

**BIO-MEDICAL WASTE MANAGEMENT IN PUBLIC & PRIVATE HOSPITAL'S: A CASE
STUDY OF PESHAWAR**



A thesis submitted in partial fulfillment of the requirements for the degree of

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In

Urban and Regional Planning

By

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THESIS ACCEPTANCE CERTIFICATE

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Dedication

This thesis is dedicated to my beloved daughter, always believe in yourself.

“She stood in the storm and when the wind didn’t blow her way, she adjusted her sails – Elizabeth Edwards.”

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Surely, Allah is the best of planners. First and foremost, I am grateful to Allah Almighty for bestowing upon me his blessings and the intellectual ability to search for the facts surrounding this research.

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Grateful,
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Abstract

Peshawar city's health care system has gone through major changes in recent years to improve the services it provides to the community. This research is designed to evaluate the standards of health care services and hospital waste management from different hospital stakeholder's viewpoint and to compare the gap between public and private hospitals in Peshawar. Stakeholder satisfaction and awareness of medical waste management is one unavoidable indicator of the HCWM; nevertheless, enhancing stakeholder satisfaction and awareness in developing countries is very challenging due to the shortage of resources as well as low awareness level regarding hospital waste. A combination of all these three objectives i.e., Service quality improvement, factors affecting hospital waste management and stakeholder perception and awareness regarding waste management can help in ensuring the practice of sustainable waste management.

Further research on the sustainable waste management and leadership dimensions of health care quality will contribute to improved planning for health care services. This highlights importance of service quality dimensions for the promotion of sustainable waste management in public and private hospitals. Therefore, targeted interventions that directs to improve the dimensions of patient satisfaction where the proportion of satisfaction is low are needed. Similar studies should be conducted regularly at different levels of health facilities across the province to capture a wider picture of patient satisfaction, awareness, improvement of affecting barriers in the current practices at various levels.

A mixed-method approach is adopted for the research, using a combination of expert interviews, questionnaire-interview schedule surveys, and literature review. The data will undergo descriptive data analysis, factor analysis, and content analysis. The study will try to find out the ways and methods in which we can improve hospital biomedical waste management, implement them in both public and private hospitals, by doing so we can improve the quality of life of the people and regulate any informal waste management that otherwise goes unaccountable. The findings of the research are expected to provide insight into the waste management problems associated with current practices in hospitals and act as a helping tool in the decision-making and policy formulation regarding sustainable waste management for Peshawar city.

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Abbreviations

HCWM	Health Care Waste Management
US	United States
SDG	Sustainable Development Goals
PPE	Personal Protective Equipment
KPK	Khyber Pakhtunkhwa
m	Meters
SPSS	Statistical Package for Social Sciences
UNDP	United Nations Development Plans
WHO	World Health Organizations
S.NO	Serial Number
BI	Barrier Indicator
SI	Satisfaction Indicator
FI	Factors Indicator
AI	Awareness Indicator
UNEP	United Nations Environment Programme
GIS	Geographic Information System
BMW	Bio-Medical Waste Management
LG	Locally Government
CD	Community Development

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CHAPTER 1

INTRODUCTION

Biomedical waste system of Peshawar has faced many challenges in the years to make sure that the services they are providing follow sustainable waste management guidelines issued by HWM 2005 policies and WHO recommendations, to enhance current quality of services for the people of Peshawar. This study focuses on measuring the level of services provided by the hospitals and hospital waste management from different stakeholder's opinions and to find the gap of facilities provided by public and private hospitals.

Environment and public health are greatly affected by medical waste and causes a threat to the current situation. As we see the trend of increasing hospitals both private and public which inherently means that the hospitals are creating waste more than ever and are mostly left untreated. From literature review we find out that on average 1.5- kgs of waste is generated by the patients per day. On a usual day patients occupy about 75% of the hospital beds (Bhanot, 2010). The waste generated by the hospitals are of different nature which includes both non-risk domestic waste and hazardous waste such as infectious, pathological, sharps etc. To cope up with this issue cordially, proper segregation and disposal of biomedical waste is important and needs to be done at the very grass-root level to hit the core issue.

The reasons behind inefficiency of waste management process are many but the bigger issues which causes barriers towards modern practices are lack of funds, low level of awareness, waste management process knowledge, training health personnel, stakeholder participation related to waste management process and policy making. However, research on this issue in Peshawar has been very limited, and there is serious dearth of knowledge, learning opportunities, planning, and implementation of sustainable biomedical waste management practices.

Policies and guidelines have been set by government such as in 2005 HWM policies and non-profit organizations like WHO. It's the responsibility of the private and public hospitals to follow the government rules and regulations and dispose of all kinds of hospital waste in a proper way

according to the standard protocols. The ideal practice involves efficiency of waste management from the first stage to the very seventh stage to ensure sustainable waste management. These stages include generation, segregation, collection, storage, treatment, transportation and final disposal. Each stage has its own standard protocols and importance in ensuring an integrated hospital waste management.

All the developed and developing countries are struggling with proper waste management and waste disposal in a sustainable manner be it in India, Tanzania, United Kingdom, or the United States (Globalization 2010). Hospitals are centers of healing and rehabilitation they are supposed to be safe havens where patients are treated and do not have to fear getting sicker or affected by the atmosphere. In order to achieve that the hospitals don't just have to provide medical treatment but also the cleanliness, hygiene, safety and healthy environment for both their working staff and the various stakeholders of the hospital community (Patil & Pokhrel, 2005).

As the developing countries are struggling with this issue, Pakistan also has same challenges. Three methods of disposing waste exist in our healthcare system such as open dumping, landfills and incineration. Existing landfills are not constructed on the standard guidelines or on scientific lines. Also, except the very rare situations mostly incinerators which exist do not have mechanism of proper filters and scrubber's (Arshad et al. 2011). Proper HWM practices are lacking which include color coding of wastes according to the international standards, labeling of waste with relevant details such as: date, nature, content, source, proper personal protective equipment, awareness about the facts that how dangerous can it be if the biomedical waste is disposed of in landfills and incinerator without following proper techniques.

Khyber Pakhtunkhwa's capital province is Peshawar, with an estimated population of 3.7 million and around ten tertiary care teaching hospitals on average (Muhammad Nazeer, 2019). HWM 2005 rules have a standard guidelines and rules about how to manage waste but even after more than a decade we don't see its true implementation in the current practices both in public and private hospital in Peshawar District (Zeeshan, 2018).

The HWM (Health waste management) practices among these hospitals have not been reported as a whole. More specifically, to the best of our knowledge, no recent study has assessed adherence to the HWM 2005 rules after a decade of enactment among all tertiary care teaching hospitals of

Peshawar District (Zeeshan, 2018). Two main groups of wastes are generated by the hospital, one is the direct byproduct of the health facility activities and the other is predictable wastes from other departments of the hospitals such as administration, food services, building maintenance and construction (EHP 2000).

Stakeholder satisfaction and awareness of medical waste management is one vital indicator of the HCWM; however, enhancing stakeholder satisfaction and awareness in developing countries is very challenging due to the insufficiency of resources as well as low knowledge regarding biomedical waste. In this study, we evaluate stakeholder satisfaction in public and private hospitals and its level of awareness in Peshawar.

Stakeholder satisfaction regarding hospital waste management is important as they are the ones running the system of the hospital and have direct contact with the waste generated by the hospitals. Hospitals generate various types of waste such as general waste, hazardous waste, infectious waste and radioactive. The stakeholders should know about the different nature of respective waste how to handle it, manage it or reuse/recycle them. This can only be achieved if the hospital staff are aware of the knowledge and its implementation mechanism. Especially, during times of pandemic the waste generated by hospital has increased in amount and medical waste containers are the barrier provided which saves the hospital and outside world from getting contaminated. Sensitization of waste handling is crucial so the safety of the waste handlers and environment is ensured.

Clinical processes and patient's health outcome is directly proportional to patient's satisfaction level. Numerous studies have shown that positive patient results are because of increased patient satisfaction (Licciardone J, 2002). Patient will only be satisfied if the staff around is following all the safety guidelines and making sure that there is no outbreak of infection because of inefficiency of waste segregation and collection processes. Another study also supports this, that the odds of patient's improvement doubles in number if the satisfaction levels are higher (Renzi C, 2005). Realizing numerous positive outcomes, patient satisfaction has been implemented widely in developed countries as an index of health care quality (Al-Abri R, 2014).

Therefore, to study the lack of knowledge of various stakeholder perception regarding hospital waste management this study aims to assess different dimensions of waste management and awareness level regarding guidelines in public and private hospitals of Peshawar.

Stakeholder satisfaction can be affected by six different domains such as: general satisfaction, technical satisfaction, interpersonal manner, communication, functional capacity, accessibility and convenience. Whereas, stakeholder awareness regarding hospital waste management includes various parameters such as: waste generation, segregation, collection, transportation, storage, treatment, disposal and PPE Usage. Through analyzing these parameters, we can assess the level of awareness among various stakeholders.

1.1 Problem Statement

The main three problem areas found in Pakistan and other developing countries are: Absence of government legislation and regulation. No coordination or integrated system is to be seen in managing the hospital waste. Secondly, policies of health care establishment, there is no link between the policies set by Hospital waste management rules 2005 & WHO guidelines and the practices seen on the ground. Thirdly, available resources to invest in treatment and disposal technology.

Even though national HWM 2005 rules and regulations exist but the study shows that its implementation hasn't been done up to the mark. There is an urgent need of its physical implementation and awareness of its dire need in the current practices of Public and Private hospitals. Most importantly safety policies aren't followed which leads to unusage of PPE while handling waste which exposes the handler to risk. Therefore, the government authorities should take charge and play an important role in backing up health care stakeholders by providing timely trainings, workshop, funds, record monitoring, designated waste management team and plan in every public and private hospitals of Peshawar. Keen monitoring can resurface other factors and barriers which could be improved by corrective action and strengthened implementation by frequent checks of current practices.

1.2 Advantages

With this research, we can understand the correct way of waste management process and its benefits to the stakeholders and environment. This research will help Local Governments and City

District Governments in drafting policies that will ensure that hospital waste management is implemented as per stakeholder perspective, effective, and contributing to the socio-economic need of the city and its people and an integrated waste management system for the hospitals.

1.3 Aim

The aim of this research is to propose strategies, based on current practices in public and private hospitals, which can ensure sustainable waste management process and provide and improved experience of stakeholders and increase the awareness level regarding waste management.

1.4 Research Objectives

The objectives of the research are below.

- To investigate the current practices, standards and implementation status of hospital waste management.
- To assess hospital waste management in public and private hospitals and identify the gap between the current practices and waste management standard process.
- Determine the factors affecting hospital waste management in private & public hospitals.
- To study stakeholder satisfaction and awareness regarding hospital waste management.
- To recommended strategies and policies for promoting sustainable waste management in public & private hospitals.

1.5 Research Questions

The research questions formulated for the research are:

- What are the current practices, standards and implementation status of hospital waste management?
- To investigate hospital waste management in public and private hospitals and identify the gap between the current practices and waste management standard process?
- Identify the factors affecting efficient hospital waste management in private & public hospitals?
- To investigate stakeholder satisfaction and awareness regarding hospital waste management?

- What are the recommended strategies and policies for promoting sustainable waste management?

1.6 Limitation

Due to limited resources and time, the economic aspect of the biomedical waste management has not been included in the scope of this research. The scope of this research also does not cover all of the annual reports of waste management from all the hospitals which could have helped in understanding the trend of current practices and gap between public and private hospitals over the years. Inclusion of all the reports could explore other unfamiliar factors affecting efficiency of hospital waste management. Due to no proper timeline and plan provided by the authorities regarding hospital waste management, during the timeframe of this research, the aspect could not be studied in detail.

1.7 Organization of Thesis:

This Research thesis is consisting on following parts:

Chapter 1: It is the introduction of thesis. This chapter provides an idea about the research, areas which are covered in this research and a general view about all chapters and their structure. This Chapter defines the statement of problem, Research Objections and Linkage of research with Sustainable Development Principles.

Chapter 2: It is the literature review that covers the past researches which have been done on this topic nationally and internationally, this chapter link research topic with previous researches by finding research gap.

Chapter 3: Defines the overall methodology and procedure step by step adopted for the execution of this study. The general to specific approach is adopted in order to complete the study. This chapter describes all the procedure from selection of the topic till suggestion of recommendations and compilation of the thesis document.

CHAPTER 2

LITERATURE REVIEW

2.1 General Background

In order to achieve efficient waste management issues like reducing waste is of high priority. The waste generated as a result of medical treatment are of various nature such as hazardous waste, non-hazardous waste, general waste and radioactive. If the waste is not dealt with care and through safety protocols it has a potential that it can cause a risk of spreading infection and injury. To minimize risk of getting affected by waste exposure it's safe handling through proper channel is essential. If the waste is not managed properly, it may have adverse impact on the people and environment. Thus, sustainable waste management is directly proportional to environmental health protection.

Sound hospital waste management requires multiple participation and cooperation at different levels of execution. As, it is not a one-person job and needs multiple cooperation to ensure efficient waste management. Hospital policies should be set globally and implemented in the regional hospitals accordingly with national policies making sure that it's implication can hit the core issues of mismanagement of waste. This process requires availability of policies, sound implementation, training and workshop of health personnel, awareness regarding hospital waste management and it's positive and negative impacts. Awareness of hospitals' public is of high importance because it would lead to make better decision while handling waste. Therefore, a hospital management team should be devise making sure of the implementation and monitoring process at multiple levels ending up in an integrated system.

2.2 Bio-Medical Waste: definition and classification

Bio-medical waste is the waste generated at the hospital establishment comprising of both general waste and waste which causes risk. Majority of the waste generated by the hospital is general waste and makes up to 75%-90% of the total weightage, this is non-risk waste and can be disposed of by municipal committee without extra precautionary measures. This waste mainly comes from the department of administration, housekeeping and maintenance of the hospital facility. The rest of the 10-25% of the waste is hazardous and can cause infections and injury to waste handlers. Waste

management process focuses on a sound process to make sure hazardous waste doesn't muddle-up with the general waste and cause distress. The proper mechanism of generation, segregation, collection, storage, treatment and disposal allows the various stakeholders to be vigilant through each stage and avoid hazardous waste to cause adverse effects.

Classification of bio-medical waste contains of various clusters each with different nature of waste such as: infectious waste, pathological waste, sharps, pharmaceutical waste, genotoxic waste, chemical waste, waste with high content of heavy metals and radioactive waste. The table below explain each waste category studies from WHO guidelines of waste management. Table 1

Table 1: Waste Categories

Waste Category	Description and examples
1. Infectious waste	Waste suspected to contain pathogens e.g., laboratory cultures, waste from isolation wards, equipment that have been in contact with infected patients
2. Pathological waste	Human tissue or fluids e.g., body parts; blood and other body fluids; fetuses
3. Sharps	Sharp waste e.g., needles; infusion sets; scalpels; knives; blades; broken glass
4. Pharmaceutical waste	Waste containing pharmaceuticals e.g., pharmaceuticals that are expired or no longer needed; items contaminated by or containing pharmaceuticals (bottles or boxes)
5. Genotoxic waste	Waste containing substances with genotoxic properties e.g., waste containing cytostatic drugs (often used in cancer therapy)
6. Chemical waste	Waste containing chemical substances e.g., laboratory reagent's; film developer; expired disinfectants
7. Wastes with high content of heavy metals	Batteries; broken thermometers; blood-pressure gauges; etc.
8. Radioactive waste	Waste containing radioactive substances

e.g., radiotherapy unused liquids, contaminated glassware, packages, and urine/excreta from patients.

Source: *WHO, Safe management of wastes*

2.2.1 Sources of bio-medical waste

Waste in hospitals is generated through various departments of the hospitals and its characteristics vary from one another. Also, the percentage of hazardous and non-hazardous differs, the awareness regarding the nature of the waste and its source is important because then only can it be dealt with a certain level of safety measures. Hospital waste is comprised of medical wards waste, operating theatres and surgical wards waste, laboratory waste, pharmaceutical waste and general waste in an outcome of construction and maintenance of the facility.

Medical ward waste is mainly infectious as it is an outcome of medical treatments. It consists of bandages, gloves, masks, dressings, needles, IV sets, urine and excreta, medicine boxes and food items. Operation theatres and ICU comprises of waste which are body parts like tissues, fetus, organs, general waste, scalpel and other sharp instruments. Laboratories contain infectious waste as they collect samples, tissues, cultures, urine/excreta and testing animals. Pharmaceutical stores generate packaging and general waste. Last but not the least construction and maintenance waste comprises of building materials, equipment for cleaning and maintaining the vicinity.

2.2.2 Bio-medical waste generation

Different countries have different ratios of waste generation, not only between countries but even within cities the findings are different. This is because a number of factors are involved in waste generation which is different in each hospital such as management mechanism, type of hospital, nature of hospital, the average range of waste which are reusable and recycled, number of beds per hospital, number of in-patients and outpatients, and location accessibility of the hospital. These are the main factors affecting waste generation in each hospital, the major percentage of the hospital waste is general waste but a small chunk of it is radioactive waste. The ratio of radioactive waste which is produced as an outcome of medical treatments is very less as compared to the industries byproduct.

2.3 Health impacts of bio-medical waste

The process in which cleanliness, safety policies, proper hygiene, stakeholder training and workshops are conducted is called Biomedical waste management (Sanitation Connection, 2002). In order to minimize risks from medical waste within and outside healthcare institution we need to adopt proper waste management. This process starts at the very first stage of generation and segregation, waste needs to be segregated into its proper waste containers labelled, reusable, non-recyclable, hazardous components and non-hazardous components to avoid muddling of wastes and ending in infections. The essential steps which need to be considered while managing the waste are first of all monitoring the generation of the waste, safeguarding the sharp and hazardous waste, reduction in waste generation, avoidance of hazardous substances wherever possible, making sure of waste handlers' safety, following secure methods of waste collection and transportation, waste treatment and disposal mechanisms (Abor 2012).

2.3.1 Service Quality Comparison in public and private

Quality of service is that service which the stakeholder wishes to experience while getting a certain facility. It is based on stakeholder's expectation level as per his/her preconceived notions. In order to measure quality of service the difference between quality expectation and quality delivered is compared. This elaborates the scenario on ground and functional aspect of service quality and the ideal wish of stakeholder i.e., quality expectation of stakeholders. Through literature review we find out that more or less the services provide by public and private hospitals are same but the difference lies in the management system of the hospital. Every hospital has its ideology and follows its own principles in public hospital the governance focuses on the functionality of the services because of the non-profit approach and huge number of patients. Whereas, in private hospitals the focus is on the quality of facilities and experience provided to the user as they pay the extra cost for additional good experience.

Besides the patients care public hospitals also focuses on the consumer part of the business which is patient overall experience and facilities provided along the way. Besides the governance the difference also lies in the free of charge which is more in private hospitals and less in public as most of the charges are free of cost as their motto is to treat people not make money out of them. But the waiting time in public hospitals is more than the private hospitals as larger number of

patients are waiting in public hospitals because of which attention given to patients in public hospitals isn't as thorough. Due to this the machines and equipment in public hospitals are damped or in worse shape than the modern up to date equipment found in private hospitals.

2.3.2 Current practices & Standards of Waste Management:

Validly, it's the responsibility of hospitals to devise a proper waste management plan with defined standard protocols for each step of the process. The plans should thoroughly elaborate the roles and responsibilities of various health personnel to establish a sound hospital waste management plan. Developing countries are struggling with this issue just like in Pakistan, the knowledge and awareness regarding waste management process is lacking throughout all 7 stages of the process. The 7 stages of waste management process include, generation, segregation, collection, storage, treatment, transportation and final disposal.

Khyber Pakhtunkhwa's capital province is Peshawar, with projected population of 3.7 million and around ten tertiary care teaching hospitals on average (Muhammad Nazeer, 2019). HWM 2005 rules have a standard guidelines and rules about how to manage waste but even after more than a decade we don't see its true implementation in the current practices both in public and private hospital in Peshawar District (Zeeshan, 2018).

As the developing countries are struggling with this issue, Pakistan also has same challenges. Three methods of disposing waste exist in our healthcare system such as open dumping, landfills and incineration. Existing landfills are not constructed on the standard guidelines or on scientific lines. Also, except the very rare situations mostly incinerators which exist do not have mechanism of proper filters and scrubber's (Arshad et al. 2011). Proper HWM practices are lacking which include color coding of wastes according to the international standards, labeling of waste with relevant details such as: date, nature, content, source, proper personal protective equipment, awareness about the facts that how dangerous can it be if the biomedical waste is discarded in landfills and incinerator without following proper techniques.

2.3.3 Gap between Quality of Services in Public & Private Hospital

Gap between quality of services provided by public and private hospitals are natural and the competition between them results in different positive outcomes. In public hospitals the pressure

is in the form of political and administrative sector there is a fixed allotted fund which is given to the government hospitals. That allows public hospitals to focus on its survival of management and cater to basic essentials which limit them from making innovative interventions. On the other hand, in private hospitals the ownership is private and the focus is on the efficient service delivery with high tech innovative solutions to attract the population of patients to give them their desired expectant treatment and experience. That's the reason of better overall ambience and provision of greater facilities.

2.4 Health-care waste management planning

The process in which cleanliness, safety policies, proper hygiene, stakeholder training and workshops are conducted is called Biomedical waste management (Sanitation Connection, 2002). In order to minimize risks from medical waste within and outside healthcare institution we need to adopt proper waste management. This process starts at the very first stage of generation and segregation, waste needs to be segregated into its proper waste containers labelled, reusable, non-recyclable, hazardous components and non-hazardous components to avoid muddling of wastes and ending in infections. The essential steps which need to be considered while managing the waste are first of all monitoring the generation of the waste, safeguarding the sharp and hazardous waste, reduction in waste generation, avoidance of hazardous substances wherever possible, making sure of waste handlers' safety, following secure methods of waste collection and transportation, waste treatment and disposal mechanisms (Abor 2012). There are generally seven steps required to manage waste such as waste generation, waste segregation, waste collection, transportation, storage, treatment, and final Disposal.

Implementation of these 7 stages of waste management process is important for improving biomedical management at national, regional and local level. For efficient waste management implementation necessary monitory and check balance needs to be done. For this involvement of all the health care personnel is needed to pin point immediate actions to be taken and solve on ground problems. Once the survey and stakeholder participation are achieved it will open the opportunities for waste reduction, reuse and recycling and cost-effective solutions of waste treatment.

2.4.1 International recommendations for waste management

Improper waste handling in hospital is a global issue in many developing countries. It has many significant impacts on the health personnel, waste handlers and environment if the waste is not handled according to the policies and guidelines set by WHO and national legal framework. The main reasons behind high upturn of waste are the growth increase of population, disposal medical items, increase in the trend of private hospitals and accessibility of the community members (Y., 2014).

Sound management plans are those which are formulated by national legislation based on internal agreements which are reached on principles that follow safe management of biomedical waste of hazardous waste. The important international agreements are mentioned below which supports sustainable waste management:

1. The Basel Convention

On 22 March, 1989 in reaction to disposal of hazardous waste into the countries where lack of awareness and policies existed, Basel Convention in Switzerland took place which highlighted the policy which promotes reduction of hazardous waste and disposal according to sustainable practices. Also, it agreed upon transboundary movement and only if it was allowed between the parties then the hazardous waste must be exported but keeping all the safety measures and following safety protocols. This convention focused on legitimacy of agreed transboundary shipments from one country to another but labelled and disposed according to WHO standards and recommendations. This convention was signed by more than 100 countries.

2. The Polluter Pays Principle

This principle highlights the fact that whoever is generating the waste is solely responsible for its disposal and following all the safety guidelines and policies, in failure to do so shall bear the consequences. Thus, disposal should be in such a way that the environment and stakeholders who are in direct contact are not affected in a bad way and financial costs should be compensated by the party which produced the waste.

3. Precautionary Principle

This principle follows the concept which elaborates that when the level of ambiguity and uncertainty arises regarding a certain nature of waste. Instead of taking it lightly it should be given

high importance and considered risky by taking all the safety measures to handle the waste. This principle helps in promoting safety and monitoring of waste in a sustainable fashion.

4. Duty of Care

This principle states that the waste handler or any health personnel who is in direct contact of the hazardous waste has a duty to make sure that the related equipment is up to the mark and effort is made to make sure it is not exposed to the patient or the environment. It's safe usage and disposal is the utmost responsibility of the handler.

5. Proximity

The “proximity” principle recommends that treatment and disposal of hazardous waste take place at the closest possible location to its source in order to minimize the risks involved in its transport. According to a similar principle, any community should recycle or dispose of the waste it produces, inside its own territorial limits.

2.4.2 National plans for bio-medical waste management

In order to achieve sound and efficient bio-medical waste management in regional and local hospitals it is necessary for the country to have national legislation framework. It sets byelaws and legal controls are defined who are responsible for monitoring and sound implementation on the ground level. To achieve this aim responsibility should be defined to avoid mismanagement and overlapping of duties which leads to issues of accountability. Environmental protection agency should also be involved to make sure the policies and legal framework follow all the international principles of safe environment protection.

2.4.3 Factors Affecting Waste Management Process

Various factors are involved while handling waste management process. The first stage involves waste generation, any person who is generating waste needs to understand the nature of the waste, the category it lies in and how to handle the situation in case of emergencies like needle prick incident or lead expulsions according to the set guidelines. The second and third stage involves segregation and collection, the stakeholder who is in contact with the waste generation shall segregate the waste in accordance with the categories provided by the hospitals. There are a multiple number of factors affecting waste management process such as failure of segregation of

hazardous and non-hazardous waste, lack of rules and regulation obedience, temporary storage area for waste collection, its protocols and standards. Also, to keep monitoring that the waste isn't stored for more than 48 hours, lack of proper waste treatment, training and workshop to waste handlers so they have knowledge regarding waste management process, Usage of PPE and awareness of its importance while handling waste, lack of knowledge about the proper use of such equipment are among the factors contributing to poor healthcare waste management (Khajuria A, 2007).

Fourth and fifth stage consists of the factors revolving transportation and storage, the personnel responsible for this stage needs to have the know-how of how much longer should a certain waste be stored and the protocols involved in transporting the different categories of waste. Also, all biomedical waste should be securely packaged and labelled with symbols to avoid accidents. The sixth stage is treatment of the waste, before the final disposal the waste is treated in a manner to ensure sustainable waste management to avoid additional waste and reuse/recycle the waste to refrain from added carbon emissions. The last steps involve final disposal of the waste, factors such as safety of waste handlers, PPE usage, on-site or off-site facility should be taken into consideration especially in the times of pandemic.

2.4.4 Barriers to follow Waste Management Process

There are various barriers because of which biomedical waste management in public and private hospitals are not done efficiently. The most prominent barriers are: 1) Healthcare waste management system: This barrier includes indicators such as waste segregation, labelling, storage, treatment, transportation and disposal. 2) Understanding rules and regulations: Government rules and regulations such as HWM 2005 policies regarding sustainable waste management and WHO recommendations. 3) Technology: this barrier includes team knowledge regarding waste management process, budgetary allocation for treatment, maintenance and innovation. 4) Stakeholder participation: Indicators such as training of stakeholders, workshops, availability of annual reports, safety measures and equipment availability fall under the umbrella of this barrier. 5) Covid-19 Pandemic Affect: Last but not the least Covid-19 pandemic has been an additional barrier towards sustainable waste management because of an upturn of more waste generation as a consequence. This barrier includes various indicators such as handling of waste, safety protocols and guidelines, maintaining physical distance and isolation zones protocols.

2.4.5 Sustainable Development Goals (SDGs) and Waste Process

Many parts of the society issues and economy is affected because of waste management. Global problems such as sustainable production and consumption, food security, health, climate change and reduction of poverty are directly or indirectly connected with waste management. In order to resolve the issue waste management should aim to follow international goals and principles which will in return address the issues.

There are 17 sustainable development goals which have linkage to waste management. Therefore, an argument can be generated that if this issue is taken seriously it can help in achieving other developmental goals as well. Biomedical waste management in particular can help in achieving several goals of UN sustainable developmental goals, such as: Good health and wellbeing, Sanitation and clean water, Decent work and economic growth, Responsible consumption and production and climate action (Nations, 2015).

2.5 Health and safety practices for health-care personnel and waste workers

2.5.1 Principles

Bio-medical waste management plan should also focus on the check and balance of workers safety and health to make sure that the protocols and standards are being followed through all stages of waste process. From waste generation to final disposal the waste handlers should be provided by the workshops, trainings and knowledge transference regarding the risks and consequences of handling infectious waste without safety gears and equipment.

Also, after the outbreak of Covid-19 pandemic there should be high priority given to the waste handlers like doctors to get their vaccinations as they are on the front line dealing with Covid-19 affected patients and in contact of isolation zones. Apart from this vaccination of hepatitis B and all necessary precautionary measures should be taken to minimize the chances of getting affected. Workers who are at frontline and need safety measures to take into consideration are doctors, nurses, janitors, waste handlers, maintenance and operators of waste management and all the stakeholders who are responsible for handling and disposing of the waste.

2.5.2 Workers' protection

A comprehensive study and manual and presentation should be given to all the workers focusing on their safety and protection. It should mention all the waste management process and its standard protocol to handle each stage from generation, segregation, collection, storage, treatment and disposal along with possible hazardous byproduct of each stage. After the presentation a thorough training should be given to each waste handler while monitoring them. Apart from instilling awareness and training, provision of PPE, reaction to spillages of hazardous waste and needle pricks should be focused on.

Protective clothing of waste handlers consists of head gear/helmets, face masks, eye protectors, overalls, industrial aprons, industrial boots, and gloves. These are the basic equipment which should be provided to waste handlers and in terms of more exposure to radioactive waste extra precautionary measure should be taken. In case of spillages and cleaning it off in addition to mask, respirators should also be used to minimize the chances of inhaling toxic dust or residue off the floor. Apart from saving oneself in order to clean the vicinity the area should be sealed and carefully the toxic dust or contaminated residue should be cleaned off while wearing all the safety gears and upon cleaning should be disposed of safely by using hand tools. Also, if mercury droplets are spilled on the floor, it is of high importance to recover it and then disinfect the floor to avoid contamination.

2.5.3 Stakeholder Satisfaction & Awareness of Medical Waste Management

In order to ensure an efficient waste management process from all the stages initiating from waste generation, segregation, collection, transportation, storage treatment and final disposal it is essential that everyone plays a role. Hospitals comprise of different stakeholders from doctors to waste handlers, each of them should make sure to dispose of any waste according to the set guidelines and policies then only can we achieve sustainable waste management. Efficient waste management can generally improve the service quality of the hospital and patients experience. As, both the staff member and patient can be ensured of safe environment, cleanliness, no contamination or risk of getting affected, labelled bins access so that there is no confusion in disposing waste and designated waste storage areas, isolation zones for Covid-29 wards and treatment stations to avoid indulgence of the unneeded population in such areas.

Whatever concerns the patients is of the higher property just as a business man's approach following the motto of , "whatever concerns the consumer", in health department patient is the main stakeholder and needs to be catered to (PM.).In future, sustainable health waste management would be followed in those hospitals where patients opinion will be taken into consideration regarding quality assessment provided by the hospital while taking administration and financial decisions regarding waste management (L.) This elaborates the fact how important it is to take all the stakeholder's perception and views into consideration while planning hospital waste plan and guidelines. Currently, we do not see stakeholder participation in policy making which results in ineffective waste management system as they miss out on the issues experiences by the general population of the hospital on daily basis.

2.5.4 Public education on hazards linked to health-care waste

Importance of bio-medical waste management awareness is not only important for the health workers and waste handlers but the awareness is equally essential for the people of community visiting hospital. In order to make them aware regarding waste processes risks, exposure of infections in case of spillages or contact of hazardous waste, scavenger's potential to experience hand pricks if waste is not disposed of responsibly, they need knowledge and prevention techniques to handle these circumstances.

As formal training of all the population coming in to the hospitals at every hour is a challenge but smart ways can be introduced to make them aware of what needs to be done in order to promote safe waste management. Visually expressive info graphs can be designed in the form of posters and leaflets which can be spread over to all the people coming to the hospital. Another solution could be on the spots where the chances of experiencing mismanagement and spillages, posters or LED video is played 24 hours to guide the patients about the risks and proper handling process.

2.5.5 Education and training of health-care personnel

There can be various ways where the health-personnel education and awareness can contribute in having an efficient waste management system such as:

- 1) Following color-coding waste garbage containers and make sure to dispose of the waste in its respective bins and guide those who have no knowledge about them.

2) Making sure the waste is not stored beyond 48 hours and is disposed of to avoid hazards and contamination, this could help in monitoring by active participation.

3) Recycle/ Reuse where possible. In Melbourne, some manufacturers are working with a third party with hospitals to convert PVC plastics from bags, face mask and oxygen tubes into children's toys and agricultural pipes. Such cases studies can be followed to ensure sustainable practices but it can only happen with the joint collaboration of staff members, infection control members, environmental protection agency and recyclers (Mcgain, 2018).

4) Ensure safety of waste handlers and staff members by giving them education, workshops and proper personal protective equipment before dealing with biomedical waste.

5) Follow plans and policies.

6) Promote conducting routine waste audits: Having a system isn't worth it if you're not checking up on it periodically.

Sustainable waste management requires participation of all the stakeholders involved in the hospital at all the stages which can not only result in sustainable environment but high level of patients and hospital staff members satisfaction and awareness level.

Sustainable waste management believes in making sure our future generation have safe environment and resources to live in and for those measures needs to be taken to reduce carbon foot print and diseases outbreak due to mismanagement of waste. The main principles found through literature review which supports sustainable waste management are: solutions to promote recycling, reuse and reduce the waste generated, program design to create awareness to various stakeholders and educate them about the risks attached in case of contact with hazardous waste and treatment of biomedical waste before responsibly disposing of either into the incinerator or assigned sites for waste.

CHAPTER 3

METHODOLOGY

This phase of the research elaborates the line of actions to achieve the impartial and truthful results of the research based on the literature review, and the studies carried out so far. The following phase of research tries to provide the sound justification to adapt this methodology with reference to the context of similar study efforts at the international & national levels. The study anticipates the detailed illustration of overall research methodology schematics, and all the phases are explained to achieve the results.

3.1 Literature Review

This phase of the study dealt with a literature review to evaluate the type of research carried out and validate the previous extensive literature to evaluate research objectives formulated and the selection of the study area. This literature review consists of secondary data. The sources for this data are *ScienceDirect*, *Google scholar*, *web of science*, *Jstor*, *Academia*. Government Published Reports by World Health Organization, WHO are also reviewed for the research. Internationally published Reports on *Sustainable Development Goals by United Nations (UNDP)* have also been reviewed. At this stage, the literature review is more focused on the national level. It explores the trend and ongoing scenario at the local level in terms of bio-medical waste management planning and processes and its impact on public and private hospitals. The user satisfaction and awareness with biomedical waste management has been reviewed in developing countries, using the indicators from previously done studies to explore and evaluate the selected study areas to measure stakeholder perception and satisfaction with hospital waste management.

3.2 Study Area

The study focuses on Peshawar. Peshawar is the most populated and capital city of the Khyber Pakhtunkhwa province and the administrative and economic hub of the Federally Administered Tribal Area. The city is the sixth-largest in the country, with a population of 1,970,042 (Pakistan Bureau of Statistics). Peshawar city has long been the center of health care facilities in the region. Peshawar dates back to the 2nd century AD when Peshawar was the capital of the Kushan Empire. Later on, the city became part of the Huns, Sikhs, Mughal, Durranis, Suri, and other Muslim dynasties. The city's name was once Purusha Pura which means "The city of men". The current

name Peshawar is used since the Mughal emperor Akbar's era. Due to its strategic position in the region, Peshawar has always been an important city. The importance of the city has historically been linked with Khyber Pass, a mountain pass that connects the Peshawar valley with Afghanistan forming a connection between south Asia and central Asia.

Peshawar is home to numerous universities and hospitals that cater to the need of the province and the adjacent Federally Administered Tribal Area. The city has an international airport and is connected by a motorway and many highways and Railways to the rest of the country. Peshawar is home to many historic buildings and markets like Fort Bala Hisar, Gorkhatri, Kanishka stupa, Qissa Khwani Bazar, Ghanta Ghar Mohalla Sethian. After the Soviet invasion of Afghanistan, Peshawar was flooded with migrants from across the border. The city has ever since been a host of a huge population of Afghan nationals. This mass migration of people from Afghanistan has also influenced the healthcare system in the city. Other than the Afghans residing in Peshawar, a huge number of people from across the border visit the city for medical treatment in hospitals of the city. The war in Afghanistan has negatively influenced the economy of the. Peshawar witnessed a stream of terrorist attacks in the early 2000s resulting in economic and social degradation of the region as a whole and Peshawar in particular.

This study is intended to compare the current practices, factors affecting health care services, and stakeholder's awareness perception and satisfaction in public and private hospitals of Peshawar. 12 hospitals were studied out of which 6 are private and 6 public, all of them are located in Peshawar's different localities. These 12 hospitals were mainly selected because they are the major private and public hospitals of KPK. Average number of beds in public hospitals are around 620 approx. and 290 beds in public hospitals. On average all the 12 hospital's age lies between 25-50 years old making it established prior to 1995.

3.3 Research Method

Considering the prime importance of the research thematic area, a general to specific approach has been adopted. Mixed research methodology, a technique used for hybrid research, has been adopted in this study to develop a triangulation framework of quantitative and qualitative data obtained. Figure 1 describes the research flow in the form of schematics dividing the research evaluation into four major stages, i.e., literature review and study area, data collection, data analysis, and deductions in the form of results and conclusions. The initial literature review is done

to identify the research gap, which is furthered discussed with field experts, supervisor and GEC members, which lead to the selection of topic and formulation of research objectives.

Through literature review and expert opinion, indicators were identified for the characteristics of the hospital waste management process, barriers affecting waste management, stakeholder awareness and satisfaction of the users' table 2, 3, 4 and 5, respectively. A working definition for bio-medical waste management in the case study area was developed by analysis of existing literature and expert opinion in the local context. A questionnaire for hospital administration to record current practices of bio-medical waste management system and a questionnaire for the stakeholders to collect data on the satisfaction and awareness was conducted. In order to include all stakeholders, a Focal Group Discussion with operators and administration was also conducted. Interviews were also scheduled with Infection control members. Questionnaires used to collect data are annexed with this thesis report. An initial survey was conducted to identify the major public and private hospitals in Peshawar that fit the requirement of our research. The data was interpreted after analysis with the help of SPSS, leading to the conclusion, recommendation of the research and leaving the last stage of report writing.

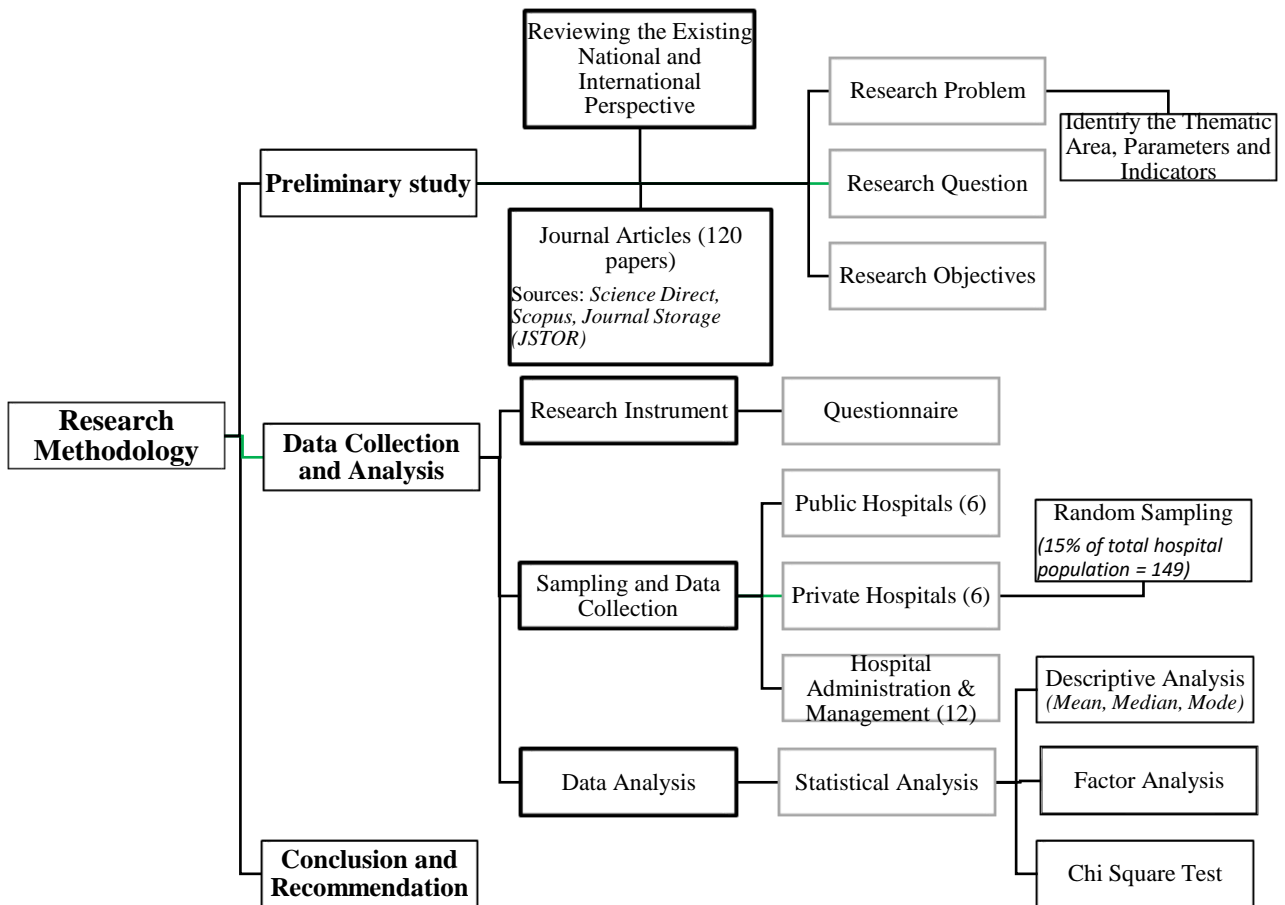


Figure 1: Research Schematic

The public and private hospitals' mean service quality doesn't differ significantly in all seven stages of waste management process. The major seven stages involved in handling healthcare waste are Waste Generation, Segregation, Collection, Transportation, Storage, Treatment and Disposal. Each stage of waste processes has a cluster of various indicators which are explained as follow:

Table 2: HCWM Process

HCWM 7 Stages Process:	Mean	Standard Deviation
Generation (Mean=10.3, std=2.2)		
Government regulations and legislations related to biomedical waste management followed by your hospital	1.1	0.7
Is training of medical staff available regarding HCWM	1.1	0.7
Access to annual report(s) of activities easily available	1.0	0.8
Do you participate in making policies used in this hospital to handle waste	1.5	0.6
Staff refuses to handle waste	1.6	0.6
Is maintaining BWM records mandatory in your hospital	0.9	0.6
Have the containment of the spread of COVID-19 pandemic significantly affected waste management	1.2	0.5
Are the waste handlers hesitant to deal with the waste due to COVID-19 pandemic	1.7	0.4
Segregation (Mean=5.3, std=1.8)		
Doctors do not see waste separation as their concern	1.3	0.7
Nurses do not see waste separation as their concern	1.3	0.7
Laboratory staff does not see waste separation as their concern	1.4	0.7
Is it possible for you to tell the difference between the different categories of medical waste	1.1	0.5
Collection (Mean=5.2, std=1.2)		
Are the waste bins easy to reach	1.0	0.4
Waste Bins are not well labeled	1.6	0.5
I don't know where to place medical waste after use	1.5	0.6
During Covid-19 use of Personal Protective Equipment (PPE) by waste collectors done efficiently	1.0	0.3
Transportation (Mean=4.2, std=1.3)		
Are there any guidelines for transport of biomedical waste disposal	0.8	0.5
Do you have a waste management strategy or team monitoring and supervising waste management schedules being followed	1.0	0.6
Do you know what happens to waste after it is picked up from the station where you work	1.2	0.7
Usage of Personal Protective Equipment (PPE) by relevant stakeholders done efficiently while handling waste	1.0	0.3
Storage (Mean=3.6, std=0.8)		
Are you aware about the theoretical and practical knowledge required to manage and/or recycle/reuse hospital waste	1.1	0.5
Do you follow color coding while disposing waste during your hospital duties	1.0	0.3
Do you feel the threat of getting affected by Covid-19 pandemic as hospitals are producing and storing more waste	1.4	0.5
Treatment (Mean=3.5, std=1.0)		
Would you like to have program to enhance knowledge regarding biomedical waste management and treatment during times of pandemic?	1.1	0.4
Are you aware if recycling of medical waste is done at this hospital	1.2	0.7
Do waste handlers feel safety policies instated during COVID-19 while treating waste	1.1	0.5
Disposal (Mean=4.7, std=1.3)		
Can inappropriate biomedical waste disposal cause health hazards	0.96	0.5
Do you think biomedical waste disposal is an institutional problem & extra burden	1.2	0.6
Waste is not removed when the available bins are full	1.5	0.7
Should there be quick changes in the waste disposal system and waste management	0.9	0.5

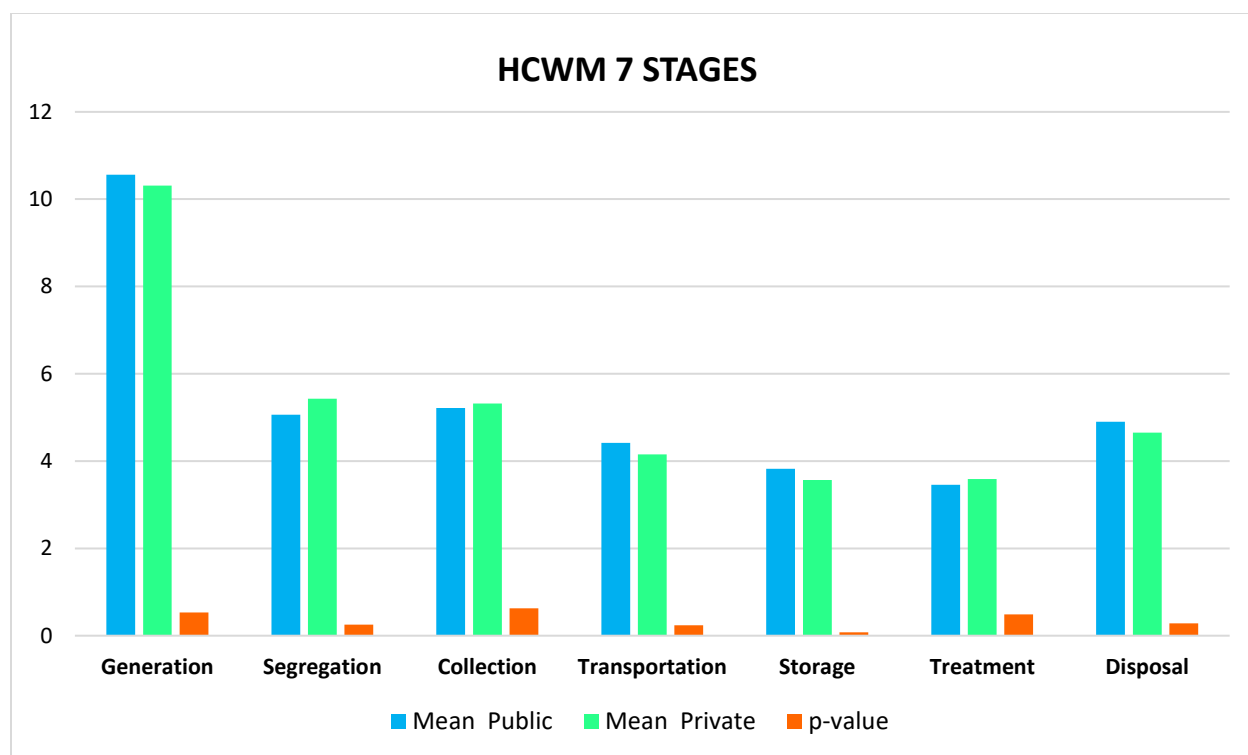


Figure 2: HCWM 7 Stages

Mixed method research design was used to conduct this research and an indicator-based approach was utilized to identify the prominent barriers affecting respondent’s perception about waste management.

Table 3: Barriers Indicators Affecting Respondent’s Perception

Code	Barriers	References
B 35	B-35 Removal of waste when the available bins are full	(Gupta S, 2006)
B 36	B-36 Designated placement of medical waste after use	(Khajuria A, 2007).
B 34	B-34 Lack of well labeled waste bins	(Abor 2012)
B 37	B-37 Staff’s hesitance to handle waste	(Arshad et al. 2011)
B 32	B-32 Stakeholder’s policy participation in hospitals to handle waste	(Patil & Pokhrel, 2005).
B 24	B-24 Nurses reluctant to aid in waste separation	(Sanitation Connection, 2002)
B 25	B-25 Laboratory staff reluctant to aid in waste separation	(Sanitation Connection, 2002)
B 23	B-23 Doctors reluctant to aid in waste separation	(Sanitation Connection, 2002)
B 41	B-41 COVID-19 pandemic effect on waste management	(Abor 2012)
B 45	B-45 Usage of PPE by waste collectors and relevant stakeholders	(Khajuria A, 2007).

B 43	B-43 Waste handlers cautious to deal with waste due to COVID-19 pandemic	(A. Coker, 2009)
B 31	Insufficiency of the width of walkways.	(Adeel, 2014)
B 20	B-20 Allocation of sufficient funds to manage hospital's waste	(A. Coker, 2009)
B 17	B-17 Biomedical waste disposal is an institutional problem & extra burden	(A, 2014)
B 19	B-19 Availability of training of medical staff regarding HCWM	(Adeel, 2014)
B 28	B-28 Is Infection control department monitoring waste	(ACRPlus, 2020)
B 26	B-26 Knowledge between different categories of medical waste	(Khajuria A, 2007).
B 22	B-22 Are waste management plans followed by strategy or team monitoring	(Patil & Pokhrel, 2005).
B 40	B-40 Do waste handlers feel safety policies instated while managing waste	(World Bank, 2020)
B 47	B-47 Physical distancing of 2m maintained in public during COVID-19	(Arshad et al. 2011)
B 44	B-44 Is management of waste essential to minimize risks to human and environmental health	(Mol M.P.G., 2020)
B 13	B-13 Are you aware of government regulations and legislations related to BWM	(Mol M.P.G., 2020)
B 12	B-12 Are there any guidelines for biomedical waste disposal	(World Bank, 2020)
B 18	B-18 Is there a need to have a program to enhance knowledge regarding BWM	(Gupta S, 2006)

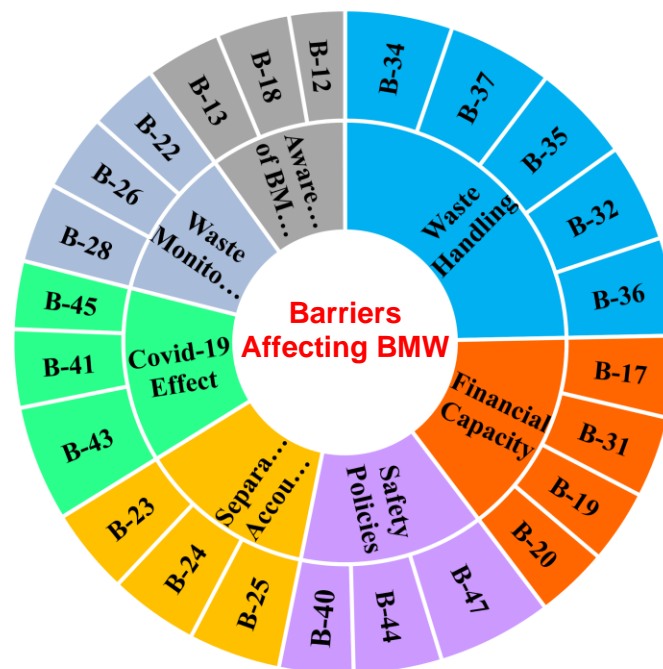
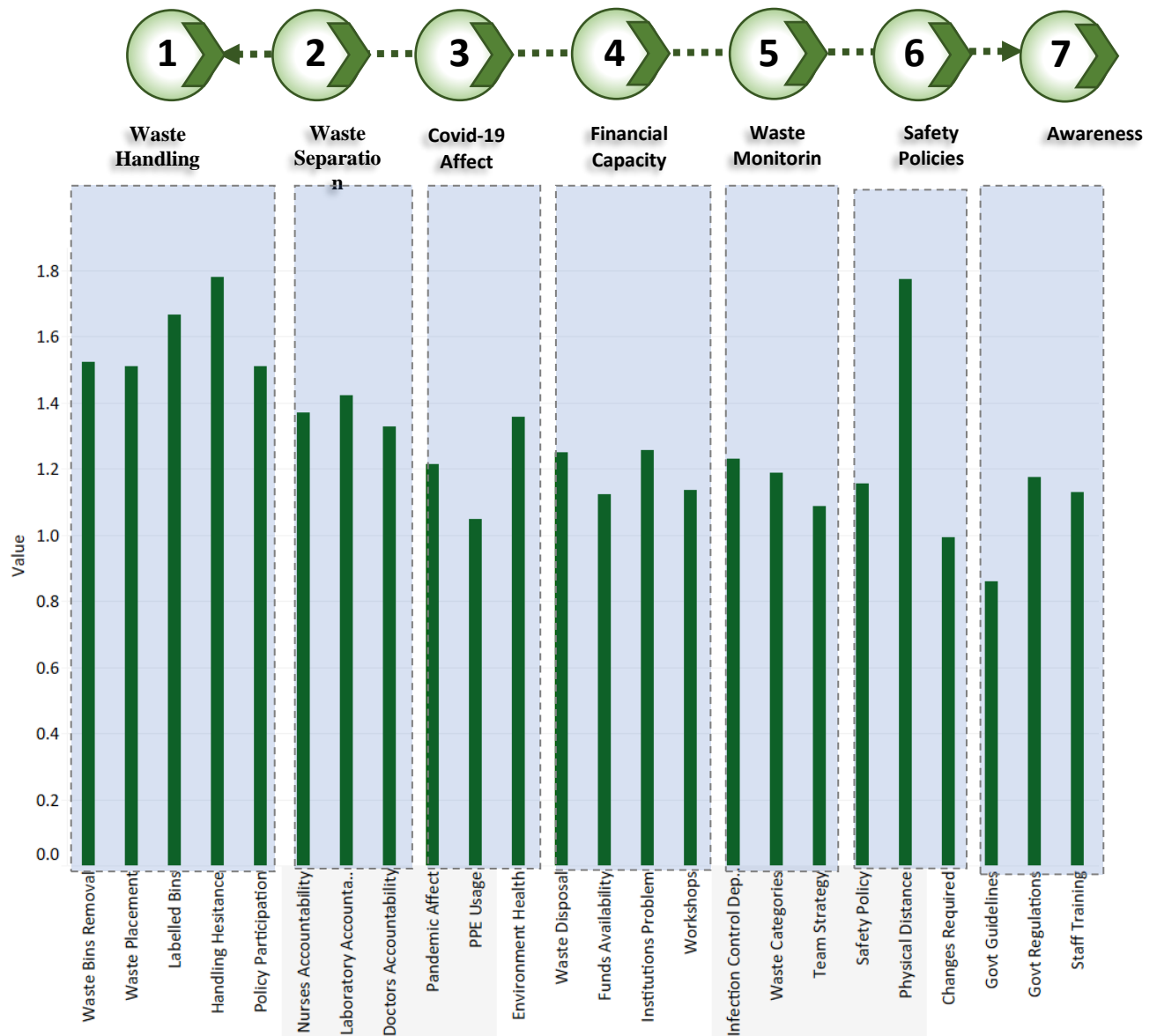


Figure 3: Barriers Affecting Biomedical Waste Management

Table 4: Factors Affecting HCWM Process

Factors Affecting Respondent Perception about HCWM	Mean	Standard Deviation
Waste Handling (Mean=7.83, std=2.0)		
B-35 Removal of waste when the available bins are full	1.5	0.7
B-36 Designated placement of medical waste after use	1.5	0.6
B-34 Lack of well labeled waste bins	1.6	0.5
B-37 Staff's hesitance to handle waste	1.6	0.6
B-32 Stakeholder's policy participation in hospitals to handle waste	0.5	0.6
Waste Separation Accountability (Mean=4.12, std=1.8)		
B-24 Nurses reluctant to aid in waste separation	1.3	0.7
B-25 Laboratory staff reluctant to aid in waste separation	1.4	0.7
B-23 Doctors reluctant to aid in waste separation	1.3	0.7
Covid-19 Effect (Mean=4.04, std=0.9)		
B-41 COVID-19 pandemic effect on waste management	1.2	0.5
B-45 Usage of PPE by waste collectors and relevant stakeholders	1.0	0.3
B-43 Waste handlers cautious to deal with waste due to COVID-19 pandemic	1.7	0.4
Financial Capacity (Mean=4.75, std=1.9)		
B-31 Treatment of waste after disposal	1.2	0.7
B-20 Allocation of sufficient funds to manage hospital's waste	1.1	0.8
B-17 Biomedical waste disposal is an institutional problem & extra burden	1.2	0.6
B-19 Availability of training of medical staff regarding HCWM	1.1	0.7
Waste Monitoring (Mean=3.50, std=1.2)		
B-28 Is Infection control department monitoring waste especially during pandemic	1.2	0.5
B-26 Knowledge between different categories of medical waste	1.1	0.5
B-22 Are waste management plans followed by strategy or team monitoring and supervision	1.0	0.6
Safety Policies (Mean=4.28, std=0.8)		
B-40 Do waste handlers feel safety policies instated while managing waste	1.1	0.5
B-47 Physical distancing of 2m maintained between people in public during COVID-19	1.7	0.5
B-44 Is management of waste essential to minimize risks to human and environmental health	1.3	0.5
Awareness of BMW Guidelines (Mean=3.17, std=1.1)		
B-13 Are you aware of government regulations and legislations related to BWM	1.1	0.7
B-12 Are there any guidelines for biomedical waste disposal	0.8	0.5
B-18 Is there a need to have a program to enhance knowledge regarding BWM	0.5	0.4



Labelled Bins, Changes Required, Safety Policy, Doctors Accountability, Environment Health, Funds Availability, Govt Guidelines, Govt Regulations, Handling Hesitance, Infection Control Dept., Laboratory Accountability, Nurses Accountability, PPE Usage, Pandemic Affect, Physical Distance, Policy Participation, Institutions Problem, Workshops, Staff Training, Team Strategy, Waste Bins Removal, Waste Categories, Waste Disposal and Waste Placement.

Figure 4: Factors Affecting HCWM Process

The approach is very useful in conceptualization and operationalization of complex constructs like sustainable waste management. For this purpose, after reviewing literature extensively and consulting with both public and private hospitals, 24 different barriers were shortlisted for further analysis. For this purpose, after reviewing literature extensively and consulting with both public

and private hospitals, 15 different variables were shortlisted for stakeholder satisfaction analysis and 18 parameters of stakeholder awareness analysis regarding health-care waste management as follow:

Table 5: Stakeholder Satisfaction regarding HCWM

Stakeholder Satisfaction regarding HCWM:	Mean	SD
General satisfaction (<i>Mean=4.3, std=1.3</i>)		
S-45 Usage of Personal Protective Equipment (PPE) by waste collectors and the involvement of relevant stakeholders especially during Covid-19	1.1	0.47
S-64 cleanliness of the facility	1.5	0.67
S-65 Adequate level of safety equipment to prevent the spreading of infectious diseases	1.6	0.6
Technical quality (<i>Mean=6.3, std=1.5</i>)		
S-40 Safety policies instated during COVID-19 while managing waste	1.4	0.6
S-42 Threat of getting Corona virus as hospitals are producing more waste than usual	1.5	0.5
S-66 Training workshops provided by the administration regarding BWM	1.8	0.8
S-69 Intervention required at all stages of waste management from handling, treatment, and disposal	1.6	0.8
Interpersonal manner (<i>Mean=4.9, std=1.1</i>)		
S-43 Waste handlers hesitant to deal with the waste due to COVID-19	1.8	0.4
S-61 Efficiency level of your hospital in collecting waste	1.5	0.7
S-67 Health personnel should take measures to ensure hazardous waste is not generated in the first place	1.5	0.7
Communication (<i>Mean=3.1, std=0.8</i>)		
S-32 Participation in making policies to handle waste	1.5	0.6
S-60 Your hospital in regard to: Accessibility (Location, Environmental, Attitudinal, Communication)	2.2	0.9
Functional capacity (<i>Mean=1.4, std=0.5</i>)		
S-63 Safe disposal of biomedical waste at your hospital	1.4	0.5
Accessibility & convenience (<i>Mean=3.3, std=0.7</i>)		
S-47 Physical distancing of at least 2 meters maintained between people in public spaces during COVID-19	1.9	0.3
S-68 Garbage bins accessible, color coded and strictly enforced to dispose waste in their respective bins at	1.4	0.6

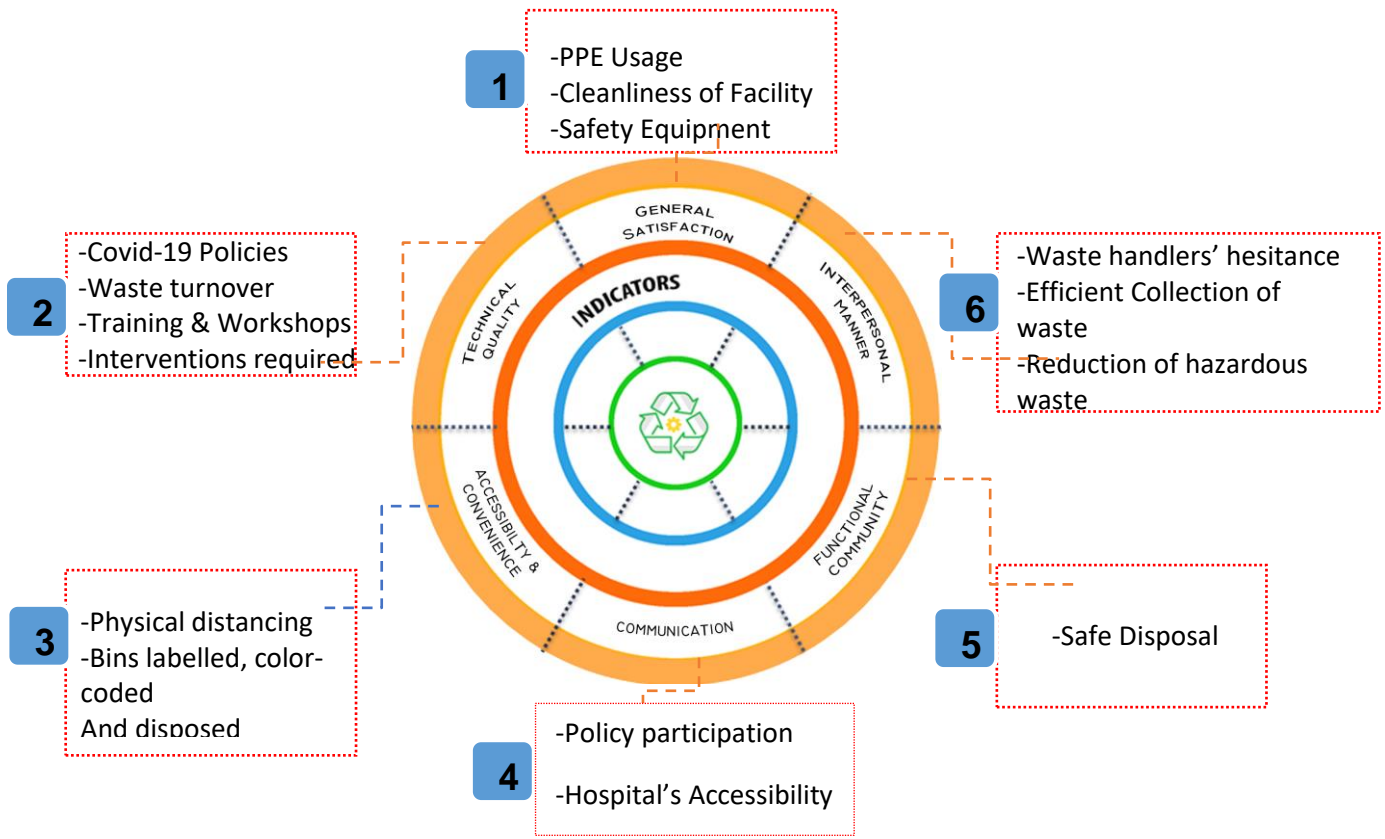


Figure 5: Stakeholder Satisfaction 6 Dimensions

Stakeholder perception regarding medical waste management comprises of 6 main domains of satisfaction which are: general satisfaction, technical quality, interpersonal manner, communication, functional capacity, accessibility and convenience. Through Descriptive statistical analysis as shown in Table 1 we can see descending order of 6 different domains on the basis of its arithmetic mean which tells us about popular opinions of stakeholder and dispersed responses i.e., technical quality ($\bar{X} = 6.3 \pm 1.5$) > Interpersonal manner ($\bar{X} = 4.9 \pm 1.1$) > General satisfaction ($\bar{X} = 4.3 \pm 1.3$) > Accessibility and convenience ($\bar{X} = 3.3 \pm 0.7$) > Communication ($\bar{X} = 3.1 \pm 0.8$) > Functional capacity ($\bar{X} = 1.4 \pm 0.5$).

Table 6: Stakeholder's Awareness Parameters

Stakeholder Awareness Parameters:	Mean	SD
Waste Generation (Mean=2.1, std=0.7)		
A-13 Are you aware of government regulations and legislations related to BWM	1.1	0.7
A-48 Is Bio-medical waste generated during diagnosis, treatment, immunization or research activities in medical, or laboratory set-up	0.9	0.4

Overall Index			1
Segregation (Mean=3.4, std=0.9)			
A-14 Are you aware about the knowledge required to manage, recycle/reuse waste	1.1		0.5
A-15 Do you follow color coding while disposing waste	1.0		0.3
A-26 Is it possible for you to tell about different categories of medical waste?	1.1		0.5
Overall Index			1.06
Collection (Mean=2.9, std=1.1)			
A-16 Can inappropriate biomedical waste disposal cause health hazards	0.9		0.5
A-30 If waste is not properly handled it can be a risk to healthcare workers and patients?	0.9		0.4
A-51 According to guidelines, untreated biomedical waste should not be stored beyond 48 hours	0.9		0.4
Overall Index			0.9
Transportation (Mean=2.4, std=1.0)			
A-31 Are you aware what happens to waste after it is picked up from the station where you work	1.2		1.1
A-50 Correct sequence of biomedical waste management is Segregation, Collection & Storage, Transportation	0.7		0.6
Overall Index			0.95
Storage (Mean=1.3, std=1.2)			
A-52 Glassware and metallic body implants are disposed in Blue container	0.6		0.7
A-53 Infectious sharps and needles are disposed of in white containers	0.6		0.7
Overall Index			0.6
Treatment (Mean=1.2, std=0.7)			
A-29 Are you aware if recycling of medical waste is done at this hospital	1.2		0.7
Overall Index			1.2
Disposal (Mean=4.5, std=1.4)			
A-27 Do you know about the policies in this hospital about reporting needle stick injuries	1.2		0.5
A-49 Biomedical waste should be handed over to Bio-medical waste management agency	1.1		0.5
A-54 Infectious biodegradable are disposed of in yellow container	1.0		0.7
A-55 Infectious non-biodegradable disposed in red containers	1.2		0.7
Overall Index			1.1
PPE USAGE (Mean=0.9, std=0.2)			
A-56 Waste handlers should be made aware of risks involved and usage of PPE should be a compulsion	0.9		0.5
Overall Index			0.9



Figure 6: Stakeholder Awareness Dimensions & Indicators

Stakeholder awareness regarding medical waste management comprises of 8 main indicators of waste process which are: waste generation, segregation, collection, transportation, storage, treatment, disposal and PPE usage. Through Descriptive statistical analysis as shown in Table 2 we can see descending order of 8 different variables on the basis of its arithmetic mean which tells us about average opinions of stakeholder and dispersion of responses i.e., Disposal ($\bar{X} = 4.5 \pm 1.4$) > Segregation ($\bar{X} = 3.4 \pm 0.9$) > Collection ($\bar{X} = 2.9 \pm 1.1$) > Transportation ($\bar{X} = 2.4 \pm 1.0$) > Waste Generation ($\bar{X} = 2.1 \pm$) > Storage ($\bar{X} = 1.3 \pm 1.2$) > Treatment ($\bar{X} = 1.2 \pm 0.7$) > PPE usage ($\bar{X} = 0.9 \pm 0.2$).

3.4 Research Design

The data obtained during collection is of two types, i.e., quantitative data and qualitative data. Both of the data types required different analysis techniques and methods as per the requirement of research evaluation. Qualitative data is normalized to a scale where needed to perform analysis along with quantitative data. The research technique used for this study is as follow:

3.4.1 Qualitative

The qualitative data in this research has been described in the following manner

Contextual Analysis: The context of qualitative data has led us to answer questions such as how economic, political, social, and organizational factors influence the bio-medical waste management within the city.

User Analysis: This will help the study to identify the people (stakeholder) sense of experience towards hospital waste management processes. It will elaborate on the stakeholder awareness and satisfaction level when it comes to dealing bio-medical waste.

Operational and Regularization Analysis: This analysis will help in the identification of interaction of operators and regulatory bodies of hospitals in the city. It will evaluate the existing policies and strategies to manage hospital waste process. This will be done through the data collected from interviews with hospital administration and field observations.

3.4.2 Quantitative

Statistical Analysis: The Statistics data attained from questionnaire-based surveys, interviews, and observations recorded from the field survey have been analyzed as quantitative data.

Descriptive Analysis: The quantitative data such as socio-demographics, hospital age, number of beds, number of patients, status of job and experience level will be analyzed through descriptive analysis by deriving the mean mode, and median and central tendency of quantitative data will be established.

Factor Analysis: The factor analysis is used to meet the objective of identifying factors affecting hospital waste management process. The KMO measure and Bartlett's tests were conducted for sampling adequacy and sphericity.

3.5 Sampling & Data Collection

Data collection techniques

The research has been conducted while adopting primary and secondary data collection approaches. The following primary and secondary sources have been used in the data collection:

Primary data collection sources: Field Survey with health personnel and managerial staff using interview schedule technique. Structured Interviews with administration of hospital waste management team, stakeholder perception regarding the process of waste management, observations, and by using a checklist prepared for assessment of characteristics proper segregation, collection and disposal methods.

We interviewed a total of 149 staff members with various positions such as doctors, nurses, interneer, infection control member, anesthesiologist, housekeeping, waste collector, medical officer, ward boy, laboratory technician, waste management technician and engineer. In twelve hospitals of Peshawar and 12 questionnaires per hospital from the administration unit, 6 in public and 6 in private sector. The questionnaire was based on the recommendations of sustainable waste management and HWM 2005 existing rules and to see factors affecting waste management, stakeholder perception and awareness regarding waste management and its physical implications existing in the hospital or not.

Secondary data collection sources: Secondary data was retrieved from sources like Published Reports, WHO recommendation's and SDG'S. Previous Researches and Research Articles were also reviewed for secondary data collection. The sources for these were, ScienceDirect, Google scholar, web of science, Jstor, Academia, Google Books.

3.6 Data Analysis

The data obtained from field surveys, including questionnaires and interviews, have been analyzed using Statistical Package for the Social Sciences (SPSS).

Descriptive statistics: Frequencies and cross-tabulation techniques have been used to provide the central tendency of the data and to explain the relationship between different study variables. The

purpose of descriptive statistics was to identify the profile of respondents and hospital. Also, to see the gap between current practices of public and private hospitals.

Data collected from the aforementioned sources have been explored through different analysis techniques such as:

Qualitative Data Analysis Techniques: Documentation, Categorization, and Conceptualization, examining co-relations and data display, Derive Conclusions

Quantitative Data Analysis Techniques: Tabulation of Results in different data set, Statistical Analysis (Factor Analysis)

Software used: SPSS, Tableau, MS Word for Descriptive Report writing

CHAPTER 4

DATA ANALYSIS AND RESULTS

This chapter contains the data analysis and interpretation of this analysis. The analysis is conducted on data obtained from literature, field surveys, observations, and in-depth interviews from various stakeholders. The analysis ranges from content to factor analysis in accordance with the type of data collected. The chapter follows the order of the objectives and has discussions on the findings of the study. The first part is focused on the service quality of current practices of hospital waste management process and gap between public and private hospital in Peshawar city, the second part the factors that affect bio-medical waste management and identification of barriers of hospital waste management. Thirdly, stakeholder satisfaction and awareness regarding biomedical waste management are analyzed. Lastly, the strategy and recommendation for sustainable waste management are discussed.

4.1 Current practices of services and gap between Public & Private Hospitals

This study's objective was to measure current practices, standards and implementation status of hospital waste management and to assess hospital waste management in public and private hospitals and identify the gap between the current practices and waste management process. A comparison of the means for each stage of waste management's reveals that the stakeholder overall had neutral and satisfactory experiences in both public and private hospitals.

Data was collected through interviews by a various number of stakeholders with different nature of, spread over different localities to understand the status of health waste management and the gap among them.

4.1.1 Profile of Respondents

Table 7: Profile of Respondents

Respondent's Profile	Category	Public N= (%)	Private N= (%)	Total	Pearson Chi-Square	p-Value
Position	Doctor	30 (39.4%)	46 (60.5%)	76	18.0	0.08
	Nurse	6 (33.3%)	12 (66.6%)	18		
	Internee	4 (44.4%)	5 (55.5%)	9		
	Infection Control	1 (33.3%)	2 (66.6%)	3		
	Anesthesiologist	3 (100%)	0 (0%)	3		
	House Keeping	0 (0%)	7 (100%)	7		
	Waste Collector	0 (0%)	3 (100%)	3		
	Medical Officer	3 (25%)	9 (75%)	12		
	Ward Boy	2 (50%)	2 (50%)	4		
	Laboratory Technician	1 (9%)	10 (90.9%)	11		
	HWM Technician	0 (0%)	2 (100%)	2		
	Engineer	0 (0%)	1 (100%)	1		
Gender	Male	36 (37.8%)	59 (62.1%)	95	2.2	0.13
	Female	14 (25.9%)	40 (74%)	54		
Age	<25	5 (9.4%)	48 (90.5%)	53	63.5	0.00
	25-50	44 (47.8%)	48 (52.1%)	92		
	>50	1 (25%)	3 (75%)	4		
Status of Job	Full time	39 (33.9%)	76 (66%)	115	0.02	0.8
	Part time	11 (32.3%)	23 (67.7%)	34		
Experience	<10	39 (31.2%)	86 (68.6%)	125	50.1	0.00
	10-20	8 (42.1%)	11 (57.8%)	19		
	20-30	1 (50%)	1 (50%)	2		
	>30	2 (66.6%)	1 (33.3%)	3		

Data signifies the fact that the personnel interviewed were majorly Doctors (51%), whereas the Nurses were secondary (12%) and the rest of the positions followed. Total of 149 interviews were conducted from a variety of people such as, Doctors, Nurses, Internees, Infection Control, Anesthesiologist, Housekeeping, Waste collector, medical officer, Ward boy, Laboratory technician, health waste management technician and Engineer. Recipients were dominated by male gender (63.8%) whereas females were less in number comparatively which also tells how males make the majority of the hospital population and are more proactive in speaking to outside people. Our research indicates that the large audience from the interviewees aged around 25 to 50 years old (61.7%) and above 50 were lesser in number (2.7%) comparatively. This also tells us that the younger age was more upfront and cooperative to answer our questions regarding health waste

management status of the hospital. As they were more aware of what was going on currently and the trends found nationally and internationally. Mostly the staff members were full time (77.2%) employees with a varied percentage of experience. Generally, the experience of the interviewees was up to 10 years (86.6%) who made the main part of our data and around 10.1% of the data collected was from the members whose experience was between 10-20 years.

4.1.2 Hospital's Profile

Hospital profile signifies majority (34.9%) were filled from Rehman medical college, whereas the rest comprised of 6.7% of the total with maternity hospital to be the lowest in number (4.7%) to respond to the interviews. These 12 hospitals are spread over the entire city of Peshawar but the data tells us that the hospitals which are established post 1970s are placed in Hayatabad both public and private. This can be due to multiple of reasons one is that the city growth is more towards that end of the city and it has somehow become a hub of hospitals and about 63.8% of the hospitals exist in this very location. The other reason is that the travel distance from rest of the city is quite accessible. On average 39.5% of the total hospitals studied consists of 350-550 beds and 30.8% has beds lower than 150 whereas there are very less hospitals which comprise of beds above 750 in number. Majority of the hospitals studied were 25 to 50 years old (61.7%) whereas 35.6% were under the age of 25 which elaborates the result that hospitals established post 1990 were higher in percentage (74.4%). As discussed in the table below:

Table 8: Hospital Profile

Variables	Public Hospital's						Private Hospital's						t-test		
	H1	H2	H3	H4	H5	H6	Avg.	H7	H8	H9	H10	H11		H12	Average
Age of the Hospital: <25 25-50 >50	25-50	25-50	<25	25-50	25-50	25-50	36	<25	<25	25-50	25-50	25-50	25-50	28	4.34
Number of Beds: <150 150-350 350-550 550-750 >750	>750	>750	<150	<150	<150	150-130	618	350-550	<150	350-550	550-750	<150	150-350	293	3.4
Number of Patients: <150 150-350 350-550 550-750 >750	>750	150-350	550-750	<150	<150	>750	1050	150-350	>150	150-350	>750	<150	150-350	478	5.0
Number of Doctors:	3	9	5	6	2	5	5	26	8	2	2	3	5	8	-1.40
Number of Nurses:	2	0	3	0	0	1	1	6	0	2	3	0	1	2	-1.49

H1: LRH
H2: KTH
H3: HMC
H4: BURN CENTRE & PLASTIC
H5: PARAPLEGIC
H6: NASEER ULLAH BABAR
H7: RMI
H8: NORTHWEST
H9: PIMS
H10: MATERNITY
H11: KHYBER MEDICAL CENTRE DABGARI
H12: NASEER TEACHING HOSPITAL

4.1.3 Hospital's Location

Hospital profile signifies majority (34.9%) were filled from Rehman medical college, whereas the rest comprised of 6.7% of the total with maternity hospital to be the lowest in number (4.7%) to respond to the interviews. These 12 hospitals are spread over the entire city of Peshawar but the data tells us that the hospitals which are established post 1970s are placed in Hayatabad both public and private. This can be due to multiple of reasons one is that the city growth is more towards that end of the city and it has somehow become a hub of hospitals and about 63.8% of the hospitals exist in this very location. The other reason is that the travel distance from rest of the city is quite accessible. On average 39.5% of the total hospitals studied consists of 350-550 beds and 30.8% has beds lower than 150 whereas there are very less hospitals which comprise of beds above 750 in number. Majority of the hospitals studied were 25 to 50 years old (61.7%) whereas 35.6% were under the age of 25 which elaborates the result that hospitals established post 1990 were higher in percentage (74.4%).

Table 9: Hospital's Location Profile

	Hospital Name	Type of Hospital	Specialty	Location
H1	Lady Reading Hospital	Public	Tertiary Hospital	Pipal Mandi
H2	Khyber Teaching Hospital	Public	Tertiary Hospital	University Town
H3	Hayatabad Medical Complex	Public	Medical Teaching Hospital	Hayatabad
H4	Burn Centre & Plastic Surgery	Public	Medical Teaching Hospital	Hayatabad
H5	Paraplegic Centre	Public	Rehabilitation Centre	Hayatabad
H6	Naseer Ullah Babar Hospital	Public	Public Hospital	Kohat Road
H7	Rehman Medical Institute	Private	Private Hospital	Hayatabad
H8	Northwest General Hospital	Private	Private Hospital	Hayatabad
H9	Peshawar Institute of Medical Sciences	Private	Tertiary Hospital	Hayatabad
H10	Maternity Hospital	Private	Maternity Hospital	Hashtnagri
H11	Khyber Medical Centre Dabgari	Private	Private Hospital	Hashtnagri
H12	Naseer Teaching Hospital	Private	Private Hospital	Nasir Bagh Road

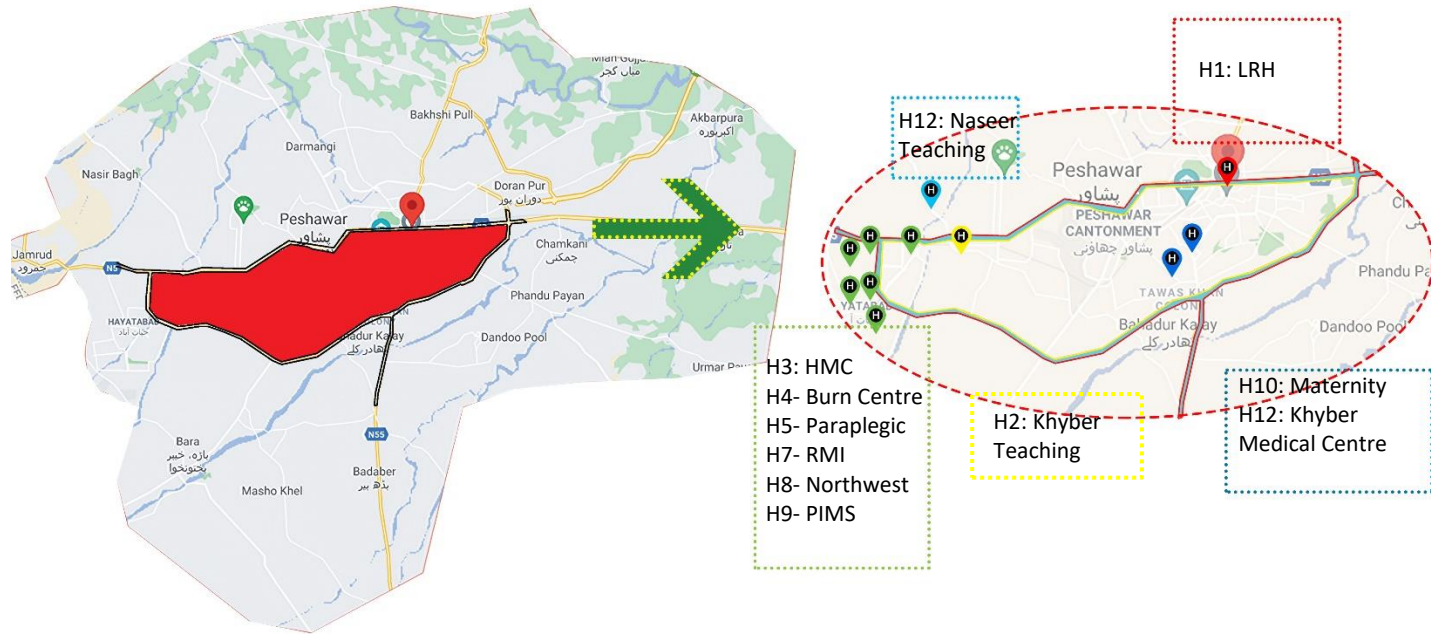


Figure 7: Hospital's Location

4.1.4 Measuring Service Quality of Current Practices

The public and private hospitals' mean service quality doesn't differ significantly in all seven stages of waste management process. The major seven stages involved in handling healthcare waste are Waste Generation, Segregation, Collection, Transportation, Storage, Treatment and Disposal. Each stage of waste processes has a cluster of various indicators which are explained as follow:

1. Waste Generation:

Healthcare wastes originating from healthcare facility dumped either into their backyard in a simple pit or put in open garbage to bins on the roads (A. Coker, 2009). Waste generated by the hospital needs to be handled in a proper way to ensure efficient hospital waste management. This

stage is comprised of various indicators such as government regulations regarding hospital waste management, Training of medical staff, annual reports of waste management process, policy-participation of stakeholders, Covid-19 effect on waste generation and waste handler's hesitance to deal with the waste due to pandemic.

While conducting interviews regarding waste generation, it is found that relatively higher percentage (47.7%) know about regulations related to BMW and training of medical staff (40.3%) but there is no significant difference found between stakeholders that know and don't have much knowledge. To maintain an efficient hospital service, it is essential to keep the records up to date and access to the reports available whoever wishes to. Data tells us that significant difference is not found among the two parties but slightly more (38.3%) of the audience tend to believe that annual reports of activities are available and it is important (54.4%) to maintain waste management record.

World health organization (WHO) has framed guidelines for the disposal of infectious and non-hazardous healthcare waste during COVID-19 outbreak. The proportion of noninfectious waste, which is more than 80.00% of the total quantity of healthcare waste generated, needs to be collected and disposed as municipal waste to avoid waste handlers and stakeholders from getting affected by pandemic (World Bank, 2020). It was mandatory to use masks, gloves, sanitizers and other PPE tools to ensure safety which did increase the upturn of the waste that the hospital was generating. Around 69.1% of the total stakeholder believes that the containment of the spread of Covid-19 significantly affected waste management but the waste handlers weren't hesitant (79.9%) to handle waste as the research or guidelines didn't suggest that you can catch the virus from the waste generated.

2. Segregation

There are a multiple number of factors affecting waste management process such as failure of segregation of hazardous and non-hazardous waste, lack of rules and regulation obedience, temporary storage area for waste collection, its protocols and standards. Also, to keep monitoring that the waste isn't stored for more than 48 hours, lack of proper waste treatment, training and workshop to waste handlers so they have knowledge regarding waste management process, Usage of PPE and awareness of its importance while handling waste, lack of knowledge about the proper

use of such equipment are among the factors contributing to poor healthcare waste management (Khajuria A, 2007).

The results tell us that the staff is cooperative (73.2%) and do not hesitate from considering staff to be responsible for handling waste but a major percentage (57%) said that they are not involved to participate in making policies to handle waste in the hospital which could help to improve the current system of waste management both in public and private hospitals. The most critical indicator in this cluster is that the laboratory staff do not see waste separation as their concern ($\bar{X} = 1.4$) the mean value inclination is towards more negative responses upon inquiring from various stakeholders. This could be a major reason that the waste doesn't get separated efficiently and into its own designated places.

3. Collection:

The third stage of waste management is waste collection in this cluster the most important indicator is lack of labelled waste bins ($\bar{X} = 1.6$). Medical waste bins are plastic containers designed in such a way that the hazardous and non-hazardous waste can be safely disposed in their respective bins. While making sure of spillage, contamination and reducing the chances of risk from getting harmed in anyway. Hospital generates majorly four different categories of waste that is, General, Infectious, Hazardous, and radioactive. The waste bins should be properly labeled and cater to all these four categories without any mix-up.

The other indicators from this cluster include, waste bins accessibility ($\bar{X} = 1.0$), medical waste placement ($\bar{X} = 1.6$) and usage of PPE by waste collectors during pandemic ($\bar{X} = 1.0$). Especially during times of pandemic, the waste collection must be done efficiently while maintain safety. For that access to PPE equipment should be readily available for all the people who are in direct contact to waste. Medical waste containers help the hospital from getting infections, needle pricks, and other risks.

4. Transportation:

Waste transportation is the fourth stage of waste management process, study identifies the fact that majority of the stakeholders use PPE more efficiently while handling waste especially more promptly since pandemic. Also, hospitals have designated teams and their own strategy to deal and monitor waste management within the hospital whereas half of the percentage (41.6%) aren't

aware of what happens, the rest 41.6% knows and the remaining 16.8% have no idea about the waste disposal once it's picked from the site.

5. Storage:

Storing waste is an important part of the waste management and the study tells us that the pandemic did increase the waste generation and storing it has become a challenge and 51% of the stakeholder believe that the chances of getting virus is more as the hospital is producing more waste than ever and no changes have been made in the storage capacity of the hospital. The rest of the indicators in this stage includes, awareness about guidelines and practical knowledge to manage/recycle/reuse hospital waste ($\bar{X} = 1.1$), and color-coding implementation while disposing waste during hospital duties ($\bar{X} = 1.0$).

6. Treatment:

On the other hand, the relevant stakeholders do know about the recycle/reuse of the waste and color coding involved in storing the waste into categories. 67.1% of the stakeholders believe that safety policies were instated during pandemic while handling waste and there is no significant difference between stakeholders who know and don't know about what happens to waste if it is recycled or reused. The other indicator from this cluster includes, program design to enhance knowledge regarding biomedical waste management and treatment during times of pandemic ($\bar{X} = 1.1$). Majority of the stakeholders agree that this should be a part of hospital training and workshops to ensure that all the stakeholders know about the protocols required to handle the waste and store them in their correct places so that the process of treatment could initiate. The knowledge regarding nature of waste is essential which tells if the particular waste can be managed/recycled or reused.

7. Disposal:

The last stage of waste management process is final disposal, study shows that stakeholders have known how about color coding and the bins are emptied whenever they are full. 53.7% of the total believe that biomedical waste management is an institutional problem and extra burden on the hospitals and 64.4% believe that the changes should be made in the current system of disposal and management for more sustainable waste management process. The hospital management and the stakeholders feel that the waste disposal and following the steps to ensure sustainable waste

management is not their problem. They shouldn't be held with this extra responsibility as it is an institutional problem which should be dealt by a third party instead of an inside-out approach.

4.1.5 Gap of Service Quality between Public and Private Hospitals

Service quality in dealing with biomedical waste management process differs in values but not significantly in public and private hospitals through all seven stages, with private hospitals having higher mean values in 3 stages i.e., Segregation, Collection and Treatment whereas in the remaining 4 stages public hospitals exceeded in value. In public hospitals the focus is less on the quality because of its non-profit nature especially on sustainable waste management process in terms of segregation, collection and treatment of waste, thus leading the private hospitals to produce better results in these particular stages, as their administrators must focus on selling their services to gain greater profits. Overall, the p-value is greater than 0.05 which shows there is no significant difference as t-values are significant at $\alpha=0.05$ for these measures of HCWM 7 stages between private and public hospitals.

Table 10: Gap Between Public & Private Services

HCWM 7 Stages	<u>Mean (SD)</u>		Mean Difference	p-value	t-test
	Public	Private			
Generation	10.56 (2.34)	10.31 (2.32)	0.25	0.53	0.61
Segregation	5.06 (1.81)	5.43 (1.91)	-0.37	0.25	-1.14
Collection	5.22 (1.23)	5.32 (1.24)	-0.10	0.63	-0.48
Transportation	4.42 (1.40)	4.15 (1.27)	0.26	0.24	1.16
Storage	3.82 (0.98)	3.57 (0.77)	0.25	0.08	1.72
Treatment	3.46 (1.11)	3.59 (1.04)	-0.12	0.49	-0.66
Disposal	4.90 (1.26)	4.65 (1.42)	0.25	0.28	1.06

4.2 Factors affecting stakeholder's satisfaction and awareness perception

Data were analyzed using IBM SPSS 23 software. **Principal component analysis (PCA)** was performed to reduce the data of barriers to more manageable groups and to determine the clusters of variables known as latent factors that correlate highly with each other (Azar and Al Ansari,

2017, Biernat et al., 2018, Fu and Farber, 2017, Göçer and Göçer, 2019). *Keyser-Mayer-Olkin* (KMO) and Bartlett's values for barriers were calculated to identify the suitability of PCA. The KMO value should be above 0.5, while Bartlett's test of sphericity value must be significant (Azeem et al., 2017, Ozorhon and Karahan, 2017).

Mean value method (Nordhoff et al., 2018, Mao et al., 2015) was used to measure the role of variables contributing in each latent factor obtained from PCA.

Pearson Chi-square technique was employed to ascertain differences in service preferences between the two hospitals (Field, 2013, Dagiliūtė et al., 2018). Yate's continuity correction in case 2 X 2 matrix, was implemented (Göçer and Göçer, 2019, Field, 2013).

Cronbach's alpha, with a threshold value of 0.7, was used to check the reliability of data collected (Azeem et al., 2017, Xia et al., 2017).

4.2.1 Comparison between Bio-Medical Waste Management Public & Private Hospitals

The rigidity which lies in application of the up-to-date practices is essential to the insufficient funds, lack of responsiveness, know-how of waste management process and stakeholder participation associated to health perils associated with waste management. However, research on this serious issue in this region of KPK has been very limited, and there is a grave access of knowledge, planning and implementation of typical actions required in biomedical waste management.

After conducting interviews, the major factors that were found to be affecting hospital waste management in public and private hospitals were waste handling, waste separation accountability, Covid-19 effect on waste management, financial capacity, waste monitoring, safety policies and awareness of bio-medical waste management policies and guidelines. Analysis signifies that there was a significant difference between public and private hospitals under two factors, one was waste monitoring and the other safety policies. Waste monitoring Mean value in public hospital was greater (3.88) than the private hospitals (3.31) with p value to be less than 0.05. The second factor with significant difference was safety policies which were seen to be better instated in private hospitals with a mean value of 4.41 whereas in public hospitals the value was lesser, 4.02 with $p < 0.05$.

On the other hand, difference did exist between public and private hospitals among all the remaining 5 factors but the difference wasn't significant. In public hospitals waste handling and financial capacity were relatively better in comparison. The reason behind it was the large amount of funds being allocated by the state for the government hospitals and due to increased number of staff capacity waste handling was better as the responsibilities weren't overlapped and the system existed to handle waste in an efficient way. Whereas, in private hospitals waste separation accountability was better exceeding by 0.91 difference which tells us that the different stakeholders like doctors, nurses, laboratory technicians do take responsibility for waste generation and handling of the waste instead of pinning it on just the third party. Covid-19 pandemic had an immense effect of health care institutions and a lot of guidelines were followed to ensure safety of all the stakeholders by taking care of PPE, availability of masks and sanitizers, physical distancing and isolation zones. Relatively in private hospitals these guidelines were more followed and the awareness level of respondents was higher with a mean difference of 0.36 between private and public hospitals. In order to make sure efficient waste management in hospitals it is important to understand the bio-medical waste guidelines, policies and protocols required to handle the waste. For this training and teaching of the knowledge to all the members of the hospitals is essential and so is the monitoring if it. Awareness of BMW guidelines were comparatively better in private hospitals rather than public hospitals with a mean difference of 0.07.

Table 11: Factors Affecting Waste Management Process

Factors Influencing Respondent Perception	Mean (SD)		Mean Difference	p-value	t-test
	Public	Private			
Waste Handling	8.00(1.57)	7.75(2.25)	0.25	0.47	0.70
Waste Separation Accountability	3.74 (1.94)	4.31 (1.77)	-0.91	0.74	-1.80
Covid-19 Effect	3.80 (1.12)	4.16 (0.87)	-0.36	0.33	-2.15
Financial Capacity	5.00 (2.06)	4.63 (1.88)	0.37	0.26	1.10
Waste Monitoring	3.88 (1.30)	3.31 (1.17)	0.57	0.00	2.67
Safety Policies	4.02 (1.02)	4.41 (0.71)	-0.39	0.00	-2.74

Awareness of BMW Guidelines	3.12 (1.25)	3.19 (1.08)	-0.07	0.71	-0.36
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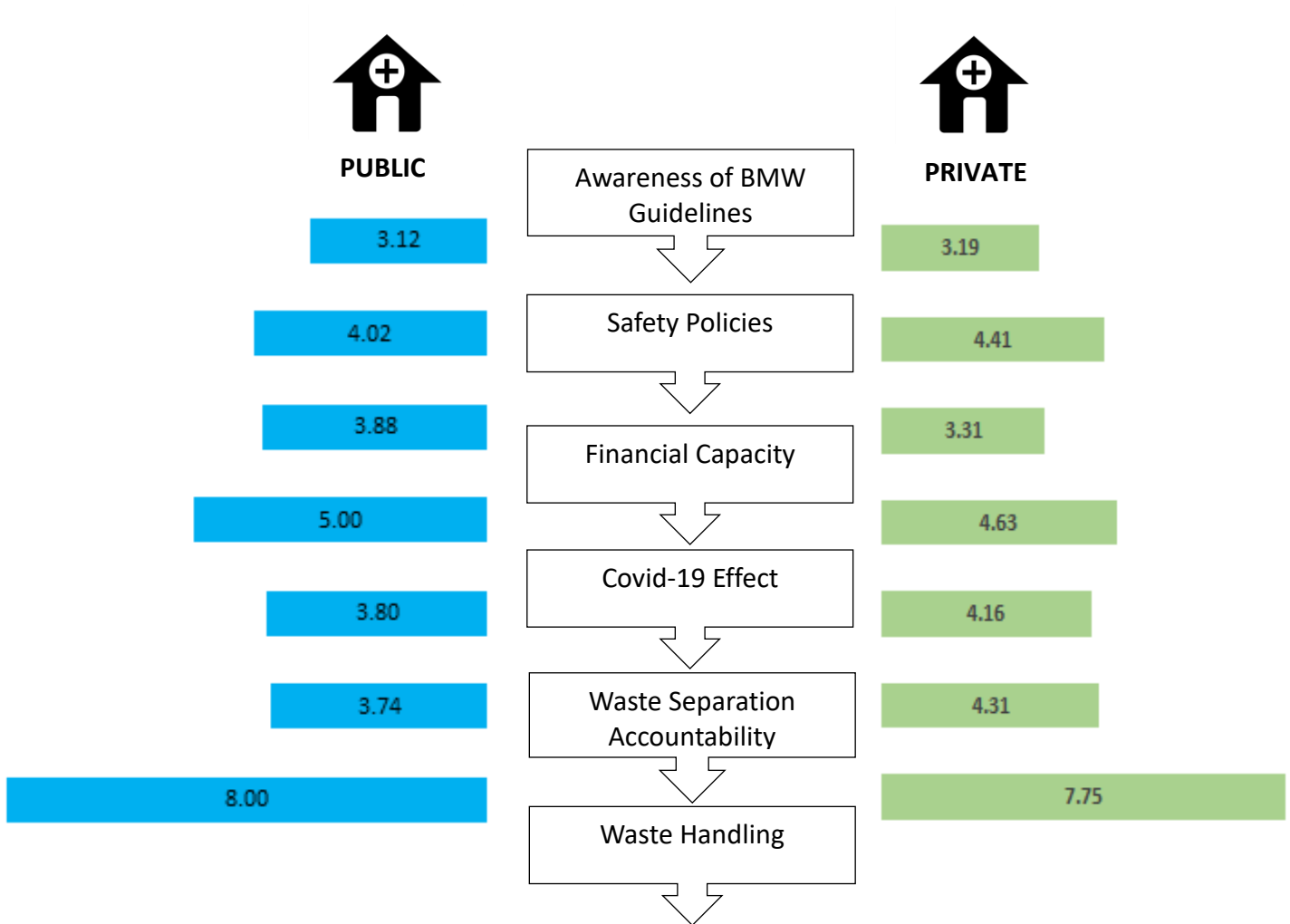


Figure 8. Factors Affecting Waste Management Process

4.2.2 Principal Component Analysis

The initial checks for barriers show that Cronbach’s alpha value of 0.71 and KMO value of 0.591 for barriers which is above 0.5. The Bartlett’s test of sphericity value (X^2) is 276 and significance value (*p-value*) is less than 0.001 unveiling that the correlation matrix is not an identity matrix and PCA can proceed. The Principal Component Analysis of barriers affecting the waste management

of public and private hospitals in Peshawar categorized 54 barriers into 08 lateral factors using varimax rotations with the Eigenvalues greater than “01”. 8th lateral factor having the same nature as 7th and being one in number paired up with 7th lateral factor. These 07 lateral factors explained the total variance of 60.78% (see **Error! Reference source not found.**)

Table 12: The Principal Component Analysis of barriers affecting

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.064	12.76	12.76	12.76	12.76	12.765
2	2.318	9.65	22.42	22.42	9.65	22.423
3	1.982	8.25	30.68	30.68	8.25	30.680
4	1.834	7.64	38.32	38.32	7.64	38.323
5	1.622	6.76	45.08	45.08	6.76	45.083
6	1.346	5.60	50.69	50.69	5.60	50.691
7	1.310	5.45	56.15	56.15	5.45	56.150
8	1.121	4.67	60.82	60.82	4.67	60.821

All variables were retained with no factor loadings below 0.4 (see **Error! Reference source not found.**).

Table 13: Factors Affecting HCWM Process

FACTORS	Code	Mean (\bar{X})	SD	Factor Loadings							
				1	2	3	4	5	6	7	
Waste Handling	B-35	1.52	.70	.695							
	B-36	1.51	.65	.641							
	B-34	1.66	.55	.621							
	B-37	1.62	.67	.562							
	B-32	1.51	.61	.539							
Waste Separation Accountability	B-24	1.37	.75		.815						
	B-25	1.42	.78		.742						
	B-23	1.33	.74		.723						
Covid-19 Effect	B-41	1.21	.51			.769					
	B-45	1.05	.35			.707					
	B-43	1.78	.46			.480					

Financial Capacity	B-31	1.25	.72	.646
	B-20	1.12	.89	.612
	B-17	1.26	.64	.509
	B-19	1.13	.76	.508
Waste Monitoring	B-28	1.23	.59	.686
	B-26	1.19	.53	.670
	B-22	1.09	.62	.647
Safety Policies	B-40	1.15	.55	.747
	B-47	1.77	.57	-.686
	B-44	1.36	.54	.590
Awareness of BMW Guidelines	B-13	1.17	.70	.799
	B-12	.86	.55	.725
	B-18	1.13	.44	.779

4.2.3 Barriers Affecting Bio-medical Waste Management Process:

Principal component analysis has categorized the 24 barriers into following 07 latent factors as follows:

1. Waste Handling

Healthcare wastes originating from healthcare facility dumped either into their backyard in a simple pit or put in open garbage to bins on the roads (A. Coker, 2009). Waste generated by the hospital needs to be handled in a proper way to ensure efficient hospital waste management. This factor comprised of various barriers in public and private hospitals, found while studying them. The most eminent barrier which caused lack of efficient waste handling is B-34: Lack of well labelled waste bin ($\bar{X} = 1.66$). The second major barrier was B-37: Staff's hesitance to handle waste ($\bar{X} = 1.62$). These two barriers cause inefficiency as the poor labeling or lack of label creates confusion and mix up of the waste which leads to mismanaged segregation of waste into its respective coded bins. Also, the staff doesn't feel responsible in handling the waste and believes that this is the sole responsibility of the waste handlers which fails to result in an integrated hospital waste management.

Currently, in many developing countries, poor segregation and the question of how to manage HCWs has become a critical concern (LK, 2017). Other waste handling barriers include, B-35: Removal of waste when the available bins are full ($\bar{X} = 1.52$), B-36: Designated placement of medical waste after use ($\bar{X} = 1.51$), and B-32: Stakeholder's policy participation in hospitals to handle waste ($\bar{X} = 1.51$). Percentage of variance between the barriers is 12.7% which tells us that the values aren't dispersed enough from the mean value of waste handling.

2. Waste Separation Accountability

There are a multiple number of factors affecting waste management process such as failure of segregation of hazardous and non-hazardous waste, lack of rules and regulation obeyance, temporary storage area for waste collection, its protocols and standards. Also, to keep monitoring that the waste isn't stored for more than 48 hours, lack of proper waste treatment, training and workshop to waste handlers so they have knowledge regarding waste management process, Usage of PPE and awareness of its importance while handling waste, lack of knowledge about the proper use of such equipment are among the factors contributing to poor healthcare waste management (Khajuria A, 2007).

The most critical barrier in this cluster is B-25: Laboratory staff reluctant to aid in waste separation ($\bar{X} = 1.42$) and B-24: Nurses reluctant to aid in waste separation ($\bar{X} = 1.37$). The remaining barrier includes B-23: Doctors reluctant to aid in waste separation ($\bar{X} = 1.33$). The reason behind this is that the various stakeholders do not take waste separation to be their responsibility and refrain from participating in following efficient ways of waste management. They believe it to be the responsibility of waste handlers which makes it difficult to ensure sustainable waste management as it should be a top-down approach where everyone does their part to make it a holistic and integrated hospital waste management system. Percentage of variance between the barriers is 9.65% which tells us that the values in the cluster are not far from the mean and from each other as it is lower in ratio.

3. Covid-19 Effect

World health organization (WHO) has formulated guidelines for the disposal of infectious and noninfectious healthcare waste during COVID-19 outbreak. The proportion of noninfectious waste, which is more than 80.00% of the total quantity of healthcare waste generated, needs to be collected and disposed as municipal waste (World Bank, 2020). Otherwise, we may risk further

spread of the coronavirus mainly in developing countries due to poor waste handling conditions associated with inappropriate use of personal protective equipment and other unfavorable conditions (Mol M.P.G., 2020). The main barrier affecting waste management in public and private hospitals because of the pandemic is B-43: Waste handlers cautious to deal with waste due to Covid-19 ($\bar{X} = 1.78$). The reason between the higher mean value is that the waste handlers fear from getting the virus as initially there was less research on transmission of the virus and it was declared that the virus can be caught from surfaces as well.

The other barrier IS B-41: Covid-19 pandemic effect on waste management ($\bar{X} = 1.21$). Current coronavirus pandemic is posing challenges to municipal waste management practices and procedures such as safety and health measures for employees, waste treatment requirements, general procedures due to coronavirus for waste sector (ACRPlus, 2020). The last barrier includes B-45: Usage of PPE by waste collectors and relevant stakeholders ($\bar{X} = 1.05$). Many stakeholders were reluctant to use PPE and follow the guidelines instated by the hospitals which made them prone to getting affected and also such vulnerability caused distress for the people who were following physical distancing and safety policies. Percentage of variance between the barriers is 8.25% which tells us that the values in the cluster are not far from the mean and from each other as it is lower in ratio.

4. Financial Capacity

In this cluster, the highest-scoring barriers are B-17: Biomedical waste disposal is an institutional problem & extra burden ($\bar{X} = 1.26$) and B-31: Treatment of waste after disposal ($\bar{X} = 1.25$). The reason of high significance of these two barriers are that the hospital management and the stakeholders feel that the waste disposal and following the steps to ensure sustainable waste management is not their problem. They shouldn't be held with this extra responsibility as it is an institutional problem which should be dealt by a third party instead of an inside-out approach.

The other barriers from this cluster are, B-19: Availability of training of medical staff regarding HCWM ($\bar{X} = 1.13$) and B-20: Allocation of sufficient funds to manage hospital's waste ($\bar{X} = 1.12$). In low- and middle-income countries, health care waste management receives little attention as the health sector competes with other sectors of the economy for very limited resources. In most of these countries, health care waste is still handled and disposed of as domestic waste, with the resulting appreciable threat to the waste workers, the public, and the environment (Muhwezi L,

2014). Percentage of variance between the barriers of Covid affecting waste management is 7.64% which tells us that the values in the cluster are not far from the mean and from each other as it is lower in ratio.

5. Waste Monitoring

Waste monitoring is an important step in aiding towards efficient hospital waste management as this could help with identifying the current situation of the waste and it can save time and set focus regarding what is working and what isn't in your respective hospitals. The most critical barrier in this cluster is B-28: Is Infection control department monitoring waste especially during pandemic ($\bar{X} = 1.23$). This barrier holds critical importance as it could help in containment of virus from outbreaking and making sure the hospital isolation zones are well marked and all set precautions are being followed to save the common population from getting affected especially during the times of pandemic.

The other two barriers are, B-26: Knowledge between different categories of medical waste ($\bar{X} = 1.19$) and B-22: Are waste management plans followed by strategy or team monitoring and supervision ($\bar{X} = 1.09$). Check and balance of waste being disposed in their right designated places and plans followed by the various stakeholders could help in maintaining efficiency of waste management in hospitals. If there is no monitoring done at all the stages of waste management process the problems could emerge resulting in haphazard system. Percentage of variance between the barriers of Waste Monitoring affecting waste management is 6.76% which tells us that the values in the cluster are not dispersed from the mean and from each other as it is lower in percentage.

6. Safety Policies

Although waste collectors are more likely to be injured due to their low educational status, low training, less attention from the management, and often have no or inadequate PPE, there is limited information on them worldwide and especially in low-income countries (A, 2014). Safety policies provide a safety net to the waste handlers and all the stakeholders who have direct contact with the waste. It helps to follow a set of rules from ensuring the usage of PPE, physical distancing, training regarding how to deal with different categories of waste, how to store or transport them and what steps can be taken to minimize the risk of spreading viruses and cases of injuries caused by handling waste. The most critical barrier from this cluster is B-47: Physical distancing of 2m

maintained between people in public during COVID-19 ($\bar{X} = 1.19$). The reason behind this significance is that the safety policy issued by the government to follow 2m physical distancing in all public places to minimize the chances of getting corona virus was that people didn't believe in the seriousness of the issue and how it can affect in spreading virus in the hospitals.

The other two barriers from this cluster are B-44: Is management of waste essential to minimize risks to human and environmental health ($\bar{X} = 1.36$) and B-40: Do waste handlers feel safety policies instated while managing waste ($\bar{X} = 1.15$). These barriers elaborate the fact that the waste handlers feel more upfront and up to the duty if safety policies, safety gears and safety knowledge and training is being given. Also. Management of waste is directly proportional to human and environmental health. Percentage of variance between the barriers of Safety policies affecting waste management is 5.60% which tells us that the values in the cluster are not dispersed from the mean and from each other as it is lower in percentage.

7. Awareness of BMW Guidelines

Stakeholder awareness regarding bio-medical waste management comprises of various factors such as the government regulation and policies about medical waste management, guidelines to follow these policies and 7 steps of waste management process: Waste generation, segregation, collection, transportation, storage, treatment and final disposal and a training program to enhance the current knowledge and adopt international standards of hospital waste management. The most critical barrier found under this cluster is B-13: Awareness of government regulations and legislations related to BWM ($\bar{X} = 1.36$). This barrier signifies the fact that the know-how regarding policies is very limiting and execution of those policies implementation is not seen efficiently on ground.

The other two barriers are B-12: Existing guidelines for biomedical waste disposal ($\bar{X} = 1.36$) and B-18: Is there a need to have a program to enhance knowledge regarding BWM ($\bar{X} = 1.36$). This tells us that there is a lack of awareness regarding guidelines for biomedical waste disposal and knowledge regarding sustainable waste management. Percentage of variance between awareness of Biomedical waste guidelines affecting waste management is 5.06% which tells us that the values in the cluster are not dispersed from the mean and from each other as it is lower in percentage.

4.3 Stakeholder Satisfaction & Awareness Perception Regarding BWM:

This study's objective was to analyze stakeholder perception and awareness regarding hospital waste management current practices, standards and implementation status of hospital to assess hospital waste management in public and private hospitals and identify the gap between them. A comparison of the means for each stage of waste management's reveals that the stakeholder overall had impartial and satisfactory experiences in both public and private hospitals.

4.3.1 Observation of Patient Satisfaction in seven dimensions:

1. General satisfaction:

First dimension of stakeholder perception about waste management is General satisfaction. It consists of different satisfaction variables such as PPE usage by waste handlers and relevant stakeholders especially during Covid-19, Cleanliness of the facility and adequate level of safety measures to stop the spreading of infectious diseases. Current municipal waste management practices are challenged by the outbreak of Corona virus as the fear of getting affected and the increase of waste makes it difficult to follow safety of waste handlers and staff members, waste treatment procedures, treatment requirements, and general procedure (ACRPlus, 2020). Upon asking various stakeholders regarding satisfaction level of these stated variables we found out the most critical variable to be regarding adequate level of safety measure and personal protective equipment (PPE) to prevent the spreading of diseases ($\bar{X} = 1.6 \pm 0.6$).

The other two reasons affecting stakeholder perception about BWM are, Cleanliness of the facility ($\bar{X} = 1.5 \pm 0.67$) and Usage of PPE by waste collectors and relevant stakeholders during pandemic ($\bar{X} = 1.1 \pm 0.47$). World health organization (WHO) has formulated guidelines for the disposal of infectious and noninfectious healthcare waste during COVID-19 outbreak. The proportion of noninfectious waste, which is more than 80.00% of the total quantity of healthcare waste generated, needs to be collected and disposed as municipal waste (World Bank, 2020).

2. Technical quality:

Stakeholder satisfaction queries asked under the domain of technical quality are training workshops, administration involvement, knowledge about biomedical waste, safety policies and measures and if intervention or innovative solutions are vital at all steps of waste management process. The most critical variable found was satisfaction of training workshops provided the

administration regarding BWM ($\bar{X} = 1.8 \pm 0.8$). The other variable gives us the Mean value for intervention obligatory at all phases of waste management from handling, treatment, and disposal ($\bar{X} = 1.6 \pm 0.8$).

The other two variables signify the current Covid-19 pandemic that how it has burdened the hospitals waste management and upturn of the waste has increased. In order to make sure masks, gloves and other PPE equipment's are recycled/ reused the hospital needs to improve the technical quality of waste treatment. Due to inappropriate usage of PPE and other conditions we put developing countries at a more vulnerable stage as they are more prone to catching corona virus and failing in minimizing the outbreak can worsen waste handling conditions (Mol M.P.G., 2020). Stakeholders' satisfaction regarding getting affected by Corona virus as hospitals are producing more waste than usual ($\bar{X} = 1.5 \pm 0.5$). The last variable interrogates about the safety policies satisfaction that were instated during Covid-19 while managing waste ($\bar{X} = 1.4 \pm 0.6$).

3. Interpersonal manner:

The third domain of stakeholder satisfaction consists of variable of interpersonal manner. The most critical factor affecting interpersonal manner domain was waste handlers being hesitant to deal with waste because of Covid-19 pandemic ($\bar{X} = 1.8 \pm 0.4$). During times of pandemic, the waste collection must be done efficiently while maintaining safety of waste handlers and other stakeholders who have direct contact with waste. For that access to PPE equipment and knowledge about safety guidelines and policies should be readily available for all the people who are handling waste.

The other factor influencing stakeholder satisfaction is efficiency level of respective hospitals both private and public in collecting the waste ($\bar{X} = 1.5 \pm 0.7$). Medical waste bins are plastic containers designed in such a way that the hazardous and non-hazardous waste can be safely disposed in their respective bins. While making sure of spillage, contamination and reducing the chances of risk from getting harmed in anyway. Hospital generates majorly four different categories of waste that is, General, Infectious, Hazardous, and radioactive. The waste bins should be properly labeled and cater to all these four categories without any mix-up. The last factor elaborates the fact that health personnel should take measures to ensure hazardous waste in not generated in the first place ($\bar{X} = 1.5 \pm 0.7$). The reason behind this is that the various stakeholders do not take waste separation to be

their responsibility and refrain from participating in following efficient ways of waste management. They believe it to be the responsibility of waste handlers which makes it difficult to ensure sustainable waste management as it should be a top-down approach where everyone does their part to make it a holistic and integrated hospital waste management system. Minimizing the generation of waste can help in managing the waste efficiently and sustainably.

4. Communication:

The fourth domain of stakeholder satisfaction is communication it elaborates the factor of accessibility in terms of location, environmental, attitudinal and approachability. Mean value for the stakeholder responses to hospitals accessibility is ($\bar{X} = 2.2 \pm 0.9$). Mean value for the stakeholder participation in making policies to handle waste is ($\bar{X} = 1.5 \pm 0.6$).

5. Functional capacity:

Healthcare wastes originating from healthcare facility dumped either into their backyard in a simple pit or put in open garbage to bins on the roads (A. Coker, 2009). Waste generated by the hospital needs to be handled in a proper way to ensure efficient hospital waste management. Stakeholder satisfaction regarding functional capacity comprises of safe disposal of biomedical waste at respective hospitals ($\bar{X} = 1.4 \pm 0.5$).

6. Accessibility & convenience:

Safety policies provides safety net to the waste handlers and all the stakeholders who have direct contact with the waste. It helps to follow a set of rules from ensuring the usage of PPE, physical distancing, training regarding how to deal with different categories of waste, how to store or transport them and what steps can be taken to minimize the risk of spreading viruses and cases of injuries caused by handling waste. Accessibility and convenience are the last domain of stakeholder satisfaction, the critical factor affecting this domain questions physical distancing of at least 2 meters maintained between people in public spaces during Covid-19 ($\bar{X} = 1.9 \pm 0.3$).

The other factor affecting is garbage bins accessible, color coded and strictly enforced to dispose waste in their respective bins at ($\bar{X} = 1.4 \pm 0.6$). Hospital generates majorly four different categories of waste that is, General, Infectious, Hazardous, and radioactive. The waste bins should be properly labeled, accessible and color-code and cater to all these four categories without any mix-up.

Especially during times of pandemic, the waste collection must be done efficiently while maintaining safety. For that access to PPE equipment should be readily available for all the people who are in direct contact with waste. Medical waste containers help the hospital from getting infections, needle pricks, and other risk.

4.3.2 Stakeholder overall satisfaction among its 6 Parameters:

Six parameter of stakeholder satisfaction are General satisfaction, technical quality, interpersonal manner, communication, functional capacity and accessibility & convenience. The first domain is General satisfaction, 62.6% percent of the total respondents are extremely satisfied from the current practices taking place in the hospital whereas 28.3% are quite satisfied and 8.9% are little satisfied and need changes to be made. The second domain is technical quality, 57% of the respondents are extremely satisfied and do not want interventions to be made, 26.3% are quite satisfied and 16.5% are barely satisfied. In interpersonal manner 46.7% are extremely satisfied, 42.4% are quite satisfied and 10.7% are not or very little satisfied. Stakeholder satisfaction in communication is 50.3% extremely satisfactory, 22.1% quite satisfactory and 11.7% not satisfactory. 60.4% stakeholders are extremely satisfied, 34.2% are quite satisfied and 5.3% of the total respondents are not satisfied in functional capacity domain. The last parameter is accessibility and convenience in which the results show that 39.2% are extremely satisfied, 52% are quite satisfied and 8.7% are not satisfied. In comparison to reach 100% satisfactory results the domains in which the hospitals can make improvement are mentioned in descending order base on priority of improvement capacity: Technical quality > Communication > Interpersonal manner > General satisfaction > Accessibility & convenience> Functional capacity. These values have been elucidated in Table 4.

Table 14: Overall Stakeholder Satisfaction

Overall Stakeholder Satisfaction	Scale			MEAN	MODE	SD
	A lot & extremely satisfied (%)	Quite Satisfied (%)	At all or little satisfied (%)			
General satisfaction	93.3 (62.6)	42.3 (28.3)	13.3 (8.9%)	1.4	1	1.3
Technical quality	85 (57.0%)	39.2 (26.3%)	24.7 (16.5%)	1.6	1.5	1.5

Interpersonal manner	69.6 (46.7%)	63.3 (42.4%)	16 (10.7%)	1.6	1.3	1.1
Communication	75 (50.3%)	33 (22.1%)	17.5 (11.7%)	1.55	1.5	0.8
Functional capacity	90 (60.4%)	51 (34.2%)	8 (5.3%)	1.4	1	0.5
Accessibility & convenience	58.5 (39.2%)	77.5 (52%)	13 (8.7%)	1.6	1.5	0.7

4.3.3 Observation of Awareness regarding current practice of medical waste management:

Stakeholder awareness have 8 different parameters which are: waste generation, segregation, collection, transportation, storage, treatment, disposal and PPE usage. Waste generation comprises of two awareness indicators, the first one asks about, A-13: stakeholder awareness of government regulations and legislations related to biomedical waste management with a higher mean value ($\bar{X} = 1.1 \pm 0.7$). The second parameter, A-48: is awareness regarding waste generated during diagnosis, treatment, immunization or research activities in medical, dental or laboratory set-up with a mean value ($\bar{X} = 0.9 \pm 0.4$) and the overall index value of waste generation is $\Sigma = 1$.

Stakeholder awareness regarding segregation consists of 3 parameters, the first one is A-14: stakeholder awareness about the knowledge required to manage, recycle/reuse waste ($\bar{X} = 1.1 \pm 0.5$). The second is, A-15: awareness regarding color coding while disposing waste ($\bar{X} = 1.0 \pm 0.3$) and the last one is, A-26: awareness about different categories of medical waste ($\bar{X} = 1.1 \pm 0.5$) and the overall index value of segregation is $\Sigma = 1.06$.

Collection is an essential stage in the waste process and its awareness is essential in order to make sure sustainable waste management. This parameter of awareness consists of 3 sub-variable, A-16: Can inappropriate biomedical waste disposal cause health hazards ($\bar{X} = 0.9 \pm 0.5$), the second one is A-30: If waste is not properly handled it can be a risk to healthcare workers and patients ($\bar{X} = 0.9 \pm 0.5$). The last one, A-51: According to guidelines, untreated waste shouldn't be stored beyond 48 hours ($\bar{X} = 0.9 \pm 0.5$) with an overall index of all three indicators $\Sigma = 0.9$.

Transportation is the fourth domain of stakeholder's awareness which consists of 2 parameters: A-31: Are you aware what happens to waste after it is picked up from the station you work ($\bar{X} =$

1.2±1.1). The other is, A-50: Correct sequence of biomedical waste management is segregation, collection, storage & transportation ($\bar{X} = 0.7 \pm 0.6$) with an overall index of $\Sigma = 0.95$.

Storage comprises of two domains A-52: Glassware and metallic body implants are disposed in blue container ($\bar{X} = 0.7 \pm 0.6$) and A-53: Infectious sharps and needles are disposed of in white containers ($\bar{X} = 0.7 \pm 0.6$) with an overall index $\Sigma = 0.6$. Awareness regarding this domain ensures the fact that the waste handlers and all the respective stakeholders who have direct contact with the waste has knowledge about the waste containers color coding and its significance of being kept in its own respective places.

Awareness regarding treatment of biomedical waste helps in achieving sustainable waste management. A-29: Are you aware if recycling of medical waste is done at this hospital ($\bar{X} = 1.2 \pm 0.7$) with an overall index $\Sigma = 1.2$.

Waste disposal awareness comprises of various indicators such as, A-27: Do you know about the policies in this hospital about reporting needle stick injuries ($\bar{X} = 1.2 \pm 0.5$), A-49: Biomedical waste should be handed over to Bio-medical waste management agency ($\bar{X} = 1.1 \pm 0.5$), A-54 Infectious biodegradable are disposed of in yellow container ($\bar{X} = 1.0 \pm 0.7$), A-55 Infectious non-biodegradable disposed in red containers ($\bar{X} = 1.2 \pm 0.7$) with an overall index $\Sigma = 1.1$.

PPE usage helps waste handlers from getting injured or catching viruses especially in the times of pandemic. This factor of awareness signifies the fact that how important the stakeholders think its usage is. A-56 Waste handlers should be made aware of risks involved and usage of PPE should be a compulsion ($\bar{X} = 0.9 \pm 0.5$) with an overall index $\Sigma = 0.9$.

4.3.3 Awareness about medical waste management process in Public & Private hospitals

The case study for this study consisted of 6 public hospitals and 6 private hospitals in Peshawar. The public and private hospitals' mean value for the awareness level differs in values but not significantly in all eight stages which are: Generation, Segregation, Collection, Transportation, Storage, Treatment, Disposal, and PPE usage. In Public hospitals the mean value is greater in segregation ($\bar{X} = 1.25$), storage ($\bar{X} = 0.69$), treatment ($\bar{X} = 1.36$), and PPE usage ($\bar{X} = 1.02$) than the Private hospitals. Whereas on the other hand in certain areas private hospital awareness is better such as: generation ($\bar{X} = 1.08$), collection ($\bar{X} = 0.99$), transportation ($\bar{X} = 1.20$), and disposal

($\bar{X} = 1.20$). Overall, the p-value is greater than 0.05 which shows there is no significant difference as t-values are significant at $\alpha=0.05$ for these measures of awareness at 8 different stages of waste management process between private and public hospitals. The comparison between Public and private hospitals stakeholder awareness is given below in Table 5.

Table 15: Stakeholder Awareness in Public & Private Hospitals

Stakeholder Awareness Parameters:	Scale			MEAN		Mean Difference	p-value	t-test
	Yes	No	Don't Know	Public	Private			
Generation	93.5 (62.7%)	33.5(22.4%)	22(14.7%)	1.07	1.08	-0.01	0.8	-0.14
Segregation	111(74.4%)	29.3(19.6%)	8.6(5.8%)	1.25	1.08	0.17	0.2	2.32
Collection	85.6(54.7%)	29(19.4%)	34(22.8%)	0.93	0.99	-0.06	0.3	-0.10
Transportation	71.5(47.9%)	54.5(36.5%)	24(16%)	1.18	1.20	-0.02	0.5	-0.25
Storage	48(32.2%)	37(24.8%)	76.5(51.3%)	0.69	0.64	0.05	0.6	0.40
Treatment	53(35.3%)	67(44.7%)	29(19.3%)	1.36	1.20	0.16	0.2	1.19
Disposal	76(51%)	47(31.5%)	25.7(17.2%)	0.96	1.20	-0.24	0.2	-5.55
PPE USAGE	140(93.3%)	4(2.7%)	6(4%)	1.02	0.97	0.05	0.2	1.11

4.3.4 Awareness about waste management process among Full/ Part time health care providers
 Awareness about waste management process among full and part time health care providers mean value differs in values but not significantly in all eight stages which are: Generation, Segregation, Collection, Transportation, Storage, Treatment, Disposal, and PPE usage. The Full-time employees' awareness regarding waste management mean value is greater in Generation ($\bar{X} = 1.18$) and PPE usage ($\bar{X} = 1.01$) than the Part-time employees. Whereas on the other hand in certain areas private hospital awareness is better such as: segregation ($\bar{X} = 1.14$), collection ($\bar{X} = 1.14$), transportation ($\bar{X} = 1.25$), and disposal ($\bar{X} = 1.15$), storage ($\bar{X} = 0.72$), treatment ($\bar{X} = 1.32$). Overall, the p-value is greater than 0.05 which shows there is no significant difference as t-values are significant at $\alpha=0.05$ for these measures of awareness at 8 different stages of waste

management process between full-time and part-time employees. The comparison between full-time and part-time employees' awareness is given below in Table 6.

Table 16: Comparison of Awareness between Full time and Part time workers

Stakeholder Awareness Parameters:	Scale			MEAN		Mean Difference	p-value	t-test
	Yes	No	Don't Know	Full Time	Part Time			
Generation	93.5 (62.7%)	33.5(22.4%)	22(14.7%)	1.18	1.04	0.14	0.5	0.26
Segregation	111(74.4%)	29.3(19.6%)	8.6(5.8%)	1.13	1.14	-0.01	0.2	0.27
Collection	85.6(54.7%)	29(19.4%)	34(22.8%)	0.95	1.14	-0.19	0.4	-0.71
Transportation	71.5(47.9%)	54.5(36.5%)	24(16%)	1.18	1.25	-0.07	0.4	-0.46
Storage	48(32.2%)	37(24.8%)	76.5(51.3%)	0.63	0.72	-0.09	0.5	-.57
Treatment	53(35.3%)	67(44.7%)	29(19.3%)	1.23	1.32	-0.09	0.5	-.59
Disposal	76(51%)	47(31.5%)	25.7(17.2%)	1.14	1.15	-0.01	0.4	-0.73
PPE USAGE	140(93.3%)	4(2.7%)	6(4%)	1.01	0.91	0.1	0.05	1.93

4.3.5 Awareness about medical waste management process among Doctors & Nurses

Awareness about waste management process among full Doctors and Nurses mean value differs in values but not significantly in all eight stages which are: Generation, Segregation, Collection, Transportation, Storage, Treatment, Disposal, and PPE usage. Doctors' awareness regarding waste management mean value is greater in Generation ($\bar{X} = 1.09$) and segregation ($\bar{X} = 1.15$) PPE usage ($\bar{X} = 2.18$), and treatment ($\bar{X} = 1.29$) than the Nurses. Whereas on the other hand in certain parameters nurse's awareness is better than doctor such as: collection ($\bar{X} = 1.02$), transportation ($\bar{X} = 1.25$), and disposal ($\bar{X} = 1.23$), and storage ($\bar{X} = 0.65$). Overall, the p-value is greater than 0.05 which shows there is no significant difference as t-values are significant at $\alpha=0.05$ for these measures of awareness at 8 different stages of waste management process between full-time and

part-time employees. The comparison between doctors and nurse’s awareness is given below in Table 7.

Table 17: Comparison of Awareness between Doctors & Nurses

Stakeholder awareness parameters:	Scale			Positions		Mean difference	p-value	t-test
	Yes	No	Don't Know	Doctors	Nurse			
Generation	93.5 (62.7%)	33.5(22.4%)	22(14.7%)	1.09	1.03	0.06	0.6	0.48
Segregation	111(74.4%)	29.3(19.6%)	8.6(5.8%)	1.15	1.12	0.03	0.7	0.36
Collection	85.6(54.7%)	29(19.4%)	34(22.8%)	0.95	1.02	-0.07	0.6	-0.49
Transportation	71.5(47.9%)	54.5(36.5%)	24(16%)	1.17	1.25	-0.08	0.5	-0.54
Storage	48(32.2%)	37(24.8%)	76.5(51.3%)	0.64	0.65	-0.01	0.8	-0.02
Treatment	53(35.3%)	67(44.7%)	29(19.3%)	1.29	1.21	0.08	0.5	0.53
Disposal	76(51%)	47(31.5%)	25.7(17.2%)	1.10	1.23	-0.13	0.3	-0.69
PPE USAGE	140(93.3%)	4(2.7%)	6(4%)	2.18	2.03	0.15	0.4	0.76

4.4 Sustainable Biomedical Waste Management:

Sustainable waste management believes in making sure our future generation have safe environment and resources to live in and for these measures needs to be taken to reduce carbon foot print and diseases outbreak due to mismanagement of waste. The main principles found through analysis which supports sustainable waste management are: solutions to promote recycling, reuse and reduce the waste generated, program design to create awareness to various stakeholders and educate them about the risks attached in case of contact with hazardous waste and treatment of biomedical waste before responsibly disposing of either into the incinerator or assigned sites for waste. Eleven basic methods from our analysis can be solutions for adopting sustainable bio-medical waste management stated as follow:

- 1) Elimination
- 2) Reduction
- 3) Focus on segregation first
- 4) Institute a sharps management system
- 5) Waste auditing
- 6) Ensure worker safety through education, training and proper
- 7) In-facility Transportation and Storage
- 8) Provide secure collection and transportation
- 9) Require plans and policies
- 10) Invest in training and equipment for reprocessing of supplies
- 11) Invest in environmentally sound & cost-effective health care waste treatment and disposal technologies
- 12) Develop an infrastructure for the safe disposal and recycling for hazardous materials
- 13) Develop an infrastructure for safe disposal for municipal solid waste

CHAPTER 5

CONCLUSION

Even though national legislation framework, HWM 2005 states rules and regulations but the research shows that its implementation hasn't been done up to the mark. There is an urgent need of its physical implementation and awareness of its dire need in the current practices of Public and Private hospitals. Most importantly safety policies aren't followed which leads to unusage of PPE while handling waste which exposes the handler to risk. Therefore, the government authorities should take charge and play an important role in backing up health care stakeholders by providing timely trainings, workshop, funds, record monitoring, designated waste management team and plan in every public and private hospitals of Peshawar. Keen monitoring can resurface other factors and barriers which could be improved by corrective action and strengthened implementation by frequent checks of current practices.

As the new hospitals made are more private the health care system moves towards privatization to focus on the consumer part of the business that is health facilities in hospitals, it is significant for hospital management to evaluate and compare the services provided by hospitals both public and private. The various stakeholder observations can help the management to recognize the characteristics of health waste management that require utmost attention so that they can develop plans for efficient waste management process and service delivery.

The outcomes specifies that, the current system is monotonous in both public and private hospital and importance is not given to sustainable waste management or to tackle challenges of waste in result to the pandemic especially in Peshawar. The study's restrictions include lack of waste collection data per hospital and waste management monitoring which could have given a better understanding that how much waste is generated in total. Thus, additional inquiries of public and private hospitals should be directed to find out the fundamental reasons of hospitals' mediocre waste management and quality of services gap between hospitals.

Besides these other issues need to be observed at in forthcoming comparable researches in Peshawar, such as monetary issues and administration perception, which will improve the plans for Peshawar's health care waste management process. This study has suggestions for a positive impact on the improvement of the total quality of health care services, therefore taking them closer to accomplishing objectives of the HWM policies and WHO recommendations. This will enlighten

policy-makers in the public and private sector hospitals so that they can make advancements in the waste management services and therefore make changes to improve quality from the stakeholder's perspective.

Using Principal Component Analysis and Mean Value Method, 24 barriers have been examined as major hurdles affecting hospital waste management in 12 hospitals, out of which 6 are private and 6 public in Peshawar. The result shows seven clusters with waste handling factors, consisting of unaccountability of waste management by different personnel, occurrence of Covid-19 pandemic, financial capacity, medical waste guidelines and monitoring as vital barriers to Biomedical waste management. Moreover, the data suggest that existing practices of waste management in hospitals are an extra burden on the hospital stakeholders and an integrated hospital waste mechanism should be generated with proper waste management plans, guidelines, team and strategies of implementation to improve the current practices and face the barriers.

There is an urgent need of its physical implementation, stakeholder perception and awareness in the current practices of Public and Private hospitals. In order to achieve stakeholder satisfaction level to be at its optimum level hospitals waste management should priorities developing these parameters stated in the descending order in terms of its need: Technical quality > Communication > Interpersonal manner > General satisfaction > Accessibility & convenience > Functional capacity. This elaborates the fact that technical quality improvement can help stakeholder satisfaction as it will cater to the problems like, monitoring, recycling/reuse, treatment, training and Intervention required at all stages of waste management from handling, treatment, and disposal

Most importantly safety policies aren't followed which leads to unusage of PPE while handling waste which exposes the handler to risk. Therefore, the government authorities should take charge and play an important role in backing up health care stakeholders by providing timely workshops, funds, record monitoring, designated waste management team and plan in every public and private hospitals of Peshawar. Keen monitoring can resurface more issues regarding awareness and satisfaction which could be improved by corrective action and strengthened implementation by frequent checks of current practices.

The results of stakeholder's awareness regarding hospital waste management was studied in comparison with three different variables i.e., 1) Public and Private hospitals, 2) Full-time and Part-time Employees, and 3) Doctors and Nurses. The results tell us that they do have slight

differences showing that one domain is slightly better in certain aspects whereas the other exceed in the rest but not significantly overall, the p-value is greater than 0.05 which shows there is no significant difference as t-values are significant at $\alpha=0.05$ for these measures of awareness at 8 different stages of waste management process between public/private, full-time/part-time employees and doctors/nurses.

Last but not the least in order to fulfil the last objective of promoting sustainable waste management all the results of these analysis should be taken into consideration and steps should be taken by the national, local and hospital managerial body to take these barriers and findings to use. By doing so the waste management in hospitals will help the current practices in terms of elimination, segregation, collection, monitoring, safe disposal, storage, treatment, safety of waste handlers, stakeholder policy participation, satisfaction and awareness level of various stakeholder's such as health personnel, waste handlers, staff members and local community.

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ANNEXURE

Annexure ‘A’ Questionnaire for Stakeholder Awareness & Satisfaction



**Department of Urban and Regional Planning
 School of Civil and Environmental Engineering SCEE,
 National Institute of Transportation, NIT
 National University of Science and Technology, NUST**

Survey Questionnaire of Stakeholder Awareness & Satisfaction of Bio-Medical Waste
 (BMW) Management

*Purpose of Survey: The purpose of this interview schedule is data collection for research. Stakeholder Awareness & Satisfaction of Bio-Medical Waste (BMW) Management in **Public & Private Hospitals, Peshawar** the information will be used for academic purposes.*

PROFILE	Position (<i>Doctor, Post Graduate, Nursing, Interns, Laboratory Technicians, Housekeeping, Waste Collector etc.</i>): _____	
	Age: _____	Hospital Type: _____
	Gender: _____	Year of Establishment (approx.): _____
	Experience: _____	No. of beds: _____
	Status of job (Full time/Part time): _____	Average no. of outpatient: _____
	Business Location: _____	

Stakeholder Awareness & Satisfaction					
S. No	Questions	Yes	No	Don't Know	Remarks

1.	Are there any guidelines for biomedical waste disposal by Government in Pakistan?				
2.	Are you aware of government regulations and legislations related to biomedical waste management in our country?				
3.	Are you aware about the theoretical and practical knowledge required to manage and/or recycle/reuse hospital waste?				
4.	Do you follow color coding while disposing waste during your hospital duties?				
5.	Can inappropriate biomedical waste disposal cause health hazards?				
6.	Do you think biomedical waste disposal is an institutional problem & extra burden?				
7.	Would you like to have a lecture or program to enhance knowledge regarding biomedical waste management during times of pandemic?				
8.	Is training of medical staff available regarding HCWM?				
9.	Do you think sufficient funds are allocated to HCWM?				

10.	Could I obtain a copy of your annual report(s) of activities?				
11.	Do you have a waste management strategy or team monitoring and supervising waste management plans being followed?				
12.	Doctors do not see waste separation as their concern?				
13.	Nurses do not see waste separation as their concern?				
14.	Laboratory staff does not see waste separation as their concern?				
15.	Is it possible for you to tell the difference between the different categories of medical waste?				
16.	Do you know about the policies in this hospital about reporting needle stick injuries?				
17.	Is there an infection control department in this hospital that deals with waste management during COVID-19?				
18.	Are you aware if recycling of medical waste is done at this hospital?				
19.	Do you think that if waste is not properly handled it can be a risk to healthcare workers and patients?				

20.	Do you know what happens to waste after it is picked up from the station where you work?				
21.	Do you participate in making policies used in this hospital to handle waste?				
22.	Are the waste bins easy to reach?				
23.	Waste Bins are not well labeled?				
24.	Waste is not removed when the available bins are full?				
25.	I don't know where to place medical waste after use?				
26.	Staff refuses to handle waste?				
27.	Should there be quick changes in the waste disposal system and waste management?				
28.	Is maintaining BWM records mandatory in your hospital?				
29.	Do waste handlers feel safety policies instated during COVID-19 while managing waste?				
30.	Have the containment of the spread of COVID-19 pandemic significantly affected waste management?				
31.	Do you feel the threat of getting Corona virus as				

	hospitals are producing more waste than usual?				
32.	Are the waste handlers hesitant to deal with the waste due to COVID-19 pandemic?				
33.	Do you think management of hazardous waste is also essential to minimize long-term risks to human and environmental health?				
34.	During Covid-19 use of Personal Protective Equipment (PPE) by waste collectors and the involvement of relevant stakeholders done efficiently?				
35.	Is sanitizer and mask available in the hospital if you have forgotten to carry along?				
36.	Is physical distancing of at least 2 meters maintained between people in public spaces during COVID-19?				
37.	What do you mean by Bio-medical waste?	a) Waste from house-hold <input type="checkbox"/>	b) Waste usually generated during various activities like diagnosis, treatment, immunization or research activities in medical, dental or laboratory set-up. <input type="checkbox"/>	c) Don't know <input type="checkbox"/>	
38.	How biomedical waste should be disposed of?	a) Dump directly into garbage bin <input type="checkbox"/>	b) Handing it over to Bio-medical waste management agency <input type="checkbox"/>		

		c) Don't know	
39.	Correct sequence of biomedical waste management?	a) Segregation Collection & Storage Transportation Treatment & Disposal b) Collection Transportation Disposal c) Don't know	
40.	According to the government guidelines, untreated biomedical waste should not be stored beyond?	a) 24 hours b) 48 hours c) Don't know	
41.	Glassware and metallic body implants are disposed in?	a) Blue b) White c) Don't know	
42.	Infectious sharps and needles are disposed of in?	a) White b) Blue c) Don't know	
43.	Infectious biodegradable (extracted teeth, human tissues, membranes, cotton dressings, suture material like black braided silk, etc.) are disposed of in?	a) Yellow b) Red c) Don't know	
44.	Infectious non-biodegradable (Gloves, IV set, Syringes, nylon sutures, etc.) disposed in?	a) Yellow b) Red c) Don't know	
45.	Biomedical waste handlers should:	a) Be made aware of risks involved in handling biomedical waste. b) Use Personal Protection Equipment like gloves, mask, protective glasses, gum boots etc. c) Both of above d) None of above	

46.	Is HCW treated on-site or off-site?	a) On-site b) Off-site	
47.	Are the workers designated for handling the waste restricted to only waste handling purpose or being employed for other patient care works?	a) Only waste handling b) Other patient work c) Both	
48.	Do you use personal protective devices while handling waste during Covid-19?	a) Apron b) Glove c) Masks d) Goggles e) None	
49.	Please rate your hospital in regard to: Accessibility (Physical location, Environmental, Attitudinal, Communication)	a) Excellent b) Good c) Fair d) Poor e) Unacceptable	
50.	In your opinion, how efficient is your hospital in collecting waste?	a) Excellent b) Good c) Fair d) Poor e) Unacceptable	
51.	Do you think your hospital has ample staff members to ensure well-organized disposal system of BMW?	a) Excellent b) Good c) Fair d) Poor e) Unacceptable	
52.	Are you satisfied with the training workshops provided by the administration regarding biomedical waste management?	a) Yes b) No c) Never attended	
53.	What do you think of safe disposal of biomedical waste at your hospital?	a) Excellent b) Good c) Fair d) Poor	

		e) Unacceptable	
54.	Do you think it is the responsibility of the health personnel to take all appropriate measures to ensure that unnecessary hazardous waste is not generated in the first place?	a) Yes b) No c) May be	
55.	Are the garbage bins accessible, color coded and strictly enforced to dispose waste in their respective bins at your hospital?	a) Yes b) No c) May be	
56.	Are you satisfied with the cleanliness of the facility?	a) Excellent b) Good c) Fair d) Poor e) Unacceptable	
57.	Are you satisfied with existing level of awareness on using safety equipment to prevent the spreading of infectious diseases?	a) Excellent b) Good c) Fair d) Poor e) Unacceptable	
58.	Do you think intervention is required at all stages of waste management from waste handling, treatment, and disposal activities?	a) Yes b) No c) May be d) Don't know	

Thank you for your cooperation and for giving us your valued time, your help will benefit us in understanding the ground realities of the stakeholder perception and satisfaction regarding bio-medical waste management our city is facing.

Annexure ‘B’ Questionnaire for Bio-Medical Waste Disposal System



**Department of Urban and Regional Planning
School of Civil and Environmental Engineering SCEE,
National Institute of Transportation, NIT
National University of Science and Technology, NUST**

Survey Questionnaire of Bio-Medical Waste Disposal System

Purpose of Survey: The purpose of this interview schedule is data collection for research. Bio-Medical Waste Disposal System in Public & Private Hospitals, Peshawar City the information will be used for academic purposes.

PROFILE	Position (<i>Doctor, Post Graduate, Nursing, Interns, Laboratory Technicians, Housekeeping, Waste Collector etc.</i>): _____	
	Age: _____ Gender: _____ Experience: _____ Status of job (Full time/Part time): - _____	Hospital Type: _____ Year of Establishment (approx.): _____ No. of beds: _____ Average no. of in/outpatient: _____
Business Location: _____		

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S. No	Questions	Yes	No	Don't Know	Remarks
1.	Does your hospital provide any training regarding recycling or waste management?				
2.	Do you have working knowledge or operational knowledge of the working of an incinerator?				
3.	Do you see that hospital waste is being managed by professionally trained staff in your hospital?				
4.	Are you aware of waste water treatment process?				
5.	Do you know lead aprons and lead collars should be disposed by licensed recyclers?				
6.	Are you trained for any environment friendly technology that converts organic waste into commercially useful by products?				
7.	Do you know the component of fixer solutions used in X-rays that is considered hazardous?				
8.	Do you feel that biomedical waste should be a practical exercise in teaching institutes?				

9.	Are you aware of the fact that improper biomedical waste management effects population?				
10.	Do you feel hospitals and other organizations are financially equipped to maintain biomedical waste management?				
11.	Is the vendor company responsible for transportation and disposal licensed?				
12.	Do the people handling the infectious waste properly equipped with safety equipment?				
13.	Is the infectious waste disinfected before transportation or disposal?				
14.	Do you always know what type of waste you are handling?				
15.	Do the people who handle the waste products receive any vaccination for immunity?				
16.	In your opinion do you think your hospital is doing enough for creating awareness regarding the handling of hazardous waste especially during corona pandemic?				
17.	Should your hospital conduct more training workshops?				

18.	Do doctors focus on waste disposal at your hospital?				
19.	Do you think that you will be harmed while handling waste at your hospital?				
20.	Are the policies regarding waste disposal system strictly followed and monitored?				
21.	Have you experienced the consequences of poor waste management at your hospital?				
22.	Does the hospital ask for your opinion when handling waste products and handling policies?				
23.	Have your hospital instituted policies during COVID-19 to ensure sustainable management of waste while protecting the safety of waste handlers?				
24.	Does your hospital pay attention towards establishment of a safe disposal facility for the infectious COVID-19 waste generated?				
25.	Do you think if the medical waste isn't managed properly there are chances of spreading of COVID-19 which may exceed the limit and rate of infections as increase mortality rates?				

26.	Have your hospital identified effective strategies for the management of exponentially increased medical waste over a short time?				
27.	Is the availability of masks and sanitizers at every point facilitated by your hospital?				
28.	Does your hospital allow patients without masks?				
29.	Does your hospital have isolation zones in case of COVID-19 exposure?				
30.	Is there a Proper Waste Management System at your hospital? Define Briefly				
31.	What are the major factors affecting hospital waste management?	a) Policy makers b) Hospital administrators c) Waste management committee d) Healthcare personnel e) Funding f) All above			
32.	What are the major factors affecting hospital waste management?				
33.	What is the role of different personnel involved in the system?				
34.	What are the reasons for choosing the present system?				

35.	How is waste separated at your hospital? Is this separated based on the material of the product or color-coded system is followed?		
36.	What different categories do you separate your waste into during Covid-19?		
37.	Do you know the six effective steps of biomedical waste management?		
38.	Does your hospital have a working incinerator? And how many numbers of incinerators?		
39.	Do you know defective incineration emits greenhouse gases? What do you do to minimize this hazard?		
40.	Are you aware of the methods besides incineration and landfills, of waste disposal?		

41.	How is Biomedical Waste transported out of the Hospital?		
42.	What regulations of transportation are followed?		
43.	What is done with infectious waste?		
44.	What safety protocols are to be followed in case of any spill of infectious waste?		
45.	Are there any waste storage/treatment methods?		
46.	What is done with non-biodegradable waste like plastic bags etc.?		
47.	Do you think the present protocols followed by your hospital helps in making an		

	effective waste disposal system during corona Pandemic?				
	Checklist of HWM according to HWM policies 2005 & Internal Practices.				
	Questions	Yes	No	Don't Know	Remarks
48.	Does your hospital promote practices that reduce the volume of wastes generated and ensure proper waste segregation?				
49.	Does your administration develop strategies and systems to incrementally improve waste segregation, destruction and disposal practices with the ultimate aim of meeting national and international standards?				
50.	Any future campaigns in raising awareness of the risks related to health-care waste, and of safe practices?				
51.	Does site have clearly assigned staff responsibilities that cover all steps in the waste management process?				
52.	Does hospital have a written management plan (to show the observer) for nonhazardous general waste, liquid medical waste, and solid medical waste?				
53.	Does hospital site have and use infection prevention job				

	aids and medical waste management protocols or curricula from USAID, WHO, etc.?				
54.	Handling: Is there appropriate collection and transportation of medical waste within the facility?				
55.	Interim storage: Is medical waste appropriately and temporarily stored safely, packaged, and labeled within the facility?				
56.	If final disposal is off-site, are precautions taken to ensure that waste is transported and disposed of safely?				
57.	Do waste management and treatment options prioritize the protection of the health-care workers and minimize indirect impacts from environmental exposures to HCW?				
58.	Does your hospital make sure infectious and hazardous HCW are properly segregated from general waste so as to reduce disposal costs and increase materials for recycling?				
59.	Does your hospital have an HCWM plan which includes collection points, routes of waste transport, and timetable				

	of the frequency of collection?				
60.	Does your hospital ensure that hazardous / infectious HCW and non-risk HCW are collected on separate trolleys which should be marked with the corresponding color (black/yellow) and washed regularly?				
61.	Do the hospital administrators and planning officers make sure that washing facilities are made available to people handling HCW?				
62.	Is the hospital staff aware of the protocols and general procedures to be followed in case of spillages?				
63.	Are your staff members aware of the general procedures to be followed in case of spillages?				

Thank you for your cooperation and for giving us your valued time, your help will benefit us in understanding the ground realities of bio-medical waste management our city is facing.