(Review Article)

Medical waste management in healthcare institutions

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Abstract

Studies over the past decade have shown that medical waste generated has increased significantly and will continue to increase with the pandemic. To identify solutions to solve this global issue, the assignment focuses on defining the existing waste management practices followed in developing countries and highlights specific challenges faced. The purpose of this assignment is to identify ways where healthcare organizations can improve the overall medical waste management (MWM) process and create awareness among co-workers.

The assignment is divided into three main components where critical analysis of primary research, policy for waste management and use of IT/IS tools were analyzed. Three articles analyzed in this assignment were published in high impact journals/international reports between 2014-2018. Findings from the primary research were obtained using a Likert-scale questionnaire from 156 healthcare institutions, the results indicated that MWM practices followed in healthcare institutions are impacted by three factors, awareness of staff, technological availability and attitudes of top-board management. The three factors had a p-value of 0.00 in the correlation analysis carried out indicating a highly significant relationship between them.

Integrated sustainable waste management model following the GWMO (Global Waste Management Outlook) framework was identified to be most adaptable method. The advantage of this model is such that it can be remodeled based on the country's requirement with the help of digital tools and country-level indicators. The use of IT/IS tools were critically analyzed in the last article with use of GIS integrated real-time waste management system being identified as the most feasible option, where using online tracking systems and smart bins the type of waste and quantities produced can be measured and provide real time updates to local authorities to ensure safe waste management practices are followed.

Recommendations from the assignment identifies that countries needs to conduct a preliminary analysis of types of medical waste being generated in healthcare institutions to provide a better understanding of types of hazardous waste exposed to the environment. Additionally, frequent training workshops needs to be conducted to ensure the management and staff understand the importance of MWM.

Keywords: Medical Waste Management; Information Technology; Information Systems; Healthcare

1. Introduction

Most healthcare institutions globally have different management teams overseeing responsibilities of various departments in the healthcare industry. However, in regards to medical waste management (MWM) very few institutions have a dedicated team that oversees this. MWM market is expected to rise to $17.89 billion by 2026 [47]and will continue demonstrating an uprising trend increasing the management cost of medical waste. Evidence suggests 10-

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25% of the medical waste is hazardous and could potentially cause health related issues if not managed properly [5]-[14]

The main aim of the study is addressing issues faced by hospitals in handling medical waste and identify ways of improving the productivity of the process. The main objectives of the assignment are to address the issue of medical waste management in the healthcare industry, to identify methods to implement changes and mobilize resources effectively and to find solutions to protect the environment from medical waste and spread of hazardous infections.

Structure of the assignment focuses on critically analysis three research articles, a primary research paper addressing the issue of medical waste management, a policy framework that provides organization with a plan to address the issue and an innovative research outlining how IT/IS can be used to address these concerns.

2. Analysis

2.1. Overview of Primary Research

For my primary research paper, my focus in on medical waste management practices followed in the healthcare sector. A study carried out by Gunawardana [19] on "An analysis of medical-waste-management practices in healthcare sector in Colombo" was chosen for critical analysis. This study was published at Emerald Publishing, and the author possesses a PhD in Accounting. As stated by Mingers and Xu [36], publishing company and author background are drivers of overall article impact score which is an essential factor of a primary research paper, this article has both these drivers needed to address the global agenda of MWM [36].

2.2. Overview of the Problem

Medical waste management (MWM) is a growing concern among developing countries, this research article focuses on identifying types of waste management practices followed in Colombo, Sri Lanka. The author addresses this issue as Sri Lanka has no specific MWM practices followed in the country. However, as Colombo is one of the developed cities in Asia, this study can be compared against international MWM practices followed in other parts of the world [9]. Designing the study specific to a region of a country is an effective research practice as stated by the WHO guidelines [33]. This also shows that the author is focused on addressing a global issue using a specific region.

Evidence suggests that global waste produced on a yearly basis crosses 2 billion tons, of which medical waste has been increasing steadily over the past decade [40]. The literature review focuses on addressing the management practices, strategies and challenges faced by healthcare institutions over waste management. The structure of the literature is similar to the study conducted by Mathur [34], where he focuses on addressing the same issues addressed by Gunawardana [34]. Review of findings suggests that hospitals and medical centers produce highest amount of medical waste globally, this statement is supported by several other studies indicating that the author has conducted an in-depth analysis of literature [27]. One of the key challenges identified by the author is that healthcare workers and staff handling the medical waste have a high possibility of contracting infectious diseases which could impact the overall performances. Studies carried out in other countries also suggest that handling medical waste imposes a lot of responsibility where adequate training is not provided to staff [11][29].

Different methods of managing healthcare waste is discussed in the literature review of the article where the author identifies use of autoclaves, chemical disinfection and incineration as efficient methods of destroying micro-organisms. Training for these methods are relatively less complex than other methods such as irradiation. The author concludes the literature review by specifically stressing on the attitudes of top management towards managing waste and how it is neglected as an area of concern in different institutions. Previously conducted studies suggests that most countries do not stress on the importance of MWM as top board management are not directly involved in the process [2]

2.3. Study Design and Setting

The research uses a quantitative questionnaire model that uses a Likert-scale to score responses. Leung found that the average size of the questionnaire correlates with the number of associated topics [30]. In this study despite the length of the questionnaire (25-questions) the author was able to justify to the reader that the questionnaire needed to be long as 4-hypotheses were tested. Evidence from other findings [7] suggests that a questionnaire-based model is effective in understanding waste management practices of organizations. Formulated hypotheses were focused around waste management practices in the organization where, awareness of the staff, technological availability, attitudes of top management and type of organization were areas that were assessed. Developing hypotheses in quantitative research has been identified to be effective in providing valuable insights to the reader [13]. The questionnaire was designed by

the author and he has justified the validity and reliability by building a conceptual framework as shown in figure 1. Krosnick stated that, authors can design their own questionnaire model provided that hypotheses are used to justify the reasons [28].
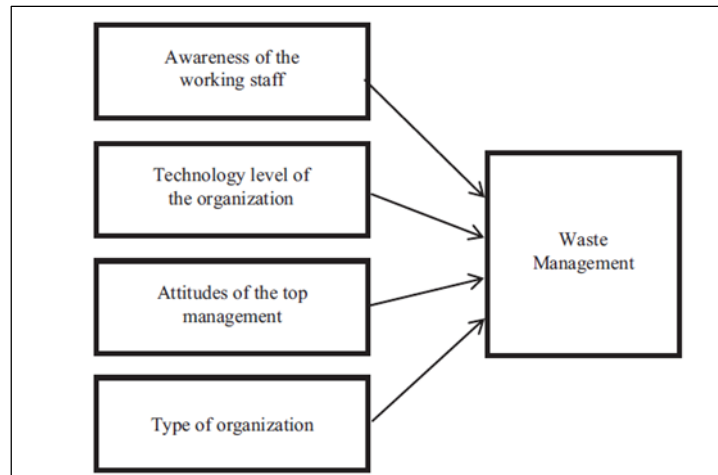
Figure 1 Questionnaire Model and Research Framework [19]

The study focused on analyzing the waste management practices across private hospitals, medical centers and laboratories rather than the government facilities. As stated by Gauld [16], private institutions across Asia are more developed than public institutions, making this study findings ideal to compare against international MWM standards. 156 samples of the available 296 healthcare institutions were taken for the study, covering over 50% across all three types of institutions. As illustrated in the study carried out by Binu [6], any sample size of above 100 is accepted as a good research practice, moreover the research methodology is such that it generates qualitative data at different organization levels [23].

3. Findings and Results

To ensure that the results collected remained discrete, the author provided the institutions with numerical labels, this is a sign of good ethical practice as stated by Earl where discreteness of results are maintained [10]. Hospitals produced the highest amount of medical waste in the region between 5000-8000 kg produced on a monthly basis. 25-30% of these wastes were infectious, this is a significantly lower amount compared to other countries as the population size is smaller in the region alone. Smyth indicates that an estimate of a healthcare issue can be gathered by carrying out studies at different geographical locations, this has not been followed by Gunawardana making the findings specific to a geographical hotspot [42].

The four hypotheses developed for this questionnaire showed significant relationship with MWM, where p-value obtained was <0.05 indicating all variables show a significant relationship with MWM practices. Type of organization and availability of technology were found to be the most significant factors that impacted the overall MWM practices across different organizations. Similar trends were observed over the years, where MWM practices and inadequate training has led to failures in healthcare institutions [31]. The scores for the questionnaire across all institutions lied between 3.4-3.7 on a consistent level indicating high statistical significance [44].

The author concludes with his recommendations stating that medical waste generated on a daily basis continues to rise significantly impacting the environment. In order to tackle this issue, organizations need to ensure that proper waste management strategies are implemented with digital tools incorporated into healthcare setup. Most medical institutions globally suggests that management practices and awareness are main factors influencing waste management process [15] and this research identifies the same issues presented in Sri Lanka as well.

3.1. Sustainable Framework and Policy for Medical Waste Management

WHO estimates 15% of medical waste to be hazardous and have the potential to cause infectious diseases [38]. In terms of medical waste produced yearly, USA produces the highest while European and Asian countries produce significantly lower amounts [37]. As an integral part of United Nations Environment Programme (UNEP), a book published by Wilson on Global Waste Management Outlook (GWMO) was analyzed to identify a sustainable framework for MWM [48].

Unlike other models, GWMO focuses on building a life-cycle approach to understand implications of waste to the environment. As discussed in section 3.1, the growing concerns of MWM post COVID-19 will continue to increase and contingency plans are required to tackle these problems. GWMO framework identifies medical waste as "high-risks" as the process of collection and disposal needs to meet international guidelines to prevent contamination of environment. The report evaluated all prior incidents and identified that MWM should be the main priority in developing countries.

GWMO framework focuses on using integrated sustainable waste management model involving physical and governance components. Healthcare institutions across the world do set a lot of importance towards health coverage provided rather than the management aspects, this example can be seen in recent events where Sri Lanka received several tons of medical waste to be disposed [12]. The main reason for problems such as these arising are due to organizations being unable to manage the medical waste generated yearly. The UNEP report also provides a list of country-level indicators that can be used as tools in designing protocols for waste management. As suggested by Gray [18] having multiple indicators in designing a policy provides organizations with feasible solutions.
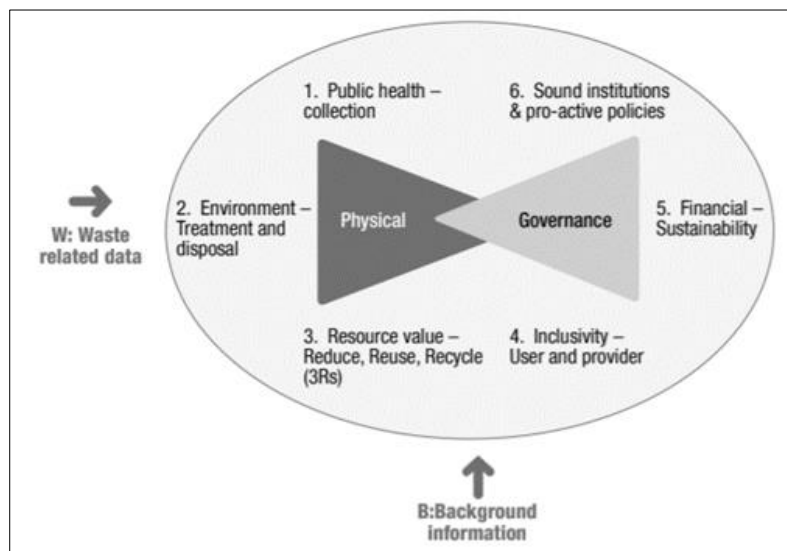
**Figure 2** GWMO Framework (Wilson et al., 2015)

By using the set of derived indicators several countries can build their own plans, in UK the Barts Health NHS waste management plan is one of few practices that has been successfully following UNEP guidelines [22]. The goal of the GWMO is to ensure citizens across the world understand the importance of waste management, in terms of healthcare setup it stresses on the importance of good governance on MWM which contributes towards good-health and well-being of individuals [49]. As stated by Gunawardana [19], the main areas of concern in MWM can be addressed using this model as both long and short-term solutions are provided. By following the framework designed by UNEP, hospital and healthcare institutions can cut down a large part of CO_2 emissions and solve the gap of understanding MWM practices.

3.2. Role of IT and Information Systems in Medical Waste Management

Information systems (IS) have been an integral part of the E-Health setup in many hospitals [39]. To bridge the gap between MWM practices and policy implementation, IT/IS tools can be implemented which helps organization to monitor and maintain charts on waste management. A study carried out by Ion on "The innovator role of technologies in waste management" was analyzed to identify methods to implement IT tools into MWM [25].

The study focuses on building a geographical information system (GIS) which tracks real-time waste management in the country, this system has been successful in several countries where civilians can monitor quantities of waste being disposed using the smart-bin technology which uses sensors to measure waste. Studies have shown the use of smart bin can be applied into MWM where color coding on medical waste can provide insights to types of waste produced in healthcare institutions [45]. Additionally, to the tracking and monitoring of waste, this system can make predictions using machine learning to estimate amount of waste generated on yearly basis. As stated by Ilyas, post COVID the manpower required to disinfect and manage medical waste will be higher than previous years due to the nature of COVID-19 [24].

Kapoor [26] stated that having a real-time system with instant updates with numbers provides the healthcare institution extra responsibilities and concerns over the MWM practices. This real-time monitoring will also be useful for local government bodies to understand how medical waste disposals are taking place and identify methods in which they can regulate the process. By implementing a system like this, healthcare institutions can monitor and track waste movement in and out of the medical institutions which will create awareness and change the attitudes of the top management over importance of regulating waste management.
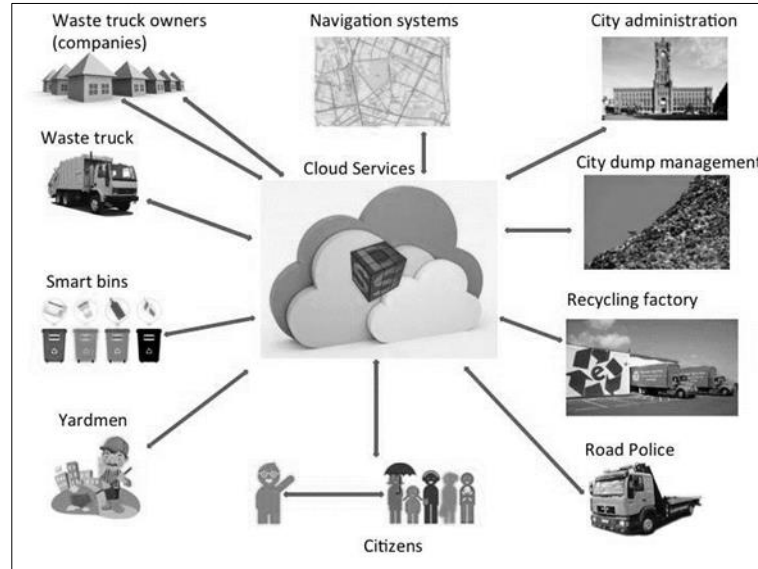
Figure 3 Waste Management Setup [35]

4. Conclusion

In this assignment, the implications and potential threats of medical waste management (MWM) were highlighted using critical analysis of available research findings. The findings from the analysis illustrates that the attitudes of top board management, availability of technology and awareness among staff are chief drivers that contributes towards improper waste management. The study carried out by Gunawardana [19] demonstrated that these factors are universally common with other developing countries in the EU and OEDC territories [17].

In order to improve the awareness and attitudes among healthcare workers, GWMO framework developed by the UNEP was taken for policy implementation. The key findings from this policy paper involved the use of life-cycle approach used in waste management which uses physical and governance components to improve the country-level management of waste. Studies carried out by Wilson [49] and Osibanjo [23] have proven that the GWMO policy is "an effective building-capacity tool" for waste management in countries.

To bridge the gap between limitations faced globally in MWM, the use of waste management IS was analyzed, of which the implementation of IT integrated waste management system showed the highest compatibility addressing the issue. Implementation of an IS waste management system provides countries to utilize their resources effectively and provide solutions in overcoming hurdles of future challenges such as the post pandemic waste management practice.

In conclusion, MWM is a growing concern among all stakeholders globally, increasing population results in increasing waste. To tackle the common problem, organizations need to establish policies that shows the public the importance of MWM. With the uprising trends of E-Waste management practices, the future prospects indicate that several developing countries will be able to use IT/IS tools to combat this issue.

Compliance with ethical standards

Acknowledgments

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