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Engineering Waste Management Systems: Efficiency Through Strategic Planning and Management Tools

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Abstract

Expanded life expectancy and higher health consciousness have been the pivotal contributors to the growth of the medical service sector. With a growing population, medical service facilities have additionally increased largely and proportionately the quantity of BMW produced. The growing quantity of biomedical waste is a public health issue internationally, drawing concern from all health authorities, associations and the government. The current biomedical waste management system in India has flaws that lead to inefficient and unproductive biomedical waste treatment procedures. A thorough understanding of the types and quantities of waste that must be managed is necessary for the first crucial stage in the biomedical waste management system, which is creating a trustworthy waste management plan. Therefore, the current study considered both identifying constraints related to biomedical waste management in hospitals and situational evaluation of biomedical waste management techniques. By using interpretive structural modelling and environmental auditing techniques, this study seeks to assess current biomedical waste management procedures and investigate several obstacles that stand in the way of an efficient and successful biomedical waste management system.

Keywords: *Hospital, Waste, Management, Engineering, Patients.*

1. Introduction

The worldwide condition of bio-medical waste management is outrageous, as it is estimated that 18 to 64 per cent of medical services settings have an unsuitable bio-medical waste management system. The widespread use of disposables in healthcare facilities has led to an increase in the production of biomedical waste in recent years. Similarly, improper handling of these wastes, including their storage, transportation, and disposal, raises the possibility of health hazards for both the environment and humankind. Health care waste management is a problem in Indian cities [1]. As the population grows, hospitals are trying to keep up with urbanisation, which results in a significant amount of medical waste being produced. The improper disposal of medical waste poses a serious health risk to residents and is extremely harmful to the environment. A hospital is a healthcare establishment where consultation, diagnosis, or treatment is carried out. Hospitals must care for the people. Their exercises may incorporate therapeutic, rehabilitative, precautionary, patient care assistance and furthermore the encouragement of health education [2]. This may straightforwardly be through patient consideration or in a roundabout way by ensuring a hygienic, healthy environment for their workers and community [11]. In the procedure of health care service, waste is produced, which normally contains sharps, human body parts or tissues and other contagious substances [12]. Hospitals produce different categories of contagious and perilous biomedical waste during the procedure of health care that pose tremendous peril to patients, medical care providers, rag pickers and society at large [16]. Waste production is not only confined to hospitals and research facilities; however, waste can also be generated at households through dialysis or utilising insulin injection and even during animal wellbeing functioning in rural sectors [3]. This is precarious and requires germane disposal techniques. Although, industrial waste, municipal solid waste, horticulture waste, etc., are unsafe and may contaminate water, air and soil, their handling and disposal are less dangerous when contrasted with the consequences of handling and disposal of bio-medical waste because of the production of deleterious effluents from the burning of healthcare waste. Biomedical waste management is still in its infancy everywhere in the world [4]. The safe management of biomedical waste is a topic that many generators, administrators, decision-makers, and members of the general public find extremely confusing. The lack of awareness could be the cause. As a result, environmental awareness is crucial for hospital administrators, surgeons, physicians, nurses, paramedics, and garbage retrievers [18]. When a strong outcry was made about medical trash floating on East Coast seashores and children playing with used needles in the 1980s, the management of medical waste in the US initially became a source of concern.

2. Literature Review

Ordinary home trash that is collected by municipalities and dumped in a landfill or incinerator is commonly referred to as solid waste. Any undesired or abandoned material that is neither a liquid nor a gas is considered solid waste. Organic waste, paper, metals, glass,

cloth, brick, rock, yard waste, and wood waste are all examples. The production of solid waste is an issue that is getting worse on a local, regional, and worldwide scale [10]. Organic and inorganic waste products created by different societal activities that are no longer valuable to the original user are known as solid wastes [14]. All of the essential elements of the living environment—air, land, and water—are contaminated both locally and globally when solid waste is improperly disposed of. Solid material is frequently rejected and generated by urban life as a result of the sharp rise in production and consumption. Because of their faster rates of urbanisation and economic growth, developing countries face a more severe problem than developed ones [5]. According to the best practices in public health, economics, engineering, conservation, aesthetics, and environmental considerations, solid waste must be managed environmentally soundly at all stages of generation, storage, collection, transfer, transportation, processing, and disposal. Therefore, all planning, engineering, financial, legal, and administrative tasks are included in solid waste management. Citizens and national and international policy-making agencies have taken notice of the issue of environmentally sustainable solid waste management. At the global level, waste awareness started in 1992 with the Rio Conference, when Agenda 21 declared effective waste management a top priority [6]. Initiatives to hasten the transition to sustainable production and consumption, as well as the mitigation of waste, pollution, and resource degradation, were the main topics of the 2002 Johannesburg World Summit on Sustainable Development [13]. Garbage minimisation, recycling, and reuse are prioritised, and then garbage is disposed of safely to reduce pollution. Since the 1960s, the Indian government has taken a number of steps to promote appropriate solid waste management, implementing new technologies and techniques by providing loans for the establishment of composting plants. Rapid urbanisation made the MSWM issue worse [8]. The Municipal Solid Wastes Act was the outcome of a public lawsuit that was launched in the Supreme Court as a result of growing public awareness of MSWM. For the first time, commercial entities are now part of the government's efforts to provide this public service. Innovative approaches to collection, transportation, processing, disposal, and storage are being investigated and put into practice. At this point, it is essential to assess the current procedure to determine whether the techniques being used are appropriate for the Indian context and to pinpoint any shortcomings in the chosen approaches [7].

3. Methods

The significant sources that are liable for the generation of biomedical waste include diagnosis, prevention, and treatment of ailments. The kind, quality, and quantity of biomedical waste are influenced by various health care characteristics, such as the size of the medical institution, the number of patients seen each day, the location, and others.

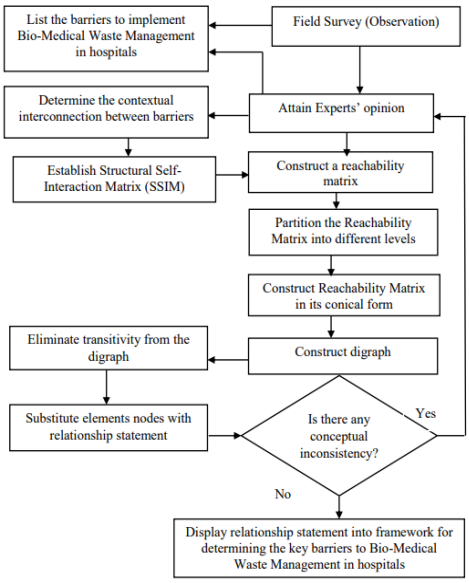

Fig 1. Proposed flow

It has been published that 80% bio biomedical waste originates from hospitals, while pathological waste comprises about 15%. Pharmacological waste contributes to about 3% of the total biomedical waste. While 1% waste is derived from sharp substances, approximately less than 1% comprises cytotoxic waste. Bio-Medical Waste is classified into the minor and major sources. Major sources include hospitals, laboratories, medical colleges, veterinary colleges, research centres, animal research laboratories, blood banks, autopsy centres, paramedic service centres and biotechnology institutions, whereas minor sources of biomedical waste include blood donation camps, slaughterhouses, vaccination centres, dental clinics, acupuncturists, and physicians' clinics.

Major sources include hospitals, laboratories, medical colleges, veterinary colleges, research centres, animal research laboratories, blood banks, autopsy centres, paramedic service centres and biotechnology institutions, whereas minor sources of biomedical waste include blood donation camps, slaughterhouses, vaccination centres, dental clinics, acupuncturists and physicians' clinics. Infectious waste substances required to be managed with cautious consideration to stop the proliferation of microorganisms and to safeguard environmental health, notwithstanding being separated from other waste substances [17]. Infectious squanders is defined as the infectious waste substances produced in health care establishments because of clinical care or research, which comprises microorganisms that can possibly spread contagious diseases. Infectious waste includes blood and body fluids, sharp items infected with blood and body fluids, tissues, body parts and organs. One of the most accepted techniques of information gathering is conducting interviews in both qualitative and quantitative research. Interviews could be classified into three kinds based on the aim and process of research, specifically structured interviews, semi-structured interviews, and unstructured interviews. Differentiate with other techniques, for instance, questionnaires, interviews could attain a comparatively immense response rate. It prevents misinterpretation about what the investigator desired to communicate/ask and what the interviewee comprehends. The current study used semi-structured interviews to assess biomedical waste management practices and identify representative obstacles to implementing successful and efficient biological waste management in

hospitals [9]. To enhance the information and fill up the gaps, the investigator carried out semi-structured interviews of administrators, waste handlers, nurses, and ward boys of selected health care establishments and experts.

4. Result and Discussion

Healthcare facilities are health organisations that render patient care assistance. Hospitals and other healthcare facilities have a responsibility to protect the public's health both directly by caring for sick patients and indirectly by providing a clean, healthy environment for both the public and their employees.

Table 1. Segregation methods of Bio-Medical Waste in hospitals

S.No.	**Parameter**	**Observation**	**Percentage(%)**
1	Availability of different colour-coded containers/bags at the genesis of waste generation in the facility	Available	2(5%)
		Not Available	38(95%)
2	Segregation is done according to categories of waste as prescribed by the guidelines of CPCB	At the source	1(2.5%)
		After the collection of waste	9(22.5%)
		Not done	30(75%)
3	High-density polyethene bags are present in facility	Present	
		Not Present	40(100%)
4	Waste containers used with plastic liners	Used	10(25%)
		Not used	30(75%)
5	Specified containers spliced with a sealed fitting cover	Yes	5(12.5%)
		No	35(87.5%)
6	Containers are situatedatexactspot of waste generation	Yes	4(10%)
		No	36(90%)
7	Waste bins are placed safely and unapproachable to public	Yes	8(20%)
		No	32(80%)
8	The biohazard mark is embossed over the waste containers	Yes	24(60%%)
		No	16 (40%)
9	Sterilisation of waste bins with 1% hypochlorite fluid after unloading the waste bins	Regular	
		Within a week	40(100%)
10	Waste bags are replaced with new waste bags After filling three-fourths	Yes	12(30%)
		No	28(70%)
11	Public display of colour-coding and segregation Norms of waste generation in hospitals	Present	13(32.5%)
		Not Present	27(67.5%)
12	Handling blood spills according to the prescribed guidelines	Present	
		Absent	40(100%)
13	Mercury waste management	Present	16(40%)
		Absent	24(60%)
14	Presence of Effluent Treatment Plant	Yes	
		No	40(100%)
15	Drain liquid waste directly into the sewage system Without any sterilisation	Yes	40(100%)
		No	
16	Waste is segregated by	Untrained sweepers	6(15%)
		Trained sweepers	
		Skilled workforce	
		Clinical staff	
		Clinical staff & Untrained weepers	32(80%)
		Clinical staff & Trained weepers	2(5%)

The various kinds of activities in healthcare service centres create varied types of waste, and there is a constant risk of spreading infectious disease due to the mismanagement of toxic waste and sharp [15]. Over the past 15 years, various endeavours have been made to improve the administration structures and policies for bio-medical waste management and to recognise and spread relevant practices at local, national and global levels.

Table 2. Collection and Transportation of Bio-Medical Waste in Hospitals

S.No.	**Parameters**	**Observation**	**Percentage(%)**
1	The waste containers are replaced when filled three fourth	Yes	3(7.5%)
		No	37(92.5%)
2	Collection frequency of bio-medical waste from various wards	Once a day	26(65%)
		Twice a day	14(35%)
		Thrice a day	
		Weekly	
3	Separate route for the transportation of waste	Yes	

		No	40(100%)
4	Different timing for the transportation of general waste and contagious waste	Yes	
		No	40(100%)
5	A separate covered trolley is used for waste transportation	Yes	4(10%)
		No	36(90%)
6	Trolleys are cleaned and sterilised after each use	Yes	
		No	40(100%)

Policy and administrative issues are frequently shortcomings in the administrative structure, especially in low- and middle-income nations, and need assistance to strengthen institutional structure and competency building. Inadequate sanitation practices may bring about the blending of unsafe waste with general waste, which may worsen the issue of waste administration by expanding the expense of treatment and removal.

5. Conclusion

Clinic waste administration has become a crucial problem as it leads to potential health hazards and harm to nature, which has assumed a focal position in the national health policies of various countries. In developing countries, biomedical waste management has not received adequate consideration. This is because, frequently, health problems compete for the very restricted resources. World Health Organisation (WHO) assessed that in 2000, about 23 million individuals were contaminated with Hepatitis B, Hepatitis C, and HIV around the world because of inoculation utilising infected syringes in hospitals. Comparative cases are inclined to happen when biomedical waste is disposed of in an uncontrolled way and becomes available to the general public. Knowing very well that health and environmental problems are to a great extent connected, it is important to adopt a couple of strategies to assist developing nations in addressing problems associated with biomedical waste disposal. An escalation in the comprehension of health risks caused by ineffectively handled clinical waste has led various nations to generate national and local strategies in an attempt to better deal with their waste.

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