



Vol. 4 No. 2 (February) (2026)

Silent Hazards: Bridging Policy And Practice In Hospital Waste Management In Pakistan

Ar. Mohsin Iqbal Deo

Assistant Professor, Architecture Design Department, NFC-IET, Multan

Email: mohsin.deo@gmail.com

Ar. Seemi Aslam

Assistant Professor, Dept. of Architecture, School of Architecture & Planning, UMT, Lahore. Email: seemin.aslam@umt.edu.pk

Ar. Dr. Omer Shujat Bhatti (Corresponding Author)

Associate Professor & COD, Dept. of Architecture, School of Architecture & Planning, UMT, Lahore. omer.shujat@umt.edu.pk

ABSTRACT

Over the last few decades, Poor segregation, weak enforcement of regulatory systems and inadequate capacity of the healthcare system to manage hazardous streams of waste have contributed to hospital waste management as a high profile public health and environmental issue in Pakistan. Biomedical waste types are infectious, chemical waste, pathological waste, and sharps waste, which when not well disposed, exposes medical workers, waste workers, patients, and the communities to risks. In spite of the national policy directives in the Pakistan Environmental Protection Act (PEPA, 1997) and Healthcare Waste Management Rules (2005), organizations obeying it is low and rather disjointed. According to the recent research, the lack of knowledge, training, and infrastructure in both public and private hospitals remains a persistent issue, and unsafe behaviors, including recapping needles and conflating the infectious waste with the general garbage, are still frequent. The level of awareness among nurses and paramedical staff is unequal, and core operational practices cannot be deemed as per defined by WHO standards. This study builds on a secondary data exploration method through which the research critically evaluates the existing situation of hospital waste management in Pakistan through synthesising peer-reviewed reports, national case study evaluation and policy analysis. Problems outlined through analysis included inefficient segregation, inefficient training programs, unreliable treatment technologies and lack of monitoring. The article identifies such environmental liabilities as open dumping and incompetent incineration, and focuses on the occupational risks of health care workers. Recommendations emphasize the necessity to have tighter enforcement mechanisms, capacity building, investing in sustainable technologies and community-based awareness activities. The findings should help guide policymakers, hospital administrators, and environmental regulators to sustainable hospital waste control that safeguards the health of the people and the environment.

KEYWORDS: Environmental Health in Pakistan, Hospital Waste Management, Biomedical Waste; Policy Implementation.



Vol. 4 No. 2 (February) (2026)

INTRODUCTION AND BACKGROUND

Biomedical waste, also commonly referred to as healthcare waste, refers to all the wastes produced in the processes of diagnosis, treatment, immunization, research and laboratory work involving human beings in hospitals. This wastes stream will contain infected materials, sharps, chemicals, pharmaceuticals, pathological remains and maybe radioactive material as well. The healthcare waste in the world is composed of several categories that are hazardous and must be controlled with specific management to reduce the threat to human health and environment safety (Bhatti et al., 2024). Despite the fact that most of this waste is regarded as the general waste, which is not hazardous, the other 15-25 percent is the infectious and dangerous waste that must not be neglected, and the measures to control it must be strict to avoid its contamination, spreading the disease, and ecological degradation.

The government of hospitals waste management is a critical issue on its governance and operation in Pakistan. Increased population, urbanization, and the use of healthcare services have also led to the rise in levels of medical wastes in metropolitan and regional health care centers. This has increased strains on the already poorly-equipped healthcare infrastructure to engender systematic waste segregation, treatment and disposal. Although there are regulatory frameworks, mainly the Pakistan Environmental Protection Act (PEPA, 1997) and Healthcare Waste Management Rules (2005), the enforcement and compliance levels in different provinces and institutions are inconsistent. Sector analyses show that most hospitals do not have a working waste management system, and there is a poor observance of protocols in segregation and management of hazardous streams.

There are direct health and safety consequences of the lack of proper waste management (Iqbal et al., 2025). Disproportional exposure of healthcare workers, waste handlers, patients, and local communities to hazardous materials exposes them to the risk of infectious diseases like Hepatitis B, Hepatitis C and HIV. These risks are aggravated by unsafe practices such as the improper mixing of infectious waste with municipal solid waste, lack of proper training and disposal in open dumps; which hamper the objectives of environmental health. Recapping of the needles, absence of personal protective equipment (PPE), and loopholes in the practice of segregation have been reported as observed even in the tertiary care areas.

In addition to direct health effects, inappropriate disposal of biomedical wastes leads to future environment problems. Incineration and open dumping without emission qualities leads to release of toxic pollutants into the air, soil, and water systems which influence the balance of the ecosystem and human health. Pakistan has cities that are quickly turning urban and are placing a significant strain on the environment and medical waste is bringing another dangerous dimension to the problems of waste management in Pakistan.

Moreover, knowledge and awareness, which is a key constituent of waste management systems are not satisfactory at the moment. Some research shows that medical workers do not have enough training on appropriate handling of biomedical waste even when they are aware of the theoretical guidelines. Practical implementation lag is still a significant problem even where knowledge is available since there are no institutional support, supervision and monitoring mechanisms. The study has utilized an exploratory secondary data design, which will include the synthesis of peer-reviewed articles published in 2020-2025, policy reviews, and empirical evidence collected in Pakistan. It has focused on an in-depth examination of the existing hospital waste management strategies, outline the ongoing challenges and suggest the strategic directions the improvement. The research



Vol. 4 No. 2 (February) (2026)

identified systemic problems that transcend facility level practice and blame regulation and lack of education and training, infrastructural limitations and inefficiencies in governance. By so doing, it highlighted the much-needed integrated policies and operational reforms that can substitute the international best practices and environmental sustainability objectives.

PROBLEM STATEMENT

In spite of the regulatory frameworks, hospital waste management in Pakistan evidences systemic failure in terms of segregation, treatment and disposal, which increases the risk of health and degrades the environment. Hence there was need to explore and synthesize current published reports and policies along with relevant research articles to evolve the solutions and future research directions for current challenges.

RESEARCH OBJECTIVES

Following were the major key research objectives set forth:

To assess the existing hospital waste management practices and system failures in Pakistan in reference to the new peer-reviewed statistics (2020-2025).

To evaluate how the biomedical waste disposal gaps affect the people and the environmental sustainability.

To determine evidence-based practices in enhancing institutional compliance, training and waste governance frameworks.

RESEARCH SIGNIFICANCE

The study summarizes and integrated the new research on the biomedical waste management in Pakistan, which is a gap in the recent peer-reviewed literature focusing on the current challenges. The findings can guide the policymakers, hospital administrators, and environmental regulators on areas that are of priority and require interventions and capacity building to protect the health of the people and the environment.

LITERATURE REVIEW:

Hospital waste management (HWM) has become an acute issue of public health, environmental, and governance in most countries worldwide, especially in low- and middle-income (LMIC) countries where the rate of healthcare growth has not been commensurate with the development of waste management infrastructure and through the enforcement of regulations. According to the estimates of the World Health Organization (WHO), around 15 percent of healthcare waste is hazardous, such as infectious, pathological, and sharps waste, which needs special handling and treatment (World Health Organization [WHO], 2018). In most developing nations, however, such a situation is often caused by insufficient separation at source, which leads hazardous and non-hazardous waste to be mixed together and has to undergo dedicated treatment, exposing those who handle it to higher risks of being infected and contaminating the environment (Chartier et al., 2014; Windfeld and Brooks, 2015). According to the latest reviews in the world, even though technical guidelines and policy frames exist, there are gaps in their implementation due to poor governance, inadequate funding, and absence of training the healthcare staff (Sharma et al., 2020; Singh, Tang, and Ogunseitan, 2020).

Hospital waste management in Pakistan is regulated by the Hospital Waste Management Rules (Government of Pakistan, 2005) within a wider scope of the Pakistan environmental protection act (Government of Pakistan, 2010). Such rules ask the source separation of waste, color-coded containers, secure storage, transfer, and disposal by



Vol. 4 No. 2 (February) (2026)

incineration or new technologies. Regardless of this regulatory structure, empirical research continues to report high levels of non-compliance in both the public healthcare and the private healthcare setup. In a comparative analysis of the public and the private hospitals in Quetta, Ali, Murtaza, and Ashraf (2023) have discovered that there are severe gaps in the practice of segregation, record keeping, and ultimate disposal. Their results showed that privately managed facilities were not characterized by formal waste management committees and public hospitals were not characterized by the scarcity of resources and lack of consistency in their supervision. These results support the previous national data indicating that regulatory presence does not always correspond to operational compliance (WHO, 2018; Windfeld and Brooks, 2015).

The policy-practice gap is further evidenced by recent empirical studies that were undertaken in Khyber Pakhtunkhwa (KPK). Ahmad et al. (2024) evaluated the effectiveness of waste management in tertiary and primary healthcare institutions and found out relatively high levels of awareness of the doctors and paramedical personnel about waste types and related risks. Nonetheless, there was poor-quality execution—especially regular segregation and use of personal protective equipment (PPE) (Bhatti et al., 2025). The research cited faulty incinerators, inconsistent waste collection times, and absence of monitoring as some of the major obstacles of operations (Iqbal et al., 2023). This lack of linkage between knowledge and behaviour is reflective of general world research findings which indicate that awareness alone cannot be effective without the institutional reinforcement of enforcement mechanisms and active practice training (Singh et al., 2020; Sharma et al., 2020).

The gap between knowledge and attitude and practice (KAP) is now an overwhelming topic in the recent Pakistani literature (Bhatti et al., 2023). Waris et al. (2025), who analyzed the compliance with the biomedical waste disposal in primary care physicians in Karachi, noted that although the physicians had sufficient theoretical knowledge about the concepts of segregation and infection control, standardized disposal practices were not adhered to uniformly. Arshad et al. (2025) reported similar findings among nurses in Lahore where the high awareness was accompanied by the unsafe practice of needle recapping and inadequate sharps disposal. These results are consistent with the research of international scholars that state institutional culture, supervisory systems, and access to effective infrastructure have a strong influence on behavioural compliance (Chartier et al., 2014; Singh et al., 2020).

Another weak link in the HWM system is nursing personnel and paramedical workers that frequently deal directly with healthcare waste. In a study that was carried out at Nishtar Hospital Multan, Anjum et al. (2024) noted moderate levels of awareness among the nurses involved and that there were high levels of inconsistency in the procedures of dealing with infectious and biochemical waste. Riaz et al., (2023), also discovered that the paramedical employees of Lahore hospitals had a low compliance with segregation measures even after they were initially trained about the segregation protocols. All these studies point to the fact that continuous professional development has systemic flaws and therefore training in isolated sessions cannot work to guarantee continued compliance (Bhatti et al., 2024). Formed and ongoing, competency-grounded training modules are becoming part of the literature that is increasingly advocated to be embedded in hospital accreditation systems (Ahmad et al., 2024; Sharma et al., 2020).

The shortage of infrastructure is an issue that continues to be a structural problem in Pakistan healthcare facilities. Incineration remains the most widely used mode of treatment but most of them are either not operational or their operating temperature fall short of the recommended optimum level, thus resulting in a lack of total discharge and



Vol. 4 No. 2 (February) (2026)

release of toxic emissions (Ali et al., 2023; Shahid, 2025). In a case study Shahid (2025) conducted regarding a large hospital in Islamabad, revealed poor segregation and overuse of old-fashioned incineration units, which lead to deterioration of the environment and the possibility of health risks to communities around them (Javed et al., 2025). These results include previous environmental studies, which show that aircraft emissions of dioxins, furans, and particulate matter are emitted uncontrollably during incineration, and this has long-term ecological and respiratory effects (Windfeld and Brooks, 2015; Sharma et al., 2020).

In addition to facility-level practices, the environmental effects of poor hospital waste management also are getting academic attention. The activity of open dumping and uncontrolled burning (especially in the peri-urban and rural regions) leads to the contamination of soil and groundwater (WHO, 2018). In the ecologically susceptible areas like in Balochistan, there is poor integration of municipal waste and poor treatment of hazardous waste, which increases ecological inequalities. Although there is a paucity of empirical studies on the environmental impact of the situation in Pakistan, the global literature emphasizes that disadvantaged groups residing around dumping sites are in a disproportionate position to experience exposure to pathogens and toxic pollutants (Chartier et al., 2014; Singh et al., 2020). The environmental justice aspect of healthcare waste management therefore requires to be more included into the sustainability strategies in the country (Bhatti et al., 2023).

Lack of funds and other administrative issues also make effective implementation difficult. Research always refers to insufficient funding of waste segregation resources, PPE supplies, incinerator maintenance, and specialists responsible for waste management (Ali et al., 2023; Ahmad et al., 2024). Waste management is not given priority as an administrative task without the presence of ring-fenced funding and performance based accountability systems. Filter analysis of the LMIC setting indicates that effective hospital waste restructurings must be part of larger health system empowerment approaches, such as the measurement of indicators related to accreditation and licensing (Sharma et al., 2020; WHO, 2018).

The COVID-19 pandemic greatly increased the volume of healthcare waste in the world and revealed the weaknesses in the structure of waste management. The PPE disposal and test materials also increased the amount of infectious waste in Pakistan, which burdened the already weak infrastructure (Sharma et al., 2020). Despite the implementation of emergency guidelines, empirical follow-up research proposes that long-term structural upgrades have been minor, which supports the resilience-driven planning of waste management (Singh et al., 2020).

The infrastructure of treatment is one of the primary limitations of the hospital waste management environment in Pakistan (Bhatti et al., 2024B). Historically, the most common treatment method has been incineration, but the vast majority of incinerators do not have an appropriate emission control system, and this aspect has become a concern in relation to the environment and human health (Windfeld & Brooks, 2015). The incinerators in some government hospitals are either dysfunctional because of maintenance or they are dysfunctional because of shortage of fuel.

It has been established that autoclaving is a safer method of sterilizing infectious wastes, although its usage has been low due to the cost of purchase and technical maintenance considerations. Sharma et al. (2020) point out that due to the lack of adequate investments in the treatment capacity during the COVID-19 surge, emergency open burning and uncontrolled dumping in various developing nations, including Pakistan, have taken place. These activities emit dioxins, furans, and particulate matter, which



Vol. 4 No. 2 (February) (2026)

contaminate the air and cause health risks in the long term.

Even more infrastructural deficiency is experienced in rural healthcare centers, in most cases there are no on-site treatment facilities. These environments even end up disposing of hazardous waste by using municipal systems which are not meant to dispose biomedical hazards. WHO (2022) notes that centralized treatment centers that share services could be a cost-effective option, although they need effective regulatory control and transport safety measures (Bhatti et al., 2022). The literature, therefore, highlights that infrastructural deficiencies are not just technological failures but an indication of underinvestment in the system and poor maintenance planning in the area of the public health sector (Ali et al., 2024).

The literature is still centred on governance and enforcement of regulations. Although the provincial environmental protection agencies are mandated to check compliance, the frequency and enforcement measures are haphazard (Government of Pakistan, 2010). Recent empirical findings indicate that hospital waste management committees are usually formally present, yet have no power and resources to take remedial measures (Ali et al., 2023; Shahid, 2025). Researchers believe that third-party audit, open reporting, and public reporting on compliance records would build on accountability (Singh et al., 2020).

Synthetically, the 2020-2025 literature shows that there is a recurrent trend of structural issues in the hospital waste management situation in Pakistan (Tanoli & Bhatti, 2024). Although healthcare personnel has been increasing awareness about regulatory frameworks and essential gaps in operational compliance, infrastructure functionality (Bhatti & Ghufra, 2020), training continuity, occupational safety, environmental protection, and regulatory enforcement persist (Ahmad et al., 2024; Ali et al., 2023; Anjum et al., 2024; Arshad et al., 2025; Riaz et al., 2023; Shahid, 2025). These obstacles are mirrors of wider structural problems in the LMIC health systems where the capacity of governance (Bhatti et al., 2024C), financial constraints, and institutional culture collide to limit the progress (Sharma et al., 2020; Singh et al., 2020; WHO, 2018).

The sum of the considered literature proves that the current state of mismanagement of hospital waste in Pakistan is not only a technical issue, but a multidimensional governance problem that has to be addressed by complex changes. Sustainable development necessitates the aligned policies implementation, infrastructure renewal, repetitive skill-driven training, job health interest, ecological control, and institutional liability reinforcement devices. Unless there is systematic change, the problem of hospital waste is going to persist, threatening health care professionals, community, and ecosystems, compromising larger objectives of health and sustainability.

RESEARCH METHODOLOGY

The research methodology used in this study is the exploratory research approach which is founded on secondary data analysis. Systematic review of peer-reviewed academic articles, policy documents at the national level, WHO guidance, and other applicable empirical studies was carried out. Web of science, Scopus and national research journals were incorporated in databases. The presented analysis was aimed at determining the existing practices, gaps in the system, environmental effects, risks to occupational health, and restrictions of regulatory enforcement in hospital waste management in Pakistan. Primary data collection was not done.



Vol. 4 No. 2 (February) (2026)

DATA ANALYSIS & DISCUSSION

The research concluded that operational non-compliance has been one of the most severe flaws of the hospital garbage waste systems in Pakistan. Although there are official regulations that environmental and health agencies provide, with numerous healthcare institutions failing to manage waste segregation at the point of origin. Hazardous, infectious and general waste are often combined especially in the hospitals in the public sector where the monitoring mechanisms are weak. The practice compromises the core principle of healthcare waste management, which is based on the idea of segregation to minimize the risk and costs of treatment. Combination with municipal waste stream can also cause increased chances of disease transmission, biological hazards to waste handlers, and hindered downstream treatment processes when infectious waste is mixed with municipal waste streams. The problem is also complicated by the absence of color-coded bins, wrong labelling, and control. Administrative negligence, lack of adequate resources and high patient loads are the common causes of operational lapses. As a result, hospitals with basic infrastructural facilities do not manage to become compliant in their day-to-day operations. This continued existence of non-segregation practices demonstrates that there is a discrepancy between policy development and practice on the ground and therefore that operational monitoring, accountability frameworks, and internal audit mechanisms need to be strengthened immediately.

One of the main results of the study is related to infrastructural shortcomings of healthcare waste treatment systems. Even though some of the tertiary hospitals indicate that incinerators or autoclaves are available, most of them are either old, worn out or not functional because of technical and financial limitations. In other instances, plants depend on common treatment units which are not large enough to handle the rising volume of waste produced. Consequently, medical waste, which is untreated or partially treated, is disposed of in an open dumping system, uncontrolled burning, or informal waste disposal. Not only does such practices contravene environmental safety requirements, but also releases toxic emissions such as dioxins and particulate matter, which are extremely hazardous to the safety of the population. There is a high level of vulnerability in rural and sub-urban healthcare centers which frequently do not have any formal treatment infrastructure but instead rely on municipal waste systems that do not cater to hazardous materials. The research suggests that the infrastructural investment has failed to match the rise in the number of healthcare services, which has created a systemic imbalance in treatment. Compliance is only mere formal and not real without the maintenance and functionality of technologies. Increasing the infrastructure needs not only the purchase of equipment but also the permanent technical support, financing the maintenance, and the centralized treatment solutions.

The study indicated that there exist significant gaps in the capacity-building and training of the health care staff dealing with the waste. Although most medical workers have theoretical understanding of the waste segregation and safety measures, regular and systematic training courses are frequently missing. Junior staff or outsourced workers who are often given very little orientation on the management of hazardous materials often have the responsibility of waste management. This deficiency of continuous professional growth leads to the lack of consistent practices, the inappropriate methods of disposal, and the inadequate usage of protective machinery & PPE. Moreover, the existing training programs are usually on a one-time basis as opposed to being part of the institutionalized systems of running hospitals. The turnover in the medical staff and more occupancy in wards & allied domains, brings in the sanitation workers further interfering continuity in poor or non-compliant safe handling of waste. Lack of monitoring and



Vol. 4 No. 2 (February) (2026)

refresher courses decreases the compliance with laid down protocols with time. The results indicate that policy documentation is insufficient in enabling behavioural change and operational discipline, they need continuous education, supervision, and institutional buy of the process. Inclusion of waste management module in medical, nursing, and paramedical education may provide lasting effects. Finally, it is necessary to bridge the gaps in training in order to convert the regulatory standards into safe and consistent activities in healthcare facilities daily.

SUMMARY OF FINDINGS

The improper disposal of hospital waste has huge impacts to the environment, especially in the urban and peri-urban areas. The research project highlighted that through open dumping and unregulated burning of wastes, toxic substances are emitted into the environment, air, soil and groundwater. Biomedical waste includes toxic ash residues and untreated waste, that pollute nearby land causing ecological risks in the long-term. The water bodies in the immediate vicinity of dumping are particular to the infiltration of leachate that may force the introduction of pathogens and chemical contaminants into the drinking water sources. Another issue that increases the risk of contamination is informal scavenging of medical waste to sell-off, or recycle. Environmental impact is not limited to hospital grounds as it spreads to the surrounding communities living around the disposal areas. These activities eliminate sustainable waste management goals and enhance degradation of the environment at large. In addition, inadequate management of waste contributes to augmentation of greenhouse gas emissions and air pollution which is contrary to the national environmental protection objectives. The results indicate that there is a tendency to externalize environmental effects and lack adequate monitoring of the same which indicates ineffective coordination between the health departments and environmental regulatory bodies. The combination of waste treatment systems, a stringent inspection of the disposal facilities and deployment in larger environmental sustainability models should be addressed to curb these environmental issues.

Although there are formal waste management regulations and environmental protection rules, there is still inconsistency and fragmentation in the enforcement of the rules. The research indicates that there is inconsistency in the inspections, sanctions against non-compliance are seldom applied, and institutional sanctions against irresponsibility are weak. Jurisdiction in the field of health between the health departments, the municipal authorities and the non-environmental agencies can lead to confusion in jurisdiction. As a result, hospitals can be paper compliant when there are deficiencies in operations on ground. The lack of proper data collection and reporting systems also inhibits monitoring compliance levels in evidence-based manner. In most instances regulatory agencies lack manpower, technical capacity and budget limits that limit oversight functions. Lack of transparency on the performance indicators and public reporting decreases institutional pressure towards improvement. The research concludes that regulatory systems should be shifted towards proper enforcement instead of policy-making. The enhanced inter-agency coordination, defining the standards of compliance, and incorporating independent audits may contribute to a meaningful change in governance outcomes. Absence of sound regulatory mechanisms will not ensure that the facility level improvements are maintained.

RESEARCH CONCLUSIONS

The issue of hospital waste management in Pakistan is a complex problem that can have far reaching consequences with regard to health, sustainability of the environment and



Vol. 4 No. 2 (February) (2026)

governance of institutions. Regardless of regulatory frameworks and international guidelines, there is a lack of a safe and comprehensive implementation of hospital waste management throughout healthcare facilities. The poor performance of systems through operational loopholes in segregation, treatment and disposal practices is indicative of systemic vulnerability which undermines the protective nature of the existing policies. Non-functional technologies of waste management, mixed waste streams, and informal modes of disposal undermine the process of infection control and risk reduction. These gaps are severe occupational risks to healthcare workers and waste handlers and spread to the surrounding communities particularly where open dumping and dump waste heaps exist.

These challenges are even enhanced by training and behavioural factors. Despite the knowledge of the types of biomedical waste and the principles of overall adherence, there is weak and irregular compliance among professional employees. The behavioural gaps that can be identified through unsafe practices, like mishandling of sharps and recapping needles, have to be addressed through training and reinforcement. Besides, scarce resources, inadequate PPE and poor institutional supervision hamper long-term gains. The knowledge-practice gap epidemiology highlights the necessity of routine and mandatory training courses as per the recommendations of the WHO as well as state-imposed requirements.

The environmental effects are also problematic. The present research indicates that the uncontrolled air, soil and water pollution occurs due to poor disposal practices being incinerated, openly burnt, and dumped. Such activities do not only harm ecological systems, but also add to the overall general population health issue through exposing the community to toxic substances and polluted materials. Moreover, the problem of healthcare waste management is linked to the larger context of environmental justice, in which vulnerable populations and Indigenous communities tend to have a larger risk of disproportionate exposure.

A focus point of a bottleneck is regulatory enforcement. Despite the existence of laws, there is inadequate traction to best practices due to weak monitoring, institutional accountability and non-consistent enforcement testing. The regulatory loophole requires strong performance appraisal, reporting of data and non-compliance, as well as rewards to facilities that show significant improvements.

Nevertheless, despite this, there are evident reform directions. A change toward safer and more environmentally responsible practices can be enhanced by strengthening institutional capacities by the establishment of waste management committees, ongoing training activities, and technological modernization, and the involvement of the community. Accountability and sharing of resources The partnership with government agencies, healthcare institutions and civil society can be supportive, through collaborative partnerships. The involvement with the global standards and the incorporation of innovative technologies, including the use of digital tracking of waste streams are also promising improvement in governance and transparency.

On the whole, the hospital waste management in Pakistan is a burning issue which needs multi-level policy-practice measures. The fact that the problem is systemic indicates that the interventions will not be effective enough when they are piecemeal. Rather, holistic plans comprising of enforcement, education, investment in infrastructure, and engagement of stakeholders will be critical towards the reduction of risks to the health of the population and the maintenance of the quality of the environment.



Vol. 4 No. 2 (February) (2026)

RESEARCH FUTURE DIRECTIONS

The key aspects that should be addressed in further studies are more detailed quantitative and qualitative measurements of the patterns of waste that hospitals produce in various kinds of healthcare facilities such as BHQ, DHQ, tertiary hospitals, and speciality hospitals. A thorough level of baseline data on the waste levels, treatment capacity, and compliance rates will provide more accurate benchmarking and interventions. Several studies also urge the comparative studies across the provinces to determine the existence of disparities in waste management practice and policy implementation in a region. Research designs based on the mixed methods approach that include observational evaluations, interviews with medical staff, and community impact surveys are the ones that are likely to clarify behavioural and socio-cultural aspects of waste management. The research will strengthen the comprehension of the knowledge-practice gaps and will inform the development of a specific training program that will address issues of the local barriers to compliance.

Surveys on the use of technology and preparedness of infrastructures are also essential. The study ought to consider the use of cost effective and sustainable treatment options to incineration including microwave sterilization, autoclaving, and high end chemical treatment in light of the resource constraint of low-income healthcare environments. Sustainability objectives should be in line with technology feasibility studies so that life cycle assessment and environmental impact evaluation are part of their assessment. The other direction is the involved policy implementation research that studies institutional responsibility mechanisms, monitoring structures, and the effectiveness of regulatory implementation. Research may investigate forms of decentralized governance, data reporting schemes and performance metrics that encourage adherence and punish failures. Other developing countries can provide a comparison of the effective policy frameworks.

New areas like smart waste tracking systems based on barcode or GPS tagging biomedical waste streams can help increase accountability and transparency. Future studies are required to determine the performance and extensibility of such systems in the context of Pakistan with regard to resource and technological issues. It is also important to study environmental health issues that examine the ecological consequences on the long-term effects of the current waste disposal methods, including soil pollution, water pollution, and air pollution. These research works are supposed to measure the levels of exposure in the communities surrounding the waste dumping areas and provide correlations of the results with the health outcomes.

Evidence on targeted interventions can be presented by conducting public health research on the outcome of occupational health among waste handlers and health care workers. The incidence rates of infectious diseases and workplace injuries related to the exposure to waste will be tracked over long periods, which will strengthen the argument in favor of more effective safety protocols and the use of PPE. Finally, the interdisciplinary research of environmental science, the study of public health, policy analysis, behaviour change theory, and implementation science will play a critical role. These combined methods can provide comprehensive systems of sustainable hospital waste management balancing operational feasibility and health and environmental protection.

REFERENCES

Ahmad, T., Arshad, U., Shahjehan, A., Ishaq, M., & Wajid, A. (2024). Assessing the effectiveness of hospital waste management practices among tertiary care hospitals and primary health centres in KPK: A comparative cross-sectional



Vol. 4 No. 2 (February) (2026)

- study. *Journal of Health and Rehabilitation Research*, 4(3), 1–9.
<https://doi.org/10.61919/jhrr.v4i3.1235>
- Ali, A., Bhatti, O. S., Salahuddin, S., & Iftakhar, N. (2024). Optimizing Green Design: Evaluating Environmental Satisfaction of End Users in Bhimber's Dhq Outpatient Department for Sustainable Future Usage & Optimum Functionality. *Sustainable Business and Society in Emerging Economies*, 6(2), 195–214.
<https://doi.org/10.26710/sbsee.v6i2.2985>
- Ali, F. A., Murtaza, G., & Ashraf, M. (2023). A comparative study of hospital waste management at public and private hospitals of Quetta City, Pakistan. *Journal of Development and Social Sciences*, 4(4), 728–739.
[https://doi.org/10.47205/jdss.2023\(4-IV\)65](https://doi.org/10.47205/jdss.2023(4-IV)65)
- Ali, M., & Kuroiwa, C. (2009). Status and challenges of hospital waste management in Pakistan: A case study in Lahore. *Journal of Public Health*.
- Ali, M., Wang, W., & Chaudhry, N. (2017). Hospital waste management in Pakistan: A case study of tertiary care hospitals. *Journal of Environmental Management*, 190, 58–66. <https://doi.org/10.1016/j.jenvman.2016.12.007>
- Anjum, M., Majeed, S., & Zubairy, M. (2025). KAP analysis of nurses regarding biochemical waste management at Nishtar Hospital, Multan. *Biological and Clinical Sciences Research Journal*, 6(2), 150–152.
<https://doi.org/10.54112/bcsrj.v6i2.1596>
- Arshad, N., & Ali, S. (2025). Assessing nurses' knowledge, attitude, and practices regarding medical waste management at a teaching hospital in Lahore. *Journal of Health and Rehabilitation Research*, 3(3). [Note: The search result for this specific citation was an abstract with incomplete details. The authors' full names and the exact page range could not be verified. Please check the original source for a complete reference.]
- Asif Mahmood Mattoo, S. H., & Maqsood Butt, A. (2020). Healthcare waste management: Current knowledge, attitude, and practices at secondary and tertiary care hospitals. *Pakistan Journal of Medical Research*, 58(4), 187–192.
- Bhatti, A. O. S., Bhatti, A. W. A., & Zahid, A. R. (2024). Crafting Environmental Prioritization for End Users: Revamping the Thermal Comfort at Shifa Gyne Hospital, Rawalpindi. *Journal of Development and Social Sciences*, 5(1), 598–616.
- Bhatti, O. S., & Ghufuran, A. (2020). YOUNG SCHOLARS CONTRIBUTIONS PAKISTAN HEALTHCARE INFRASTRUCTURE AND COVID-19: A CASE FOR ISOLATION AND QUARANTINE FACILITIES OPTIMIZATION IN THE CONTEXT OF PAKISTAN Omer Shujat Bhatti *. *Journal of Research in Architecture and Planning*, 29, 36–45.
- Bhatti, O. S., Ghufuran, M. A., & Shah, A. (2023). RETHINKING ARCHITECTURAL DESIGN AND HOSPITAL TRANSFORMATION THROUGH NEED BASED ASSESSMENT IN LIEU OF COVID19 PANDEMIC. A CASE FOR MISSING EPIDEMIC CONSIDERATIONS IN HEALTHCARE DESIGN OPTIMIZATION.
- Bhatti, O. S., Ghufuran, M. A., & Shah, A. U. (2023). Transforming adversity into opportunity: Assessing user satisfaction in hospital transformation in lieu of a pandemic through the multi-corridor expansion model for epidemic management and environmental design enhancement. *Nakhara: Journal of Environmental Design and Planning*, 22(2), 308–308.
- Bhatti, O. S., Tayyab, N. A., & Iftakhar, N. (2024). Unveiling Patient Perspectives: A



Vol. 4 No. 2 (February) (2026)

- Quality Assessment of User Satisfaction in a Leading Private Hospital in Gujranwala, Pakistan: Patient Satisfaction in Gujranwala Private Hospital. *Journal of Health and Rehabilitation Research*, 4(3), 1-5.
- Bhatti, O. S., Usman, M., & Zahra, R. (2025). Optimizing Healthcare Spaces In Post-Covid19: An Environmental Evaluation Of Outpatient Department Design At DHQ Teaching Hospital. *International Journal of Human and Society*, 5(01), 78-103.
- Biswas, J., et al. (2019). Healthcare waste management practices in developing countries: A review.
- Chartier, Y., Emmanuel, J., Pieper, U., Prüss, A., Rushbrook, P., Stringer, R., ... Zghondi, R. (2014). *Safe management of wastes from health-care activities* (2nd ed.). Geneva, Switzerland: World Health Organization.
- Government of Pakistan. (2005). *Hospital waste management rules, 2005*. Islamabad, Pakistan: Ministry of Environment.
- Government of Pakistan. (2010). *Pakistan environmental protection act (PEPA), 1997 (amended 2010)*. Islamabad, Pakistan: Ministry of Climate Change.
- Iqbal, M. A., Bhatti, A. O. S., & Iftakhar, A. N. (2023). Evaluation of User Satisfaction with Garbage Handling Systems in Selected High-Rise Building of Islamabad City Developing: Case for Waste Smart Highrise Buildings in Pakistan. *Journal of Development and Social Sciences*, 4(4), 394-408.
- Iqbal, M. A., Bhatti, O. S., & Khan, F. (2025). Climate-Resilient Solutions: The Anticipated Role of Reed Bed Technology in Transforming Rural Hygiene and Waste Treatment in Pakistan. *Dialogue Social Science Review*, 3(3), 664-675.
- Javed, A., Bhatti, A. D. O. S., & Naseer, A. K. U. D. (2025) HEALING ENVIRONMENTS FOR CHILDREN: AN ENVIRONMENTAL ASSESSMENT OF THE PEDIATRIC WARD AT ALLIED HOSPITAL, FAISALABAD CITY.
- Malik, M., Yunus, N., Niazi, H. R., & Ayub, U. (2025). Biosafety, biosecurity and hospital waste management: Current status and future directions. *Chronicles of Biomedical Sciences*.
- Malik, N., Mehmood, Z., & Mahmood, B. (2021). Bio-medical waste management practices among health care professionals: A case study in Faisalabad, Punjab, Pakistan. *Pakistan Journal of Social Research*.
- Ministry of National Health Services, Regulations and Coordination. (2022). *National guidelines for hospital waste management*. Islamabad, Pakistan: Government of Pakistan.
- Omer, A., Bhatti, S., Nuaman, E., Mughal, I., & Iftakhar, A. N. (2024). Turning Threats Into Opportunities: Revamping the Gaps in Hospital Waste Management Through Documentation, Awareness, and Sensitization for Public. *International Journal of Contemporary Issues in Social Sciences*, 3(1), 872-888.
- Omer, A., Bhatti, S., Nuaman, E., Mughal, I., & Iftakhar, A. N. (2024). Turning Threats Into Opportunities: Revamping the Gaps in Hospital Waste Management Through Documentation, Awareness, and Sensitization for Public. *International Journal of Contemporary Issues in Social Sciences*, 3(1), 872-888.
- Riaz, A., et al. (2023). Assessment of biomedical waste management practices and paramedical staff knowledge and attitude at healthcare facilities in Lahore, Pakistan. *Pakistan Journal of Health Sciences*.
- Riaz, A., Majeed, F., Sabir, S., Imran, M., Fatima, S. N., Shahbaz, M., Saleem, J., Shahbaz, F., Tahir, M. N., & Amjad, A. (2023). Assessment of biomedical waste



Vol. 4 No. 2 (February) (2026)

- management practices and paramedical staff knowledge and attitude at healthcare facilities in Lahore, Pakistan. *Pakistan Journal of Health Sciences*, 4(6), 170–176. <https://doi.org/10.54393/pjhs.v4i06.836>
- Rutala, W. A., & Weber, D. J. (2019). Disinfection, sterilization, and control of hospital waste. In J. E. Bennett, R. Dolin, & M. J. Blaser (Eds.), *Mandell, Douglas, and Bennett's principles and practice of infectious diseases* (9th ed., pp. 3294–3309). Philadelphia, PA: Elsevier.
- Shahid, S. (2025). Clinical waste management practices and its impact on human health and environment in the Islamabad region: A case study of PIMs hospital. *Social Science Review Archives*, 3(3). <https://doi.org/10.70670/sra.v3i3.947>
- Sharma, H. B., Vanapalli, K. R., Cheela, V. R. S., Ranjan, V. P., Jaglan, A. K., Dubey, B., ... Bhattacharya, J. (2020). Challenges, opportunities, and innovations for effective solid waste management during and post COVID-19 pandemic. *Resources, Conservation and Recycling*, 162, 105052. <https://doi.org/10.1016/j.resconrec.2020.105052>
- Shujat Bhatti, O., Anjum, N., & Abid, M. (2022). Spatial Design Evaluation of Accident and Emergency Department Optimization: a Case of Capital Hospital G-6, Islamabad. *Journal of Research in Architecture & Planning*, 32(2), 48–59. https://doi.org/10.53700/jrap3222022_5
- Singh, N., Tang, Y., & Ogunseitan, O. A. (2020). Medical waste: Current challenges and future opportunities for sustainable management. *Critical Reviews in Environmental Science and Technology*, 52(11), 2000–2022. <https://doi.org/10.1080/10643389.2020.1885325>
- Tanoli, T. K., & Bhatti, O. S. (2024) FROM CURRENT DEFICIENCY TO DESIGN INTERVENTION: DEVELOPING PSYCHIATRIC HOSPITAL ARCHITECTURAL DESIGN FOR SUSTAINABLE HOLISTIC MENTAL HEALTHCARE IN PAKISTAN.
- Ullah, S., Khan, U., & Saifuddin, T. (2025). The impact of medical waste on Indigenous communities in Balochistan, Pakistan. *Annals of Global Health*.
- Waris, A., & Khan, M. (2025). From knowledge to practice: A cross-sectional analysis of biomedical waste disposal compliance and its determinants among primary care physicians in Karachi, Pakistan. *Frontier in Medical & Health Research*.
- WHO. (2014). *Safe management of wastes from health-care activities* (2nd ed.). World Health Organization.
- Windfeld, E. S., & Brooks, M. S. L. (2015). Medical waste management – A review. *Journal of Environmental Management*, 163, 98–108. <https://doi.org/10.1016/j.jenvman.2015.08.013>
- World Health Organization. (2018). *Health-care waste fact sheet*. Geneva, Switzerland: WHO.
- World Health Organization. (2022). *Global analysis of health care waste in the context of COVID-19*. Geneva, Switzerland: WHO.