followed the requirements of available regulations and policies, ranging from the highest to lowest levels.’ They were also aware of the sanctions and penalties that applied. The hospital had an onsite policy with relevant guidelines and SOPs. They suggested a process of socialisation for dissemination of the regulations, making every single stakeholder aware of them, to
encourage compliance. HM4 also thought a few things need to be added to the Health Ministerial Decree No. 1204/2004. ‘The decree did not cover the requirements of residues/ash disposal from incinerated medical wastes, emission standards, specification of an appropriate incinerator, and disposal of pharmaceutical wastes aside from being returned to the distributors.’ Similarly, HM6 also commented on the lack of dissemination of information concerning relevant regulations, and agreed that non-compliant waste generators be penalised.

HM1 also raised the problem pertaining to the insufficiency of information about HCWM regulations and policies. They were only familiar with Health Ministerial Decree No.1204/2004, and did not know that there were several government regulations regarding hazardous waste including HCWM. They believed that the above decree followed, or consolidated the other regulations, so that it provided sufficient guidance for hospitals to implement HCWM. They also confirmed that their hospital established a HCWM system, based on available resources.

When interviewed about their points of view concerning HCWM regulations and policies, all the HC sanitarians said that they followed the policies of the district/municipal health services, since administratively, they are under the district health services after decentralisation. Therefore, they were more familiar with the regulations from provincial and district/municipality authorities. However, they would be happy if the Central Government provided them with relevant regulations and guidelines to improve their knowledge of HCWM.

5.13.5 Knowledge of stakeholders about current co-ordination and collaboration in HCWM

Regarding current co-ordination amongst stakeholders at central level, three institutions raised various concerns about it. CP1 stated that they were not being fully involved in regular coordination meetings to discuss any concerns regarding environmental health matters, including HCWM. The CP3 argued that CP1 has not contributed to the development of environmental health issues including HCWM, since there was no comprehensive environmental health action plan. CP3 added that CP1 sent staff who aren’t capable of actively participating in important regular meetings. CP3 comments: ‘...CP1 institution is only concerned about traditional health hazards, such as, basic sanitation, whereas, we are now confronted with modern hazards of environmental
problems... So we have to be more proactive, particularly when we are invited to participate in international meetings to discuss our policy and strategy dealing with environmental health issues.’ CP1 opined that Indonesian hospitals must be the most non-compliant amongst different industries, by failing to manage their medical wastes according to available regulations.

CP1 also mentioned the importance of inter-sectoral coordination to share common problems and also eliminate the gaps of each sector’s vision to build strong commitment with different roles and responsibilities. They added: ‘...we have to sit together to discuss about environmental health standards and guidelines so that the outcome will be more integrated in terms of targets, contents, and clear roles and responsibilities, since we have the same problems to deal with...’

On the existing coordination between central and local levels, CP1 underlined the importance of synchronisation of environmental health planning, as the owners of hospitals are mostly at local level. Therefore, good coordination and collaboration between central and local governments were imperative to overcome HCWM problems. CP1 also highlighted the importance of a Healthy City approach to build stronger collaboration and partnership among all the stakeholders involved, not only the government sector. The healthy city programs could be used as media for better coordination and collaboration.

CP2 confirmed that coordination between them and the MoE has been good, and the MoE has involved them in formulating policies regarding environmental issues that affect hospitals. There had been several decrees issued with the involvement of their division, e.g., Environment Ministerial Decree No. 58/1995, and other technical guidance.

The IHA, too, confirmed the value of coordination in relation to HCWM, specifically, among stakeholders within the MoH, and between the MoE and the MoH was essential, since they were key stakeholders in HCWM. The IHA also proposed the Central Government initiate collaboration and partnerships with international organisations and non-governmental organisations. Coordination between hospitals could be mediated by the IHA, and is one of its core functions. The association now has a Green Hospital Committee working to improve hospitals’ environmental health conditions and
adaptation to climate change. They will develop relevant guidelines and reward hospitals implementing green hospital initiatives.

5.13.6 Knowledge of stakeholders about current HCWM practices

CP1 felt strongly about current HCWM practices, and stated that ‘...hospitals are the most difficult industry to regulate among industries generating hazardous wastes...’ Further: ‘Many hospitals disposed of their medical wastes which are infectious and hazardous improperly, although the regulations are very clear.’ On the availability of regulations on HWM: ‘...medical wastes are regulated wastes as stated also in the Basel Convention regarding hazardous wastes,...government regulations Nos. 18 and 85/1999 govern the mechanisms and stages of HCWM in the form of solid, liquid, as well as gas. ...However, many hospitals did not have appropriate incinerators to treat their wastes.’ Reference was also made to the few private companies within the Java Island providing offsite waste treatment facilities, which hospitals in that area could use.

Dealing with current HCWM practices which were considered as lacking best practices, CP2 said that hospitals should be empowered to improve their safe HCWM capabilities through regular training to build capacity, establishing a national task force, regular consultation, and monitoring and evaluation. They also agreed with the offsite system, as long as, the costs are affordable, given the fact that hospitals provide all important health services.

Similar sentiments were expressed by CP3 concerning current HCWM practices. They confirmed their division will monitor the implementation of HCWM in hospitals, since one of their functions was to ensure that every hospital can provide high quality medical services that can be accessed by all Indonesian people.

Expressing their opinions regarding HCWM practices, CP4 confirmed collaboration with the MoH since 2005 to provide radioactive treatment services, so that hospitals producing medium and high levels of radioactive wastes can send them to their centre. Their main constraint was the strict requirements of radioactive waste transport which cost the hospitals. However, their centre can arrange transport to reduce the costs of treating radioactive wastes safely, if the hospitals communicate their problems. They also stated that using third parties for radioactive waste transport will be costly, and they
will need to involve police officers to safeguard the transportation, as required by the regulation.

The IHA opined that incineration was the most popular waste treatment technology among current HCWM practices. However, the price of an incinerator that conforms with regulations is more expensive than other incinerators available in the market. Therefore, they felt that collaboration amongst hospitals is important to overcome the problems of waste treatment, and enable small hospitals to send their wastes to licensed incinerators owned by big hospitals.

Hospital managers’ responses to current HCWM practices are noteworthy, because it is they who manage hospital wastes with regulations in mind, on a daily basis. HM1, HM2 and HM3 made similar comments. They manage their wastes according to the Health Ministerial Decree No.1204/2004 only partially, since there are constrains to fully implement WMH. The first, was the costs of colour coded plastics and bins, and the operational costs of incinerators. The second was that not all hospital staff followed the SOPs for segregation at source.

In comparison, HM4 confirmed that their hospital has implemented HCWM as provided by relevant regulations and policies, since the hospital was aware of the potentially adverse health impact of medical wastes, and the environmental impact through contamination of soil, water, and air.

Moreover, HM4 stated that their hospital’s problems were, mainly, dealing with maintenance costs of the permitted incinerator, and the costs of regular effluent and gas emission examinations and reports, which are required twice a year.

On application of 3Rs, HM4 stated they used composted organic wastes from the kitchen to fertilise the hospital garden. They also hired a third party for internal collection and transport of general wastes, and medical waste collection from wards, and transport to the incinerator. Therefore, segregation, containment, treatment and final disposal of residues were conducted by this hospital, fulfilling the WMH. The final disposal of general wastes is done by the municipal authority.

On occupational health and safety, HM4 had established a surveillance system in the hospital. They did not mention needle injuries suffered by waste handlers or nurses.
HM6 and HM7 confirmed that their hospitals monitor needle injuries, and is the responsibility of the occupational health and safety division.

HCWM practices of HM5 and HM6 are similar in terms of the WMH. The hospital staff performed segregation daily, at source, followed by containment, onsite transport and storage. They also hired a waste contractor for medical waste treatment. They found it better to choose offsite treatment, as the hospital did not have to examine emissions for mandatory regular reporting. However, the cost of medical waste treatment was relatively expensive, at Rp.10,000 (AUS$1.10) per kg. They also composted some general wastes, and sold recyclable wastes such as cardboard, paper, and used plastic bottles. Their problems related to onsite waste transport, which had the same route as other activities, and the high turnover of waste handlers made them provide induction training frequently.

HM7 had similar HCWM practices to HM4, and they are located in the same city. HM7 was Central Government owned, while HM4 was owned by the local government. HM7 had a licensed and smokeless incinerator that could combust medical wastes up to 1200° C. A WWTP was installed for wastewater treatment, using active sludge and rotating biological contactor. However, HM7 did not implement 3Rs of general and medical wastes. They treated medical wastes from other waste generators, and the interviewee stated the incinerator was environmentally safe, provided, it is checked regularly, and maintained, to meet the maximum allowable concentration of each prescribed parameter of emission.

HM8 implemented HCWM by performing waste audits that enabled them to estimate the waste generated per day, and the incinerator capacity. The staff segregated the wastes at each ward into three types: infectious, sharps, and general. Since they do not yet have colour-coded plastics and bins, they use bins with the 3 labels.

HM8 encountered problems with maintenance costs of the incinerator and WWTP, including the cost of regular examination of effluent and emissions, as required by the regulation. Ignorance among hospital staff and visitors about waste segregation and containment was an added the problem, they said.

The last interviewees on HCWM practices were the five HCs in five provinces. There were differences between HCs in Java Island and outside Java Island. The HCs from
Java Island practised waste segregation at the point of generation facilitated by their district/municipal health services, every three months. They also received sharps boxes from international organisations to contain their sharps wastes safely, before sending them for incineration. The district health services also provided them with SOPs, and regularly monitored their progress in implementing HCWM. Since their medical wastes generation was less than general wastes, the wastes of HCs were treated together, to reduce operational costs.

The HCs from outside Java Island used the same colour plastics and bins for general and medical wastes. Sometimes they put sharps wastes in used bottles or jerry cans to avoid spills and punctures. They buried their wastes, especially sharps wastes, in the HC premises.

5.13.7 Knowledge of stakeholders about available resources and capacity building for HCWM

Perceptions of policy makers at central level, CP2, CP3 and CP4, on available resources, reflected that capacity building was very important to empower hospital staff in managing their wastes. This includes induction programs and regular training for all staff, and specialist WM training for waste management unit staff. The trainings need cover principles and practices of WMH, and also ICP and UP.

CP3, highlighting the importance of capacity building, said that their division continuously worked to improve capability in delivering health services, and that they also provide guidelines and training on patient safety, occupational health and safety, and HPH, in collaboration with the Centre of Health Promotion within the MoH.

CP4 also mentioned that their centre provided regular training on radioactive waste management. Their superior agency conducts a national seminar and training to disseminate latest information on radioactive-related management, annually. These could be used by hospitals and their owners to gain knowledge on the material topics, and, in turn, could improve their staff performance in managing HCW.

The IHA spoke about resources needed for hospitals to perform HCWM. They underlined how hospital managers’ commitment to improving environmental health in hospitals was paramount to reduce HAI. Therefore, hospitals should provide sufficient funds for HCWM, not only for complying with the regulations, but also for minimising
the risk of HAI. They felt that this was as important as providing funds for advanced medical appliances. Capacity building could also be complemented through cooperation between big and small hospitals.

All hospitals perceived multiple trainings as essential to improve their staff skills, including HCWM. They also mentioned about training provided by local and central authorities, such as the MoE, the MoH, and other organisations, including private companies.

Similarly, all HCs also stated that they were trained in HCWM by provincial and district health services, and one had received training by an international organisation, too.

5.13.8 Expectations and suggestions of stakeholders for sustainable HCWM system

All interviewees at central level expected hospitals to improve their performance in environmental health activities and HCWM, to provide patients and hospital staff with a healthy workplace, with minimal health impacts. CP1 emphasised the commitment of other sectors to see current coordination improving, so that, the bigger and broader environment-related problems will be overcome. CP3 also expected better coordination between local and central governments, and all stakeholders of hospitals.

The IHA anticipated that hospital policy makers would manage their hospitals with vision and commitment to greening hospitals. Starting with small things they could move to big things that ensure a healthy hospital community and sustainable hospital operations.

Hospital managers, HM4 and HM7, suggested that local authorities could issue permits for incinerator operation, instead of the central government, which would reduce the cost, and promote private companies to invest in medical wastes treatment. HM6 expected a policy that would favour reducing the costs of offsite treatment.

All HCs expected more training and assistance for better HCWM. One HC sanitarian, which had an incinerator for shared medical waste treatment also proposed to improve its incinerator performance as its current fly ash triggered public protests, although its chimney has been extended. He also requested a guideline for reducing mercury from incinerator residues and socialisation of better HCWM practices.
6. DISCUSSION

6.1 INTRODUCTION

There is a need to reconsider the current HCWM policy framework to improve implementation of HCWM systems in Indonesia. This chapter discusses the attainments of research findings and literature review to answer the research questions about proposing a new policy framework for improving HCWM. This chapter also identifies barriers of, and drivers for, developing the proposed policy framework. Some important lessons learned from the Queensland HCWM model are also discussed.

6.2 LESSONS LEARNED FROM HEALTH CARE SYSTEMS AND HCWM IN THE STATE OF QUEENSLAND

6.2.1 Health care systems in Australia

The Australian health care system, comprising primary and secondary health care services, is considered one of the best health care systems, since it has achieved universal coverage of all Australians. Indicators like LOS, BOR, decreased waiting periods, increased elective surgeries and quality services for people from remote areas, across the states and territories, prove that several improvements have been made to providing the best quality health services. These indicators can also be determined from the percentage of accredited hospitals, which was 93% in 2010.

Complementing the improvement of health care services, the NHRA, covering eight streams of work (see section 4.2.1), resulted from reform in the national health system. These demonstrate continuous improvement in health care systems in all of Australia. Since HCWM also contributes to satisfaction of health care quality service indicators, the implementation of HCWM in Queensland is indicative of this overall improvement.

6.2.2 Regulations and policies on HCWM

In relation to improved health care systems, the federal, state, and territorial governments have paid considerable attention to HCWM, by establishing clearly identifiable national and local systems, strengthened by relevant regulations and policies, administered by the EPA or DERM of each state and territory. There is, thus, a harmony of regulations and policies between Federal and local governments, and
amongst local governments. These provide a clear mechanism that facilitates resolution of disputes or problems, if and when they arise, between states and territories. For instance, in the case of prohibited hazardous waste movements inter states, the appropriate action is taken by the state whose regulations are allegedly violated, based on the ‘proximity principle,’ that also encourages waste generators to treat their wastes as close to the point of generation, as possible.

The regulations and policies of Queensland also govern the implementation of safe and sustainable HCWM, to minimise and prevent adverse health impacts. As was detailed in section 4.3, the availability of regulations and policies deal comprehensively with environmental protection, SWM and HCWM.

Indonesia and Australia, and e.g., Queensland, have similar institutions, with similar roles and responsibilities; the MoE, and the MoH at central level, and the Environmental Protection Agency, e.g., Queensland EPA, and its counterpart, Badan Pengelolaan Lingkungan Hidup Daerah, at local or State level.

A significant difference is, e.g., Queensland updates laws, regulations and policies to accommodate latest conditions and changes, without changing the year of its first issuance, and by providing the date of enforcement. In contrast, Indonesia changes the year and the name of regulations when they are updated, thus, confusing relevant stakeholders. The researcher believes that this goes beyond a mere matter of ‘style,’ as the Australian practice reduces confusion, while the Indonesian one can confuse and discourage compliance.

It was also observed that Queensland issues regulations and policies on the same date, which is clearer, since the policies explain details of the enforcement of regulations, enabling stakeholders to understand, and comply with, the regulations. For instance, the Environmental Protection (Waste Management) Regulation, 2000, and Environmental (Waste Management) Policy, 2000, which provide for all aspects and mechanisms of HCWM, are available for waste generators, even in remote areas, to refer, and comply with, in managing their wastes (DERM, 2010b).

In Australia, public consultations, combining risks communication, before introducing new regulations, help gain public acceptance of such regulations, and raise awareness of how they will be affected at different levels by the proposed regulations. Indonesia
could benefit by adopting this kind of public consultation, and discuss benefits and risks, beforehand.

Comparing similar regulations in Indonesia, the issuance of Regulation of Hazardous Waste Management No.18/1999, partly amended by Regulation No. 85/1999, was based on the Environment Act No. 23/1997, and replaced by Environmental Management Act No.32/2009. Guidelines explaining these regulations were issued a few years later, which could be one reason for non-compliance by waste generators. This accords with Smith’s arguments (Smith, 2004) regarding the environmental policy paradox that typifies governments issuing an environmental policy a little bit too late, on one hand, and industries capitalising on this delay, as compliance is considered costly, and non-compliance is profitable, on the other hand.

In the case of Indonesian hospitals, they are more conveniently regarded as places providing community health care services, rather than service industries which generate medical wastes. This undermines the gravity of considering medical wastes as by-products of their activities as health care providers, as well as, the relationship between their quality of services and HCWM. Consequently, the abandonment of safe HCWM will jeopardise the health services.

Another lesson from Queensland’s experience is the role of law enforcement and environmental regulations, to ensure that relevant stakeholders comply with regulations, in order to protect the environment and public health. Of course, there would be some offenders of HCWM regulations, e.g., dumping illegally; however, they will be penalised under the regulation. Another example of implementation of environmental instruments is the application of the waste tracking system and the waste levy at the point of disposal. These instruments provide incentives for industries to invest in resource recovery facilities, and conversely, are disincentives to industries without such facilities (DERM, 2010b).

6.2.3 Best practices of HCWM
As mentioned earlier, HCWM is sustainable when it encompasses technical, institutional, management, socio-economic and public health aspects, in a way, that hospitals comply with relevant regulations, and obtain benefits for their duty of care towards their workers, preventing them from contracting waste-related diseases. The
extent to which the Queensland model achieves HCWM best practices is demonstrated by each hospital establishing a HCWM system, in accordance with existing regulations and policies. Its success depends on each stakeholder within the hospital following the adopted system, and by vigilant monitoring and evaluation of every stage of the WMH, to ensure cost-effectiveness of the system. In this regard, the HCWM practices at the RBWH is an example of sound HCWM practices in Australia.

A number of significant HCWM practices that can be learned from the RBWH, in particular, and Queensland hospitals, in general, are discussed in the following sections.

Reliable strategy and planning

In accordance with the available regulations, as mentioned in section 4.3, the state government has set waste management strategies and plans, covering all aspects of WMH, and considering the variations of health care facilities in Queensland, without compromising the community’s safety from the risk of wastes. Subsequently, the RBWH also refers to these regulations, policies, and strategies, to set their own policy and strategy that is applied on-site. The RBWH waste management team has also set a benchmark for cost-effective HCWM, which is reliable for general circumstances and changes that may occur. As a result, since 2003, the RBWH has annually received awards for excellence of HCWM practices, utilising the 3R approach. The following HCWM practices can be adopted by Indonesian hospitals to improve their current practices which are neither sustainable nor safe.

Auditing

Apart from initial auditing prior to development of the waste management plan, the RBWH also conducts waste audits, annually, to evaluate the progress of the implementation of the plan, and also, conducts contingent audits, upon detection of any failure, to remedy the problem.

Training

The RBWH’s training system can also be adopted, as it is. It includes regular induction programs for new staff, regardless of category, to ensure that all staff are trained in, and are aware of, safe HCWM, and committed to proper waste handling whenever they perform their tasks. The training materials cover all necessary areas for new staff, including HCWM and ICP.
Segregation and containment of solid wastes

It is very clear and evident that segregation and containment of wastes at the point of generation are of paramount importance in reducing the costs of wastes management. The RBWH has a segregation and containment system operating in each ward that segregates wastes, contains them in colour coded bags and bins, and has signage, hand washing basins, and clear SOPs. Segregation and containment conform to the relevant DERM regulations.

Onsite collection, transport and storage of solid wastes

The hospital also provides facilities and SOPs for interim collection and storage on each level, after the segregation process in each ward, which can be accessed only by authorised staff. Thus all wastes generated are secured, and each bin is digitally scanned for waste online tracking purposes. The most important thing in the segregation system is that the containers of general wastes are of a transparent type of plastic, so that it will be easy to detect any erroneous waste segregation at source. This can also measure the compliance behaviour of ward staff towards waste handling.

Implementation of 3R approach

The hospital also implements the 3R approach, by providing facilities for recyclable wastes from general wastes, and electronic wastes. These have economic value that can reduce waste management costs. Since general waste is about 75% of the total generation of hospital wastes, the 3R practices are currently the best solution for waste management, when wastes production cannot be avoided. The provision of a general waste compactor has also decreased the cost of waste transport to offsite sorting centres. In the case of sharps wastes, the hiring of Daniel Sharpsmart to provide reusable, self-seal, syringe containers also reduces the costs of incineration, and the risk of needle-stick injuries.

Hazardous wastewater management

The RBWH has paid special attention to the management of hazardous wastewater, by providing mercury spill kits, and collecting body fluids from dialysis and blood samples, to be hauled by an assigned contractor for incineration. In contrast, at present, Indonesian hospitals discharge all wastewater into WWTPs, or by insanitary disposal methods.
Occupational health and safety program

The occupational health and safety program and ICP established to protect staff from suffering occupational illnesses and injuries from sharps wastes, provides an important learning point. This cannot be fully adopted in Indonesian hospitals due to limitation of resources; but can certainly be adapted to introduce surveillance of waste related injuries, recording, reporting and monitoring of such accidents, etc., which are not consistently followed at present. Its official introduction will help overcome the reluctant attitude of staff, who ignore reporting sharps related injuries.

6.2.4 Collaboration with third parties in hospital waste management

The Indonesian hospitals can also learn from the collaboration between the RBWH and the four licensed private companies with specific functions. This collaboration is based on the performance of the four companies which satisfies the needs of the RBWH, favouring cost efficiency without undermining the regulations and policies.

When comparing the current privatisation of waste management in Indonesia, the system in Queensland is more cost effective. E.g., the cost of medical incineration in Australia is AU76 cents per kg, compared to AU$1.10 per kg in Indonesia. One possible reason is the limited number of licensed waste contractors in Indonesia, which does not promote price competitiveness. Another reason could be the relative novelty of the waste management sector, meaning that the length of investment has not been enough for contractors to reach breakeven point, considering they are profit oriented companies. Therefore, policy makers should consider reducing the cost of waste incineration as complained by two interviewees (HM5 and HM6) in the qualitative study (see section 5.13.6). This could promote compliance of hospitals to manage their medical wastes in a safe manner.

6.2.5 Leadership in health care systems and HCWM

Sustainable health care systems can exist if there is strong political will of policy makers to introduce relevant policy to safeguard public health. Statutes and regulations are, by themselves, insufficient, and these would not be implemented in the absence of a relevant policy accompanied by strong political will, that will bring the health care system within the main stream of national policy. This is true as a policy is a set of
courses of actions following the relevant regulations to address the problem faced by the general public (Christie, 2008; Smith & Larimer, 2009).

In implementing health care systems that accommodate challenges to improve health care services, a supportive leadership is required to ensure that available policies are implemented to achieve improved health outcomes. In the case of Queensland, the health care system has been put in place in accordance with relevant regulations, both, from federal and state (Queensland) governments, under supportive leadership.

Indeed, the Australian health care system has been developed and reformed to address the challenges in health care services, as the Australian demography changes to an ageing population, with visionary leadership necessary to create optimal environments that are supportive of, and contributive to, healthy, positive workplaces.

In line with the visionary leadership, Wong and Cummings (2007) state that leadership capacity in the Australian health care system is an important part of the solution to inefficient, sub-optimal management and poor co-ordination of health care services, and realisation of improved patient/client care, and improved health outcomes. In this regard, the researcher found that supportive leadership in Queensland Health, especially in health care settings, has importantly guided the implementation of effective health care services for all Queenslanders.

The researcher also found that, in keeping with the importance of visionary and supportive leadership, the successful HCWM in RBWH grew from the roles of dedicated waste management team members, under the supportive leadership of managers concerned. The most important lesson is the success of the segregation and containment system, following the 3R approach, and involving all hospital staff in each ward, prompted by the motto ‘know which bin to throw it in.’ This kind of leadership can be adopted in Indonesian health care settings, with suitable resources.
6.3 CURRENT STATUS AND BARRIERS TO THE IMPLEMENTATION OF HCWM

6.3.1 Regulations and policies

Availability of regulations

The literature review reveals numerous Acts and regulations being available in relation to environmental management, including regulations governing HCWM. There are also regulations relating to public health and health care systems. The two sets of regulations need be equally implemented to establish sound HCWM, as there are differences in acceptance levels among health care stakeholders. Dirhamsyah (2006) concurs that any kind of regulations will be considered good regulations if they are highly accepted and complied by all stakeholders involved, regardless of its quality perceived by regulators. Hence, sufficient public consultation and socialisation will be prerequisites to introducing such regulations.

The role of clear policies that will aid implementation of HCWM must be emphasized. Policies are seen as the link between higher regulations and stakeholders executing HCWM, including all levels of decision makers within the MoH, and health care settings. Turner, Bishay, Bastien, Peng, and Phillips (2007), set out a model public health policy, which can be adopted in implementing HCWM. This allows flexibility in the application of public health initiatives, to enforce policies in a complex situation and jurisdiction. However, this should be adopted with care, since it requires advanced knowledge and sufficient data. Nonetheless, it can be a learning a tool for long-term improvement of health care systems in Indonesia.

The mailed survey shows the proportion of hospitals’ knowledge about HCWM related regulations at the central level. Although a number of such regulations are available at central level, about a quarter of the sample hospitals confirmed that they did not know them (Figure 5-8). This is evidence of weak dissemination of important information required to implement HCWM. This data is also confirmed by a policy maker at central level, who stated that a reason for non-compliance with relevant regulations may be insufficient information, leading to ignorance of safe HCWM practices (Section 5.13.4). This could happen in hospitals in districts which are far from the Central government, usually class C or D hospitals, compounded by decentralisation, which means they are no longer familiar with the central policy.
Availability of policies

The majority of hospitals perceived policies as similar to regulations, ranging from Laws, Acts, Government Regulations, Ministerial Decrees, Governor Decrees, etc., and agreed that policies available from the central level are complete and clear in guiding them to manage their wastes, since only 15.08% hospitals stated that the central policies were neither clear nor complete. This is, however, contrary to the finding of in-depth interviews, where the majority stated that the central policies were not clear enough. This was revealed in relation to the obligation of hospitals to manage their wastes in a safe manner, and their ability to afford technology for wastes treatment and disposal (see Section 5.13.4). Regarding these opposing findings, the researcher believes that the latter statements are significant as they were from class A and B hospitals, which are typically better at having access to such policies. Moreover, the MoH was the primary source of central policies (see Table 5-1).

A study in HCWM of a large and teaching hospital in Johannesburg revealed that policy documents were accessible by the majority of nurses (86.91%), despite it being opposed by a few doctors amounting to 5.15% (p<0.001), as doctors are more likely to spend their time performing curative health services (Ramokate & Basu, 2009).

Further, the proportion of hospitals that was aware of such guidelines was similar to that of the hospitals which found the policies clear (Figure 5-10). Conversely, when asked about green hospital initiatives, less that 20% were aware of it, since the initiative is relatively new in health care settings. In developed countries, however, this initiative has been adopted by many hospitals, which is also called P2 or CP as the concepts are similar, and they use environmentally friendly products and equipment, targeting resource recovery to achieve more efficient and effective consumption of resources in health care services (Allen, 2006; Zimmer & McKinley, 2008).

6.3.2 Health care systems and HCWM

Health care systems

Health care systems in Indonesia have gradually grown since the implementation of Swadana, followed by the enactment of Hospital Act No. 44/2009. However, its complexity and limited resources have made the improvements seem plainly incremental. Hospitals have increased significantly, both, in numbers and classes.
Between 2006 and 2010, general hospitals have grown by 28.36%, from 1,012 to 1,299 hospitals, with the number of beds increasing by 21.03%, from 118,504 to 143,428 beds (MoH, 2011). However, they continue to face tremendous challenges to improve their quality. Kruk and Freedman (2008) state that health care quality encompasses quality of care, access to care, including disadvantaged groups, accountability, adequacy of funding, and administration. Thus, strategic reforms must be made under policies for better health care services, within the limited resources available, to attain these indicators. Glikman et al. (2007) add that a management framework for promoting quality in the health care sector is imperative, as it comprises leadership, clear hospital board responsibilities, corporate culture, incentive structure, and information management and technology. Lee (2009) also argues that affordable quality coverage is not about the availability of abundant funds, but visionary leadership and great leadership are more important in achieving such high quality care.

Policy itself is inadequate to stimulate practical changes in health care settings; however, it should be comprehensively integrated into the context of various elements within them, to gain better implementation of such policy (Watt et al., 2005). Hotchkiss and Jacobalis (1999) state that the Indonesian health care system should be reformed, using better tools and systems, and by continuing to improve capacity, and assessing financing targets and program mechanisms.

High quality health care is the primary goal of health care systems. However, the provision of adequate resources to provide high quality health care remains a challenge. The phenomenon of many Indonesians seeking health care in neighbouring countries, like Singapore and Malaysia, is clear evidence that the quality of health care is still unsatisfactory.

In its financial aspects, the implementation of community managed health care programs is gaining popularity, as it reduces out of pocket expenses for Indonesians who are not covered by any health insurance scheme. Hence, substantial effort is needed to attain universal coverage, as achieved by other SEAC, like Malaysia and Thailand (Tangcharoensathien et al., 2011).

Hospital accreditation, which is the appropriate instrument to measure health care quality, has also revealed that less than half of Indonesian hospitals were not accredited. In contrast, almost all Australian hospitals were accredited, meaning, that they were
able to provide high quality health care services. According to Sekimoto et al. (2008), teaching hospital accreditation had a positive relationship with the ICP in Japan. Since the ICP is also closely related to the implementation of safe HCWM, the two programs need to be emphasised in attaining safe HCWM.

Hospital accreditation has included safe HCWM as part of its requirements for Indonesian hospitals to receive accreditation, which is categorised into 5, 12, and 16 health care criteria, depending on the types of services and classes of hospitals. For instance, the accreditation of 12 and 16 health care services are typically granted to class A and B hospitals with more specialist care services.

Current performance of hospitals in delivering community health services are assessed by indicators like, BOR, LOS, and number of outpatients. The secondary data shows that BOR increased over the last five years. From the survey, the highest BOR was from 83 hospitals with BOR ranging from 60.00-70.00%. Only 6 hospitals recorded BOR greater than 90%, indicating the high demand for inpatient care. The survey also revealed that 2 hospitals, only, had BOR up to 30%, indicating that there were not many people admitted to them for staying overnight (see Figure 5-5). The researcher cannot assume that the health status of people living near the two hospitals was high, as there aren’t any additional data, warranting such an assumption.

With decentralisation it seems that the local governments tend to authorise more profit making in health care services. Kristiansen and Santoso (2006) assume that there has been lack of transparency and good governance in the local health care systems. Similarly, Bossert et al. (1997) also argued that hospital autonomy has not impacted yet on the quality of health services. Hence, the decentralisation era, which allows local governments to regulate health services, should not compromise the quality of health services, while increasing local revenue for other purposes.

Discussing the quality of health services, several indicators, like BOR, LOS and the number of inpatients and outpatients, are closely related to the production level of HCW; therefore, these indicators are very important, and they have thus been used to determine HCWM in inferential statistic analysis, in Section 5.11.
Onsite policy on HCWM

Onsite policies on HCWM are of importance for improving HCWM. More than half of the sample hospitals possess onsite policies, varying from hospital director decrees, to SOPs, and almost all of them perceived the policies as being clear enough to follow. Several studies also confirmed similar statements that onsite policies affect the performance of HCWM in hospitals, since the policies enunciate relevant strategies and plans to implement HCWM (Rahman & Ali, 2000; Ananth et al., 2010).

When compared with inferential statistics results, there was no direct relationship between onsite policy and hospital waste generation with the level of confidence at 5%. This indicates that onsite policy should be accompanied by sufficient infrastructure to be effectively implemented in health care settings. However, when compared with the availability of a waste management unit and a routine budget, there is a significant relationship. This demonstrates that the availability of an onsite HCWM policy without appropriate funds, and even if executed by a waste management unit, will not have a significant impact on the generation of either general or medical wastes.

Waste management unit

As mentioned above, HCWM is usually under an environmental health/sanitation unit, depending on the organisational structure of the hospital. These units typically execute functions and roles to accomplish waste management based on a set policy.

More than 79% of the sample hospitals had sanitation units, which was high. This is a good sign that HCWM will be a key environmental factor of health care systems. This variable will also significantly determine the compliance of hospitals with the relevant policies, through implementation of waste segregation and colour coding systems, etc.

Waste audits

Comprehensive waste audits, as part of HCWM systems, are the first step of eliciting reliable data on current HCWM, to establish HCWM strategies and plans for improvement. However, only a few hospitals conducted comprehensive audits, while the majority conducted initial waste audits solely for contracting offsite waste treatment (see Figure 5-15). Since 2011, there are private companies providing waste audits as required by the regulations, and several hospitals in DKI Jakarta and West Java province conducted comprehensive waste audits. The researcher assumes that this is
partly due to limited budgets to perform waste audits, and the lack of awareness of their benefits.

**HCWM strategy and plans**

Guidelines for HCWM provide enough information on ways to establish HCWM systems, including its strategies and plans, accommodating a variety of conditions affecting health care establishments (Prüss et al., 1999). However, many hospitals were yet not willing to access these guidelines. This is, thus, more about the willingness of hospital policy makers to prioritise HCWM within their duty of care.

Similar to the case of waste audits for HCWM strategies and plans, although a majority of hospitals confirmed that they had strategies and plans, not all of them had waste minimisation plans as part of their strategies (Figure 5-16). And, almost all of them had SOPs for waste reduction (see Figure 5-17).

To underline the importance of HCWM plans, Chaerul et al. (2008b) provide a planning model that comprehensively includes important variables under various structures. The results would be useful to evaluate the effect of the HCWM policy on the system’s performance as a real-life situation. This model could be utilised in Indonesia to establish a national strategy and plans for a better HCWM system.

**Resources and training**

The implementation of HCWM systems requires adequate resources and capacity building through appropriate training. The mailed survey found the availability of resources for HCWM to be moderate, while a majority of hospitals had routine budgets for HCWM (Figure 5-68).

The availability of infrastructure, like environmental health/waste management units and their equipment, is, to some extent, sufficient. Given the presence of the important aspect of willingness of policy makers within the MoH, the local governments owning local hospitals, and within the hospitals itself, to manage their wastes in accordance with relevant regulations, what is required to establish sound HCWM is a comprehensive assessment of existing resources. This can use any available tool like LCA and CP, with local expertise, noting the success stories from neighbouring, and also, developed countries.
A crucially important element of HCWM is the adequacy of skilled personnel to implement safe HCWM. More than half the sample hospitals complained about the lack of personnel capable of conducting HCWM, both, amongst permanent or outsourced staff.

Agamuthu et al. (2009b) suggest that the determination of local drivers is the most important aspect of MSWM to make it sustainable, especially in developing countries. This approach can be adopted in developing HCWM in Indonesia, as it is similar in terms of waste streams and WMH. Moreover, learning from overseas experiences is useful when the foundations of the local system are strong enough to adapt the imported experience.

Good governance to achieve health for all should be taken beyond a slogan only, as it is a key driver to improve the health care system, and make it more efficient and effective, to accomplish universal coverage, surmounting the numerous challenges.

As discussed earlier, the value of risk assessment and its communication to stakeholders must importantly precede the implementation of the HCWM system. Poor public consultation and risk communication is one weakness seen in Indonesia’s public policy. Ishizaka and Tanaka (2003) state that good risk communication techniques can resolve community unacceptance of the choice of land for landfills or incinerators. This means that engaging the public as stakeholders, sharing information, communicating risks and benefits, etc., would reduce the problem of environmental management.

The weakness of recording and reporting systems in health care settings was noted above, highlighted by the lack of surveillance outcomes of e.g., HAI and injury-related illnesses. This study revealed that recording and reporting on HCWM was inadequate, since less than a quarter of sample hospitals possessed complete records of HCWM activities. However, with the continuous improvement in hospital accreditation systems and the needs of hospitals to be accredited, most hospitals would realise that systematic surveillance, recording and reporting, are necessary to accomplish high quality health services.

The survey found the lack of facilities, funds, and trained staff, to be the most common constraints faced by hospitals in implementing HCWM systems. Interestingly, the lack of regulations and policy was the least of the constraints. This is contrary to the findings
of in-depth interviews with selected hospitals, which confirmed that unclear policies led to non-compliance with HCWM regulations. It is probable that the interviewees, who were from class A and B hospitals, had greater access to resources, when compared with class C and D hospitals, which constituted more than half the sample hospitals that received the mailed survey.

Training in HCWM, either for all, or staff selected to implement HCWM, will enable them to perform the necessary roles and functions to accomplish safe HCWM. Lack of trained staff was found to be the third highest constraint by the sample hospitals. This can be resolved by collaboration with available training providers, ranging from governmental institutions to non-governmental organisations.

Moreover, the institutions providing HCWM training, that can be contracted to deliver a series of training the trainer programs, which will help take HCWM training across provinces. The study also revealed that most training providers were at local provincial and district levels that could cater to hospitals at local level. The existing training system could be improved to reach a larger number of personnel, to satisfy the current needs, as only around 60.00% of hospital staff are trained now (Figure 5-75).

The impact of education and training on behaviour changes in HCWM has been positively shown in European health care facilities, e.g., Botelho (2012) calls it the most significant component of policy with a 5% level of confidence. Botelho (2012) also reveals that hospitals with HCWM trained staff produce less hazardous waste than those without trained staff. Training must cover the essential modules of safe HCWM and the particular needs of hospitals, so that the training outcomes will be relevant and appropriate for implementation in varying conditions prevalent in today’s hospitals. Training providers can utilise the core modules prepared by the WHO and the MoH for HCWM training and adapt them suitably for local conditions. Theoretical input needs to be balanced with ample practical exercises, since the desired outcome will be the application of safe HCWM, emphasizing segregation and containment of different types of HCW.
6.3.3 HCWM practices

Waste streams and generation

As noted previously, the wastes produced by hospitals are practically categorised as general and medical wastes, although the available guidelines are based on the WHO’s segregation and colour-coded system. Since the definition of medical wastes includes infectious, sharps, pharmaceutical and other hazardous wastes, the calculation of medical wastes below considers all of them. However, they usually do not take into account radionuclides wastes, which are counted separately for offsite treatment and disposal.

The mailed survey found that the majority of sample hospitals weighed their two types of wastes as was seen in Figure 5-18. The highest number of hospitals producing general wastes per day per occupied bed was those with general wastes between 1.41-2.10kg, whereas only a few produced general wastes higher than 4.21kg/occupied bed/day. Thus, the average production of general wastes was 2.1655kg/occupied bed/day. When compared with the results of waste audits at selected wards (see Table 5.16), production of general wastes according to the mailed survey are higher since they included health service wards and other rooms which potentially produce more general wastes, like offices and kitchens.

The mailed survey revealed that the average production of medical wastes per occupied bed was 0.4395kg per day; whereas, the waste audits showed medical wastes of 0.60477kg/bed/day (see Table 5-16). The reason for the quantity of medical wastes from waste audits to be higher than that of the mailed survey is probably because the mailed survey counted the medical waste for a year, while the waste audits were confined to a week, which probably had peak production of medical wastes. Another possibility is that the waste audits included less wards with a higher concentration of medical wastes, than the mailed survey which had more wards producing less medical wastes over the year.

In comparison with the average medical wastes generation in other countries, Indonesia resembles the figures of Nigeria, Tanzania, Taiwan, and Brazil: between 0.50kg to less than 1.0kg. The generation of medical wastes in developed countries is higher than the developing countries.
General waste production is influenced by many factors, as seen in Section 5.11.3: the determinants of general waste generation. Multivariate linear regression was applied to determine the factors influencing the generation of general wastes, as the scale of dependent variables is in ratio (see Model 1 and its hypotheses in Table 5-6). Necessary transformations to acquire a normally distributed dependent variable (GENW) were done prior to regressing it on the explanatory variables.

The selection of explanatory variables was based on theoretical backgrounds and other studies relating to HCW in several countries (Bdour et al., 2007; Cheng et al., 2009; Jahandideh et al., 2009). There are five explanatory variables. Two of them are numerical, while the remaining three are dummy variables. The overall model is statistically significant and yields a coefficient of determination ($R^2$) of 10.80%, which means only 11% of the total variation in GENW can be explained by the variation in all the explanatory variables. Such low value is not uncommon in cross-sectional studies with a large number of variations (Gujarati & Porter, 2009).

Both numerical variables (NIP and NOP) were found to be statistically influencing production of general wastes. 1% rise in the number of inpatients is expected to decrease the general waste generation by, on average, 0.37%, ceteris paribus. Bdour et al. (2007) found a similar negative relationship, but it was not statistically significant, even at the 10% level of significance. Moreover, an 1% increase in the number of outpatients is, however, expected to increase general waste by, on average, 0.19%, ceteris paribus. Cheng et al. (2009) found the relationship between the number of outpatients and medical waste generated to be different in terms of the direction. However, it was not significant.

One fundamental limitation of their study is that they did not check for multicollinearity—the extent of correlations between explanatory variables. Severe multicollinearity, if not perfect, could still inflate the variance of the explanatory variable, making it more likely to be insignificant, while the overall model is significant (Hill et al. 2011; Studenmund, 2011). This was evident in the general waste model presented by Cheng et al. (2009), where all the explanatory variables were found to be insignificant at the 5% percent level of significance, despite the whole model being highly significant. Another consequence of severe multicollinearity is that the estimates will become very sensitive to changes in specification, such as, addition or deletion of
an explanatory variable, or of a few observations (Hill et al. 2011; Studenmund, 2011). This explains the different findings of the relationship between number of outpatient and general waste generation.

Moreover, only one of the three dummy variables, DLOC, is statistically significant, implying that generation of general waste differs in location stratified by development; hospitals located in Java or Bali islands produce, on average, 18% less than those located outside of those two islands. The other three variables—DWMBUDGET, DWPLAN, and DCEPOL—are statistically insignificant.

As with the previous model, the medical waste model (Model 2) underwent the same procedures regarding the normality of the dependent variable, MEDW. Overall, the model was statistically significant and produces coefficient determination of 22.99%. In other words, 23% of the total variation in MEDW can be explained by the variation in all the explanatory variables. This is still considered as a low value.

In this model, there are also six explanatory variables, comprising two numerical and four categorical ones. Both numerical variables (NIP and NOP) are significant in predicting medical waste generation. For every 1% increase in the number of inpatients, it is expected that medical waste generation will decrease by, on average, 0.51%, *ceteris paribus*; and, for every 1% increase in the number of outpatients, medical waste generation to increase by, on average, 0.29%, *ceteris paribus*. This time, the direction of the association is consistent with the finding of Cheng et al. (2009), but it was not statistically significant in their study, again, reflecting the multicollinearity problem.

In regards to the categorical variables, two out of three are statistically significant, namely, DWMBUDGET and DWMUNIT. A hospital that has a budget for HCWM was found to produce, on average, 34% more medical waste than a hospital that does not. Intuitively, this makes sense, as having funds for HCWM enables a hospital to manage its medical waste, including weighing it. Therefore, it is reflected in higher generation of medical waste.

A hospital that has an environmental health/sanitation unit was found to produce, on average, 18% less medical waste than a hospital that does not. A possible explanation of this finding is that having such a HCWM unit will enable the hospital to manage their medical wastes, including, segregation at source. This was to ensure that the general
wastes would not be counted as medical wastes; hence, the weight of medical wastes generated would not be muddled with general wastes. The remaining two dummy variables (DLOC and DTRAIN) are statistically insignificant, suggesting, that, they are not influential in medical waste generation. However, provision of education and training is the most important factor in determining compliance (Botelho, 2012).

**Segregation and containment**

Hospital waste segregation and containment at the point of generation are imperative to reducing the costs of waste treatment, and negative impact on the environment, and public health. Hospitals should provide their staff with sufficient knowledge and skills, as well as, facilities, to ensure that appropriate segregation and containment are practised.

The study found that waste segregation and containment in the majority of hospitals remain an issue for HCWM. They mostly segregated their wastes into two categories only, leaving the mixture of infectious and sharps wastes in the same containers, which were not always puncture proof. As for sharps wastes, only 13.92% hospitals weighed them, indicating that many hospitals mixed the sharps wastes with infectious wastes, to reduce the provision of sharps containers (see Figure 5-21). Moreover, some hospitals sorted their wastes into three categories, separating infectious and sharps wastes. However, they did not contain them in appropriate colour-coded plastic bags and bins, and also, placed them where they could be reached by unauthorised persons, including children.

From the survey, the segregation practices can be divided into two groups, good and bad practices, considering the importance of sharps containments, separated from other infectious wastes, to avoid sharps related injuries among workers at risk. The results show that good practices are slightly different from bad practices, counting about half of the hospitals (Figure 5-23). Combining with the fact that a significant number of cleaning service workers was still involved in daily segregation activity at each ward, the magnitude of the problem cannot be overlooked. Thus, remedial action is necessary, and importantly, action focussing on policies, and formulating codes of conduct for each stakeholder within hospitals.
This is significantly different from the results of a study by Ramokate and Basu (2009), which found that most hospital staff (doctors and nurses) knew about the different handling between general and medical wastes, and they segregate them appropriately in colour coded bins (96.00%) as such facilities were readily available.

Concerning SOPs for waste segregation and containment, more than 75% of hospitals provided each ward with relevant SOPs (Figure 5-25). This proportion is much higher than that of hospitals complying with the available SOPs, as regulated. This shows that the availability of SOPs, by themselves, does not guarantee compliance, as there are other significant factors affecting compliance with the SOPs.

Using colour-coded bags and bins as required by the Ministerial Decree No. 1204/2004 is also an important variable of compliance. As can be seen in Figures 5-26 and 5-27, more than half the hospitals used the colour-coded system. About half of them did not, due to the unaffordable costs of colour-coded plastics and bins. Similarly, most of them also contained sharps wastes in plastic containers, followed by safety boxes, and plastic bags. The use of plastic bags for sharps wastes is of concern as it leads to injuries.

Following the descriptive statistics on compliance with relevant regulations, the researcher conducted inferential statistical analyses to test whether several HCWM variables were significant predictors of hospital wastes generation (general and medical wastes). The hypotheses are tested and presented in Section 5.11.2. To the best of the researcher’s knowledge, there isn’t any published study that used logistic regression to model compliance with the relevant HCWM regulations and policies.

The logistic regression model was used because the dependent variables intended to represent compliance are categorical in nature. Its purpose was to predict discrete outcomes - whether a hospital segregates into more than three types or less/not at all (SEGREGATION), and whether a hospital fully categorised waste by colour code or partly/not at all (COLCODING) - from a set of explanatory variables. Two models were estimated and analysed: Waste Segregation Model and Colour Coding Model.

The first model attempts to determine the factors that influence the likelihood of a hospital in segregating its waste into three types or more. There are nine explanatory variables. Of those nine, four are statistically significant. They are WMBUDGET, WMPLAN, CENPOLICY, and HOSPGUIDE.
A hospital that has a routine budget for HCWM is three times more likely to segregate its waste into three or more types than a hospital that does not, implying that hospitals with a routine budget can provide adequate plastic bags and bins for segregation practices. Moreover, hospitals with waste management plans are 30% more likely to segregate waste into three types or more, than hospitals without such plans. Therefore hospitals with routine budgets and waste management plans are more likely to provide staff with facilities and SOPs to segregate waste into three or more categories.

Having hospital guidelines on HCWM implementation, however, has the inverse effect. A hospital issuing such guidelines is three times less likely to segregate its waste into three or more types than a hospital that does not. A possible explanation is that having guidelines is not enough; the provision of adequate facilities for segregation practices is necessary to complement such guidelines.

The second model seeks to determine the factors that affect the likelihood of a hospital categorising its waste according to colour codes. Of nine predictors in this model, four variables are statistically significant; they are: ROOMSOP, WMUNIT, HOSPCLASS, and LOCATION.

Having the SOP in the segregation room has considerable influence. A hospital with such SOPs is seven times more likely to fully categorise its waste by colour codes than a hospital without. This indicates that in-room SOPs will guide any staff performing medical services in containing their wastes in appropriate bins or containers.

Similarly, a hospital with a waste management unit is three times more likely to segregate its wastes into three or more categories, since such units are accompanied by sufficient funds and facilities that encourage segregation at source. In contrast, a hospital without a waste management unit is less likely to segregate its wastes into three or more categories, as the hospital does not have a budget for waste segregation facilities.

The next variable, hospital location, influences segregation practices, e.g., a hospital in Java-Bali islands is three times more likely to fully categorise its waste streams, using colour codes provided by the relevant decree, than a hospital located outside Java-Bali islands. This points to the likelihood that a hospital in Java-Bali islands has sufficient resources for segregation facilities, than one outside Java-Bali islands.
Finally, a higher class hospital is twice as more likely to fully categorise its waste using colour codes, indicating better resources that enable their staff to segregate wastes into three or more categories.

There are no comparable studies that have statistically analysed as many variables. Consequently, this study adds significant findings of determinants of HCWM in developing countries like Indonesia.

**Onsite collection, transport and storage**

Waste collection, transport and storage within hospitals are part of the WMH that need to be managed under relevant policies. Not all hospital provided equipment and facilities for these activities, leading to spilling of wastes and placing waste operators at risk of contamination. Some hospitals did not record the frequency of onsite waste collection, indicating that they did not have waste management plans or audits, and they just handled wastes as they were generated. 37.97% hospitals did not have onsite storage, indicating that they did not manage wastes according to the regulations. Those who had temporary unsecured storage, left them accessible to unauthorised persons, including scavengers for economic purposes, exposing them to risks of injury and/or contamination (Figure 5–38).

**Implementation of 3R approach**

The implementation of 3R amongst hospitals is uncommon, officially, though a few have adopted the approach. Reuse and recycling are performed outside the hospitals, by hospital staff or the informal sector, as an additional income stream. There was no record of reduction of hospital wastes by public hospitals, like using less hazardous substances or equipment, or implementing a green purchasing policy. In-depth interviews showed that the IHA established a unit in 2010 to deal with green hospital initiatives.

Most reuse and recycling is of cardboard and plastic containers for unknown purposes. The survey found that hospitals generated considerable amounts of cardboard, making up 85.19% of total recyclable general wastes. This provides a good opportunity for official recycling that can offset some costs of medical waste treatment and disposal. Tudor, Marsh, Butler, Van Horn, and Jenkin (2008b) point out that a waste
minimisation trial in UK health care settings could save a significant amount of money, at an average 15.7% reduction of clinical wastes.

Applying 3R to medical wastes, the numbers of hospitals reusing, recycling and pre-treating were 16, 81, and 210, respectively. However, there was no data regarding the types of medical wastes being reused, recycled and pre-treated. 99 hospitals cut needles, separating disposable syringes from their plastic which was fit for other purposes. This practice could reduce the amount of medical wastes going to incinerators.

**Solid waste treatment and disposal**

The methods available for medical waste treatment and disposal were incineration and non-incineration. The two methods had some advantages and disadvantages. Though incineration is widely regarded as the most effective method in reducing the volume and weight of incinerated wastes, it is not always cost-effective and environmental friendly, as they need to be operated by skilled operators, and release environmental pollutants. This is so, particularly with small-scale incinerators.

The survey found that most Indonesian hospitals used incinerators for medical waste treatment, and non-combustion treatment methods, like disinfection, autoclaving, and encapsulation, were yet not popular among the sample hospitals. Furthermore, those that did not treat their wastes, disposed them alongside municipal wastes in landfills, or just buried them in their backyards. Two hospitals even confessed to letting scavengers take their wastes in violation of regulations.

The study also found that nine hospitals incinerated almost all medical wastes, including pressure container wastes. This practice is prohibited, as they can explode, posing risks of injury to people in the vicinity.

On location of incinerators, only 12.11% used onsite incinerators, and the majority used offsite incinerators, owned, either by other hospitals, or private companies. The majority of them were between 4-6 years old, meaning, they are within their optimal life span, if well maintained.

Specifications of incinerators are important to determine the capacity and potential in treating wastes, and to meet requirements of relevant regulations to prevent environmental pollution and public health problems. Less than half the incinerators
were equipped with air pollution control devices, minimising emission of hazardous substances, such as, dioxins, furans and several heavy metals. The survey revealed that only 25.82% hospitals monitored their incinerators’ emissions. More than half, however, met the optimum temperatures of 800°C at the second chamber.

As incinerators release smoke and fumes, depending on the types of wastes and their capacity to treat the wastes, public concerns should be considered, and they be relocated at safe distances from public roads and residential areas. About half the incinerators were located within hospitals, i.e., 100 metres from public roads and residential areas. This is not appropriate in terms of potential air pollution. Further, most incinerators operated at temperatures less than 800°C.

**Wastewater treatment and disposal**

Many Indonesian hospitals did not manage their wastewater in accordance with the Environment Ministerial decree No.58/1995, and 23.20% used insanitary methods of wastewater treatment, and 27.43% did not meet the effluent standards. They also failed to treat medical wastewater prior to mixing with municipal wastewater, when, in fact, they contained more pollutants than municipal wastewater. Operational costs were the biggest constraint to operating a WWTP. About 38% did not meet the effluent standards regularly, as they did not operate WWTPs daily.

**6.3.4 Coordination, Partnership and privatisation in HCWM**

**Key stakeholders at the central and local levels**

Clark (2011) classifies stakeholders into three groups: the proponents, the decision-makers, and third parties, in relation to their engagement in a wide range of environmental issues. The engagement of stakeholders should have defined objectives to ensure that each stakeholder involved, understands the roles and benefits in participating in environmental management, to overcome potential problems.

Stakeholders in implementation of HCWM vary from regulators, and providers, to, HCWM operators. Regulators mainly deal with formulating regulations and policies. Providers make guidelines, strategies and plans, provide training, capacity building, onsite HCWM, and offside treatment and disposal, etc. HCWM operators are personnel who execute daily activities of HCWM in health care facilities.
Stakeholders’ roles and responsibilities and the mechanisms for HCWM implementation, need clear definition, in accordance with relevant regulations, to facilitate good coordination and collaboration to achieve shared goals of sustainable HCWM for protecting the environment and public health.

The secondary data from various sources show several ministries and institutions/agencies at central level, associated with HCWM implementation, like the MoH, MoE, NAAE, MHA, and MT. There are also Governors, Mayors, and Heads of Districts (Bupati) and their administrative institutions at local level, i.e., provincial, municipality, and district levels.

Health care institutions like hospitals and HCs are stakeholders, as well as, waste generators. It is imperative that they follow directions of relevant regulations to establish and implement onsite HCWM systems, regularly supervised by the regulators, to assess their performance, since the efficacy or lack of efficacy of their HCWM systems will affect the environment and public health. To implement sustainable HCWM, the health care facilities should have their strategies and plans conform to policies from higher authorities, and international principles of environmental management, as mentioned earlier, in Section 2.2.3. The details of stakeholders and their roles and responsibilities will be presented in Chapter 7.

Looking at the performance of key stakeholders at central level, there is room to expand the existing HCWM policies and guidelines for waste generators. Special consideration must be given to encouraging waste generators to comply with regulations, to attain safe HCWM. Supervision of hospitals by the MoH only where breaches of waste management are reported leads to haphazard and incremental improvements, defeating the purpose and aims of sound HCWM.

The assessment of implementation of CP showed only a few hospitals that did not observe the regulations. The performance of local governments has been similar to the central government in implementing law enforcement. Therefore, a comprehensive strategy should be set up to improve the current performance in HCWM.

Coordination among stakeholders in the central and local levels

In-depth interviews found valuable information on current situation of coordination among stakeholders at the central level. There was a significant barrier between two key
stakeholders at the central level that need rectification, as this will affect the ideal outcome of sustainable HCWM. It probably stems from a misperception about which sector is leading, or simply, because a senior official of one institution lacked the commitment to improve the current system.

Assistance may be sought from the regulations to resolve the breakdown of coordination; and there are a number of techniques that can promote better coordination. Clark (2011) provides several examples of some techniques, as follows:

- Provision of adequate information that is easily comprehended by ordinary people, without being offended;
- Giving sufficient time to all stakeholders to read, discuss and consider the information and their implications; and
- Provision of enough time to all stakeholders to present their opinions and adequate responses to gain their confidence, and to sustain their involvement.

Clark (2011) adds some rules of engagement, including accessibility, responsiveness, transparency and clarity, intelligibility, and consultation through genuine dialogue. In association with the implementation of treated municipal sewage sludge (biosolids) management and research, Beecher, Harrison, Goldstein, and McDaniel (2005) state that the involvement of stakeholders will be effective if they fully understand the risk, by providing sufficient information using risk communication techniques, so that they are willing to participate in all stages of biosolids research which was previously regarded as ‘expert business.’ This approach can be adopted to obtain stakeholders’ or public acceptance of HCWM, particularly, their willingness to perceive medical wastes are hazardous, and that all stakeholders are responsible for sound HCWM. They may thus embrace coordination of all stakeholders with different roles and interests.

Wilson et al. (2007) state that an evidence-based approach to policy making can also stimulate coordination among key stakeholders, by combining the results of research with knowledge acquired from stakeholder involvement activities. This approach is worth being tried to rectify the current problems of coordination between central and local levels, or within the central level.

The coordination between central and local levels, currently, are considered to be moderate, since in-depth interviews show that local hospitals proposed local authorities
to issue licences for medical waste treatment, instead of the central level as at present, to minimise costs, and thus, promote better implementation of HCWM locally. The local levels, provincial and district, can now authorise hazardous waste collection and supervision only (see Table 5-18). On the other hand, the regulations authorise the central institution to license and supervise all stages of hazardous waste management, including waste oil collection.

**Partnership between governments and non-governmental organisations**

Waste management used to be the responsibility of local governments and industry. Since the scale of MSW has escalated, it has outgrown the management capacity of any one agency. Hence, the central government has become increasingly involved, as a policy maker, regulator, and, in some instances, facility owner and/or operator.

With increasing decentralisation, the roles of local governments, i.e., provincial, district, and municipal, have also been enlarged, to enable relevant sectors and provide a better quality of life for their citizens. Similarly, as emerging waste management issues, including HCWM, go beyond the capacity of governments, partnership with external, non-governmental organisations become necessary.

Diverse societal roles of non-governmental organisations are recognised today, ranging from providing technical and financial assistance, and particularly, in developing countries like Indonesia, where advanced technology and funds are limited. The increasing numbers of non-governmental organisations result from increasing participatory democracy, and the need for a large and diverse range of environmental activities to keep up with the magnitude of environmental problems (Clark, 2011). Several non-governmental and international organisations have acted in developing better HCWM, by providing training and equipment for some hospitals.

Partnerships can also be a driver of sustainable HCWM, as a sustainability principle, where stakeholders involved, perform their roles to achieve shared goals (Lombard, 2002). In promoting partnerships to attract stakeholders, the leading sector should comprehensively encompass economic, ecological and social elements to advance sustainability.

As seen by the results of the mailed survey, several international and non-governmental organisations have been assisting the improvement of current performance of hospitals.
and health care facilities. Table 5-4 shows that international organisations, such as, WHO and ADB; and non-governmental organisations, such as, ETLOG, PERSI, and SANIPLAN, and other private organisations, are involved in HCWM training and capacity building. In the same table were government institutions like the MoH and MoE, as leading sectors in HCWM systems.

PATH is another international organisation that contributed to developing proper HCWM systems, by conducting a study in HCs in Yogyakarta, covering several aspects of HCWM, to formulate off-site mechanisms and proper practices of medical waste segregation and syringe capping.

Of course, the roles of non-governmental organisations are not too large, as they are supposed to provide initial assistance to stimulate primary sectors to develop their own capacity. Therefore, in the long term, the governments and hospital community will be self-reliant to improve their own conditions, without heavy reliance on assistance from non-governmental organisations.

Bangladesh provides a good example of a partnership between government, non-governmental organisations, and the public, in MSWM (Ahmed & Ali, 2006). They also reveal that a facilitating agency is needed to mediate, as spontaneous partnerships are difficult to establish, especially, when public participation is passive. As a result, better delivery of MSWM services eventuated by this tripartite partnership.

The Solid Waste Management Act No. 18/2008 also provide that the participation of organisations outside government are encouraged, to develop sustainable MSWM, and the details of their involvement and mechanisms are elaborated in related regulations and policies.

The current mindsets of stakeholders, particularly hospitals, need to be managed/shaped, to accept the temporary nature of the roles of, and partnerships with, non-governmental organisations. Importantly, they are only for a limited time, and the hospitals need to sustain the improvement of programs, beyond the partnership’s active period, to maintain and improve quality health care services.
Privatisation in HCWM

Waste generation and its management issues increase proportionately with economic and population growth. So, the conventional approach that waste management is the responsibility of governments, need to be reconsidered.

In the process of development, waste management issues become political, as they are associated with the decision making process, demanding allocation of resources to manage them, along with general environmental management.

Privatisation in HCWM in Indonesia is a relatively new approach, as HCW was not recognised by even stakeholders who lead the HCWM sector, and the protection of the environment and public health. As public awareness of the danger of HCW increases with greater access to such information globally, along with the rise of public resistance to open dumping practices of MSW, the law has recognised the need for sound HCWM systems through regulations, such as, No. 18/1990, and No. 85/1999, and the overarching Environmental Management Act No.32/2009. Another driver is the Basel Convention, relating to trans-boundary movement of hazardous wastes and their disposal, which Indonesia ratified in 1993. Therefore, HCWM, and managing hazardous wastes responsibly and sustainably, is now the concern of multiple stakeholders.

HCWM has also attracted a number of private companies, both local and foreign, to invest in HCWM in Indonesia. Given the large number of hospitals, and the geographical spread, across several islands, the regulations, too, promote private investment in HCWM. Neighbouring countries like Malaysia, have already invested in hazardous waste management and HCWM, especially, in Java island.

Some large hospitals objected to HCWM privatisation, as it reduces their clientele of small hospitals and clinics treating their medical wastes in the incinerators owned by these larger hospitals. However, the large hospitals will need to accommodate this idea of competitiveness that, in the long run, HCW generators will benefit, since the costs will decrease as clients treating wastes, increase.

Licensed private companies dealing with HCWM in offsite treatment facilities, like in Java and other big islands, should ideally expand to cater to hospitals in other islands and provinces, too. The government, too, should consider factors like the profit motive that may discourage companies from investing in HCWM, and assist the hospitals and
health care settings in remote areas. The Australian example is instructive here, where, in defined, “scheduled areas,” under certain circumstances, the health care facilities are authorised to treat and dispose of medical wastes using conventional technologies, without compromising the environment and public health.

As was suggested at an in-depth interview with a local hospital, the Central government should reconsider the existing permit mechanism for off-site treatment, and promote local industries to invest in HCWM. The Central government should place this issue on its policy agenda administered by the MoE, as a policy should be dynamic, and adjust to changes in environmental management issues for better outcomes (Baxter, 2011). Several principles are applicable when changing current policies; however, inputs from all stakeholders should be considered, to be participative in arriving at a cost-effective method of permitting off-site treatment, without jeopardising the environment and public health.

6.3.5 Public health programs in hospitals

Implementation of ICP

Infection control programs, a necessity for a healthy hospital, deals with all aspects of infection prevention and reduction. Infection of diseases in hospitals or HAI, particularly in developing countries, remains huge, even though under reported, and comprehensive disease surveillance is lacking.

Tweedy (2005) argues that ICP will be effective where components like, sound personal hygiene, individual responsibility of staff, monitoring, and investigating potentially infectious exposures, are included. Determining occupational infection risk, eliminating unnecessary procedures, and providing infection control measures, complement the program.

The potential transmission of blood-borne pathogens by needle-stick and sharps injuries, e.g., HIV/AIDS, hepatitis B and C, is a major concern of occupational injuries related to HCWM. A WHO report predicts that around 3 million percutaneous to blood-borne pathogens happen in 35 million health care workers around the world, annually (WHO, 2002). It is not surprising that 90% of these infections occur in developing countries, and are, preventable.
A few studies conducted in relation to ICP in Indonesia, and several studies from developed and developing countries can be used for rectifying the current status of ICP in Indonesia. Duerink et al. (2006) also found that most of the hospital staff studied, did not adhere to UP, as stringent ICP was absent due to lack of resources, including trained infection control officers.

Bi et al. (2006) who investigated occupational blood and body fluid exposure in an Australian hospital found that percutaneous exposures were higher among doctors and nurses, at 10.40% and 5.02%, respectively. It is, assumed, therefore, that the incidence of occupational exposures and HAI in Indonesia will be higher, considering the comparable availability of ICP resources and adherence of health care workers to ICP guidelines and SOPs.

A study of teaching hospitals in Japan found that there was a significant association between hospital accreditation and ICP. It concluded that hospital accreditation has impacted the availability ICP infrastructure and outcomes. Another study conducted in Egypt, explains the achievements and challenges of implementing ICP. The achievements include a national organisational structure, guidelines and comprehensive training programs; whereas, the challenges included lack of trained ICP personnel, and political support. This means that when sufficient funds are not available, the implementation of ICP will be constrained, as it needs adequate resources to establish infrastructure, capacity building, and training of ICP specialists.

More than half the hospitals in the mailed survey confirmed that their staff wore proper PPE while handling wastes (53.52%), and the rest confirmed that they use PPE sometimes, or did not use them at all (see Figure 5-77). Compared to a similar study in Johannesburg hospital by Ramokate and Basu (2009), the percentage using PPE was higher (95.00%). The reasons may be due to factors like education/training, provision of sufficient PPE and SOP, and a greater awareness of the importance of ICP in hospitals. Thus, Indonesian hospitals should establish comprehensive ICPs, with prioritised activities like hand washing practices and using PPE, instead of proper handling of infectious waste or materials, when resources are limited.

Regarding immunisation for hospital workers at risk of injuries and contamination, the majority of hospitals confirmed that such incidents occurred, mainly from needle
punctures. This is a big concern as the availability of PEP is also rare, putting injured workers at high risk of blood-borne diseases (Figure 5-79 and Figure 5-80).

In the same survey, the implementation of ICP was also highlighted, as the occurrence of cross-infections in Indonesian hospitals is quite high. About half the hospitals confirmed that their staff was trained in ICP, covering all important aspects of ICP, including hand washing, waste segregation and UP. More than half the hospitals also said that their sanitation units are included in ICP activities. However, the hospitals having designated infection control officers were only about 40.08%.

The availability of PEP for hospital workers is more than half, aiming at preventing the development of infectious diseases after exposure.

*Implementation of HPH*

Hospitals have many activities in relation to patients and their staff’s safety. A relatively new approach in public health targets optimising the quality of life of the hospital community.

As explained in the literature review (Section 2.6), HPH is sometimes perceived by the hospital community, even health professionals, as a hospital’s health education. Conceptually, there is a significant difference between the two, as HPH is much more comprehensive than health education. While HPH can include health education, it is not simply health education in hospitals. Aujoulat et al. (2001) posit that HPH is a combination of public health and health education activities.

Wright et al. (2002) argue that conventionally, hospitals are seen as ‘the antithesis’ of public health, as they only care for sick people, whereas public health is for healthy people. As hospitals evidently consume considerable resources, and deal with many healthy people who work there, HPH is an approach that blends public health activities with curative activities, utilising the values and resources available to ensure that public health is well maintained.

The implementation of HPH in Indonesia commenced late 1999, with the introduction of health promotion in hospitals. However, there is no data available on its progress, based on the standard indicators. Even in developed countries, there are many barriers to HPH.
The mailed survey showed that more than half the hospitals had implemented HPH, which is presumably, health education in hospitals. This has been raised again early this year, as the late Minister of Health launched the implementation of HPH in several hospitals, to revitalise the existing HPH, in collaboration with the WHO.

6.4 TRIANGULATION RESULTS

The two methods combining quantitative and qualitative research inquiry applied in this study are different in nature, but converge to answer the research questions set in Chapter 1. The research questions varied, based on the need to fill the gaps found in the literature review. The four components of mixed methods are the best and novel approach to fulfil the research aim of developing a suitable policy framework for sustainable HCWM in Indonesia, which needs to be improved.

In terms of validity of the study, there is consistency between the two methods, highlighting that there is no bias between quantitative and quantitative findings, as some qualitative results are for answering research questions that cannot be answered by quantitative results, or the quantitative ones only provide the proxy for certain research questions. For instance, current status of HCWM can be explained by both quantitative and qualitative results. In contrast, why current HCWM policy is not suitable for sustainable HCWM can only be answered by in-depth interviews.

Cumulatively, the qualitative results will enrich the quantitative findings, by adding that the non-compliance of HCWM regulations is perceived by hospital managers to be caused by unclear policies at central level, which, in turn, influences the outcome of onsite policy within hospitals. Conversely, the quantitative data cannot explain the non-compliance with HCWM regulations in depth. Moreover, the results of inferential statistics prove that many hospitals lacked some important factors, including central policy, class-connected matters, and WMH-related criteria, like, the availability of waste management plans, guidelines, SOPs, colour coding facilities for segregation and containment, means of waste transport, interim storage, and appropriate treatment technology that meets legal requirements.

In order to fulfil the research questions concerning lessons of best practice of HCWM in the State of Queensland, the onsite observation is more significant in noting the role of
leadership in HCWM, particularly in establishing sustainable segregation practices among hospital staff in each ward and the use of PPE among hospital workers.

The in-depth interviews also enabled the researcher to determine the magnitude of current coordination problems at central level, which can be a barrier to implementation of HCWM in Indonesia.

6.5 SUMMARY

Sustainable HCWM is important to be implemented in health care settings in Indonesia, since it will influence the health status of its people through minimising the spread of HAI and other waste related diseases among people at risk. A suitable policy framework should therefore be developed by evidence-based data obtained from a comprehensive research, employing concurrent mixed methods, to address the determinants of current HCWM in Indonesia.

The key findings from the comprehensive study which have been discussed are:

- The important lessons learned from the Queensland model include the comprehensive and consistent regulations and policies governing and guiding the implementation of sustainable HCWM. The involvement of all stakeholders concerned, and their roles and responsibilities is clear; therefore, any failure can be recognised and rectified, accordingly.
- The leadership observed at the RBWH empowers all personnel to perform HCWM in accordance with the code of conduct covering all aspects of safe waste handling and infection control.
- Preventing occupational exposures to hazardous waste is paramount at RBWH, to safeguard its personnel from contracting HAI. This enables high quality caring of patients.
- The study successfully elicited accurate and valid data pertaining to the current status of HCWM in Indonesia, by applying research design and methods, respecting internal and external validity of descriptive and analytical statistics, and using appropriate statistical methods to generalise the findings representing public hospitals across Indonesia.
The study can determine the generation of general and medical wastes, and can be used to represent data on hospital waste generation, which is currently not available.

The study also utilised qualitative inquiry, targeting selected policy makers of leading sectors of the HCWM system.

Overall, the study findings can be appropriately used for developing a policy framework for sustainable HCWM, which can be implemented for the improvement of HCWM in Indonesia in the near future.
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7. DEVELOPMENT OF A CLEAR POLICY FRAMEWORK FOR THE IMPROVEMENT OF HCWM IN INDONESIA

7.1 INTRODUCTION

This chapter provides a policy framework for the improvement of HCWM in Indonesia. Its development is based on the empirical study, covering multiple aspects of sustainable HCWM systems available, and suitable for current conditions in Indonesia. This framework suggests what need be reconsidered and improved, to attain safe and sustainable HCWM, using the HPH approach.

7.2 POLICY FRAMEWORK OBJECTIVES

The objectives of the policy framework are:

- To facilitate HCWM policy formulation among key stakeholders, in accordance with relevant Acts and regulations;
- To lobby policy makers to implement safe HCWM;
- To promote sustainable HCWM; and
- To reduce the negative impact of HCW on the environment and public health

7.3 SCOPE OF THE IMPROVEMENT OF HCWM

The improvement of current HCWM envisages comprehensive coverage of all possible aspects of waste management systems, within and beyond, health care settings. Each aspect is presented based on pre-determined conditions, as explained in Chapters 5 & 6.

7.3.1 Legal aspects

Environmental management is founded on a number of laws and regulations. These govern the various activities impacting the environment. However, there are no specific laws of HCWM. Regulations under principal environmental laws are either, not well understood by stakeholders, or they are interpreted and perceived in their interests. Generally, the introduction of a Law is followed by the issuance of relevant regulations to guide stakeholders to comply with the law and its regulations. Stakeholders can also
inform policy formulation, to promote the implementation of such regulations to further achieve its objectives.

There are regulations governing hazardous waste management, relating to safe HCWM systems too, but, there is no clear policy to guide health care institutions to fully comply with them. Together with the lack of law enforcement, the current conditions of HCWM are neither satisfactory, nor sustainable. Therefore, there is a need for clear policy, in consultation with all stakeholders, to cover the detailed mechanisms for implementing sustainable HCWM.

The Hospital Act No 44/2009 and related regulations and Ministerial decrees cover the health sector, but do not include HCWM. Ministerial decree No 1204/2004 is intended to guide the management of environmental health in hospitals, some of which covers HCWM. However, all ministerial decrees are not endowed with legal sanctions for violations of environmental obligations. Only central and local government regulations carry legal penalties and sanctions to enforce compliance. It should be noted with caution that local regulations must be in harmony with central government regulations, to avoid them being used purely for increasing revenue, with little regard to improving public health, in this era of decentralisation. For this, the central government must initiate regular coordination to build trust and understanding between the two levels.

The Acts and regulations governing environmental management are in Figure 7-1 below. As noted, they also govern HCWM.
Figure 7-1 Laws and regulations related to environmental management and HCWM system
7.3.2 Organisational aspects

The organisational/institutional aspects of HCWM, include the key arms of Central and local governments. Their duties include, ensuring the relevant legislations are followed by all stakeholders, and having clear mechanisms of coordination. These can bring about a conducive environment for improving HCWM, according to the Environment Act No. 32/2009.

The above organisational units should engage the stakeholders from both levels of governments, business, and the health care community; and, successful implementation of the framework will be both, possible, and lead to improvement of the systems and practices of HCWM. All stakeholders with different roles and responsibilities are presented in the following tables.

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Role</th>
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</table>
| MoE         | • Provide legislation and regulations related to environmental management system  
• Administer licenses and permits for HCW treatment and disposal  
• Provide policy framework for sustainable HCWM system in collaboration with related sectors, such as, MoH, NAAE, MHA, and MT  
• Provide clear technical guidelines for environmental assessment and HCWM treatment and disposal technology  
• Coordinate sectoral meetings to discuss the current issues of environmental management  
• Provide training of trainers of sustainable hazardous waste management in collaboration with MoH, international organisations (WHO, UNEP, ADB, etc) and non-governmental organisations  
• Provides training on environmental management system and tools  
• Mobilise political and financial support for HCWM improvements |
| MoH         | • Provide legislation and regulation related to health and health care system  
• Provide policy framework for sustainable HCWM system in collaboration with related sectors, such as, MoE, MHA, and MT  
• Provide guidelines for safe HCWM, ICP, and HPH  
• Provide appropriate HCWM strategies and plans  
• Provide accurate and updated data regarding HAI and waste related diseases for evidence-based policy making  
• Coordinate sectoral meetings to discuss current issues of HCWM and health care settings  
• Provide training of trainers of sustainable HCWM in collaboration with MoE, international organisations (WHO, UNEP, ADB, etc) and non-governmental organisations  
• Provide regular training on ICP and HPH in collaboration with IHA, WHO, UNICEF and non-governmental organisations  
• Mobilise political and financial support for HCWM improvements  
• Promote green hospital and HPH initiatives in collaboration with IHA, local governments, and non-governmental organisations |
### Stakeholder

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Role</th>
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</table>
| Local governments                    | • Provide local regulations related to environmental management system based on Environmental Act  
• Provide guidelines for implementing HCWM in local health care facilities based on relevant regulations  
• Provide and mobilise political and financial support for better HCWM in their jurisdictions  
• Provide incentives and disincentives for better HCWM in their jurisdictions  
• Encourage and facilitate 3R approach in health care facilities |
| Health care facility managers        | • Provide comprehensive onsite policy, code of conduct, in-room SOPs, for safe HCWM, based on relevant regulations  
• Demonstrate leadership values to promote healthy hospital initiatives  
• Provide appropriate plans, and sufficient budgets for HCWM system to fulfil duty of care, in addition to managing compliance with relevant regulations  
• Provide induction and regular training on HCWM, ICP, and HPH  
• Promote and facilitate 3R approach and green hospital initiative or P2  
• Facilitate implementation of safe HCWM practices in smaller health care facilities  
• Facilitate partnerships among health care facilities and other organisations to achieve better HCWM  
• Promote more preventative programs over curative ones  
• Fulfil the requirements of hospital accreditation and patient safety  
• Establish and conduct surveillance and recording systems, including sharps injuries |
| Health care doctors                  | • Implement UP and perform safe injection practices  
• Promote the use of appropriate PPE  
• Lead and support surveillance system and HAI reductions  
• Initiate and lead green purchasing policy |
| Health care nurses                   | • Perform and lead the implementation of segregation at source, adherence to UP, ICP, and HPH  
• Perform and lead 3R waste practices  
• Inform and promote safe HCWM practices to patients and care takers  
• Cooperate with environmental health staff to achieve better HCWM  
• Lead cleaning service workers to adhere to onsite HCWM policy and code of conduct |
| Environmental health staff           | • Lead in formulation of HCWM strategy and plans  
• Initiate appropriate 3R practices  
• Inform hospital managers to implement best practice of HCWM  
• Involve in surveillance, ICP and HPH activities  
• Promote other environmental health activities in hospitals |
| Other health care workers            | • Follow onsite policy, code of conduct and perform waste handling if necessary |
| Academia                             | • Provide technical assistance to health care facilities  
• Collaborate with health care sector in conducting research on HCWM  
• Provide training of trainers for HCWM |
| National and international funding organisations | • Fund new HCWM systems  
• Facilitate partnerships to promote better HCWM  
• Provide latest information on HCWM from other countries which have developed better HCWM, applicable to Indonesia’s conditions. |
The most important need to promote HCWM is for organisational leaders to lobby policy makers with persuasive advocacy to gain the political will of the members of the House of Representatives to allocate funds for relevant developmental activities. This can be realised by regular consultation facilitated by key stakeholders with the relevant ministries at the central level. The same method can apply at local levels.

Coordination amongst divisions in the MoH is also important, as there are several directorates responsible for environmental health and health care institutions, to strengthen their capacity to enable the shared goal of environmental health in health care settings. Effective coordination within the MoH will inspire coordination among relevant ministries at the central level.

7.3.3 Management aspects

In the implementation of sustainable HCWM, key stakeholders need to manage their resources effectively, with strong leadership, promoting resource recovery practices. The management system can adapt several aspects and elements from Queensland Health (Queensland Health, 2006).

The management at central and local levels, should have the capacity to utilise limited resources, by implementing environmental management principles that take into account the following elements. These can be appropriately determined by comprehensive waste audits for better waste management plans.

- Appropriate selection of treatment and disposal technology, whether onsite or offsite, and whether using incineration or non incineration, or even combining the two options.
- Knowing the characteristics and amounts of wastes and conditions of waste generators.
- Implementation of the 3R approach
- Availability of political support and resources
- The possibility of building partnerships to minimise the costs and negative impacts
- Extent of fulfilment of requirements of relevant regulations
- Existing HCWM practices and roles of stakeholders
Considering these elements for improving current HCWM, the following key management steps can be helpful:

**Definitions of HCWs**

Health care waste generation and problems should be defined for each stream, to determine appropriate methods of segregation, containment, treatment and disposal. The GoI has already adopted the definition of HCW provided by the WHO (Prüss et al., 1999), which categorises HCW into general and medical wastes. Subsequently, medical wastes are divided into: infectious, sharps, pathological, pharmaceutical, radioactive, chemical and cytotoxic wastes.

In the segregation process, HCW will be categorised into six, according to current guidelines. These categories need to be simplified to five categories to accommodate health care facilities that cannot afford management based on six categories, as revealed by the study. Therefore, the guidelines should be revised to reflect the real practice of current segregation, without compromising the safeguarding of public health. Where health care facilities can provide six categories of waste segregation, they should follow the ideal segregation method of the WHO. The five categories are: general, infectious, sharps, hazardous chemical waste, and radioactive wastes. For HCs that only generate three categories of HCW, they should also follow colour coded containment for each type of waste.

The definitions of the five categories are:

- **General wastes:** all HCWs that do not potentially pose adverse health impacts, and can be disposed of with SWM in landfills, after being sorted for recyclables.
- **Infectious wastes:** wastes generated in patient treatment or diagnosis that are suspected of containing pathogens in sufficient concentration, quantity and virulence, which could cause disease in a susceptible host.
- **Sharps wastes:** wastes, which are physically sharp, generated in patient treatment or diagnosis that are suspected of containing pathogens in sufficient concentration, quantity and virulence, which could cause disease in a susceptible host.
- **Hazardous chemical waste:** large amounts of hazardous chemicals are used in hospitals to clean and disinfect surgical equipment, and treat and diagnose
diseases. These range from genotoxic chemicals for cancer treatment, to oil and solvents used to operate boilers.

- Radioactive waste: used in disease treatment and diagnosis.

Waste management hierarchy

The WMH’s objective is to provide a framework to manage HCW effectively, to minimise their adverse impacts on the environment and human health, while simultaneously, allowing for economic efficiency to make HCWM sustainable. This hierarchy must appear prominently in the policy statement, as it is already mentioned in the Solid Waste Management Act No.18/2008.

- HCW reduction/avoidance: involve preventing, or reducing, the production of HCW, by:
  - substitution of materials being used in health care settings for direct or indirect health care activities with those producing less waste and less pollutants;
  - increasing efficiency in the use of raw materials, energy, water and space;
  - process redesign to be determined using available techniques;
  - product redesign, also to be determined using available techniques;
  - improvement of maintenance and operation of equipment; and
  - closed-loop recycling.

HCW reduction can also be learned from California’s experience in implementing six independent strategies (McGurk, 2004), and RBWH practices:

- eliminating general wastes from the medical waste stream
- reusable sharps containers
- sharps containers manufactured with recycled plastics
- recycling single use medical devices
- replacement of mercury-based diagnostic tools

These can be done in conjunction with the introduction of the green hospital initiative, considering the local resources available, and comprehensive review of the existing practices.

- HCW re-use: involve reusing HCW without changing their form, by:
- recovering solvents, metals, oil, etc., and reusing them for a secondary purpose;
- applying waste to any activity that gives agricultural and ecological benefits to the ecosystem;
- substituting waste for original material in a production process
- re-use of certain sharps: scalpels, hypodermic needles, syringes, glass bottles and containers (all should be properly sterilised prior to their reuse).

- HCW recycling: involving treating HCW that is no longer usable in its present form and using it for new products.

This can be done by recycling fixing-baths to recover silver from processing X-ray films (Prüss et al., 1999), and reuse of surgical instruments, as suggested by McGurk (2004) as follows:

- Arthroscopic shavers
- Arthroscopic wands
- Burrs, bits and blades
- Reamers and rasps
- Lap scissors, dissectors and graspers
- Laparoscopic trocars
- Ultrasonic scalpels
- Electrophysiology catheters
- SCD/DVT sleeves
- Femostops
- Inflation devices
- Pneumatic tourniquet cuffs
- Pulse oximeter sensors
- Biopsy forceps

Any items considered for re-use within health care facilities should be in consultation with the onsite ICP coordinator, for procedures and requirements to prevent contamination.

- Energy recovery: involves recovering and using energy generated from waste, by burning waste, using the heat to heat water and using the hot water in an industrial process. This can be applied in the offsite waste treatment system, where the incineration system can utilise heat from its process.

- HCW treatment and disposal: HCW treatment and disposal, which is currently dominated by the single technology of incineration, should be transitionally
transformed into multiple technologies, accommodated in proposed policy, in accordance with relevant regulations. Treatment and disposal should be least harmful to public health; such methods, for each type of waste, are:

- Cytotoxic: incinerator
- Human body parts: incineration or chemical disinfection, with the exception of placenta, with regard to cultural aspects
- Pharmaceutical products: incineration, with regard to specification of incinerator requiring minimum temperature
- Chemical wastes: incineration
- Radioactive waste: CRTT and other treatment facilities, depending on the type of radioactive wastes, according to relevant regulations
- Infectious wastes: incineration, autoclave, chemical disinfection, or landfill in scheduled areas (for remote health care facilities), with local government approval
- General waste: landfill, if waste cannot be sorted for recycling purposes
- Recyclables: materials recycling facility

Waste management committee

Health care facilities should establish waste management committees to monitor and evaluate the implementation of safe HCWM systems, according to the defined policy. This committee should represent all key stakeholders either at the Central or the local levels, encompassing terms of reference, aims and objectives, and regular meetings with clear agenda. The initiator of waste management committees can be the MoE or MoH, depending on the agreement at the Central level.

Education and training

Education and training should be tailored to meet the needs of the various levels of staff, covering all aspects of sustainable HCWM, from regulations and policies, to WMH application, and complementary programs, like ICP and HPH. These can be training modules produced by the MoH, in collaboration with the WHO. The modules need be updated periodically, to reflect changes in legislation, policy and other relevant factors. The training system must also provide training of trainers, to make it more effective and efficient, and fulfil the need for trained health care personnel in the era of decentralisation, in all provinces across Indonesia.
Additionally, health care facilities should provide induction programs for new personnel including safe HCWM modules, coordinated by their environmental health/waste management units, depending on the local situation.

**Assessment and audits**

Each health care facility should establish waste assessment and audit systems, including random waste audits, compliance assessments, and facility waste audits. Waste assessments can be conducted quarterly for identification of improvements and to ensure that waste segregation is being practised correctly, and waste audits, annually, to comply with the regulations. Subsequently, an initial comprehensive baseline audit must be conducted, as required, to follow introduction of significant procedural changes affecting waste management activities, including generation or segregation.

These should be guided through the Waste Audit System guideline of the Directorate of Environmental Health, under the MoH, in collaboration with the relevant divisions at the MoE and other facilitating agency, if applicable.

The guideline should cover the requirements, procedures, mechanisms, and instruments of waste audits. Each health care institution should form a waste audit work group, comprising all component units, to develop the waste audit plan, as required by the guideline.

**Contract administration**

When a health care facility has a contract with other organisations for offsite waste treatment and disposal, the facility should monitor the performance of its contractors, and maintain all records/documents needed for internal purposes or required by higher authorities. The contract itself should be clear and comply with the regulation, as mentioned in the contractor permit of the MoE or local authority.

**Data collection**

Data related to waste management should be recorded and maintained by each health care facility and readily available for monitoring and other requirements.

**Segregation**
Waste segregation based on the written policy is important as it ensures that HCW is handled and contained properly at the point of generation. The wrong practices of segregation will render the contents of general waste containers to be infectious, or result in increased cost of treatment and disposal of medical wastes, and expose the staff and waste handlers to health risks/injuries. Appropriate precautions for staff who handle waste containers must mandate the use of PPE for their protection from contamination, assuming that containers may contain incorrect wastes.

**Handling and transport**

Onsite waste handling and transport should be effective and efficient, using appropriate vehicles, and staff assigned responsibilities, according to work schedules administered by waste management units. The vehicles should be solely for waste transport to avoid cross-contamination. The frequency and staff involved can be determined by waste audits and assessments.

**Storage**

The HCW collected in each ward/room will be transported by assigned staff to a designated waste storage in the health care premises, before being transported to treatment facilities, onsite or offsite. The storage room should be secured, without access to unauthorised persons.

Waste must be contained in colour coded containers, as required by regulations, and each container be closed properly, weighed and recorded for monitoring and reporting purposes.

**Treatment and disposal**

As mentioned, each health care facility needs identify its waste streams and contain them, in the colour coded system, in preparation for treatment and disposal, and prevention of contamination.

There are two systems of HCW treatment and disposal as currently required by the regulation in Indonesia. The two systems apply to all health care facilities and their locations across 33 provinces, considering the production rate of HCW. On one hand, all health care facilities can treat their wastes in accordance with the regulation, and on
the other, the system promotes investment of private companies in waste treatment facilities and services at affordable prices.

The system must also allow small, rural remote health care facilities to dispose of their medical wastes in designated landfills, under defined circumstances, with local authorisation.

**Sharps containers**

Sharps containers are designed to protect health workers and waste handlers from being punctured, and infected by pathogens carried by contaminated sharps. Hence, the sharps containers should be leak and spill proof. More importantly, there should be procedures for handling, storing, assembling, collection, removal, and safe reuse of sharps containers.

**Spill Kits and procedures**

Spill over of HCW can occur if plastic bags and containers are mishandled. To contain spillage, spill kits and procedures must be provided, and located in areas where infectious, cytotoxic and mercury wastes are likely.

**Infection control and occupational health and safety**

Infection control and occupational health and safety are integral parts of sustainable HCWM. They can indicate the success of HCWM implementation, and also protect the health care community.

ICPs provide UP facilities, like hand-washing, PPE, PEP, staff immunisation, maintenance of cleanliness of health care facilities, and SOPs to prevent the spread of HAI and blood-borne diseases, and promote healthy hospitals.

Additionally, health care facilities should provide education and regular training, as part of capacity building, and appoint assigned infection control officers to administer the ICP. This includes the establishment of a surveillance system, promotion injection safety procedures, and reporting of HCWM-related incidents.

**7.3.4 Technical aspects**

Technical aspects of a HCWM system include the appropriate selection of technology and equipment for safe HCWM, covering each stage of segregation, collection,
transport, storage and treatment/disposal. These will also be influenced by financial, management, and socio-cultural factors. Consequently, all factors should be counted, using an available tool, as proposed by Chaerul et al. (2008a) or others, such as, advanced LCA.

More importantly, the adoption of such technology and methods from developed countries should be adapted to local conditions, utilising appropriate approaches like risk communication, involving all stakeholders, to gain public awareness and acceptance.

The adoption of non incineration technology can help diversify the use of technology, and meet the requirements of the regulations, in contrast to current incineration practices. This could be achieved in partnership with non-governmental institutions, facilitated by the Central government.

The diversification of HCW treatment technology contemplates reduction of costs, which bothers many hospitals, and lead to inevitable violation of HCWM related regulations.

7.3.5 Financial aspects
Financial aspects are significant in establishing safe HCWM, as was stated by the majority of sample hospitals. They can affect the entire HCWM system. Therefore, governments and all stakeholders concerned should collaborate to mobilise funds for HCWM from local, national and international bodies.

Promoting business investments in HCWM, combined with the assistance of international donors to facilitate development of incinerator and other treatment technologies, can support manage the financial aspect.

The introduction of a levy system to enforce health care facilities to comply with the regulation can be examined. However, its correct application must not be confused with a ploy to increase government revenue. Other options to gain funds for HCWM can include cross-subsidies within health care facilities implementing the 3R approach.

Transparent and committed leadership is a prerequisite for financial management that increases trust among staff administering allocation of funds, and to minimise any risk of mismanagement of collected funds.
7.3.6 Socio-cultural aspects
The acceptance of any system by stakeholders concerned is imperative, and is affected by several factors, including socio-cultural aspects. The advanced technology of HCWM cannot be sustained without considering socio-cultural aspects of people surrounding the location of technology.

Hence, gaining public awareness and acceptance must form part of the plan to install new technology. Risk communication is not only for people directly affected by the plan, but also for stakeholders directly involved in the introduction and operation of such technology.

Considering socio-cultural aspects, some HCW is not only hazardous but also a personal matter when it involves pathological waste from dead bodies and placenta. For instance, disposal of placentas must be at the discretion and wishes of family, even when categorised as infectious waste. Therefore, the disposal of dead bodies and placenta cannot use incineration technology. As such, special consideration should be given in the policy development favouring socio-cultural aspects.

As noted earlier, many disadvantaged people earn money from scavenging wastes, including HCW. This occurs when HCW is not properly managed, and left accessible to scavengers, exposing them to risks of infection. This should be of concern to stakeholders involved to reduce such risks, without denying the economic liberty of scavengers.

The steps of responsible HCWM already discussed, including segregation, proper and secure storage, and treatment and disposal will help prevent exposing scavengers to untreated wastes. This also means that the implementation of 3Rs within health care settings must be properly managed, so that it truly helps offset waste treatment costs, and not pose health risks to workers. The involvement of governments in providing income generation for disadvantaged people is an important socio-cultural intervention that must go side-by-side with responsible treatment and disposal of HCW.
7.4 CONTEXT AND STRATEGY OF HCWM POLICY FRAMEWORK

7.4.1 Stronger national policy related to HCWM

The regulatory system and HCWM policy should be designed to accomplish effective and efficient public policy objectives using several criteria, as follows:

- The regulatory system should be as clear, transparent and simple, as possible, and be readily understood;
- Criteria for compliance should be clear, consistent, and measurable, or otherwise, objectively verifiable;
- The system should avoid complexity, duplication and inconsistent, conflicting or unnecessary elements;
- Information required should be limited to what is necessary to achieve the objectives; and
- The system should be designed to enable efficient and effective administration and compliance.

As such, the national policy must strive to achieve the goal of HCWM to reduce the risks of waste related diseases and injuries. The reform needed is to harmonise regulations between central and local levels, and to reduce the gaps and uncertainty of the current administration of such regulations. Subsequently, the reform will help achieve the goal and targets of the strategy explained in the following section. A more flexible approach to keep up with changes of technology, and more effectively reduce illegal HCWM practices, is envisaged.

7.4.2 National and local strategies and plans on HCWM

National and local strategies should be developed to implement safe and sustainable HCWM, so that the generation of HCW will not reduce the quality of life, taking into account local capacity and cultural diversity.

At national level, there should be a vision, mission and goal to achieve sustainable HCWM. The three elements should be clearly and expressly stated for each stakeholder to access, and give effect to, for the successful implementation of HCWM.

The vision of the strategy is to minimise HCW impact on the environment and human health through sustainable HCWM according to the WMH. Its mission is to promote the
implementation of a safe and sustainable HCWM system, utilising local capacity, and adapted lessons learned from experienced countries. The goal is to minimise the health impact of HCW, by promoting HCWM practices, prioritising resource recovery.

The guiding principles of the national and local strategies for HCWM implementation are similar to the international principles of environmental management for sustainable development, emphasising local strength and capacity.

These include the precautionary, polluter pays, proximity, and duty of care principles, while placing the environment and public health at the highest concern. Therefore, the approach of HCWM should encompass international, national and local capacity, applying best practices, and encouraging partnership and collaboration.

The approaches and strategy will then be used to set plans of action, short-term and long-term, considering the diversity and capacity of local governments. To reduce the gaps that currently exist, the action plans should accommodate the diversity among western, middle and eastern regions in Indonesia, where the eastern is less developed than the middle and western regions.

The plans need also be measured quantitatively, using standardised indicators or instruments to assess the progress made, within a specified period of time, agreed to by all stakeholders concerned. They must also consider the actions by Central and local governments, in keeping with their different roles and responsibilities, provided in the relevant regulations.

7.4.3 Co-ordinations and partnerships to deliver change

Coordination amongst government institutions, and public-private partnerships should be developed, to successfully realise the goals and targets anticipated in the action plans. Engagement and regular consultation is essential to disseminate information necessary for these achievements, and leading sectors need act as facilitators to drive the road to change.

Public education and training through formal and non-formal systems, are evidently regarded as an effective approach to increase the knowledge and skills of HCWM stakeholders. Therefore, education and training should be facilitated to accomplish
behaviour changes in the implementation of 3R, and gain active participation of stakeholders.

The participation of all stakeholders, comprising Central government, MoE, MoH, MHA, MT, local governments, business and industry sector, health care community, academia and research community, and the general community, is imperative.

7.4.4 Empowering health care communities

The lack of adherence to HCWM-related regulations is partly associated with the current capacity of health care settings. To improve their performance, therefore, concerted efforts are necessary to empower the health care community to help themselves to improve capabilities.

Health promoting hospitals is a tool recognised as appropriate to empower all elements of health care settings. This approach can be introduced by valued leadership and commitment of key elements within the health care sector, including hospital managers.

The strategy to deliver behaviour changes is to involve the nurses, whose roles and numbers are significant, in health care services. Their selection as leading role models, combined with the strong leadership of hospital managers, will be effective in achieving a sustainable HCWM system. Nurses’ leaders have deep insight into the needs and concerns of all hospital stakeholders, as they work together with them on a daily basis.

Nurses’ roles can significantly impact HCW segregation and handling, and they are also capable of delivering ICP in cooperation with physicians. Therefore, the MoH, responsible for the implementation of HPH, should facilitate its implementation, focusing on the priorities set by hospital stakeholders, and provide relevant guidelines to hospitals, allowing flexibility in implementation.

7.5 SUMMARY

The overall results of the study indicated that existing HCWM practices are unsatisfactory in reducing the risks of HCW to the people exposed. This is primarily related to unclear policies regarding the requirements of relevant regulations, resulting in violation of, and non-compliance with, the regulations.
The development of a policy framework that suits the needs of stakeholders and health care waste establishments is essential to fill the existing gaps in the implementation of HCWM. It should cover all aspects of HCWM, and consider the diversity and capacity of various health care settings across the 33 provinces of Indonesia.

The scope and context of the policy framework are, both, the national and local levels, with emphasis on the capacity of health care facilities to achieve sustainable HCWM, utilising all factors contributing to its improvement in Indonesia.
8. CONCLUSIONS

8.1 INTRODUCTION

This thesis sought to attain its primary aim of developing a policy framework for the improvement of HCWM in Indonesia. The policy framework considers all important factors necessary for a sustainable HCWM system, acknowledging the existing capacity and conditions of various health care settings, which also need reform to achieve universal coverage to improve Indonesian health status.

This chapter summarises the study findings and outcomes, and considers their implications for better HCWM in Indonesia, to overcome the burden of the lack of best practices.

8.2 ATTAINMENT OF RESEARCH AIM AND OBJECTIVES

8.2.1 Lesson learned from the Queensland model for HCWM

The case study was conducted in the RBWH as a showcase of health care in the State of Queensland, Australia, considering homogeneity in terms of regulations and policies, availability of resources, and common leadership performance. This study gives the researcher insight, and conviction that the best practices can be adopted only if there are important positive drivers, as mentioned in Chapter 4.

The implementation of the HCWM system in Queensland is based on legislation covering all aspects of institutional management, technical, financial and socioeconomic, driven by policies striving to provide comprehensive strategies, action plans, guidelines, codes of conduct, and instruments for monitoring and evaluation.

More importantly, the legislations are complemented by all stakeholders performing their roles to mobilise available resources to comply with them. There are also instruments for providing incentives and disincentives to HCW generators, to educate them on how to comply with relevant regulations, and to promote practices according to the WMH, favouring waste avoidance rather than waste disposal. Therefore, the legislations and policies promote the 3R practices, involving all stakeholders, including the health care community.
Indeed, there has been violation of regulations, but enforcement has applied accordingly, to compel offenders to take remedial actions to rectify the problems, and to comply.

In Queensland, as in other states and territories, public consultations and risk communication before enforcing legislations are a prerequisite. This involves all stakeholders, providing clear information to raise awareness and acceptance. Problems are invariably encountered as the needs of providers and the public are not always met, but, in the end, compromise and willingness to improve the quality of life of all Queenslanders, play their part.

Subsequently, the behavioural changes within the RBWH in 3R and HCW segregation, containment and ICP, demonstrate that staff dedication under proactive leadership to improve performance of the hospital is vital.

These valuable lessons, therefore, could be adopted, taking into account local conditions of Indonesian health care settings and system.

8.2.2 Current status and barriers to the implementation of HCWM
The study employing mixed methods found that there are several aspects of the current HCWM system and its practices that need to be improved to achieve the goal of protecting the environment and public health from the risks of improper HCWM.

The quantitative data analyses show the proportions of hospitals that did not conform with, or possess, requisites for HCWM, such as, waste management units, onsite policies, guidelines, and resources. These conditions and inadequacies, coupled with the behaviour of hospital staff who did not conform with UP and segregation practices, lead to significant risks among the majority of the hospital community.

The inferential statistics findings that can be used for generalisation, show several variables important for determining HCWM status, which include availability of routine budget for HCWM, waste management plan, central policy, manager guidelines, waste management unit, in-room SOP, class of hospital, and location. The influence of each variable on the HCWM system should be carefully computed, as they could be negative or positive, depending on the odds ratio.
Similarly, the qualitative results indicated that there are different concerns among stakeholders, reflecting their roles, responsibilities, and interests. These also corroborate the quantitative findings explaining the reasons why hospitals and other stakeholders, determine the current HCWM and its problems.

The primary concern is that the existing policies do not clearly guide health care settings to comply, and it impacts on HCWM practices that do not fully follow the WMH. The other is that health care settings lack funds for proper HCWM. It is evident that only a small portion of HCW will be categorised as infectious and hazardous, if full segregation and containment are put in place. Thus, the source of the problems should be reconsidered and reformed, to enable HCW generators to implement safe HCWM.

8.2.3 Existing regulations and policies for HCWM in Indonesia

Regulations and policies related to HCWM are important to drive the implementation of HCWM in a way that witnesses outcomes of a sound environment and public health.

From the hospitals’ perspectives, the existing regulations and policies at the central level are sufficient for the majority of them. However, when matched with the policies within the hospitals and current HCWM practices, the policies are not clear to attain the objectives of sustainable HCWM, and are not supported by availability of resources and the leadership to achieve it.

The qualitative findings also indicate that the policies at central level are not clear and are confusing, particularly those dealing with waste treatment permits. These are not favourable to meeting the needs of local hospitals, nor to invite private companies to invest.

The research findings fully addressed the objective of the research, in terms of existing policies and their clarity.

8.2.4 Key stakeholders and their expectations about HCWM system in Indonesia

The study found the key stakeholders, their roles and responsibilities concerning the current HCWM system, and their expectations for improving HCWM in Indonesia.

The stakeholders function at the central level, local level and within hospitals. Their roles and responsibilities are seen in Table 7-1. These details of stakeholders’ roles and
responsibilities are important to establish better mechanisms of coordination and partnership to address the real problems of HCWM, not only as faced by hospitals, but also by governments and the public.

Within the hospitals, the various stakeholders are from diverse professions delivering public health services. Nurses are revealed to be the most important stakeholders, as they are the majority in numbers, and they also mediate between physicians and other hospital workers, to improve the existing conditions of their hospitals, including HCWM.

The study also successfully elicited current coordination details, and expectations for better HCWM. Central policy makers argue that there are serious problems in current HCWM, and they expect to improve it by proposing better coordination to disseminate information of the available regulations and policies, so that HCW generators can comply, accordingly. Furthermore, the hospital managers and HC sanitarians proposed clearer policies, encompassing all phases of HCWM practices, and resources, for better performance in HCWM.

Some hospital managers highlighted: the importance of harmonisation of central and local regulations, in terms of standards of environmental parameters related to HCWM; promotion of privatisation of services at local levels; and, decentralisation of HCWM permits.

8.2.5 Factors for formulating a suitable policy framework for the improvement of HCWM in Indonesia

A suitable policy framework for establishing sustainable HCWM in Indonesia is of paramount importance, as was elaborated and constructed in Chapter 7. It covers determinants or drivers, ranging from regulations and policies, management, technology, finance, and socio-cultural aspects.

These aspects are important as the comprehensive study revealed them in relation to the current HCWM system and practices. The perceptions and knowledge of different stakeholders are considered in formulating the appropriate policy framework, so that its implementation can fulfil the needs of all sectors.
The study also captures the importance of existing programs like, ICP and HPH, within hospitals that can be integrated into holistic environmental management programs. Since the study found limitation of resources for current HCWM practices, the researcher believes that these two programs can strengthen the system within hospitals to achieve sustainable HCWM, as funds are not the only driver of successful HCWM.

8.3 CONCLUDING REMARKS

Indonesia has confronted environmental pollution from improper hazardous waste management, especially, in health care settings that can contribute to the decreasing quality life of the hospital community and the public.

Healthcare facilities are commonly regarded as those available for the public to receive diagnosis and treatment for symptoms and diseases that reduce their capacity to perform normal activities. However, health care settings produce considerable amounts of by-products from their health services that are considered harmful for the environment and public health.

Currently, many hospitals do not manage their HCW in a safe or sustainable way, due to insufficient resources and clear policies to implement sustainable HCWM practices.

The research revealed several factors contributing to the neglect of safe HCWM, the predominant being unclear policies that fail to transform relevant regulations into actions, compliantly performed by the stakeholders concerned.

The research findings added to previous studies concerning HCWM in various countries, including developing countries similar to Indonesia, but, they also, comprehensively covered aspects and methods not covered previously. Therefore, the study regarding a policy framework for sustainable HCWM in Indonesia is the latest that contributes to the current knowledge, and for improving HCWM in the near future, through important aspects of policy improvement.
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A Policy Framework for the Improvement of Health Care Waste Management in Indonesia


A Policy Framework for the Improvement of Health Care Waste Management in Indonesia


Appendix 1
A structured questionnaire used for mailed survey.

**A policy framework for the improvement of health care waste management in Indonesia**

<table>
<thead>
<tr>
<th>Questionnaire Code:</th>
</tr>
</thead>
</table>

### A. GENERAL

1. General Hospital Code: 
2. Hospital name: 
3. Hospital Class: (Please circle the appropriate option) 
   
   A  B  C  D 

4. Hospital Address: 
   - Street
   - City/District
   - Province
   - Phone
   - Facsimile
   - E-mail
   - Website http://www......................

Please circle the appropriate option or fill in the blanks below

5. Hospital's owner: 
   - a. Central Government
   - b. Local Government
   - c. State Enterprise
   - d. Other, please specify: ..................................

6. Number of beds: .......................................... beds

7. The total number of in-patients during 2009? ..............................................

8. The total number of out-patients during 2009? ................................................


### B. HEALTHCARE WASTE MANAGEMENT (HCWM)

#### B1. MANAGEMENT AND RESOURCE ASPECTS

10. Is there any written policy on HCWM from Central Government? 
    - a. Yes 
    - b. No \(\rightarrow Q12\)

11. If yes, is it complete and clear? 
    - a. Yes 
    - b. No

12. Is there any written policy on HCWM from the hospital manager? 
    - a. Yes 
    - b. No \(\rightarrow Q14\)

13. If yes, is it complete and clear? 
    - a. Yes 
    - b. No

14. Are there any particular policies or guidelines for green policy initiatives from Central Indonesian Hospital Association? 
    - a. Yes 
    - b. No

15. Does your hospital have a guideline for HCWM? 
    - a. Yes 
    - b. No \(\rightarrow Q17\)

16. If yes, where are they from? (may choose more than one option) 
    - a. Ministry of Health 
    - b. Ministry of Environment 
    - c. Governor 
    - d. World Health Organisation 
    - e. Provincial/District Health Services 
    - f. Other, please specify: ......................
<table>
<thead>
<tr>
<th>Question-number</th>
<th>Question</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>Does your hospital have a written plan on HCWM?</td>
<td>a. Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. No → Q20</td>
</tr>
<tr>
<td>18</td>
<td>If yes, does it include waste minimisation plan?</td>
<td>a. Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. No → Q20</td>
</tr>
<tr>
<td>19</td>
<td>If there is a minimisation plan, is it equipped with standard operating procedures for its application?</td>
<td>a. Yes → Q21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. No → Q21</td>
</tr>
<tr>
<td>20</td>
<td>If there is no such plan, what is the reference of daily activities of HCWM in this hospital?</td>
<td>a. Based on the overall plan of other related unit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Other, please specify</td>
</tr>
<tr>
<td>21</td>
<td>Has your hospital implemented Health Ministerial Decree No. 1204/2004 concerning Hospital’s environmental health standards?</td>
<td>a. Yes, all aspects</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Only part of it based on the available resources</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. No, at all</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. We do not know yet about the decree</td>
</tr>
<tr>
<td>22</td>
<td>Is there any routine budget for HCWM?</td>
<td>a. Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. No → Q24</td>
</tr>
<tr>
<td>23</td>
<td>Is the budget enough for all the cost of HCWM?</td>
<td>a. Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. No</td>
</tr>
<tr>
<td>24</td>
<td>If there is no routine budget, who pays for the overall costs of HCWM?</td>
<td>a. Ministry of Health</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Provincial Health Service</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Municipal/District Health Service</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. Other institutions, please specify</td>
</tr>
<tr>
<td>25</td>
<td>Does your hospital have a unit/division of sanitation/environmental health?</td>
<td>a. Yes → Q27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. No</td>
</tr>
<tr>
<td>26</td>
<td>If no, which unit is responsible for HCWM?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>How many people usually work in managing healthcare waste including full-time and part-time personnel?:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Are the number and the quality of those personnel sufficient to perform daily activities of HCWM?</td>
<td>a. Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. No</td>
</tr>
<tr>
<td>29</td>
<td>Are operational personnel are outsourced or obtained from a third party?</td>
<td>a. Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. No</td>
</tr>
<tr>
<td>30</td>
<td>Have they been trained before performing their tasks in managing hospital waste?</td>
<td>a. Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. No</td>
</tr>
<tr>
<td>31</td>
<td>Are they equipped with appropriate personal protective equipment (PPE) to avoid risk of waste or injuries?</td>
<td>a. Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Only some of them</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. No, at all</td>
</tr>
<tr>
<td>32</td>
<td>Has all personnel in the unit/division in charge with HCWM been trained concerning HCWM?</td>
<td>a. Most of them (&gt;60%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Few of them (&lt;30%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. None</td>
</tr>
<tr>
<td>33</td>
<td>What institutions do usually provide HCWM trainings? (May choose more than one option)</td>
<td>a. Ministry of Health</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Ministry of Environment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Provincial Health Service</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. WHO</td>
</tr>
<tr>
<td></td>
<td></td>
<td>e. Indonesian Hospital Association (Central/local)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>f. Unicef</td>
</tr>
<tr>
<td></td>
<td></td>
<td>g. ADB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>h. Non Governmental Organisations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>i. Other, please specify</td>
</tr>
<tr>
<td>34</td>
<td>Is the sanitation/environmental health unit involved in the planning and decision of purchasing hazardous substances for this hospital?</td>
<td>a. Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Sometimes</td>
</tr>
<tr>
<td>35</td>
<td>Does your hospital record and report all stages of HCWM activities, including waste generation, treatment, reuse, recycle, and disposal?</td>
<td>a. Yes, all of activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Yes, only some of them</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. None</td>
</tr>
</tbody>
</table>
36. Does your hospital record and report all injuries happened to all hospital's staff caused by wastes and when they performed injections or medicine administration?
   a. Yes, routinely  
   b. Yes, but it is not routine  
   c. No, even though such accident happened  
   d. No, because such accident has never happened

37. Does the hospital provide yearly report on HCWM?
   a. Yes  
   b. No

B.2. SOLID WASTE

B.2.1. Solid Waste Generation

38. How many kg or m3 does this hospital generate general waste from all rooms daily?
   a. We do not know/never calculated  
   b. ................. kg/day  
   c. ..............................m3/day

39. How many kg or m3 does this hospital generate medical waste from all wards daily?
   a. We do not know/never calculated  
   b. ................. kg/day  
   c. ..............................m3/day

40. How many kg the average of medical waste generated from every unit/ward in this hospital. Please mention below every waste stream available in this hospital. If the medical waste generation has never been weighed (as answer no.a), please do not fill in this section.

<table>
<thead>
<tr>
<th>Unit/Room</th>
<th>Average Medical Waste (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Out-patient room</td>
<td></td>
</tr>
<tr>
<td>b. Emergency room</td>
<td></td>
</tr>
<tr>
<td>c. Obstetric and gynecology room</td>
<td></td>
</tr>
<tr>
<td>d. Surgery room</td>
<td></td>
</tr>
<tr>
<td>e. Operation theatre</td>
<td></td>
</tr>
<tr>
<td>f. Intensive Care Unit</td>
<td></td>
</tr>
<tr>
<td>g. Internal room</td>
<td></td>
</tr>
<tr>
<td>h. Pathology room</td>
<td></td>
</tr>
<tr>
<td>i. Pharmacy room</td>
<td></td>
</tr>
<tr>
<td>j. Isolation room</td>
<td></td>
</tr>
<tr>
<td>k. Oncology room</td>
<td></td>
</tr>
<tr>
<td>l. Radiology room</td>
<td></td>
</tr>
<tr>
<td>m. Dental clinic</td>
<td></td>
</tr>
<tr>
<td>n. Dialysis room</td>
<td></td>
</tr>
<tr>
<td>o. Laboratory</td>
<td></td>
</tr>
<tr>
<td>p. ..................... room</td>
<td></td>
</tr>
<tr>
<td>q. ..................... room</td>
<td></td>
</tr>
<tr>
<td>r. ..................... room</td>
<td></td>
</tr>
<tr>
<td>s. .......................... kg</td>
<td></td>
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<tr>
<td>t. ..................................kg</td>
<td></td>
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<td>u. ..................................kg</td>
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<td>v. ..................................kg</td>
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<td>w. ..................................kg</td>
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<td>x. ..................................kg</td>
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<tr>
<td>y. ..................................kg</td>
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<tr>
<td>z. ..................................kg</td>
<td></td>
</tr>
</tbody>
</table>

41. Is there any electronic waste generated from this hospital as part of medical wastes?
   a. Yes, but they have never been weighed  
   b. ................. kg/day

42. Is there any sharp waste generated from this hospital as part of medical wastes?
   a. Yes, but they have never been weighed  
   b. ................. kg/day

43. Is there any radioactive waste generated from this hospital?
   a. Yes, but they have never been weighed  
   b. ................. kg/day

44. Is there any infectious waste generated from this hospital, excluding sharp wastes?
   a. Yes, but it has never been weighed  
   b. ................. kg/day

45. Is there any pharmaceutical waste generated from this hospital?
   a. Yes, but it has never been weighed  
   b. ................. kg/day

B.2.2. Segregation and Collection

46. Are all types of waste segregated at source daily?
   a. No segregation at all  
   b. Segregation into two types (medical waste and non medical waste)  
   c. Segregation into three types (non sharp medical waste, sharp waste, and general waste)  
   d. Segregation into four types (general, sharp, non sharp medical waste and chemical waste)  
   e. Segregation into five types (general, sharp, non sharp, chemical, and radioactive waste)  
   f. Segregation into general, sharp, non sharp, chemical, radioactive waste, pathological, heavy metal, cytotoxic, and pressure container)

47. Who is in charge of waste segregation at each ward/room? (may choose more than one options)
   a. Any health personnel who are working in each room  
   b. Cleaning service personnel  
   c. Other, please specify .................................................................
48. Are there any standard operating procedures of segregation and collection of waste in each room based on its characteristics and labels?
   a. Yes  
   b. No

49. Is each characteristic of waste contained, collected, and labeled in an appropriate plastic/bin in each ward according to the Health Ministerial Decree No.1204/2004?
   a. Yes  
   b. Only part of them
   c. No

50. Why this hospital could not provide colour coded plastics for segregating and collecting medical waste?
   b. Colourful plastics for wastes are rare and expensive  
   c. We are not accustom to the Health Ministerial Decree No. 1204/2004  
   d. Other, please specify ........................................

51. Is all containers (excluding small bins in each ward) labeled according to the Health Ministerial Decree No. 1204/2004?
   a. Yes  
   b. No

52. How do you contain sharp waste in this hospital?
   a. In a safety box  
   b. In a used plastic container  
   c. In a separate infectious plastic  
   d. In the same with non sharp medical waste
   e. Other, please specify ........................................

53. Is used syringe separated from its needle before collected?
   a. Yes, needles are cut with a needle cutter  
   b. No  
   c. Other, please specify ........................................

54. What is the next activity after needles cut?
   a. To be disinfected for recycling purposes  
   b. To be incinerated  
   c. To be buried  
   d. To be mixed with building material without disinfected  
   e. Other, please specify ........................................

55. Has any needle puncture/injury happened to any of personnel?
   a. Yes  
   b. No

56. If yes, how to handle the victims?
   a. To be given post exposure prophylaxis  
   b. Wound will be cleaned only  
   c. No action  
   d. To be given ATS injection  
   e. Other, please specify ........................................

57. Types of syringes usually used:
   a. Disposable syringes  
   b. Sterilisable syringes  
   c. Auto-disable syringes  
   d. Safety syringes  
   e. Mix of them, depending the types of injections

---

**B2.3. On-site Transport and Storage**

58. Is all wastes collected, transported and stored in designated storage temporarily?
   a. Yes, at a medical waste storage  
   b. No medical waste storage (together with general waste)  
   c. Medical waste is directly loaded into incinerator  
   d. Other, please specify ........................................

59. Is the medical waste storage safe from unauthorised persons?
   a. Yes  
   b. No, easy to access

60. Is the medical waste storage arranged and labeled?
   a. Yes  
   b. No

61. Are there any waste carts to transport medical waste to on-site storage or incinerator?
   a. Yes  
   b. No

62. If there are no waste carts, how waste transported to temporary storage or incinerator?
   a. Carried by hands  
   b. Other, please specify ........................................

63. Who transport medical waste to the temporary storage or the incinerator?
   a. Cleaning service personnel  
   b. Operators of the incinerator  
   c. Nurses who are working in that time  
   d. Others, please specify ........................................
<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>64. How often the collected waste from waste stream transported to the storage or the incenerator per day?</td>
<td>a. once only b. Twice c. three times d. Depend on the amount of waste generated</td>
</tr>
<tr>
<td>65. Is there any recording of waste collected and incinerated daily?</td>
<td>a. Yes b. No</td>
</tr>
<tr>
<td>B.2.4. Reuse, Recycle and Treatment</td>
<td></td>
</tr>
<tr>
<td>66. Are there any kinds of general wastes reused?</td>
<td>a. Yes b. No → Q68</td>
</tr>
<tr>
<td>67. If yes, please specify the type of reused general waste</td>
<td>a. .................................... b. .................................... c. .................................... d. .................................... e. .................................... f. .................................... g. ....................................</td>
</tr>
<tr>
<td>68. Are there any kinds of medical wastes reused?</td>
<td>a. Yes b. No → Q71</td>
</tr>
<tr>
<td>69. If yes, please specify the type of reused medical waste</td>
<td>a. .................................... b. .................................... c. .................................... d. .................................... e. .................................... f. .................................... g. ....................................</td>
</tr>
<tr>
<td>70. Will the medical waste be disinfected prior to reuse?</td>
<td>a. Yes b. No c. Some of them which are assumed to be infectious</td>
</tr>
<tr>
<td>71. Are there any medical wastes recycled for other purposes?</td>
<td>a. Yes, but outside hospital b. No</td>
</tr>
<tr>
<td>72. If yes, please specify:</td>
<td>a. .................................... b. .................................... c. .................................... d. .................................... e. .................................... f. .................................... g. ....................................</td>
</tr>
<tr>
<td>73. Are there any processes of decontamination of medical waste prior to disposal as it will not be incinerated?</td>
<td>a. Yes b. No, because all medical wastes will be incinerated c. Other, please specify .............................................</td>
</tr>
<tr>
<td>74. Are there any treatments of medical waste prior to final disposal?</td>
<td>a. Yes b. No → Q97</td>
</tr>
<tr>
<td>75. If yes, what kind of technology used for treating medical waste?</td>
<td>a. Incineration b. Autoclaving c. Encapsulation d. Microwaving e. Disinfection/decontamination f. Combination of the above technologies g. Other, please specify .............................................</td>
</tr>
</tbody>
</table>
76. If the answer of Question no. **75** is **a**), What kind of medical wastes to be incinerated? *(may choose more than one option)*
   - Infectious waste
   - Sharp waste
   - Pharmaceutical waste
   - Heavy metal/electronic waste
   - Pathological waste
   - Chemical waste
   - Radioactive waste
   - Pressure container

77. Is incinerator located in hospital premises?
   - a. Yes
   - b. No

78. What is the type of incinerator?
   - a. One chamber incinerator
   - b. Two chamber incinerator
   - c. Other, please specify

79. Is the incinerator equipped with fly ash trap?
   - a. Yes
   - b. No

80. What is the maximum capacity?
    ..................................... kg or ......................................... litre/s

81. What is the maximum temperature used and how long to incinerate medical waste?
    ........................................... °C ............................................ minute/s
    ........................................... °C ............................................ minute/s

82. Can the maximum temperature be achieved in every incineration process?
   - a. Yes
   - b. Sometimes
   - c. No

83. How old is the incinerator?
   - a. 1-3 years
   - b. 4-6 years
   - c. 7-9 years
   - d. 10-12 years
   - e. >12 years

84. How tall is the chimney?
    ..................................... metres

85. What is the distance between incinerator and closest human settlement?
    .....................................metres

86. What is the distance between incinerator and the public road?
    ..................................... metres

87. Are there any regular checks of emission?
   - a. Yes
   - b. No

88. If yes, how many times per year?
   - a. Once
   - b. Twice
   - c. Three times
   - d. > 3 times

89. Who usually operate the incinerator?
   - a. Trained operator
   - b. Trained cleaning service personnel
   - c. Other, please specify

90. Are the operators always wearing personal protective equipment?
   - a. Yes
   - b. Sometimes
   - c. No

91. Is all waste personnel including operators immunised with anti hepatitis B vaccines?
   - a. Yes
   - b. No
<table>
<thead>
<tr>
<th></th>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
</table>
| 92. | Is it permitted by law to incinerate medical waste in the hospital premises?                                                                                                                                  | a. Yes  
|    | b. No                                                                                                                                                                                                   |----------------------------------------------------------------------------------------------|
| 93. | If the hospital does not have an incinerator, whose incinerator is used to treat its medical waste?                                                                                                        | a. Owned by other hospitals  
|    | b. Owned by private company  
|    | c. Owned by local government  
|    | d. Other, please specify                                                                                                                                                                               |----------------------------------------------------------------------------------------------|
| 94. | Is there any memory of understanding in collaboration of waste treatment between hospitals and waste treatment providers?                                                                                       | a. Yes  
|    | b. No                                                                                                                                                                                                   |----------------------------------------------------------------------------------------------|
| 95. | Are waste treatment fees expensive for your hospital?                                                                                                                                                       | a. Yes  
|    | b. No                                                                                                                                                                                                   |----------------------------------------------------------------------------------------------|
| 96. | Is your hospital manager satisfied with off-site services of waste incineration provided by third parties?                                                                                                  | a. Yes  
|    | b. No                                                                                                                                                                                                   |----------------------------------------------------------------------------------------------|
| 97. | If medical waste will not be treated, where will be the final disposal?                                                                                                                                     | a. Final disposal area (Open dumping with general waste)  
|    | b. Buried in the hospital premises  
|    | c. Dispose of to rivers  
|    | d. Giving to waste pickers/scavengers  
|    | e. Other, please specify                                                                                                                                                                               |----------------------------------------------------------------------------------------------|
| 98. | What are constraints of HCWM? (may choose more than one option)                                                                                                                                              | a. Lack of personnel  
|    | b. Lack of train personnel  
|    | c. Lack of facilities  
|    | d. Lack of Funds  
|    | e. Lack of appropriate technologies  
|    | f. Lack of policies and guidelines  
|    | g. Lack of management support  
|    | h. Other, please specify                                                                                                                                                                               |----------------------------------------------------------------------------------------------|
| 99. | Does this hospital have a wastewater treatment plant (WWTP)?                                                                                                                                                  | a. Yes  
|    | b. No \( \rightarrow Q103 \)                                                                                                                                                                                |----------------------------------------------------------------------------------------------|
| 100. | If yes, what is the type of WWTP?                                                                                                                                                                            | a. Complete WWTP  
|    | b. Primary WWTP  
|    | c. Secondary WWTP  
|    | d. Other, please specify                                                                                                                                                                               |----------------------------------------------------------------------------------------------|
| 101. | Is medical wastewater separately collected from non medical wastewater before entering WWTP?                                                                                                               | a. Yes  
|    | b. No \( \rightarrow Q104 \)                                                                                                                                                                                |----------------------------------------------------------------------------------------------|
| 102. | If yes, is medical waste treated separately before entering WWTP and mixed with non medical wastewater?                                                                                                     | a. Yes  
|    | b. No                                                                                                                                                                                                   |----------------------------------------------------------------------------------------------|
| 103. | Are there any examinations of wastewater effluents regularly?                                                                                                                                                  | a. Yes  
|    | b. No \( \rightarrow Q107 \)                                                                                                                                                                                |----------------------------------------------------------------------------------------------|
| 104. | How often are the examinations conducted per year?                                                                                                                                                            | a. Once only  
|    | b. Twice  
|    | c. Three times  
|    | d. More than three times                                                                                                                                                                                   |----------------------------------------------------------------------------------------------|
| 105. | Does the quality of effluent always meet the available quality standards?                                                                                                                                     | a. Yes  
|    | b. Sometimes  
|    | c. No                                                                                                                                                                                                   |----------------------------------------------------------------------------------------------|

### B.3 WASTEWATER

99. Does this hospital have a wastewater treatment plant (WWTP)?
   a. Yes  
   b. No \( \rightarrow Q103 \)

100. If yes, what is the type of WWTP?
     a. Complete WWTP  
     b. Primary WWTP  
     c. Secondary WWTP  
     d. Other, please specify.........................

101. Is medical wastewater separately collected from non medical wastewater before entering WWTP?
     a. Yes  
     b. No \( \rightarrow Q104 \)

102. If yes, is medical waste treated separately before entering WWTP and mixed with non medical wastewater?
     a. Yes  
     b. No

103. Are there any examinations of wastewater effluents regularly?
     a. Yes  
     b. No \( \rightarrow Q107 \)

104. How often are the examinations conducted per year?
     a. Once only  
     b. Twice  
     c. Three times  
     d. More than three times

105. Does the quality of effluent always meet the available quality standards?
     a. Yes  
     b. Sometimes  
     c. No
<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
</table>
| 106. If there is no WWTP, where is/are the final disposal of hospital wastewater? (may choose more than one option) | a. Septic tank  
b. Pond/lagoon in the hospital premise  
c. River nearby hospital  
d. Municipal sewer  
e. Ocean/beach  
f. Other, please specify .......................................................... |
| 107. What is the main constraint of providing WWTP? (only one option)    | a. Overall investment  
b. Operational costs  
c. Spareparts  
d. Location  
e. Expertise |
| B.4. INFECTION CONTROL                                                  |                                                                         |
| 108. Is there any training on infection control for personnel in sanitation/environmental health unit/division? | a. Yes  
b. No → Q110 |
| 109. If yes, what are the main topics? (may choose more than one option) | a. Universal precaution  
b. Safe injection including recapping  
c. Wastewater spillage  
d. Proper hand washing and use of personal protective equipment (PPE)  
e. Recording of contamination and sharp injuries  
f. Post exposure prophylaxis  
g. Waste segregation at source |
| 110. Are there any designated personnel in infection control practices? | a. Yes  
b. No |
| 111. Does this hospital provide personal protective equipment to prevent personnel from bloodborne infections? | a. Yes  
b. No |
| 112. Has this hospital introduced health promotion initiatives?         | a. Yes  
b. No |
| 113. Is this hospital included in the pilot project of infection control programs by Ministry of Health among 100 hospitals? | a. Yes  
b. No → STOP |
| 114. If yes, is the sanitation/environmental health unit involved in that project? | a. Yes  
b. No |

-The end of the questionnaire-

Thank you
Appendix 2A

A semi-structured questionnaire for in-depth interview with a Policy Maker at MOH (Director of Environmental Health)

Guidelines for in-depth interview:
1. The interviewee is an official who is a policy and decision maker associated with HCWM in healthcare facilities
2. Introduce yourself to the interviewee before doing an interview
3. Give an explanation manuscript form and informed consent to the interviewee to be signed upon the completion of the interview
4. Explain the research purposes, benefits and the important roles of the interviewee’s participation in the research
5. Begin the interview according to the question materials and use the list of questions (semi-structured questionnaires) as a guide only
6. Use a tape recorder and notebook to record the contents of the interview
7. Thank the interviewee after the interview is finished

Interview questions:

1. According and Government Regulation No. 18/1999 amended by Government Regulation No. 85/1999 and Solid Waste Management Act No. 18/2008, solid medical waste is one type of specific waste and its management is the responsibility of the Central Government. In your opinion, what issues are fundamental to HCWM in Indonesia?
   1.1 For a program director such as Director of Environmental Health
   1.2 For those generating health care wastes (Health Care Facilities)

2. According to article 7 of Solid Waste Management Act No. 18/2008, the implementation of waste management, the Government has 5 points of authority, first of which is to set the policy and national waste management strategy. Which government policies and strategies as mentioned above fall within the domain of Directorate of Environmental Health?
3. Ministry of Health (Directorate of Environmental Health), in accordance to its authority in setting norms, standards, procedures and criteria for healthcare waste management has issued Ministerial Decree No. 1204/2004 on Environmental Health Standards in Hospitals, including requirements on HCWM. What do you think are the benefits of this Ministerial decree so far? Are other guidelines necessary in order to speed up the improvements on safe and sustainable HCWM in Indonesia?

4. What do you know about the HCW treatment system? Is it local (on-site) or centralized (off-site), or combination of both depending on the conditions of the hospitals or the region?

5. What do you think of the inter-program within the MOH (with Directorate General of Medical Services) and intra coordination (e.g. with Ministry of Environment and IHA) in establishing safe HCWM system in Indonesia?

6. Do you have any suggestions and expectations to improve the current system for a safe and sustainable HCWM in Indonesia?
Appendix 2B

A semi-structured questionnaire for in-depth interview with a Policy Maker at MOH (Director of Referral Health Services).

Guidelines for in-depth interview:

1. The interviewee is an official who is a policy and decision maker associated with HCWM in healthcare facilities
2. Introduce yourself to the interviewee before doing an interview
3. Give an explanation manuscript form and informed consent to the interviewee to be signed upon the completion of the interview
4. Explain the research purposes, benefits and the important roles of the interviewee’s participation in the research
5. Begin the interview according to the question materials and use the list of questions (semi-structured questionnaires) as a guide only
6. Use a tape recorder and notebook to record the contents of the interview
7. Thank the interviewee after the interview is finished

Interview questions:

1. Hospitals as health care facilities produce HCW consisting of medical and non-medical wastes. According to Government Regulation No. 18/1999 amended by Government Regulation No.85/1999, solid medical waste is classified as specific waste because they contain toxic and hazardous materials and therefore these wastes must be managed properly. In your opinion, why is the compliance level in HCWM in Indonesian hospitals still low? Please explain from these aspects: availability of regulations and policies, technical, management, and social aspects.

2. What policies have been implemented by the Directorate General of Medical Services so that healthcare institutions including hospitals throughout Indonesia can conduct safe and sustainable waste management?
3. Is there existing inter program cooperation with Directorate of Environmental Health and intra cooperation with the MOE or regional governments on HCWM? If yes, please explain. To what extend do you agree that the existing co-operations have been effective to establish safe HCWM in Indonesia?

4. Are requirements for HCWM have been accommodated in hospital accreditation requirements or in ‘patient safety’ program? Please explain.

5. Has Directorate General of Medical Services been promoting “green hospital policy” such as using environmentally friendly materials, for example mercury-free diagnostic devices? If not, what are the constraints?

6. What hopes or suggestions do you have in the improvement of both central and local government policies in the realisation of sustainable HCWM in Indonesia?
Appendix 2C

A semi-structured questionnaire for in-depth interview with a Policy Maker at NAAE (Head of Centre for Radioactive Treatment Technology).

Guidelines for in-depth interview:

1. The interviewee is an official who is a policy and decision maker associated with HCWM in healthcare facilities
2. Introduce yourself to the interviewee before doing an interview
3. Give an explanation manuscript form and informed consent to the interviewee to be signed upon the completion of the interview
4. Explain the research purposes, benefits and the important roles of the interviewee’s participation in the research
5. Begin the interview according to the question materials and use the list of questions (semi-structured questionnaires) as a guide only
6. Use a tape recorder and notebook to record the contents of the interview
7. Thank the interviewee after the interview is finished.

Interview Questions:

1. A small part of health care waste contains radioactive waste that must be managed in accordance to the laws and regulations in force, such as Government Regulation No. 27/2002 on Radioactive Waste Management in Health Care Facilities. In your opinion, what are the obligations of health care facilities including hospitals in managing their radioactive wastes in order to comply with the relevant regulations?

2. In your opinion, does the Central government have clear national policies in HCWM, particularly those related to radioactive waste management in health service facilities including hospitals?

3. Do you think there are overlapping regulations regarding radioactive waste management in Indonesia?
4. Environmental Management Act No. 32 year 2009 mandates the need for coordination, cooperation, and the establishment of inter-sector cooperation at the national level to address environmental issues, as well as Solid Waste Management No.18/2008. What the cooperation between your institution with the MOE?

5. To what extent is the compliance of hospitals and other health care facilities in managing their radioactive wastes? How many hospitals are already regularly sending their radioactive waste to your institution?

6. In your opinion, what can hospitals and other health care facilities do to improve their awareness and compliance to manage their radioactive wastes according to applicable regulations?

7. What expectations or suggestions do you have in the improvement of both central and local government policies in the implementation of sustainable HCWM in Indonesia?
Appendix 2D

A semi-structured questionnaire for an in-depth interview with a Policy Maker at MOE (Deputy Minister for Management of Hazardous Substances, Hazardous Waste and MSW).

Guidelines for in-depth interview:

1. The interviewee is an official who is a policy and decision maker associated with HCWM in healthcare facilities
2. Introduce yourself to the interviewee before doing an interview
3. Give an explanation manuscript form and informed consent to the interviewee to be signed upon the completion of the interview
4. Explain the research purposes, benefits and the important roles of the interviewee’s participation in the research
5. Begin the interview according to the question materials and use the list of questions (semi-structured questionnaires) as a guide only
6. Use a tape recorder and notebook to record the contents of the interview
7. Thank the interviewee after the interview is finished.

Interview Questions:

1. According to article 2 of Solid Waste Management Act No. 18 year 2008, solid medical wastes are classified as specific waste because they contain toxic and hazardous materials that need to be properly managed. Toxic and hazardous waste is also regulated in the Government Regulation No 18 and 85/1999. In your opinion, what obligations should healthcare facilities, including hospitals, fulfil in order to comply with the available act and regulations above?

2. In your opinion, should health facilities wait out on new government regulations or Act No. 18 and 85/1999 is considered sufficient in regulating the obligations of health facilities in managing their medical wastes?
3. Solid Waste Management Act no. 18/2008 mandates the need for coordination, cooperation, and the establishment of inter-sectoral networks at the central level to deal with specific waste problems, bearing in mind that specific waste can not be solved by one sector alone. In your opinion, what are the roles and authority of the health sector in HCWM?

4. To what extent is the cooperation between MOE and MOH in HCWM? Please explain from the institutional aspects as well as substantial aspects.

5. What do you think about sustainable HCWM in Indonesia?

6. According to WHO, developing countries that are still managing their health care waste using incinerators, especially small-scale incinerators, are gradually being encouraged to switch to a non-incineration system to avoid the impact of dioxins and furans generated from the incinerators? What do you think if the government regulations in Indonesia still allow the use of incinerators? What do you think about the establishment of off-site treatment system of medical wastes in Indonesia, especially for healthcare institutions surrounding Java Island?

7. What expectations or suggestions do you have in the improvement of both central and local government policies in the implementation of sustainable HCWM in Indonesia?
Appendix 2E

A semi-structured questionnaire for an in-depth interview with a Policy Maker at Indonesian Hospital Association

Guidelines for in-depth interview:

1. The interviewee is an official who is a policy and decision maker associated with HCWM in healthcare facilities
2. Introduce yourself to the interviewee before doing an interview
3. Give an explanation manuscript form and informed consent to the interviewee to be signed upon the completion of the interview
4. Explain the research purposes, benefits and the important roles of the interviewee’s participation in the research
5. Begin the interview according to the question materials and use the list of questions (semi-structured questionnaires) as a guide only
6. Use a tape recorder and notebook to record the contents of the interview
7. Thank the interviewee after the interview is finished.

Interview questions:

1. What is the role of IHA in improving the quality of environmental health of hospitals in Indonesia? Is IHA also promoting ‘green hospital’ concept to its member hospitals? If yes, please explain how to promote ‘green hospital’ concepts to your members. If not, why?

2. According to article 2 of the Act No. 18 year 2008 on Solid Waste Management, medical solid waste is classified as specific waste because they contain toxic and hazardous materials that need to be properly managed. Toxic and hazardous waste is also regulated in the Government Regulation No. 85/1999. In your opinion, what obligations should health facilities, including hospitals, fulfil in order to comply with the Act No. 18/2008 and the Government Regulation above?
3. In your opinion, does the government (MOH) have clear policies regarding health HCWM? If not, please explain?

4. According to studies and monitoring conducted by the MOH and others, a large number of health care facilities including hospitals have not yet managed their wastes safely. Why do you think this is so? What obstacles do hospitals face in complying with their obligations to properly manage their healthcare wastes? Please explain in various aspects: technical, management, legislative, and social.

5. What is the primary role of IHA in central and regional levels in encouraging hospitals to implement sustainable and safe HCWM, so that the risks of diseases and accidents related to health care waste can be reduced?

6. According to WHO, developing countries that are still managing their HCW using incinerators, especially small-scale incinerators, are gradually being encouraged to switch to a non-incineration system to avoid the impact of dioxins and furans generated from the incinerator? What do you think if the majority of hospitals in Indonesia are still using small-scale incinerators?

7. What hopes or suggestions do you have in the improvement of both central and local government policies in the implementation of sustainable HCWM in Indonesia?
Appendix 2F

A semi-structured questionnaire for in-depth interviews with Policy Makers at Selected Hospitals (Deputy Directors of General Affairs).

Guidelines for in-depth interview:

1. The interviewee is an official who is a policy and decision maker associated with HCWM in healthcare facilities
2. Introduce yourself to the interviewee before doing an interview
3. Give an explanation manuscript form and informed consent to the interviewee to be signed upon the completion of the interview
4. Explain the research purposes, benefits and the important roles of the interviewee’s participation in the research
5. Begin the interview according to the question materials and use the list of questions (semi-structured questionnaires) as a guide only
6. Use a tape recorder and notebook to record the contents of the interview
7. Thank the interviewee after the interview is finished.

Interview questions:

1. Hospitals as health care facilities produce health care wastes consisting of medical and non-medical wastes. According to article 2 of Solid Waste Act No. 18 year 2008 and Government Regulation No. 18/1999 amended by Government Regulation No. 85/1999, solid medical wastes are classified as specific waste because they contain infectious, toxic and hazardous materials, and these wastes must be managed properly. In your opinion, is the healthcare waste in this hospital is being safely managed so that there are no risks to the environment and health of patients, hospital community and communities in surrounding areas?

2. In your opinion, should health care waste be managed in accordance to the existing rules and regulations? If yes, why?

3. What policies have been implemented in this hospital about HCWM?
4. Are there any constraints faced by managers of this hospitals in proper HCWM so far? Please explain from these aspects: technical, management, economical/costs, and legal/statutory aspects.

5. Has there been effort to improve the capability of hospital personnel in HCWM, such as training or study visits in order to conduct better HCWM? If yes, is it an induction training conducted by this hospital for new staff or a special training by MOH/MOE, etc? If not, why?

6. What laws, regulations, or policies are being used as a reference in HCWM in this hospital?

7. Is Ministerial Decree No. 1204/2004 on Hospital Environmental Health Standards considered sufficient as guidelines for safe HCWM in this hospital? If yes, please explain. If not, why?

8. Is there a surveillance system (continuous recording and reporting) of injuries caused by sharp waste puncture such as used needles and scalpels? If no, why?

9. According to article 40 of Solid Waste Management Act No. 18/2008, hospital managers (including the hospital itself as waste generator) who do not manage their wastes properly according to the norms, standard, requirements and procedures, so that the environment and community are exposed to health risks can be subjected to sanctions. What do you think about this?

10. Have there been efforts in HCWM in this hospital to implement 3R concept?

11. In HCWM, is this hospital cooperating with other parties (private, government institutions, hospitals, clinics, and other healthcare facilities) through memorandum of understanding or agreement? If yes, please mention with which party and on what kind of waste management activities such as collection, storage, treatment, transport and disposal? If no, why?
12. What do you think about the currently available medical waste treatment technology in Indonesia? Do you think that incineration using the currently available incinerators has been sufficient to manage medical waste and reduce the environmental risks?

13. What hopes or suggestions do you have in the improvement of both central and local government policies in the implementation of sustainable HCWM in Indonesia?
Appendix 2G

A semi-structured questionnaire for in-depth interviews with Sanitarians at Selected Health Centres

Guidelines for in-depth interview:

1. The interviewee is an official who is a policy and decision maker associated with HCWM in healthcare facilities
2. Introduce yourself to the interviewee before doing an interview
3. Give an explanation manuscript form and informed consent to the interviewee to be signed upon the completion of the interview
4. Explain the research purposes, benefits and the important roles of the interviewee’s participation in the research
5. Begin the interview according to the question materials and use the list of questions (semi-structured questionnaires) as a guide only
6. Use a tape recorder and notebook to record the contents of the interview
7. Thank the interviewee after the interview is finished

List of questions:

1. Has your institution been managing its health care waste generated? If yes, please explain the usual mechanism of healthcare waste management in your institution.
2. In the collection and segregation processes of healthcare wastes, do you also follow the colour-coded system? If not, why?
3. Is there any medical waste collection storage at this health centre? If not, what is done to the solid medical waste? Is it directly discharged into temporary disposal facility mixed with household waste?
4. Has this institution made calculations of weight/volume of solid medical waste generated each week/month in order to establish a regular plan for HCWM?
5. Is the medical waste generated treated first prior to disposal? If yes, in what manner and where? Please explain. If not, why?
6. Does District/City Health Office provide policy and guidelines for HCWM in community health Centres including your institution?

7. Does District/City Health Office also provide your institution with equipment and supplies for HCWM in a regular basis? If yes, please specify them?

8. Is there cooperation with other parties on processing and disposal of solid medical waste? How does this health centre dispose of their medical waste?

9. How does this health centre dispose of their liquid waste? Is it being flown into a septic tank or on open grounds or any special treatment method?

10. Have HC staff or sanitation unit staff attended training on HCWM held by Provincial Health Office or other institutions?

11. What suggestions do you have so that medical waste does not become a problem to the environment and community health?