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A Model for Predicting Medical Solid Waste in Hilla City, Iraq

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ABSTRACT

Introduction: To improve current practices and create the most effective healthcare waste treatment system, solid medical waste composition needs to be analyzed. This study aims to develop models to predict the rate of medical waste production in hospitals in Hilla city, Iraq. Predictive mode can be used to set standards, evaluate current methods for treating and disposing medical waste, and optimize healthcare solid waste management systems.

Materials and Methods: Predictive models and long-term data on the composition and rate of solid medical waste generation were developed using a longitudinal study design. A standardized questionnaire and weighted scale were used to measure solid medical waste generated from the five public hospitals. Statistics were used to create models predicting the amount of waste generated at each hospital.

Results: These models demonstrated a significant correlation between inpatient and outpatient numbers and waste generation. Different hospitals treat different numbers of inpatients and outpatients. Different models have been created based on various types of hospitals.

Conclusion: Linear rule-based models accurately represent the weights of variables, identify the sources and implications of solid medical waste, and control waste levels by using a variety of parameters. The research model can help in the development of an effective strategic plan for setting up a medical solid waste (MSW) management system.

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Introduction

The associated term ‘medical waste’ is frequently used worldwide. The term ‘solid medical waste’ is utilized in China, Korea, and the United States, while the WHO and the EU uses the term ‘healthcare waste’. In addition, the term ‘infectious waste’ is used in Japan [1]. Patients receive assistance from healthcare to overcome health issues brought on by pollution. Additionally, one of the largest polluters is the healthcare sector [2]. Effective decontamination and waste management, including recycling options, are crucial because active waste management reduces the risk of virus transmission through litter [3]. The number of hospitals and other health care facilities is rising to accommodate the expanding population [4]. In hospitals, the amount of medical waste varies [5]. Today, there is a greater risk of environmental contamination and disease transmission. This has resulted in the production of a significant amount of medical waste, which is exacerbated by inadequate handling and disposal procedures [6]. Additionally, the healthcare industry has produced more hazardous waste because of the COVID-19 pandemic. Hand sanitizer, rubber boots and gowns, disposable gloves, and masks make up the majority of this waste. Plastic from various personal protective equipment, as well as medical supplies like syringes, test kits, plastic trays, and bandages, are also discarded [7]. It has been observed that the composition of medical solid waste during the COVID-19 pandemic is roughly comparable to that of normal waste, with the exception of the production of a significant quantity of plastics. However, as a result of the pandemic, waste production has increased dramatically. [8]. The first step in setting up a system for managing medical waste is gathering sufficient data about the volume and composition of the generated solid medical waste [9]. According to the World Health Organization (WHO), the proportion of medical institutions, hospitals, specialties, proportional daily patient care, and medical care materials affect the amount of waste generated by hospitals [10]. In order to monitor and manage the current systems for managing medical solid waste (MSW), it is necessary to classify MSW according to generation rates, waste types generated, and composition [11]. By establishing a correlation between key factors that influence the rate of MSW production, such as the hospital's specialty, type, size, and percentage of patients treated per day, and the proportion of MSW produced [12], the evaluation of the various types of hospital-generated MSW looks promising. The number of hospitalized patients has the greatest impact on the amount of waste produced [13]. A technique for determining the connection between these significant variables and the quantity of solid waste produced is statistical analysis [1]. For current MSW management, the production rate, type of waste produced and waste composition ought to be characterized [10]. Utilizing mathematical prediction models to accelerate the production of solid medical waste can improve solid medical waste management. Scientists have developed predictive models that can be used to estimate the rate at which healthcare waste is produced [14-15]. The researchers have developed three distinct multiple linear regression (MLR) models in order to evaluate the daily total of hospital waste and the total amount of hazardous waste in Nablus City using the number of beds and inpatients [15]. A number of autoregressive integrated moving average (ARIMA) models have been tested to see which model was best at estimating the amount of solid medical waste produced in India [16]. In addition, Etinkaya developed a regression model to estimate the solid medical waste generated by Turkish hospitals using patient counts and GDP per capita as inputs [17]. A number of variables have an impact on the prediction model for the generation of MSW. These variables consist of the beds number, the patient's number, and the hospital type. Therefore, regional factors must be taken into account when estimating the production of solid waste in developing nations. Nevertheless, Awad discovered a significant relationship with R^2 values of 0.973, 0.486, and 0.937 between the medical waste quantities produced, the patient's number, the hospital kind, and the beds number, respectively [6]. On the other hand, a number of studies in the literature have used surveys, questionnaires, and field investigations to estimate the generated MSW [12,18-20]. These methods are reliable for estimating the MSW generation rates. It is essential to place an emphasis on the actual quantities of generated MSW in hospitals rather than data obtained from surveys or questionnaires in order to conduct a predictive study that is more accurate, healthy, and trustworthy. During several visits of each hospital, the total amount of MSW was measured.

Classification of medical waste

Hospital MSW is already divided into several categories. The research conducted by Khan [21] used ten distinct categories including pharmaceutical, chemical, pressurized containers, sharps, highly infectious, nontoxic, and radioactive waste, as well as anatomical, pathological, and infectious diseases (Table 1). MSW from hospitals can also be divided into two categories including hazardous waste and non-

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hazardous waste, or infectious and infectious waste. However, the following four categories were utilized in this study consisting of sharp, contagious, pathological, and all-encompassing. Hospitals and medical centers, on the other hand, generate a significant amount of medical waste. Bandages, syringes, contaminated needles, vials, and other medical equipment are all common sources of medical waste. Medical waste also includes soiled linens, used gowns and gloves, and food containers thrown away. Additionally, pharmaceuticals and hazardous chemicals are categorized as medical waste. Medical waste includes instruments, dressings, swabs, and clinical waste from medical procedures. Medical waste also includes pharmaceutical products like expired medicines. As shown in Table 2, medical waste can also come from infectious waste, hazardous waste, and laboratory waste. The easiest way to identify and encourage people to sort the various types of waste is to collect them in separate containers or plastic bags that are color-coded or marked with a symbol. Table 3 lists the international recommendations.

Table 1: Classification of medical wastes and their brief description [21]

Waste category	Descriptions and examples
Hazardous healthcare waste	
Sharps waste	Used or unused sharps (e.g., hypodermic, intravenous or other needles, auto-disable syringes, syringes with attached needles, infusion sets, scalpels, pipettes, knives, blades, and broken glass)
Infectious waste	Waste suspected to contain pathogens that poses a risk of disease transmission (e.g., waste contaminated with blood and other body fluids, laboratory cultures and microbiological stocks, and waste including excreta and other materials that have been in contact with patients infected with highly infectious diseases in isolation wards)
Pathological waste	Human tissues, organs or fluids,body parts, fetuses, and unused blood products
Pharmaceutical waste, cytotoxic waste	Pharmaceuticals that are expired or no longer needed; items contaminated by or containing pharmaceuticals. Cytotoxic waste containing substances with genotoxic properties (e.g., waste containing cytostatic drugs(often used in cancer therapy), and genotoxic chemicals)
Chemical waste	Waste containing chemical substances (e.g., laboratory reagents, film developer, disinfectants that are expired or no longer needed, solvents, waste with high content of heavy metals, e.g., batteries, and broken thermometers and blood-pressure gauges)
Radioactive waste	Waste containing radioactive substances (e.g., unused liquids from radiotherapy or laboratory research, contaminated glassware, packages, or absorbent paper, urine and excreta from patients treated or tested with unsealed radionuclides, and sealed sources)
Nonhazardous or general healthcare waste	Waste that does not pose any particular biological, chemical, radioactive, or physical hazard

Table 2: Major sources of medical waste in hospitals and medical centers [21]

Location	Sharps	Infectious and pathological waste	Chemical, pharmaceutical, and cytotoxic waste	Nonhazardous or general waste
Medical ward	Hypodermic needles, intravenous set needles, broken vials, and ampoules	Dressings, bandages, gauze, and cotton contaminated with blood or body fluids, gloves and masks contaminated with blood or body fluids	Broken thermometers and blood-pressure gauges, spilt medicines, spent disinfectants	Packaging, food scraps, paper, flowers, empty saline bottles, nonbloody diapers, nonbloody intravenous tubing and bags

Location	Sharps	Infectious and pathological waste	Chemical, pharmaceutical, and cytotoxic waste	Nonhazardous or general waste
Operating theater	Needles, intravenous sets, scalpels, blades, Saws	Blood and other body fluids; suction canisters; gowns, gloves, masks, gauze and other waste contaminated With blood and body fluids; tissues, organs, fetuses, body parts	Spent disinfectants Waste anesthetic gases	Packaging; uncontaminated gowns, gloves, masks, hats, and Shoe covers
Laboratory	Needles, broken glass, Petri dishes, slides and cover slips, and broken pipettes	Blood and body fluids, microbiological cultures and stocks, tissue, infected animal carcasses, tubes and containers contaminated with blood or body fluids	Fixatives, formalin, xylene, toluene, methanol, methylene chloride, and other solvents, broken lab thermometers	Packaging, paper, and plastic containers
Pharmacy store		Expired drugsand spilt drugs		Packaging, paper, and empty containers
Radiology		Silver, fixing and developing solutions, acetic acid, glutaraldehyde		Packaging, paper
Chemotherapy	Needles and syringes	Bulk chemotherapeutic waste; vials, gloves, and other material contaminated with cytotoxic agents, contaminated excreta and urine		Packaging, paper
Vaccination campaigns	Needles and syringes	Bulk vaccine waste, vials, and gloves		Packaging
Environmental services	Broken glass	Disinfectants (glutaraldehyde, phenols, etc.), cleaners, spilt mercury, pesticides		Packaging, flowers, newspapers, magazines, cardboard, plastic and glass containers, yard and plant waste
Engineering		Cleaning solvents, oils, lubricants, thinners, asbestos, broken mercury devices, batteries		Packaging, construction or demolition waste, wood, metal
Food services		Food scraps, plastic, metal, and glass containers; packaging		

Table 3: Colour coding and types of container for collecting different types of wastes [21]

S. No	Types of waste	Color-coding symbol	Type of container
1	Household refuse	Black	Plastic bag
2	Sharps	Yellow	Sharps container
3A	Waste entailing a risk of contamination	Yellow	Plastic bag or container
3B	Anatomical waste	Yellow	Plastic bag or container
3C	Infectious waste	Yellow and highly infectious	Plastic bag or container which can be autoclaved
4	Chemical and pharmaceutical waste	Brown, marked with suitable symbol	Plastic bag or container

Materials and Methods

Case study area

One of the provinces in the Middle Euphrates region is Hilla city (Figure 1). This is located in Iraq's sedimentary plain. In this city, there are numerous government hospitals that treat patients in a variety of medical specialties. Each facility had a very different total number of beds, especially public hospitals. As can be seen, the five hospitals are all different sizes and treat different numbers of patients. There are many different kinds of trash. Nevertheless, a single landfill now holds all of these hospitals waste. This study was conducted in Hilla city in 2022 to assess the management of hospital solid waste. The locations of the field visits were five public hospitals including Hilla General Teaching Hospital, Babel Hospital for Women and Children, Murjan Teaching Hospital, Al Noor Children's Hospital, and Imam Sadiq Hospital. Qualitative and quantitative methods were used in the form of questions, interviews, and observations. Inspections and observations of treatment and collection facilities were also carried out in order to triangulate the interview data. Each hospital total amount of MSW was measured over several visits. After that, the waste is recycled into plastic, glass, paper, textiles, and other products. After sorting waste by type, it was measured again by group. The laboratory of university received the samples from each batch to determine their moisture content. The sample was first weighed before being dried for an additional 24 hours at 105 °C to determine its moisture content. Moisture content of waste samples is important for a variety of reasons, such as determining the efficiency of waste-to-energy systems, maintaining quality control, and providing information about the composition and characteristics of the sample.

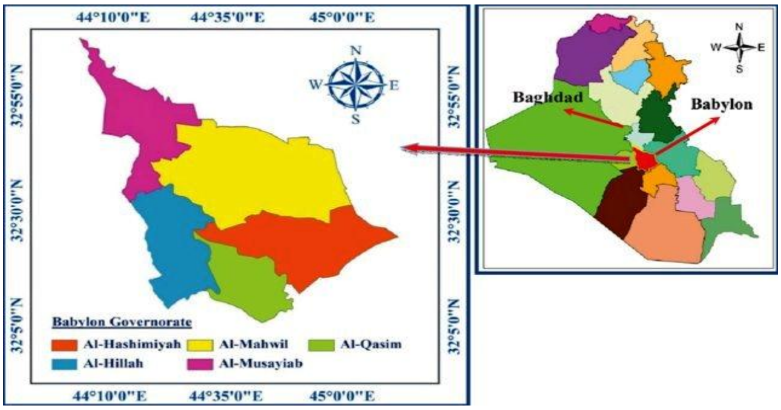

Figure 1: Map of the city of Hilla, Iraq [22]

In addition, the objective of this study is to investigate and attempt to develop specific prediction models that can predict the number of HCWs produced by a healthcare facility by taking into account a variety of factors. Morover, to determine the amount of waste produced by hospitals per bed per day, kitchen waste was added to each waste unit. Additionally, the number of overnight admissions was counted. This is the first study including HCWs' data from the hospitals in Hilla city public healthcare sector due to the limitations in Iraqi, particularly Hilla city.

Reaserch methodology

Meetings with field workers and university and administration experts were held to create a complete composition of MSW. After that, a literature review of scientific papers and reports was completed and an examination of the published data on medical waste was available. Through surveys and weighing studies, prediction models based on the patient's number, hospital type, and numbers of beds were developed to accurately predict the rates of hospital MSW. The reaserch methodology is presented in Figure 2.

Five hospitals with varying capacities and specialties provided the data. There were two rounds of data collection. The first round was held in the wet season from October to December 2022, while the second round was held in the dry season from January to March 2022. Over the course of a single day, primary and secondary data collection techniques, equipment demonstrations, and procedures were taught. Infectious waste should be labeled in black, while general MSW should be labeled in yellow. The amount of waste produced was determined by collecting solid medical waste from each unit of the study hospital and measuring it with a calibrated sensitivity scale. The number of outpatients, the number of hospital beds, and the amount of daily waste were all recorded. A number of authors claim that kg/bed/day and kg/ambulatory/day are indicators of the production of solid medical waste [5]. During the field visits, observations made in the field were also recorded. From the data gathered, a conclusion and a summary of the findings were compiled. The Statistical Package for the Social Sciences (SPSS) was used to process and analyze the data. Each of the five hospitals was a specific study site. A normal distribution was found after applying a normality test to data on the generation of MSW. As a result, bivariate associations were examined with the Pearson correlation test. Multivariate linear regression analysis was used to identify significant variables that influence the amount of waste produced by hospitals in order to develop a model that can accurately calculate or predict waste generation rates for the examined hospitals.

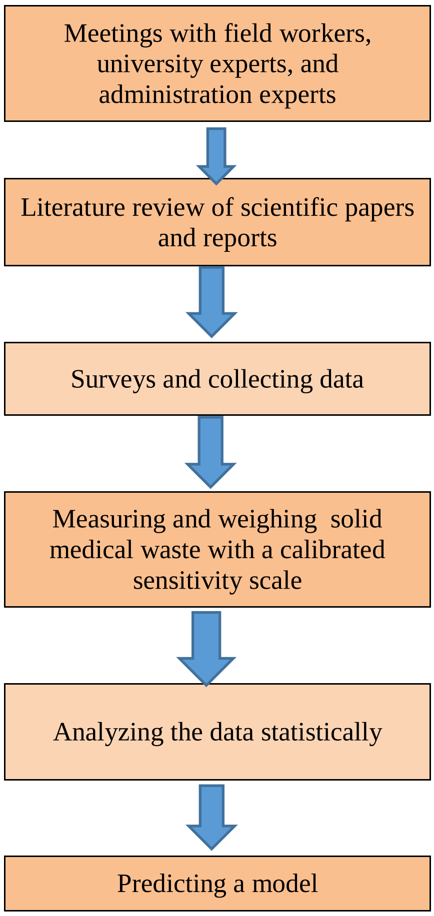

Figure 2: Flow diagram of the research steps

A fundamental correlation matrix was constructed in order to construct a model for facilitating the nature and strength comprehension of the correlation between the variables used in the study. The F-test was used to look at the removal efficiency and find significant factors. The calibrated instruments and knowledgeable supervisors ensured the quality of the data.

Ethical issues

All participants provided written informed consent for their anonymous information to be published in this article prior to enrollment in this study, which was carried out in accordance with the principles of the Declaration of Helsinki.

Results

In order to have an effective solid waste management system, it is necessary to anticipate future rates of solid medical waste production. The generation rate has an effect on the size of storage facilities, the variety and quantity of collecting tools, and the capacity requirements for subsequent treatment and disposal. Despite the increase in the number and variety of treatment facilities in Iraq, the challenges associated with managing solid medical waste have remained constant over the past few years. The significant rise in the production of solid medical waste is primarily attributed to Iraq's expanding population and economy. Hilla city, like other cities in the country, has a lot of people and makes a lot of solid medical waste. Therefore, in order to successfully manage solid medical waste in other cities of Iraq, it is necessary to locate a suitable model to explain the data. This research aims to gather and analyze data from various sources and then come up with a method that effectively finds the mean generation rates for solid medical waste. To this end, the researcher plans to use a combination of analytical and statistical processes, such as collecting and analyzing existing data or conducting surveys with national and local organizations. The methods used to calculate the mean generation rate (kg/bed/day) are relatively straightforward by simply taking samples from a known volume of MSW and calculating the mean concentration thorough analysis. According to the data that was gathered, the mean generation rates at Hilla General Teaching Hospital, Babel Women's and Children's Hospital, Al Noor Children's Hospital, Imam Sadiq Hospital, and Murjana Teaching Hospital were 0.688, 0.47, 0.167, 0.679, and 0.278, respectively (Table 4). Hilla General Teaching Hospital and Imam Sadiq Hospital experienced the worst conditions, since they provided residential or food services to patient's andgenerated the highest percentage of waste compared to other hospital. According to the data, 72 % of the wastes were for general, 19% for infectious, 1% for acute (acute waste is any waste material that is highly toxic or hazardous such as chemical waste and oil waste), 0% for pharmaceutical, 8% for pathological, and 0% for radioactive wastes of the hospitals. Compared to the WHO estimates of 80%, 15%, 1%, 3%, and less than 1% for general, pathological and infectious, sharp, pharmaceutical, and radioactive medical solid waste, these results are significantly higher. However, the lack of segregation policies for hospital samples may be the reason why the generation rate for hospitals in Hilla is lower than in other countries. The rates of MSW generation in various nations are presented in Table 5. Additionally, a variety of solids are typically present in clinical strong waste.

Table 4: Typical generation rates for Hilla hospitals (kilograms per bed per day)

Hospital	Mean generation rate
Hilla general teaching hospital	0.688
Babel women and children hospital	0.47
Al noor children hospital	0.167
Imam sadiq hospital	0.679
Murjan teaching school	0.278

Table 5: Mean rate of medical waste generation in different countries/cities hospitals [23]

Country / City	Waste generation rate	General waste %	Hazardous waste %
Iraq/Tikrit	0.75 Kg/patient/d 0.9 Kg/bed/d	63.04	36.96
Taiwan	0.88 Kg/bed/day	64	92
Greece	8.4 kg/bed/day	83.33	16.67
South Africa	0.6 kg/patient/day	60.74	39.26
Algeria	0.7-1.22 kg/bed/day	75-90	10-25
Libya	1.3 kg/patient/day	72	28
El- Beheria, Egypt	2.07 kg/bed/day	60.10	38.90
Public hospitals, Iran	3.16 Kg/bed/day	56	42

As a result, a mathematical model that can predict the amount of waste generation by hospitals in Iraq is very helpful. Correlations between inpatients and outpatients, as well as the number of beds, capacity, and type of hospital, were used in this study to identify significant variables that primarily affect the rates of MSWgeneration. Linear regression analysis was also used to create models that could be predicted. The number of inpatients and outpatients at Hilla General Medical University Hospital is strongly correlated with the amount of MSW produced (R^2 = 0.934). At Babel Women's and Children's Hospital, the rate of MSW generation was R^2 = 0.885 for inpatients and R^2 = 0.768 for outpatients. The rate of MSW generation at Al Noor Children's Hospital was inversely correlated with the number of outpatients at R^2 = 0.887 and had a correlation with the number of inpatients at R^2 = 0.870. At Imam Sadiq Hospital, there was a correlation (R^2 = 0.858) between the quantity of medical waste produced and the number of inpatients and outpatients. The MSW generation rate at Al-Murjan Hospital was found to be inversely correlated with the number of outpatients and inpatients as R^2 = 0.494 and 0.884, respectively. In addition, the bed occupancy rates at Al Murjan Hospital, Imam Sadiq Hospital, Hilla General Hospital, Babel Hospital for Women and Children, Al Noor Children's Hospital, and Imam Sadiq Hospital were 50 %, 92 %, 83 %, 45 %, and 50 %, respectively. Hilla General Hospital had a bed occupancy rate of 50 %. Furthermore, in order to ascertain the ways in which each independent variable affects the dependent variable, Figures 3, 4, 5, 6, and 7 show scatter plots of the daily rate of MSW generation against total patients, inpatients, and outpatients for all of the hospitals. Figures 3,

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4, 5, 6, and 7 depict the linear relationship between the rate at which MSW is produced and the number of inpatients and outpatients. Equations 1, 2, 3, 4, and 5 are the subsequent linear connection-based predictive models. Equation 4 depicts the prediction model for the overall rate of inpatient and outpatient MSW generation. This study employs predictive modeling to statistically identify data patterns and the likelihood of particular outcomes.

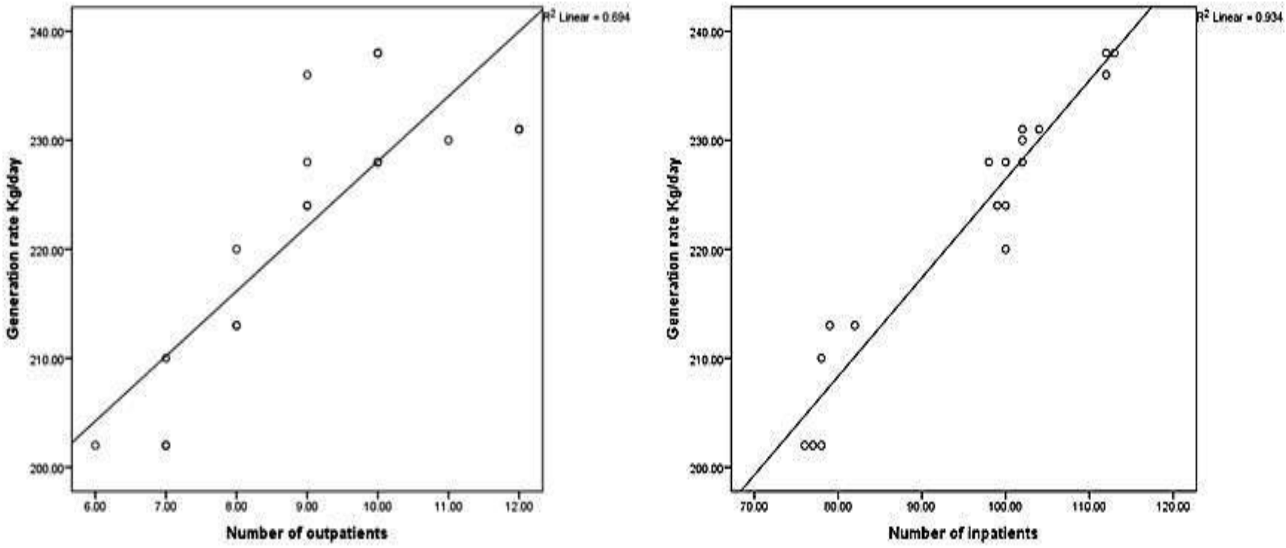

Figure 3: The correlation between the daily numbers of inpatients and outpatients and the amount of soild medical waste produced per kilogram per day at Hilla General Teaching Hospital

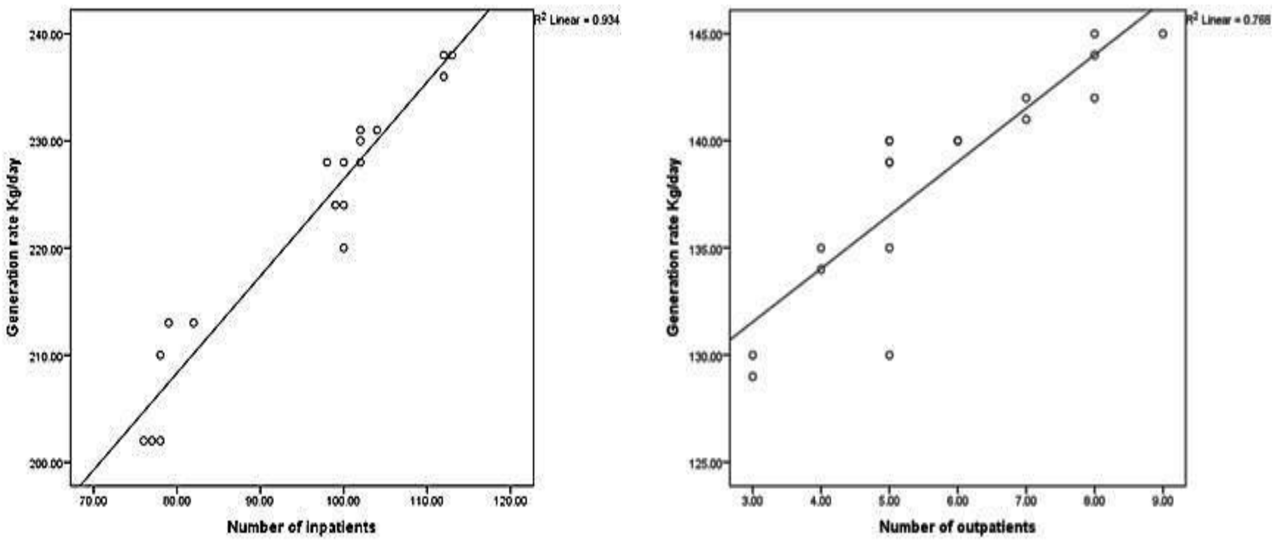

Figure 4: The correlation between the daily numbers of inpatients and outpatients and the amount of soild medical waste produced per kilogram per day at Babel Hospital for Women and Children

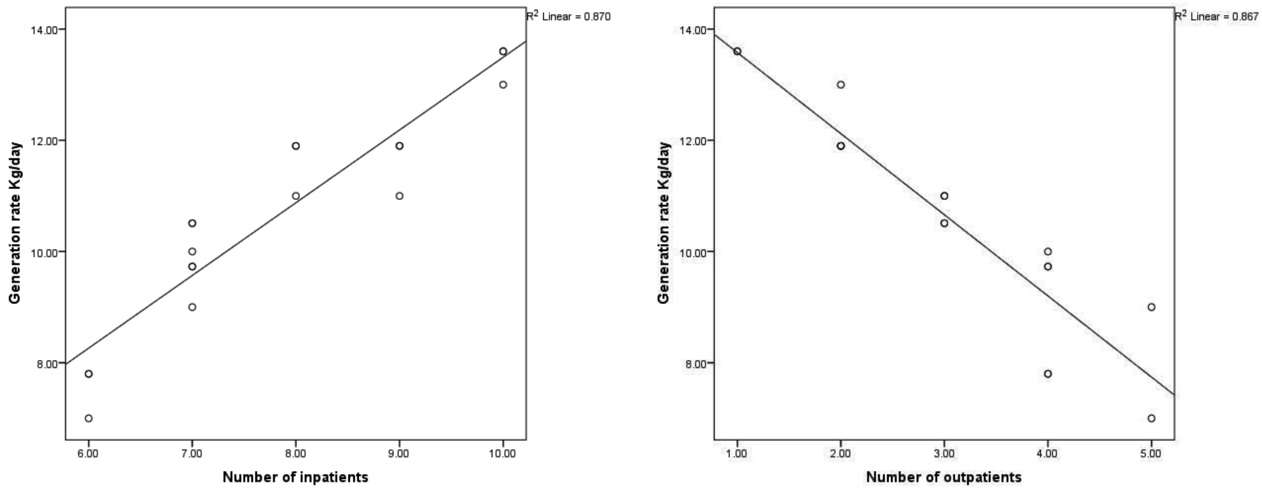

Figure 5: The correlation between the daily numbers of inpatients and outpatients and the amount of soild medical waste produced per kilogram per day at Al Noor Children's Hospital

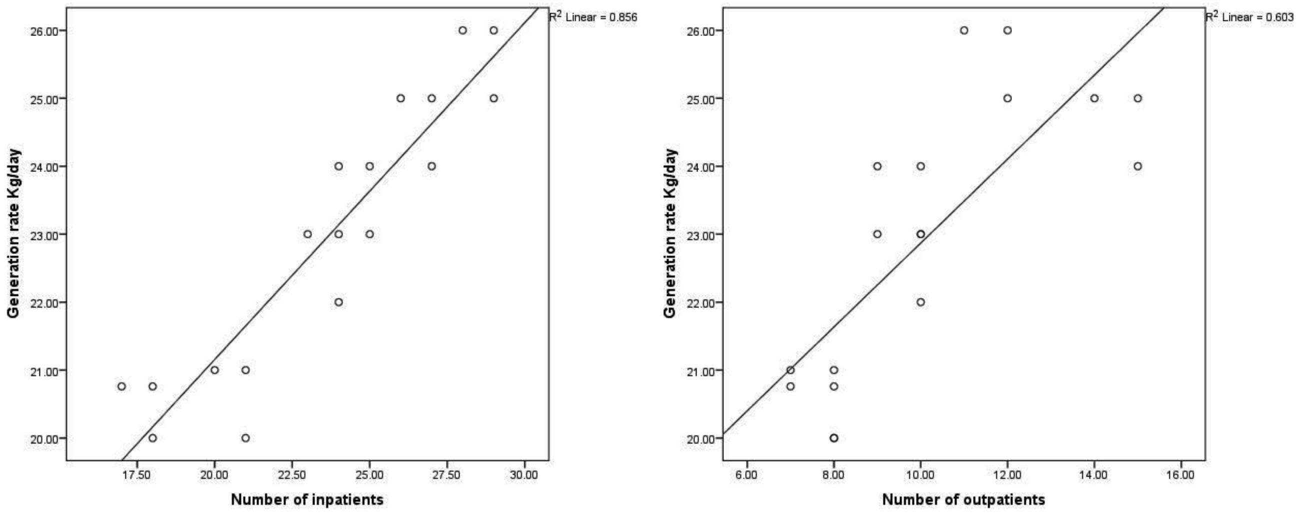

Figure 6: The correlation between the daily numbers of inpatients and outpatients and the amount of soild medical waste produced per kilogram per day at Imam Sadiq Hospital

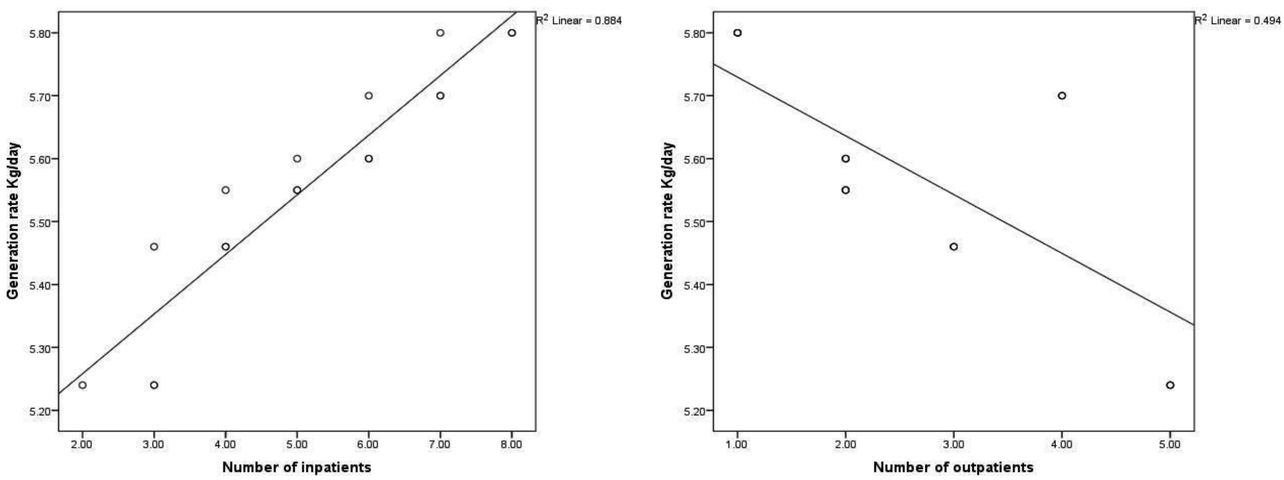

Figure 7: The correlation between the daily numbers of inpatients and outpatients and the amount of soild medical waste produced per kilogram per day at Murjan Teaching Hospital

It is essential to first define the issue and collect data in order to construct a precise predictive model. Predictive modeling also lets financial departments, medical staff, and maintenance workers know about potential risks, so they can be better prepared for the future. The impact of the patient's number treated (inpatients) and outpatients differ by hospital. Various models based on various hospital types were developed as follows:

Hilla General Teaching Hospital Generation rate (kg/day)

Y = 1.565 (NOP) + 0.747 (NP) + 136.850 (1)

Babel Hospital for Women and Children Generation rate (kg/day)

Y = 0.897(NOP) +0 613(NP) + 81.373 (2)

C. Al Noor Children's Hospital Generation rate (kg/day)

Y= -0.775(NOP) + 0. 711(NP) + 7.413 (3)

D. Imam Sadiq Hospital Generation rate (kg/day)

Y = 0.462 (NP) + 11.410 (4)

E. Murjan Teaching Hospital Generation rate (kg/day)

Y = - 0.029 (NOP) +0.081 (NP) + 5.221 (5)

Where: NP = the inpatients number, NOP = the outpatients number

In addition to the values of the selected parameters, the quantity of waste generated in these hospitals is further detailed in Table 6. The rate of bed occupancy and the capacity of the hospital (the number of beds) have been identified as the most significant factors.

In order to examine their connections, similarities, and differences, the Hilla private hospitals must be included in the study scope. The following equations were derived by analyzing the application parameters used to predict overall rates and various types of hospital waste, such as sharp, infectious, pathological, and general waste:

Total = 1.813 (HT) + 1.346 (BO) + 0.507(HC) - 36.492 (6)

General = – 1.636 (HT) + 1.024 (BO) +0.012 (HC) -9.508 (7)

Sharps = -2.280 (HT) + 0.041 (BO) -0.150 (HC) + 8.806 (8)

Infectious = 1.584 (HT) +0.234 (BO) +0.364 (HC) -22.188 (9)

Pathological = -2.048 (HT) +0.064 (BO) + 0.217 (HC) -5.418 (10)

Where: HC = hospital capacity and BO = bed occupancy

Table 7 displays the generated model's statistical characteristics. Furthermore; hospital capacity and bed occupancy are significant parameters that have an effect on residuals (≤ 0.05), as determined by the model statistical characteristics. Accurate prediction of medical waste generation rate is an essential component of hospital waste management systems. The study objective was to develop a reliable model for anticipating these numbers. The MLR model was used in this study to predict five distinct kinds of hospital waste. The generation rate and the relevant active variables for the generation rate of medical waste are correlated linearly in the findings. The ability of linear rule-based models to specify the significance of each parameter, emphasizing their success in predicting the rate of the production of medical waste, is one of the most significant advantages. The findings are encouraging and may aid in the development of effective waste management practices for medical waste, including its sources, generation, collection, transportation, treatment, and disposal.

Table 6: Waste generation rate for all hospitals in Hilla of city

Name of hospital	Capacity (beds)	Bed occupancy (%)	Waste generation rates (kg/day)			
			General	Sharp	Infectious	Pathological
General Teaching Hospital	499.00	92.00	495.00	8.18	128.00	33.00
Women and Children Hospital	295.00	83.00	285.00	5.80	85.00	41.00
Al Hussein Children hospital	65.00	45.00	55.00	1.50	8.16	0.01
Al-Furat Al-Awsat Hospital	35.00	35.00	25.00	6.84	0.18	11.80
AL-Shifa Hospital	25.00	70.00	15.00	0.11	5.87	8.50
AL-Diwaniya Hospital	22.00	50.00	18.00	0.45	2.83	3.50

Table 7: The developed MLR models statistical characteristics

Type of hospital waste	Parameter	Parameter estimate	Standard error	T-value	a-Level	R^2
Total	Intercept	-36.452	11.223	-3.159	0.013	0.998
	HT	1.813	7.241	0.237	0.825	
	BO	1.436	0.031	43.492	0.001	
	HC	0.787	0.218	2.234	0.043	
General	Intercept	-9.408	1.418	-6.633	0.000	0.997
	HT	-1.676	0.915	-1.831	0.076	
	BO	1.014	0.004	261.283	0.000	
	HC	0.013	0.028	0.484	0.631	
Sharp	Intercept	8.856	1.149	7.709	0.000	0.816
	HT	-2.280	0.741	-3.077	0.004	
	BO	0.031	0.003	9.878	0.000	
	HC	-0.140	0.022	-6.256	0.000	
Infectious	Intercept	-22.188	2.903	-7.643	0.000	0.996
	HT	1.584	1.873	0.846	0.404	
	BO	0.238	0.008	29.937	0.000	
	HC	0.364	0.056	6.449	0.000	
Pathological	Intercept	-5.215	6.241	-0.836	0.409	0.745
	HT	-2.038	4.027	-0.506	0.616	
	BO	0.054	0.017	3.149	0.004	
	HC	0.227	0.121	1.869	0.71	

Discussion

The composition of MSW is influenced by the size and type of healthcare services, solid waste management practices like handling, segregation, and disposal, and solid waste regulations. On the other hand, it depends on how busy it is, the department type (surgical theatre or office), its location (rural or urban area), and the development of the country's infrastructure [14-15]. On the other hand, this could be due to the fact that solid waste is not separated in a way that makes sense. MSW pollutes materials with blood when it is not sorted, resulting in an excessive amount of infectious solid waste [15]. The value of the waste decreased due to the rising cost of handling MSW [12,24]. Solid waste management relies on segregation, which must be carried out at the source of biomedical solid waste generation in order to prevent contamination of the entire quantity of residuals [18,25]. In terms of the individual factors effect, with the increase of each bed occupancy unit (%), the annual production of MSW increased. Furthermore, comparing to the hospitals in other cities of Iraq, such as Baghdad and Tikrit, there are some variations as a result of different hospital systems. These could be due to variations in the infrastructure of public health, a higher rate of urbanization, or a greater availability of resources. Due to the larger population and higher rates of poverty in Tikrit, the quality and accessibility of medical care may also differ. The present study at the Hilla hospital in Iraq reveals the need for more effective infection control measures. In addition, the findings of the survey suggest that not everyone is aware of or has access to medical care. In developing nations, however, the issue of medical waste has not received enough attention. When medical waste is still disposed of as normal waste, public health, the health of municipal workers, and the environment are at risk [26]. Moreover, no comprehensive investigation has been conducted on the waste management practices of healthcare facilities like hospitals and clinics. Waste management is typically handled by untrained workers, who carry out the majority of tasks with little supervision [27]. Therefore, there is no accurate information about the amount of waste generated by hospitals and waste management. This issue has a negative impact on the collection, interim storage, transportation, and disposal phases of their management [28].

The study shows that a variety of factors, including the number of beds, the type of hospital or healthcare facility, services, the number of annual inpatients, the number of days spent there, the number of scheduled surgeries, the presence of specialized units (like the intensive care unit), and the overall workforce, all have an effect on the volume of solid medical waste generated at Hilla public hospital. Some of these criteria, like the type of hospital and the ratio of inpatients to outpatients, have also been identified and supported by studies from Taiwan, Jordan, Kuwait, India, Nigeria, and Greece [29-34].

Conclusion

In order to regulate and improve the current situation in Hilla, a crowded city, it is essential to provide adequate solid medical waste management. Complete management of solid medical waste necessitates precise waste assessment. The development of a reliable model for predicting the amount of solid medical waste produced is the goal of this study. Long-term data on the composition and generation rate of solid healthcare waste as well as the development of predictive models were obtained through the use of a longitudinal study design. The majority of medical waste is general and infectious. To accurately estimate the rate of the generation of MSW, this study demonstrated that two units of measurement-kg/inpatient/day and kg/outpatient/day-should be utilized simultaneously. The number and type of hospitals may also have an impact on the generation of MSW. The results demonstrated that there was a clear linear relationship between the actual rate of generation of medical waste and the rate of generation. In addition, the effectiveness of linear rule-based models in predicting medical waste was demonstrated by their capacity to precisely determine the weights of each parameter. The field study of some Hilla hospitals solid waste management systems revealed that the implementation of the solid medical waste management system lacks a methodical and practical approach. Additionally, the majority of Hilla's hospitals' employees are unaware of the requirements for safety, worker protection, and medical waste. Medical waste bags are also not used to treat infectious tissue waste or bacterial culture dishes in the majority of hospitals. They also suffer from improperly handling chemical drug remnants used to treat cancer patients and treating them like any other medical waste. Such waste contains substances that can harm or kill human cells, posing a risk to workers. The study findings will be beneficial to Hilla, since they may help develop a reliable model for predicting MSW. Additionally, the quantity of MSW produced in the past could be used in facility design and planning. A strategy plan for building a suitable MSW management system can be created using the research model.

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Conflict of interest

The authors declare that there is no conflict of interest.

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