Management of Environmental Quality: An International Journal

An analysis of medical waste management practices in the health care sector in Colombo

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Received 8 February 2018
Revised 5 March 2018
22 March 2018
Accepted 22 March 2018

Abstract

Purpose – The purpose of this paper is to identify the type of waste generation and the management of waste in order to reduce pollution in the health care sector with special reference to Colombo, Sri Lanka. The paper further aims to determine the relationship between top management and staff attitudes toward waste management and to identify the level of technology used in medical waste management in various types of health care organizations.

Design/methodology/approach – A survey questionnaire was developed using the designed conceptual framework to achieve the objectives of the study.

Findings – The study identifies that, though governments provide legislations and regulatory support, organizations of any size must have a positive attitude, awareness, capability and technology to initiate improvements for waste management processes and be prepared to adapt to new trends. Developing positive attitudes and improved knowledge on changes in waste management technology will assist in encouraging organizations to invest in this area.

Research limitations/implications – The scope of this project is limited to private health care institutions in the Colombo district in Sri Lanka from where data were gathered.

Originality/value – Health care center waste management is a relatively new discipline in the Sri Lankan health sector. This study provides an opportunity for management to identify the level of waste generated by health care institutions and the methods followed for the disposal of waste. Environmental groups can gain benefit through this project, since they can identify whether the private institutes in the health care sector are following world-accepted methods in disposing of waste.

Keywords Waste management, Environmental pollution, Medical waste, Capital requirement

Paper type Research paper

1. Introduction

The environment supplies pure materials which industry converts through various processes to make an output or product. The final unused material becomes waste, the disposal of which often becomes a significant problem to companies and society at large. Though most companies have various methods of waste disposal, in many instances, this is not conducted effectively and does not ensure a balance between input and output.

Sri Lanka is no exception in this regard. People, in general, have little concern about pollution often due to a lack of relevant education. Common unsatisfactory practices include disposing of garbage indiscriminately, especially on road sides, which results in pollution of the rainwater runoff as well as air contamination. Factories commonly dispose of waste illegally. Sri Lanka has no strong national policy with respect to waste disposal.

The healthcare service system in Sri Lanka can be divided into government and private hospitals. Governmental hospitals serve around 95 percent of the Sri Lankan population, and the private sector serves the rest. The governmental service system in the country is divided into curative services and preventive services. Health care is provided free of cost to all people including the super specialty services. For preventive services, there is one

The author thanks Dr Alan Robertson, Dean of Studies from Nawaloka College of higher studies for his copy editing that greatly improved the manuscript.

Management of Environmental Quality: An International Journal
Vol. 29 No. 5, 2018
pp. 813-825

1477-7835
DOI 10.1108/MEQ-02-2018-0032

Medical Officer of Health (MOH) in each Assistant Government Division, per 60,000 people. Peripheral Health Mid Wives and Public Health Inspectors support each MOH. They are responsible for the mother and child health program and for the food hygiene and sanitation, respectively. In each district, there is a Deputy Director Provincial Health officer; for each province, there is a Provincial Health Officer; and at the top of this hierarchy is the Director General of Health Services. The number of private medical services is relatively small in Sri Lanka, and these services are predominantly located in Colombo and the other larger cities. Management of healthcare wastes is a major environmental issue in the country. Though healthcare services are responsible to manage healthcare wastes they generate, most of them fail to do this efficiently, which results in environmental pollution through such wastes (Chanpika *et al.*, 2015). Waste management options need to be efficient, safe and environmentally friendly to protect people from voluntary and accidental exposure to pollutants when collecting, handling, storing, transporting, treating or disposing of waste. Furthermore, in the Sri Lankan context, such options need to be cost effective, taking into account the local logistical needs (Haniffa, 2004). Though clinical waste management should be an integral part of the health care delivery system, the principal reason for the absence of such infrastructure is economic. Health personnel are still to distinguish health care waste from ordinary garbage.

Sri Lanka is beginning to see the effects of unacceptable hazardous waste disposal, particularly in the form of contaminated needles and syringes re-entering the formal health system. Further studies need to be done to document this phenomenon. Improper and unsafe re-cycling of needles and syringes is a major concern in Sri Lanka because it jeopardizes the highly successful childhood immunization program. If vaccination is perceived as unsafe by the public due to the circulation of contaminated needles and syringes, it will lead to an erosion of public confidence in the immunization program. This could have serious consequences (Haniffa, 2004). Hospital waste management has become a critical issue and increases the potential risk and damage to the environment. In Sri Lanka hospital, waste management practices are legalized under the Central Environment Authority. Hospital waste management is not only disposing the waste generated by the hospital but includes the method of transportation, storing before disposing, waste collection, waste handling and educating employees.

As a research domain, waste management is complex and multi-dimensional. It covers a vast range of research topics, from those that focus on general waste management to those with wide socio-technological implications.

In recent years, several countries have shown an interest in the management of industrial wastes (Alhumoud and Al-Kandari, 2008). Hospital waste is also one of the wastes in developing countries. There are papers which focus principally on health care waste management practices in developed countries; however, this paper intends to examine the clinical waste management practices in private-sector hospitals in Sri Lanka, which is generally regarded as a developing country, in order to contribute to an understanding of relevant issues and strategies.

Hospital waste can be classified as clinical and non-clinical. Solid waste includes materials such as ash, food waste, plastic, glass, metal, radioactive, and pathological, while liquid waste includes chemicals, urine, blood and waste water. Poor management of hospital waste will expose patients, workers, staff and the general public to possible toxic effects. Improper disposal methods can lead to environmental health hazards. In the light of all the above, this study sought to examine the medical waste management practices in selected private-sector major hospitals in Colombo through an empirical examination of the existing level of wastage, waste management practices and strategies to control waste through a survey of top management and employees in selected institutions. The study will also seek to determine the relationship between top management and staff attitudes toward hospital

waste management, and the level of technology used toward the medical waste in various types of health care organizations.

The scope of this paper will be limited to private health care institutions in the Colombo district from where data have been gathered.

2. Literature review

Medical waste management represents one of the main issues for healthcare structures and public government bodies both for the costs and for the environmental impact and associated risks which result from the lack of compliance with the relevant legislation (Giancarlo and Marchett, 2012). There are many reasons contributing to this problem including: negligence and/or poor qualifications of personnel in charge of the segregation and disposal in the healthcare structures; lack of strategies and plans for a correct and effective handling of medical waste; negligence and illegal behavior of medical waste collection transportation and treatment companies. In addition, it is important to the impact of the increasing amount of waste generated in the healthcare organizations and the high costs for handling such quantities. In many instances, the disposal of waste is assigned to contractors whose interests may conflict with those of the healthcare organizations.

In examining the critical issues, several studies have addressed the evaluation and the optimization of medical waste; Bdour *et al.* (2007) and Fisher (2005) demonstrated in their papers that the quantity of waste generated by hospitals varied by changes in local legislation. According to Tudor *et al.* (2005), the implementation of standardized and optimized management practices leads to the reduction of both infectious and general waste. Their paper looks at steps taken toward the development of a ten-year strategy for the management of healthcare waste from the National Health Service (NHS) in Cornwall, UK. The major issues and challenges that affected the management of waste by the NHS, including its organizational structure and collection infrastructure, are outlined. The waste flows of the main acute medical site are detailed, using waste audits of domestic and clinical bags, redundant equipment, bulky waste and special waste. Staff training and awareness underpin several of the short- and medium-/long-term solutions suggested to reduce the waste at the source and recover value from that produced. These measures could potentially reduce disposal quantities by as much as 20-30 percent and costs by around 25-35 percent.

Cheng *et al.* (2010) investigated the type and amount of medical waste generated from small clinical facilities in Taiwan. They sampled 200 small medical establishments, with few or no patient beds, to survey the wastes generated and disposed. The surveyed medical facilities consisted of four groups including private clinics, medical laboratories, blood centers and public clinics. The overall mean general waste production rate was 3.97 kg/bed/day (or 0.075 kg/patient/day) at all the surveyed facilities, higher than that obtained from larger hospitals in Taiwan, which ranged from 2.41 to 3.26 kg/bed/day. The highest amount of infectious wastes generated among the four groups of facilities was from blood centers (3.14 kg/bed/day), followed by private clinics, medical laboratories and public clinics (1.91, 1.07, and 0.05 kg/bed/day, respectively). The overall average was 2.08 kg/bed/day. This study suggests that the waste generated at small medical facilities ranged widely.

According to Tudor *et al.* (2008), in order to decrease the amount of medical waste in healthcare, investing significant resource and financial efficiencies is not sufficient. Due to the many factors involved, there is a need to focus both on containment and logistics, as well as social factors for success. In their paper, they reported on the results of waste minimization trials. The schemes were able to achieve significant waste reductions in both clinical and domestic waste quantities. Indeed, a reduction in domestic bag waste in the range of 1.6-33.4 percent, with an average of 14.8 percent, was realized. For clinical waste, the reduction ranged from 1.8 to 38.3 percent, at an average of 15.7 percent, with net cost benefits of nearly US$25,000 over the period of one to three years. Insa and Zamorano (2010)

presented a critical review of medical waste legislation in Spain. They proposed a set of general criteria on which medical waste management should be based: a clear definition of medical waste and of the scope of relevant legislation; basic principles to promote the reduction of the amount of waste generated at a source; a homogeneous classification of this waste; and the implementation of environment friendly waste treatment technologies.

The problem of medical waste management is even more critical in developing countries and it has been addressed by a number of scientists in the past years. Moazzam and Chushi (2009) demonstrated that healthcare waste management is a serious public health concern in developing countries, in which, compared with developed nations, the management of infectious wastes has not received sufficient attention. Recently, worldwide awareness has grown for the need to impose increasingly strict controls on the handling and disposal of wastes generated by healthcare facilities. In their research based on seven selected hospitals, they proposed an overview of handling practices, occupational safety, and the implementation status of waste management policy, together with other pertinent policy issues. Alhumoud and Alhumoud (2007) analyzed the amount of different kinds of solid wastes produced, segregated, collected, stored, transported and disposed of in the governmental hospitals of Kuwait. The weight fraction of each component in the sorting sample was calculated by the weights of the components. The amount of non-infectious and infectious waste generated in kg/day in each ward and various hospital blocks was determined and recorded. They assessed the risks associated with the lack of training courses on waste management in the analyzed hospitals. Lee *et al.* (2004) identified measures for the effective characterization methods for the reduction of the treatment and disposal costs of regulated medical waste.

Medical wastes are defined to include all types of wastes produced by health facilities such as general hospitals, medical centers and dispensaries. Medical wastes represent a small amount of total residues generated in a community. However, such residues can potentially transmit diseases and present an additional risk to the staff of the healthcare facilities, patients and the community when the wastes are not managed properly (Baveja *et al.*, 2000; Silva *et al.*, 2005) Baveja *et al.* (2000) used a case study approach of a Southern African hospital, which for the sake of confidentiality was referred to as Kotuba Hospital. The Kotuba Hospital is located in one of the oldest, largest, most advanced, and comprehensive medical compounds in Southern Africa, and therefore it was expected that the level of awareness of the importance of the proper handling of medical waste would be higher than other hospitals in the sub-region. As a teaching hospital, Kotuba hospital comprised of many departments such as the wards, the casualty, the minor operating theater, the major operating theater, a maternity section, the laboratory and the X-ray section.

3. Challenges to the environment due to pollution

The environment health conditions may be indirectly affected through the pollution of ground and surface water by leakages from disposal sites. Air pollution is often caused by open burning at dumps, and foul odors and wind-blown litter are common. Methane, an important greenhouse gas, is a by-product of the anaerobic decomposition of organic wastes in landfill sites. In addition, waste dumps may also be a source of airborne bacterial spores and aerosols. The suitability of a disposal site depends upon many factors, including specific characteristics of the subsoil, ground water conditions, topography, prevailing winds and the adjacent patterns of settlement and land-use (Schubeler *et al.*, 1996).

3.1 Awareness of working staff

The necessity of managing waste is a much-discussed concept in many countries, especially in the rapidly growing urban countries of the developing world, as hospital wastes pose a

significant impact on health and environment. For this reason, there is an urgent need for raising awareness and knowledge of medical waste issues. The lack of awareness can be considerable in some cases, and this is reflected in the lack of resources allocated to staff. Waste management strategies are needed to ensure health and environmental safety. The handling of waste can also be pertinent to the health risk for staff engaged in the health care industry. So awareness about various aspects of biomedical waste management has to be assessed frequently and training programs should be conducted for staff. Knowledge and awareness among health care personnel including medical and paramedical staff is essential for the adequate management of biomedical waste.

Training would need to focus on presenting a waste management plan, the risk associated with waste, protective measures, the role and responsibility of each member of staff, and the technical instructions concerning the activities carried out by each category of staff. The World Health Organization (WHO) published a training manual entitled Teachers' Guide: Management of Wastes from Healthcare Activities in 1998. This training material, which contains recommendations, is intended for a three-day training course targeting mainly at hospital administrators, public health professionals and policy makers. The WHO also proposes a basic three-day training course for waste managers in care facilities. In addition, the Indira Gandhi National Open University, New Delhi, offers a distance-learning course in collaboration with the WHO. This is a six-month course leading to a healthcare waste management certificate.

3.2 Technology level of the organization

The basic concept of the treatment of healthcare waste is to make it safe before the final disposal. This implies that all treatment and disposal facilities, regardless of size or type of technology used, are required to "render safe" the waste. The requirements of rendering safe depend on the type of waste treated and on the nature of the contaminants present in the waste (The Department of Health, 2006). The choice of treatment and disposal technique depends on a number of parameters: the quantity and types of waste produced whether or not there is a waste treatment site near the hospital; the cultural acceptance of treatment methods; the availability of reliable means of transport; whether there is a reliable space around the hospital; the availability of financial material and human resources; climate; ground water level; and specially whether or not there is a national legislation or any other policy. Any of the proposed methods must be selected with the objective of minimizing the negative impact on health and the environment.

Currently in Sri Lanka, most government and private hospitals' waste disposal is primarily undertaken by the state but the disposal practices have raised concern among many hospital officials. It should also be noted that the local municipalities refuse to accept any untreated sharps syringes, etc.

3.3 Hydroclave/incineration

Hydroclave, or incineration, is the controlled burning of the medical waste in a dedicated medical waste machine. In this method, waste generally passes through on a belt. This method can be applied to almost all medical waste types, including pathological waste. The process reduces the volume of waste by up to 90 percent. Normally, the waste is not sorted or separated prior to the treatment. This has the benefit of reducing the volume of waste, sterilizing and eliminating the need for pre-processing waste before treatment. The results of this waste can be disposed of in traditional methods, such as landfill. Crean and MrCrean (2011) mentioned that largest concern associated with landfill pollution is in relation to medical waste. It should also be noted that, while providing the advantage of reducing the volume of waste into ash and the ability to dispose recognizable waste and shapes, incineration may result in the release of toxic gasses. Dioxins and furans can be produced

when plastic burns. As incinerators may be designed or retrofitted with pollution prevention equipment, more of the potentially toxic chemicals that previously ended up in emissions can remain in the ash. This ash is generally disposed of in landfills, resulting in negative impacts on the environment.

3.4 Autoclaves

Autoclaves are closed chambers that apply both heat and pressure, and sometimes steam, over a period of time to sterilize medical equipment. Autoclaves have been used for nearly a century to sterilize medical instruments for re-use. Autoclaves are used to destroy all microorganisms that maybe present in medical waste before disposal in traditional landfill. The autoclave lowers the pressure within the chamber, which shortens the amount of time required to generate steam. Medical waste that is subjected to an autoclave is often also subjected to a compaction process, such as shredding, after treatment so that it is no longer recognizable and cannot be re used for other purposes (Daniel and MrCrean, 2011). The compaction process reduces the volume of the treated waste significantly. After treatment and compaction, the treated waste can be combined with general waste and disposed of in traditional manners. Waste that is treated using an autoclave is still recognizable after treatment, and therefore must be shredded after treatment to allow for disposal with general waste. Autoclaves are not recommended for the treatment of pathological waste, due to the recognizable factor after treatment and that pathological waste may contain low level of radioactive material or cytotoxic compounds. Autoclaves can be used to process up to 90 percent of medical waste, and are easily scaled to meet the needs of any medical organization. Small counter top autoclaves are often used for sterilizing reusable medical instruments. Large autoclaves are used to treat large volumes of medical waste at one time.

3.5 Land filling/dumping

A landfill for handling medical waste must be situated and designed to meet set conditions to prevent pollution of the soil, groundwater and/or surface water and ensure efficient collection of leachate (liquid which has percolated through the garbage) as and when required. Modern landfills are like huge containers. They have liners that separate the waste from the groundwater. Dumps allowed leachate to soak into the ground and contaminate the groundwater. Landfill liners prevent leachate from passing into groundwater. The geological barrier is provided by geological and hydro geological conditions below and in the vicinity of a landfill site offering sufficient attenuation capacity to prevent a potential risk to soil and groundwater. In addition to such barriers, a leachate collection and sealing system should be added to ensure that leachate accumulation at the base of the landfill is kept to a minimum. The environmental impact of land filling medical waste means that many countries do not allow untreated medical waste to be disposed of at landfills. At some sites, only residues from incineration, autoclave or microwave treatment can be landfilled. In general, the land filling of medical waste is recommended only if other treatment facilities (incineration, autoclave, and microwave) are not available.

Modern landfills are a great asset to our standard of living, as anyone living in an under developed country or who has endured a lengthy garbage strike can verify. They provide a safe, healthful and economic way to dispose of society's waste and in an environmentally protective manner. In the future, landfills could become sources of energy as methane gas is used to generate electricity. Present technology is rapidly changing and the landfill may one day even be regarded as an asset where scarce materials can be found.

3.6 Chemical disinfection

Chemical disinfection, primarily through the use of chlorine products, is another method to treat medical waste. The use of chlorine bleach for cleaning and disinfecting has been in use for many years. The Environment Protection Agency of the USA identifies chemical disinfection as the most appropriate method to treat liquid medical waste. Chemical disinfection processes are often combined with a mechanical process, such as shredding or maceration, to ensure sufficient exposure of the chemicals to all portions of the waste (Daniel and MrCrean, 2011). The disinfectant is usually combined with a large amount of water to assist with the disinfection process and to cool the mechanical equipment in the shredding process. Liquid waste with mechanical/chemical disinfection may be disposed with sewer discharge permits from the respective city. Mechanical/chemical disinfection treatment devices are primarily on-site installations, rather than mobile treatment units, though these devices are available in different sizes based on the amount of waste to be treated (Daniel and MrCrean, 2011).

3.7 Microwave

The use of a microwave to disinfect medical waste has only recently been introduced in the USA. Microwave treatment units can be either on-site installations or mobile treatment vehicles. In this type of disinfection process, the waste is first shredded. The shredded waste is then mixed with water and subjected to microwaves. The microwaves internally heat the waste, rather than applying heat externally, as in an autoclave. The heat generated in this method provides even heating over all portions of the waste, and the high temperature steam that is generated effectively neutralizes all biological material. The shredding operation reduces the volume of the waste by up to 80 percent, and the treated waste can be disposed of in a landfill (Daniel and MrCrean, 2011). The entire process takes place within a single vessel, and the system can be operated by unskilled workers. Treatment of medical waste through exposure to a microwave is less expensive than incineration.

3.8 Irradiation

Another method used to sterilize medical equipment or waste is irradiation, generally through the exposure of the waste to a cobalt source. The gamma radiation generated by the cobalt source inactivates all microbes that may be present in the waste. Dedicated sites are required for this form of treatment, as opposed to the mobile versions available for other non-incineration methods (Daniel and MrCrean, 2011). The cost of developing a dedicated facility for this method is quite high, and therefore this method is not as widely used as other treatment methods at this time. The risk of radiation exposure by workers operating the facility, while low, is also a factor.

Considering the all of these techniques, different hospital or healthcare centers may practice those techniques at different levels. Even though recently developed types of technologies are available in this industry, the final selection of technology must be chosen carefully based on the several factors which are required by a hospital or any other responsible party.

3.9 Attitudes of the top management

Historically, the initial focus of waste management was on "basic waste management," i.e. the cleansing function. This includes waste storage, collection, transport, treatment and environmentally acceptable disposal. Since it safeguards public health and quality of life, by removing the waste from the living and working areas, acceptable levels of basic waste management service provision must be seen as a fundamental. Once the fundamentals are in place then, in order to promote sustainability with regard to waste management, appropriate waste solutions must be put in place. These concepts are not easy to achieve.

The quest for zero waste and achieving sustainable waste management can be realized through a process of gradual improvement in production efficiency and waste awareness. However, the main responsibility regarding the effective waste management process should be taken by the higher management level of each responsible organization. They should therefore have a positive attitude regarding the managing of their health care waste in order to avoid the hazardous events that can be caused by the improper waste management system and to protect their working staff from an uninhabitable working environment. Additionally, policies, guidelines, procedures and codes of practice are essential components of any health care waste management system.

3.10 Type of organization

Another factor which affects the waste management practices relates to the nature of respective organizations, as different types of institutions apply different methods to acquire best practices in their waste management processes. In the selected geographical area for this project, the health care service providers fall into three categories, namely hospitals, medical centers and laboratories.

A hospital is a health care institution providing treatment with specialized staff and equipment. The hospital has an emergency department with large numbers of beds for intensive care and long-term care. Hospitals have a range of departments such as surgery, laboratory and emergency care, and specialist units such as cardiology. They perform according to their available infrastructure. Hospitals generate large volumes of medical waste on a daily basis in comparison to medical centers and laboratories. They therefore are likely to allocate sufficient financial, human and other required resources to perform effectively in waste management practices. Hospital waste is considered dangerous because it may possess pathogenic agents and can cause undesirable effects on human health and the environment. Many hospitals, therefore, outsource their medical waste disposal processes to ensure effective practices.

A medical center is a medium type of healthcare facilities provider which smaller than a hospital is generally called a clinic. They have accommodation facilities and provide short-term or long-term medical treatment of a general or specialized nature not performed by hospitals to inpatients with any of a wide variety of medical conditions. Normally, medical centers produce medical waste in considerably reduced level compared to hospitals.

A laboratory is a facility that provides controlled conditions in which scientific or technological research, experiments, and measurement may be performed. Laboratory wastes are usually segregated on-site and disposed by a specialist contractor in order to meet safety, health, and legislative requirements.

3.11 Development of hypothesis

Hypotheses were formulated based on the nature of the relationship existing between waste management practices, the awareness of the staff, technology level, attitude of the top management and the type of organization:

H1. There is a relationship between "Awareness of the Staff" and the "Waste Management Practices" of the organization.

H2. There is a relationship between "Technology level of the Organization" and "Waste Management Practices" of the organization.

H3. There is a relationship between "Attitudes of the Top Management" and "Waste Management Practices" of the organization.

H4. There is a relationship between "Type of the Organization" and "Waste Management Practices" of the organization.

Using the information gathered in the literature review, a broad conceptual framework was developed as follows (Figure 1).

The objective of this study is to examine the significant impact of the four factors identified in the literature review on medical waste management (Figure 2).

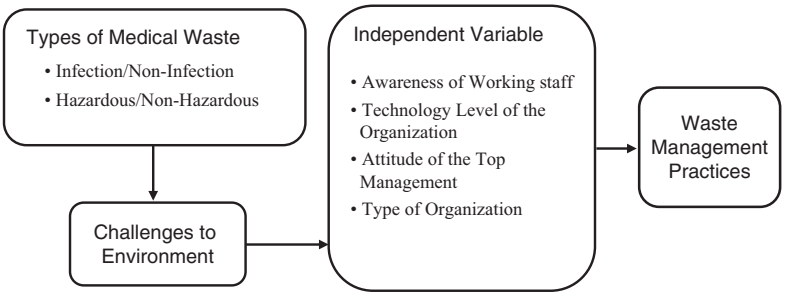
4. Research design

The methodology adopted for this study follows a two-stage strategy:

(1) examining the existing medical waste generated at the health care institutions and understanding their medical waste management practices; and

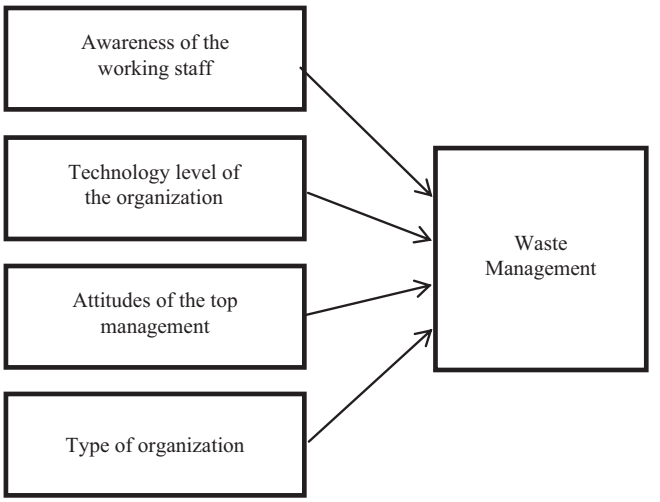
(2) identifying the relationship between top management and working staff in relation to medical waste management in selected health care institutions through surveying staff responsible for waste management.

The population consists of all health care institutions established in the Colombo district which are registered with the Ministry of Health of Sri Lanka. They have been categorized



Source: Authors' own elaboration

Figure 1.
A broad conceptual framework



Source: Authors' own elaboration

Figure 2.
A conceptual framework of the study

into private hospitals, medical centers and medical laboratories. In total, there were 47 registered private hospitals, 104 medical centers, and 145 labs. The respondent sample consists of 25 private hospitals, 55 medical centers and 76 labs.

4.1 Questionnaire details

Information was gathered from a questionnaire designed to measure the effect of awareness of working staff, technology level, attitudes of top management and type of the organization on waste management practices of the organization. The questionnaire contained 25 questions which were categorized into a meaningful order and format. Most of the questions required a response measured on a five-point Likert scale in addition to some open-ended questions.

4.2 Disclosure of the existing level of the waste volume

Healthcare organizations have an inherent responsibility to ensure that their activities do not harm human health either directly or indirectly. This requirement should be an integral part of their business model and addressed to meet statutory regulations.

The volume of medical waste from the surveyed institutions was gathered over a period of one month. Figure 1 indicates the five highest waste producers in each of the three types of health care providers. The waste is divided into five categories.

Infectious waste refers to body fluids and excreta of persons suffering from infectious diseases, such as patients in isolation wards, and from laboratory waste. Chemical waste includes solvents, unused laboratory acids and expired disinfectants. Pharmaceutical waste relates to medicines, and includes expired drugs, unused drugs, contaminated drugs, bottles and sharp waste. Examples of the latter include needles, blades, lancets, microscope slides, ampoules, glass vials and bottles. General waste includes paper waste such as bed head reports, food residues and drug containers (Table I).

Name of the organization	Total waste Qty (Kg) per month	Infectious waste (%)	Chemical waste (%)	% Pharmaceutical waste (%)	Sharp waste (%)	General waste (%)
Hospitals						
Hospital 1	4,659	25	19	3	3	50
Hospital 2	4,917	26	28	3	1	42
Hospital 3	6,005	32	15	6	2	45
Hospital 4	7,759	25	18	5	2	50
Hospital 5	8,017	30	22	5	3	40
Medical centers						
MC 1	1,564	28	26	2	5	39
MC 2	1,857	25	18	3	4	50
MC 3	2,188	31	20	3	3	43
MC 4	2,386	30	23	2	5	40
MC 5	2,525	27	23	3	5	42
Laboratory						
Laboratory 1	468	10	5	8	2	75
Laboratory 2	483	8	6	3	1	82
Laboratory 3	578	9	5	6	2	78
Laboratory 4	608	5	3	1	1	90
Laboratory 5	685	5	4	2	1	88

Table I.
Medical waste

Source: Authors' own elaboration

In each of the three groups of health care providers, general waste is the largest component, followed to a lesser extent by infectious and chemical waste. Sharp and pharmaceutical wastes make up only a small percentage of the total produced.

4.3 Disclosure of the existing level of the waste management practices

Descriptive statistics in relation to the awareness of the working staff, technology level of the organization, attitude of the top management and the type of organization are shown in Table II.

Table II indicates the mean value and the standard deviation for each of the variables. The attitude of the top management has the highest mean value (3.6769 ± 0.86943) followed by awareness of the working staff (3.5613 ± 0.8105) and type of organization (3.5283 ± 0.8167). The lowest mean value recorded was for technology level (3.4080 ± 0.82831).

4.4 The fitness of the model

Table III exhibits the statistics in relation to the fitness of the model with data. The fifth column of Table III reveals the *F*-test statistics and the sixth shows the significant probability. The results show that model is best fit for the data used, since the *F*-test statistic is significant at the 5 percent level.

4.5 Significant t-test statistics analysis

Table IV shows the significant *t*-test statistics and probabilities in relation to each independent variable in the conceptual model. The fourth column of Table IV shows the

	Mean	SD	*n*
Mgt. Practices	3.691	0.69054	156
Awareness	3.5613	0.8105	156
Technology	3.408	0.82831	156
Attitude	3.6769	0.86943	156
Org. Type	3.5283	0.81673	156

Source: Authors' own elaboration

Table II. Descriptive statistics

Model 1	Sum of squares	df	Mean square	*F*	Sig.
Regression	38.852	4	9.713	87.459	0.000
Residual	11.217	152	0.111		
Total	50.069	156			

Source: Authors' own elaboration

Table III. Analysis of variances

Variable	Coefficient (β)	*t*	Sig.
Constant	0.461	2.557	0.012
Awareness of employees	0.135	2.753	0.007
Technology	0.191	3.800	0.000
Top management attitudes	0.386	8.295	0.000
Organization type	0.192	3.661	0.000

Source: Authors' own elaboration

Table IV. Coefficients analysis

p-value which is significant at 5 percent significant level, meaning that there is an effect from independent variables on the dependent variable of the waste management practice. Therefore, it has to be accepted that there is an effect from all the independent variables.

It can be clearly shown that technology level of the organization is significant at 5 percent significant level supported by the probabilities as well. In addition, the *t*-value which appears on the highlighted area indicates that there is strong evidence to support the existence of a relationship between the "Technology Level of the Organization" and the "Waste Management Practices" of the organization.

According to the figures in Table IV, the attitude of the top management is significant at 5 percent significant level. It indicates that results strongly support acceptance of the alternative hypothesis, as the *t*-value appeared on the highlighted area which represents the alternative hypothesis. It therefore can be stated that there is a relationship between "Attitude of the Top Management" and the "Waste Management Practice" of the organization.

At 5 percent significant level, *t*-test statistics are significant for "Type of Organization." The results show that there is a significant impact on the waste management practice. It is also revealed from the above analysis that the *t*-value, which appears in the highlighted area of the chart, represents the alternative hypothesis.

5. Conclusion

In this study, 156 healthcare service providers were investigated, most having been established for more than five years. Following the empirical analysis, it has been realized that large amounts of healthcare waste are generated every day in these services.

It conclusively shows that medical waste poses a significant impact on health and the environment. This study also reveals an urgent need for awareness and education on medical waste issues, in particular, to create a positive attitude not only among people but also top managers toward the benefit of effective waste management practice, and to promote the use of high-quality technologies to reduce the harmful effects. Further, the waste management team of a hospital, clinic or laboratory must take adequate measures to ensure proper procedures are carried out for disposing waste. Proper waste management strategies are needed to ensure health and environmental safety which must be the responsibility of all concerned.

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