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BRIDGING COMMUNITY AND HOSPITAL WASTE MANAGEMENT: INSIGHTS FROM BIRENDRANAGAR, SURKHET

Neelam Budha[1] Madhav Prasad Koirala[2*]

[1] Research Scholar, MSc. in Construction Management, Mid Western University, Surkhet, Karnali Orovince, Nepal, [2] Professor/Principal, United Technical College, Bharatpur Metropolitan City 11, Bagmati Province, Nepal, ORCID: 0000-0003-3649-0198

Corresponding Author : m.koirala@unitedtechnicalcollege.edu.np(M.Koirala)

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ABSTRACT

Hospital waste management is critical in developing countries like Nepal to mitigate health and environmental risks, promote infection control, and ensure the safety of healthcare workers and the community. This study assessed waste management practices in two hospitals in Birendranagar, Surkhet, focusing on issues with labeling, cleanliness, and waste segregation. The methodology adopted was a literature survey, questionnaire, observation, and interview. It is indicated that concrete vaults, sharp pits, and labeled storage chambers may be built for better handling of waste. Some of the proper segregation practices resulted in less hazardous waste and more non-hazardous and recyclable waste. Even though both hospitals had policies related to waste management, there were no appropriate facilities, which resulted in the mixing of waste and the absence of labeled chambers. The study recommended color-coded chambers, which must be followed along with treatment methods including autoclaves and needle cutters. Karnali Province Hospital at 55% occupancy produced an average of 398.09 kg/day waste that reaches 723.8 kg/day at full capacity, while at 50% occupancy, Karnali Care International Hospital produced 78.80 kg/day waste, reaching a projection of 157.6 kg/day at 100%. To improve hospital waste management in Nepal, better segregation can reduce health risks and generate income from recyclables. Properly securing biogas plants and utilizing food waste for biogas production could lower waste management costs. This study emphasizes the need for efficient waste strategies, infrastructure enhancements, and sustainable practices for economic and environmental benefits.

Keywords: Hospital Waste; Waste Management; Waste Disposal; Hazardous Waste; Environmental Risk

1. Introduction

(Hassan et al., 2008), Improperly managed medical waste poses serious risks to both human health and the environment (Hossain et al., 2011). In Birendranagar, Surkhet, a rapidly developing city in Nepal with a growing number of hospitals and healthcare facilities, effective waste management

is of paramount importance (Giusti, 2009; Tiwari et al., 2022). The rise of medical waste in urban areas necessitates effective solid waste management to minimize negative effects, as identified by the world health organization (WHO) since 1993. This incorporates ecological, economic, and social aspects of health, which are interconnected with a mutual reinforcement relationship. From an ecological perspective, studies come with evidence that unsustainable health-related waste management can contribute to soil, water, and air pollution, commonly resulting in long-term environmental degradation and public health risks (Zhang et al., 2016). From an economic perspective, poor health outcomes due to waste that is poorly managed and pollution lead to costs for treatment, lack of productivity for the workforce, and costs for the healthcare systems, mostly seen in developing countries (Nepal et al., 2020). The social aspect refers to equity, awareness, and community; in this case, with inequity, people consisting of marginalized groups—as having more exposure to unsafe waste practices—will face worse health situations, which diminish health and worsen health inequalities while disregarding sustainable development goals (Sharma et al., 2021). Overall findings from studies give evidence to the conclusion that responding to ecological sustainability, economic sustainability, and social sustainability is necessary for improving health outcomes and the resilience of health.

Using these economic, social, and environmental factors, the present study assessed the hospital waste management at Karnali Province Hospital and Karnali Care International Hospital and Research Center in Birendranagar, Surkhet, and identified the related environmental impacts. The results are meant to inform the health authorities on implementing efficient waste management strategies to contain pollution and protect public health, although wider generalization is constrained by Surkhet being the focus of the study (Poudel, Acharya and Pokharel, 2005a). This study does not evaluate the applicability of the proposed management methods. Here, health care facilities are generators of not only municipal solid waste (MSW) but also hazardous health care waste (HCW), such as sharps and infectious waste, which represent an even greater hazard and require specific treatment (Singh et al., 2011a). If mistakenly disposed of, MSW and HCW will create environmental pollution and diseases, which is further complicated by increasing healthcare demands globally (Patwary, O'Hare and Sarker, 2011a). While high-income countries use advanced thermal means of waste treatment (Ojha et al., 2022a), low-income countries are still challenged with the segregation and safe disposal of the waste they produce (Chowdhury et al., 2021). The need for safe disposal within low-income contexts like Surkhet (due to funding constraints, operational limitations, etc.) will always require more support from government, health authorities, waste management interventions, and communities (Ali & Kuroiwa, 2009; Ballet et al., 2018).

Evidence shows that unhygienic disposal practices and lack of knowledge constitute severe public health risks in Surkhet hospitals (Oroei et al., 2014). This research, therefore, conducted a survey of hospital solid waste management with emphasis on long-term operational and financial viability, in addition to the economic benefits of goods collection and treatment (Chaerul, Tanaka, and Shekdar, 2008a; Silva et al., 2022). Findings also indicate poor segregation of hazardous waste, spreading more risks of cross-contamination and infection (Senekane, Makhene, and Oelofse, 2022). Comparison with national guidelines shows gaps in accordance with wider issues in developing countries (Paudel et al., no date; Mulya et al., 2022). Recent estimates indicate that Nepali health care facilities generate 0.533 kg of waste per bed-day, with 0.256 kg of general waste, 0.147 kg of biodegradable waste, 0.120 kg of infectious waste, and 0.009 kg of hazardous chemical/pharmaceutical waste (Mehta, Adhikari,

and Bist, 2023), which indicates the urgent need for improvement in hospital waste management both for environmental sustainability and for ensuring public health safety.

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The present study assessed hospital waste management practices at the Karnali Province Hospital and the Karnali Care International Hospital and Research Center to identify environmental impacts thereof. The findings, if applicable, are expected to help the concerned healthcare authorities in adopting effective measures to manage the waste properly in order to reduce pollution and protect public health. However, the study focuses on Birendranagar, Surkhet, which limits the generalization of results (Poudel, Acharya and Pokharel, 2005b). Besides, this publication didn't discuss the economic feasibility of those strategized, and, therefore, the cost was left undressing. Health care facilities produce both normal municipal solid wastes (MSW) and hazardous health-care waste (HCW) in the form of sharps and infectious material that require special handling for disposal (Singh et al., 2011b). Such types of waste, if not disposed of properly, can lead to pollution as well as massive outbreaks of diseases. Because of advancements in medicinal treatments and the increase in demand, the healthcare industry is booming globally. (Patwary, O'Hare and Sarker, 2011b), which in turn has given rise to medical waste. Although various methods for waste management have been developed and applied to treat waste thermally in high-income countries (Ojha et al., 2022b), low-income countries are still combating problems with the segregation and disposal of waste (Chowdhury et al., 2021). This becomes grave in developing nations where the treatment of hospital wastes is not done, as stated by (Ali and Kuroiwa, 2009), which again has been the case in Surkhet, where human resources and operational costs limit proper implementation of strategies regarding waste management (Ballet et al., 2018).

The inappropriate methods of waste disposal and unawareness of hazardous materials are causing serious public health risks due to inadequate management of waste in the hospitals of Surkhet. (Oroei et al., 2014). This research was performed to study the present status of hospital solid waste management and develop proper management techniques, which included studies on long-term operational and financial sustainability. This is besides the attempt to explore the financial benefits accruable from effective waste collection and management (Chaerul, Tanaka and Shekdar, 2008a; Silva et al., 2022). Healthcare wastes in the Karnali Province of Nepal are negligent in segregating hazardous wastes, hence raising the potential for cross-contaminations and the spread of infections (Senekane, Makhene and Oelofse, 2022). The study at hand compares local practices with the set guidelines by the Ministry of Health and Population (Paudel et al., no date), in light of gaps within

hospital waste management in developing countries (Mulya et al., 2022).

One recent estimate of waste generation from health care facilities in Nepal indicated that 0.533 kg is generated per bed-day, out of which 0.256 kg was non-hazardous general waste, 0.147 kg was biodegradable waste, 0.120 kg infectious waste, and 0.009 kg hazardous chemical and pharmaceutical waste (Mehta, Adhikari and Bist, 2023). These figures are indicative of a dire need to improve waste management practices for public health and environmental protection.

2. Material and Method

The specific study had assessed the hospital waste management practices in Birendranagar, Surkhet, using a mixed-method approach that integrates both quantitative and qualitative data collection to develop an in-depth understanding of current practices, challenges, and potential improvements.

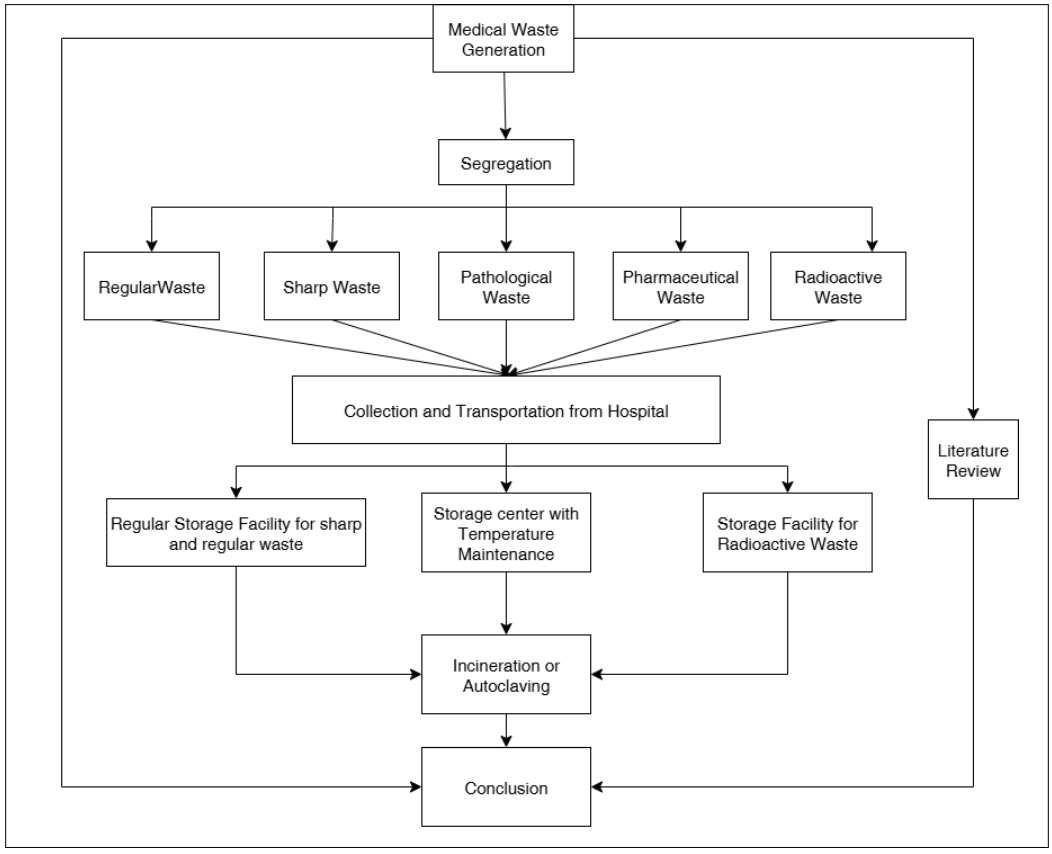
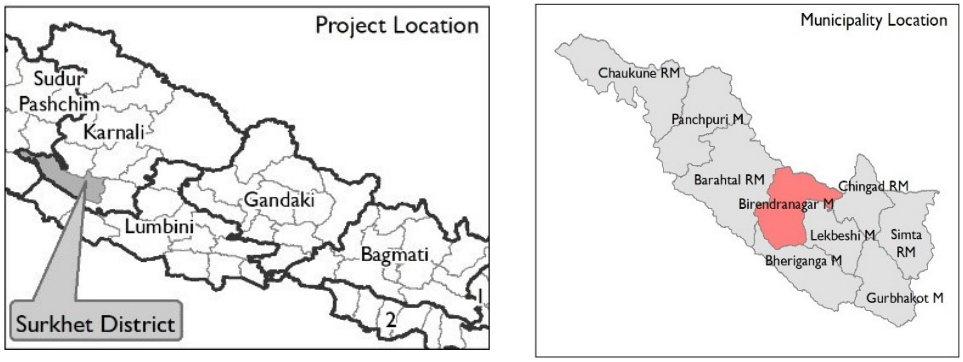


Fig:.1 Research Flow chart

A research flow chart is relevant when it clearly presents the step-by-step research process, complements the methodology text, aligns with the research design and objectives, and maintains logical clarity without unnecessary details. If it accurately reflects the methods described, it adds value; if generic or unclear, it may be irrelevant.

Study Area

Field research was conducted in Birendranagar, Surkhet, in Karnali Province, Nepal, focusing on the two major hospitals: the Karnali Province Hospital, a 300-bed governmental hospital that is located on the western part of Surkhet municipality, and the Karnali Care International Hospital and Research Center, located in Birendranagar Municipality, Ward No. 4. Fig. 2 is relevant as it geographically situates the research area, showing its location at multiple scales—from Nepal, to Surkhet District and Municipality, to the specific site at Karnali Care International Hospital and Research Center—providing spatial context for the study.



(a) (b)

(c)

Fig.:2 Map of the Research Study Area (a) Map of Surkhet on Nepal; (b) Surkhet District & Municipality; and (c) Karnali Provence & Karnali Care International Hospital and Research Center

Research Design and Approach

A descriptive and observational design was adopted to study and analyze practices concerning hospital waste management in both facilities. The mixed-method approach was applicable here, as it better analyzed the existing waste management systems, pointing out the major issues that needed resolution and where concern needed to be accorded (Hesse-Biber, no date).

Quantitative data, which included questionnaires and waste weighing, was useful in terms of

what could be measured in relation to the rates of waste generation, types of waste produced, and what stakeholders were doing with their waste, and thus it was beneficial for statistical and trend analysis. Qualitative data from observations and interviews provided context on the drivers of waste production, including operational constraints, staff attitudes, policy and system gaps, and cultural practices. The waste weighing showed the scale of the issues, interviews explained why some waste streams were highest or poorly managed, questionnaires captured group understanding, and observations identified gaps between reported and actual waste practices. Synergy and triangulation from mixed methods made the findings more reliable and actionable.

Sample and Population

The Sample and Population The respondents have been selected from a varied group consisting of hospital management, staff, waste handlers, patients, and visitors. The sample size was determined by using Slovin's formula to obtain reliable data collection with an error margin of 5%, as presented in Table 1.

Table: 1 Participants in the Questionnaire Survey for Primary Data Collection

S.N.	Category of Respondents	Sample size (nos)	Sample percentage (%)
1	Hospital staff	82	36.93
2	Patients and visitor	140	63.07
	Total	222	100

Sample size was determined by Slovin's formula(Sapra, 2022)

$$n = \frac{N}{1 + N(e)^2}$$

Where, N = No. of people size

e = precision level or margin of error significance (ie. e = ±5%).

n = no. of sample size (Rhodes et al., 2017).

Meanwhile, two residential medical and environmental doctors from each hospital were selected for observation and interview.

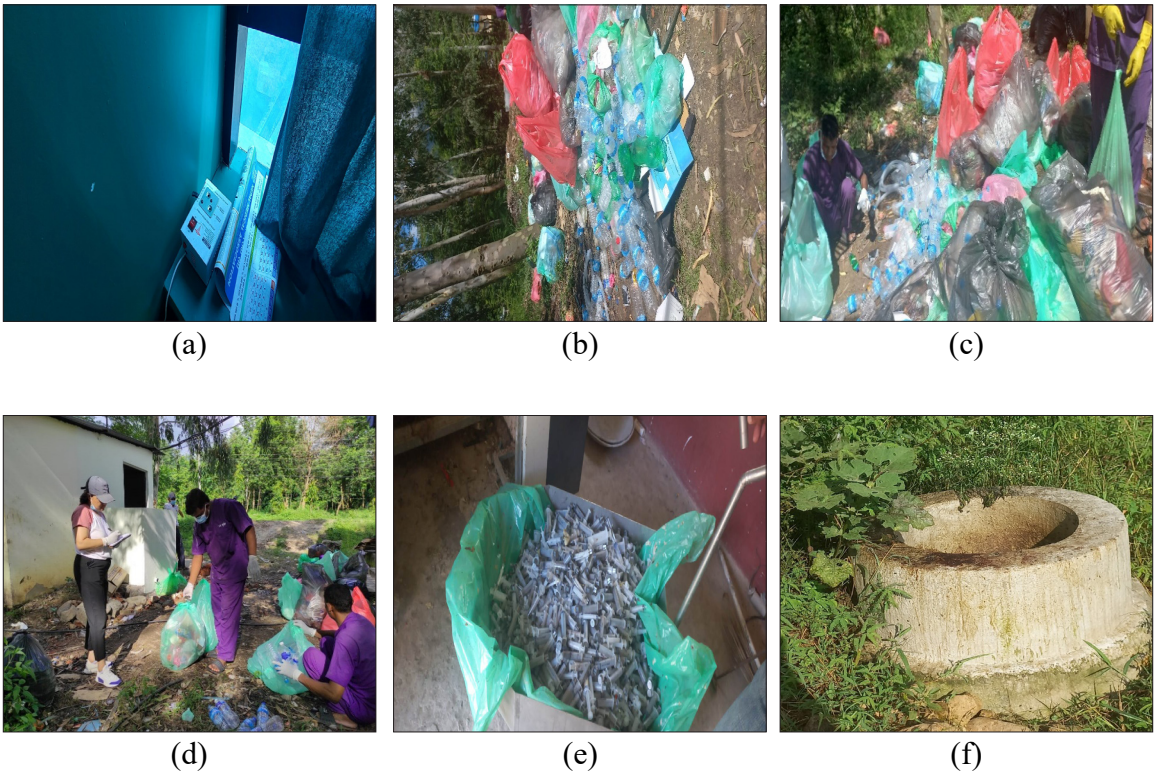
Waste Management and Categorization

The contents of each category infectious, pathological, pharmaceutical, sharps, chemical, radioactive, and general garbage were used to classify hospital waste. Despite being in wards, labs, and operating rooms, waste collection boxes were not always properly labeled or maintained. There were health and safety hazards due to the incorrect mixing of waste types and the fact that only 74.62% of bins had the correct labels for trash segregation. Table 2 displays the bin labels by the hospital.

Waste Management Practices

Table: 2 Classification and Labeling of Buckets and Bins

Sn.	Name of hospital	No. of bucket & bins	No. of Buckets and bins labeled	% of labeled
1	Karnali Province Hospital	136	100	73.62
2	Karnali Care Int. Hospital and Research Center	66	50	75.75



(a) (b) (c)

(d) (e) (f)

Fig.:3 During post seperation of waste (a) Needle cutting device for syringes, (b); Waste collected in the hospital's backyard; (c) Weighing hospital-generated;(d) Waste segregation and dispatch; (e) Pump and piston separation activities; (f) Pathological waste collection pit for potential biogas generation.

The study identifies significant problems with trash segregation, such as the blending of dangerous chemicals and sharps with ordinary garbage. Even with syringe safety containers, hospitals don't always follow the right protocols. To guarantee consistent waste management from disposal to ultimate treatment, prompt action is required through regular audits, policy enforcement, and training. As illustrated in Fig. 3, the investigation also discovered inadequate trash bin maintenance, especially at Karnali Province Hospital during waste transfer.

Data collection Tools

Adding a short description or examples of the questionnaire, the observation checklist, and the interview guide—including the question types, aspects of waste management under observation, and broad themes the interviews focused on enhanced transparency and reproducibility.

Waste Segregation and Disposal

In both hospitals, the waste disposal system lacked adequate segregation, with infectious and sharp waste being combined with other waste types. This inadequate segregation increased the risk of contamination and exposure to harmful materials for hospital staff. Figures and data collected during the study illustrate the stages of waste handling, including needle cutting, waste collection, segregation, weighing, and final disposal (Aryal et al., 2019).

By addressing these gaps in waste management, the study aims to propose practical solutions that can enhance hospital waste handling practices in the region.

Ethical consideration

This research acquired informed consent from all participants and applied to the appropriate institutional review board for approval.

Results and Discussion

The study identified several significant difficulties with labeling, hygiene, waste segregation, and disposal procedures in the hospital waste management system in Birendranagar, Surkhet. These disparities point to the necessity of enhancing procedures, facilities, and waste management techniques in addition to the possibility of using recyclable materials for long-term financial viability.

3.1 Trash Generation

The volume of patients, the breadth of services provided, and healthcare activities all have an impact on hospital trash generation. To reduce hazards to the environment and human health, proper management is crucial.

3.2 Total Production and Storage of Waste

The two hospitals' waste generation differed significantly, according to the study. Karnali Care International Hospital has an occupancy rate of 28.28% and generates 78.80 kg of garbage per day with a volume of 0.76 m3. On the other hand, Karnali Province Hospital, which has a volume of 3.84 m^3 and an occupancy rate of 58.59%, produces 398.09 kg of trash every day. As seen in Figure 4, which illustrates how hospital capacity and service variety affect overall waste output, this disparity results from variations in patient flow, outpatient services, and surgical activity.

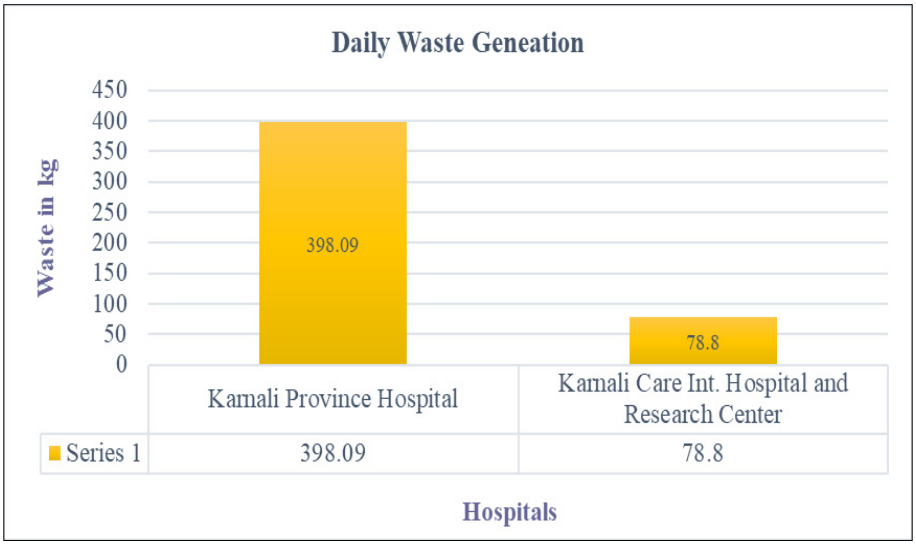


Figure 4: Daily Average Waste Generation by Weight

Karnali Care International Hospital generated 1.10 kg/person/day of waste with a volume of 0.0076 m^3 at 28.28% occupancy. In contrast, Karnali Province Hospital produced 0.52 kg/person/day with a volume of 0.0094 m^3 at 58.59% occupancy.

The daily generation in both hospitals was summarized into an overall Table 3, depicting the growth of wastes over time. Through this breakdown, a hospital management would be able to monitor waste patterns, budget the funds, and undertake environmentally and health-friendly disposal.

The results indicate that a significant proportion of the waste generated, particularly at Karnali Province Hospital, remains improperly managed due to inadequate segregation and labeling practices. Both hospitals lack effective strategies for managing the volume and types of waste produced, which raises concerns about the environmental impact and potential health risks for hospital staff and the broader community.

Table: 3 Daily and Total Waste Generation at the end of week in Kilograms

Hospitals	Total waste generation per day in kg						
	Sat	Sun	Mon	Tue	Wed	Thu	Fri
Karnali Province Hospital (KPH)	452.84	424.22	372.4	390.67	369	393	386.5
Cumulation waste Generation KPH	452.84	877.06	1249.46	1640.13	2030.8	2423.8	2810.3
Karnali Care Int. Hospital and Research Center (KCHR)	85.3	70.2	82	81.3	82.5	78.3	72
Cumulation waste Generation KCHR	85.3	155.5	237.5	318.8	401.3	479.6	551.6

3.3 Segregation and Disposal Practices

The study also highlighted challenges in proper segregation and disposal of hazardous and non-hazardous waste. As identified in the waste management practices, sharp waste such as syringes and needles is often mixed with general waste, posing safety risks to hospital staff and waste handlers. Despite the presence of safety boxes for sharp waste, poor adherence to segregation protocols results in contamination of non-hazardous waste streams. This issue is particularly pronounced in Karnali Province Hospital, where the higher volume of waste exacerbates these challenges.

3.4 Labeling and Cleanliness of Waste Bins

Waste bins in both hospitals were found to be inconsistently labeled, which hampers effective segregation. The study found that only 74.62% of waste bins were properly labeled, with Karnali Care International Hospital achieving a slightly higher labeling rate compared to Karnali Province Hospital. In addition, there were discrepancies in the cleanliness of the bins, with Karnali Care maintaining cleaner bins, while Karnali Province Hospital struggled to ensure regular cleaning, especially during waste transportation. These gaps in labeling and cleanliness compromise the overall efficiency of the waste management system and contribute to increased health hazards.

3.5 Implications and Recommendations

The findings from this study underscore the need for infrastructure improvements and better waste management protocols at both hospitals. This includes:

- Enhancing waste segregation practices through clearer labeling systems.
- Investing in proper storage and disposal infrastructure to handle the growing volume of hospital waste.
- Implementing training programs for hospital staff to improve waste handling and segregation.
- Exploring the financial potential of recycling programs to reduce waste management costs and improve sustainability.

Figure 5: Daily Average Waste Generation by Weight

As shown in Figure 5, waste generation at Karnali Province Hospital peaked on the first and second days of the week, while at Karnali Care International Hospital and Research Center, it was highest on the first and fifth days. This trend can be attributed to the availability of doctors on weekends, as well as patients taking advantage of time off work and government health insurance benefits. Saturday had the highest waste generation, with 269.07 kg, followed by Sunday with 247.21 kg.

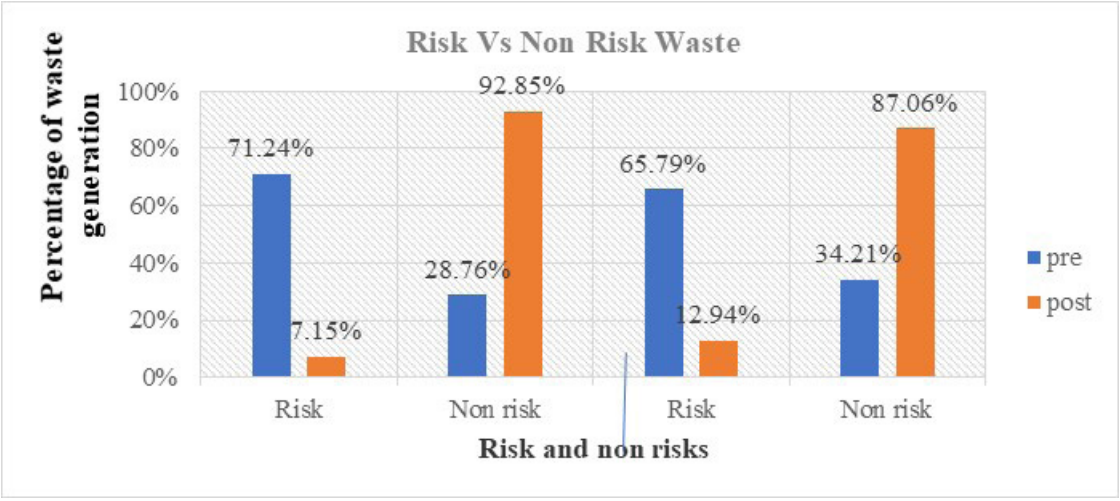


Figure 6: Comparison of Hospital-wise Pre-Separation and Post-Separation Risk vs. Non-Risk Waste Generation

Figure 6 presents the risk waste after segregation, which decreased from 65.79% to 12.94% at Karnali Care International Hospital, while decreasing from 71.24% to 7.15% at Karnali Province Hospital. The method of effective segregation used in this regard shows that proper handling of non-risk wastes is a key issue.

The study also identified key issues in waste management, such as inadequate labeling, cleanliness, and segregation practices, underscoring the need for better waste management systems, infrastructure enhancements, and recycling to support financial sustainability.

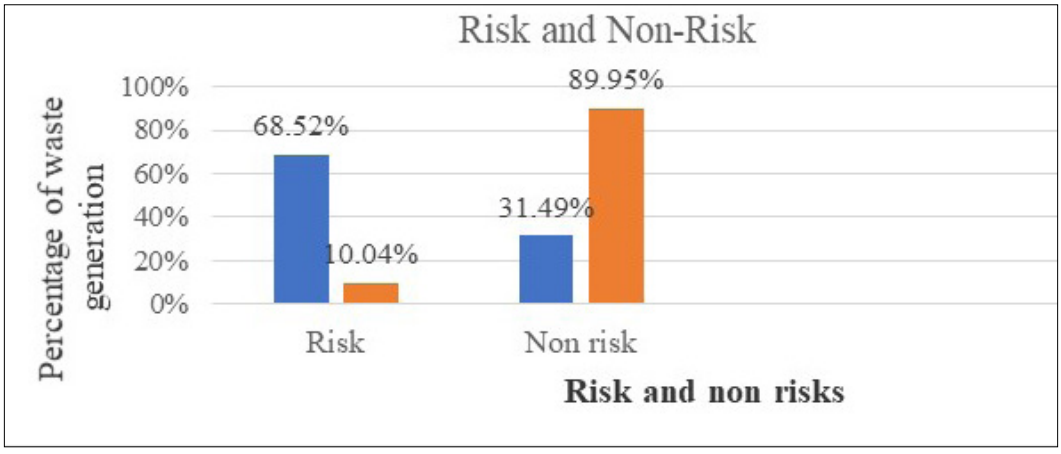
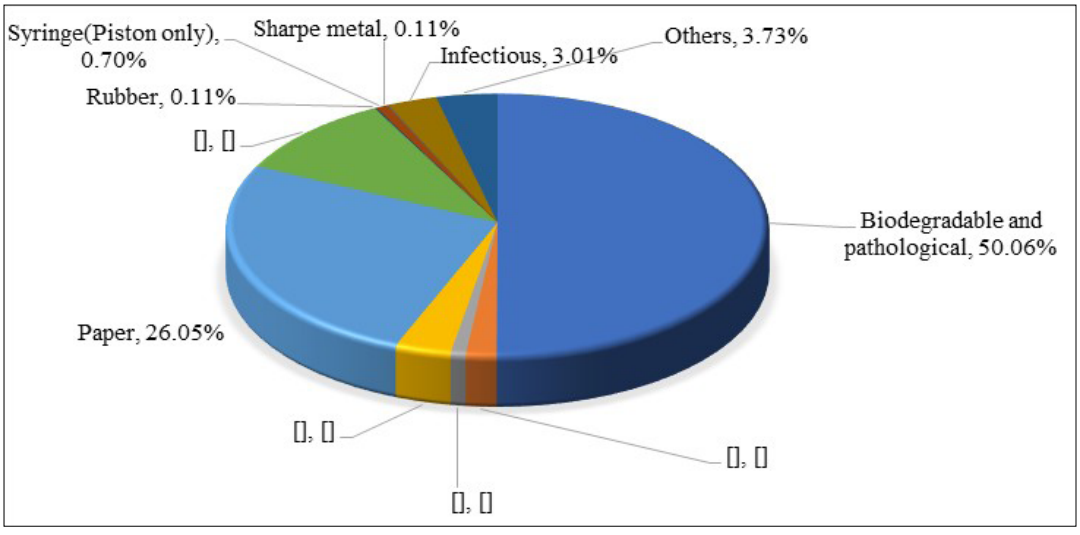


Figure 7: Risk vs. Non-Risk Waste Generation

In Figure 7, the difference in the amount of risk and non-risk waste before and after segregation represents a large fluctuation in both hospitals. As an instance, the risk waste in Karnali Province Hospital was 71.24% before separation, which came down to 7.15% afterward. Similarly, in Karnali Care International Hospital, the risk of waste dropped to 12.94% from 65.79%. Waste segregation contributes towards better management of non-risk wastes, as the figure shows below.



In Figure 8, the hospital waste generation represents how well the owned practice of waste management is. Karnali Province Hospital generates waste of 723.8 kg at full occupancy, that is 0.723 m3 by volume, whereas that for Karnali Care International Hospital is 157.6 kg or 0.157 m3. The higher generation in Karnali Province Hospital is due to its central position and wide range of services it offers, thereby attracting more patients. In this case, the hospitals in Surkhet District generate an average of 0.81 kg of waste per patient per day, much lower compared to 1.19 kg per bed reported by USAID 2019, assuming 78% occupancy. This may be comparable due to the low flow of patients and much-limited facilities in Surkhet that shift patients to seek care in Kathmandu.

During the pre-separation stage, Surkhet hospitals had 68.52% risk waste, which decreased to 10.04% after proper segregation. This is lower than the 0.48 kg of risky waste per day reported by the Environment and Public Health Organization (Joseph et al., 2015). The average risk of waste generation in Surkhet was 0.298 kg/patient/bed/day, significantly higher than the 0.2 kg reported by WHO (2011) for low-income countries(Sapkota, Gupta and Mainali, 2014a).

Proper transportation of untreated healthcare waste is crucial, yet in both hospitals, risk waste is often mixed with non-risk waste and manually transported to open storage areas. Though the hospitals have healthcare waste management (HCWM) plans, the lack of practical implementation and staff awareness is evident. Medical waste disposal practices in Surkhet District are inadequate, as many hospitals burn waste at low temperatures without proper air pollution control, exposing it to scavengers (Chaerul, Tanaka and Shekdar, 2008b; Sapkota, Gupta and Mainali, 2014a).

At Karnali Care International Hospital, risk waste is sterilized and separately collected, while syringes are autoclaved before disposal. Karnali Province Hospital sterilizes and disintegrates risk

waste and disposes of it via municipal trucks. However, a portion of the waste from both hospitals is unsterilised and dumped by the municipality. Anatomical and pathological waste, including placentas, is used in biogas production through decomposition.

Healthcare waste is often stored openly for long periods, increasing contamination risks for scavengers, staff, and visitors. Both hospitals have autoclaves and needle cutters but lack trained personnel to operate them effectively. In Karnali Province Hospital, only one autoclave is available for sterilizing waste. The burning of healthcare waste without proper air filtration releases harmful chemicals, impacting the environment and public health.

To improve waste management, the hospitals should implement systems such as constructing burial pits, concrete vaults, or sharps pits for safe disposal of sharps, syringes, and medical waste. Additionally, labeled waste storage chambers are essential to ensure safe handling and disposal. This approach would be more socially, economically, and environmentally sustainable.

Post separation waste composition

"Post-separation waste composition" refers to the analysis of waste after segregation, helping categorize waste into different streams such as hazardous, non-hazardous, recyclable, and organic waste. This analysis is essential for identifying recycling opportunities, waste reduction measures, and suitable disposal methods.

Waste Composition of Karnali Province Hospital

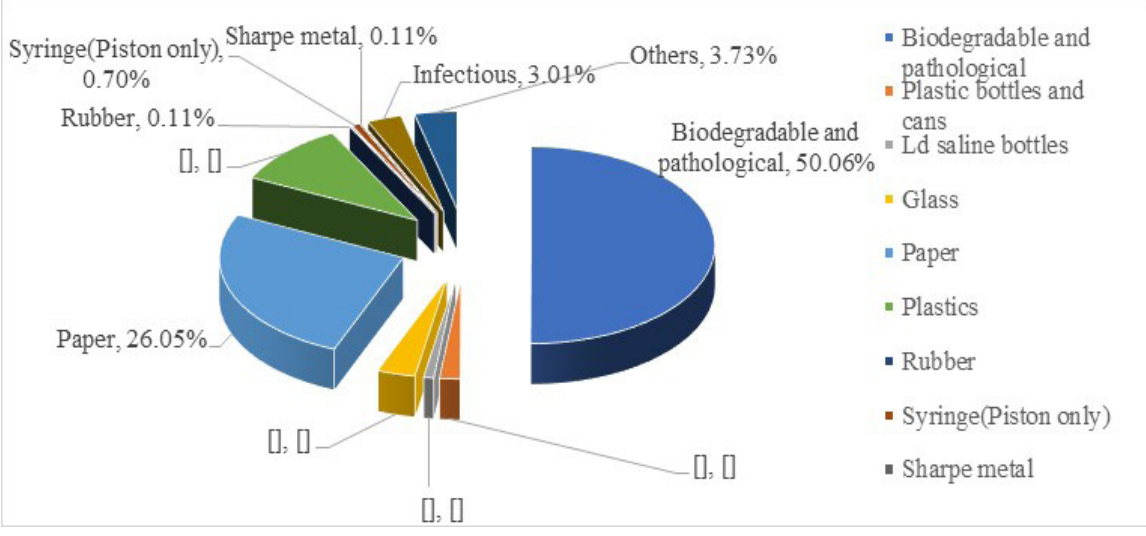


Figure 9: Waste Composition by Weight at Karnali Province Hospital

Paper waste made up 26.05% of the total garbage at Karnali Province Hospital, while biodegradable waste made up 50.06%. Figure 9 shows that 3.01% of the garbage was infectious. This demonstrates how paper recycling and composting biodegradable garbage can drastically lower the volume of waste produced overall.

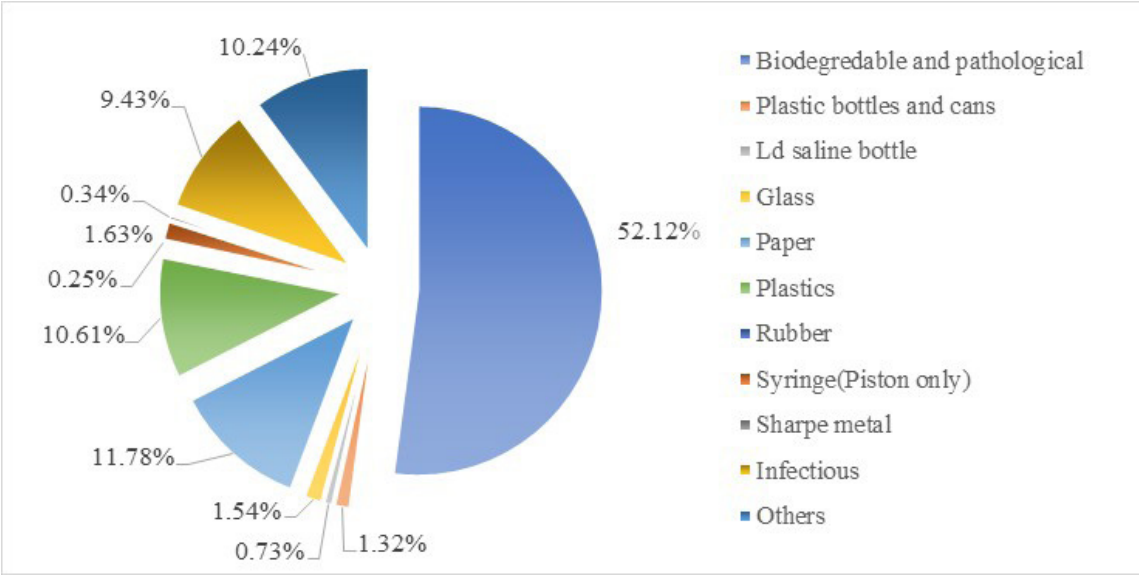


Figure 10: Waste Composition by Weight at Karnali Care International Hospital and Research Center

52.12% of the garbage at Karnali Care International Hospital was biodegradable, 11.78% was paper, 9.43% was infectious, and 10.61% was plastic. As shown in Figure 10, these ratios show considerable promise for recycling paper and plastic waste while guaranteeing that infectious garbage is properly handled.

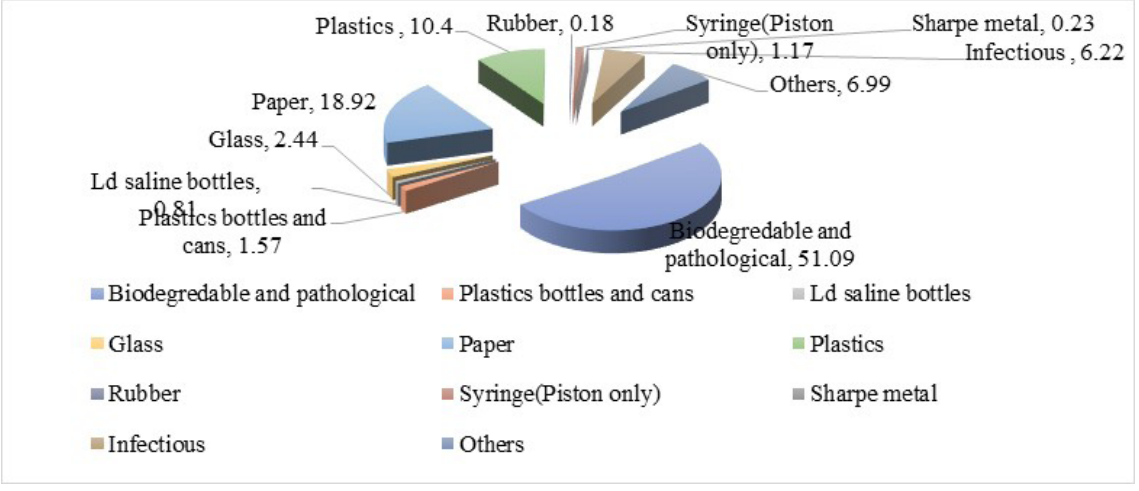


Figure 11: Average Waste Composition by Weight in Hospitals of Surkhet District

It has been observed that, in Surkhet District, hospital waste typically consists of 0.81% LD saline bottles, 10.40% plastic bottles, 1.57% plastic bottles and cans, and 18.92% paper. Infectious waste made up 6.22% of the total, as shown in Figure 11. These numbers highlight the need to classify and recycle non-risk garbage, which highlights potential areas for waste management improvement.

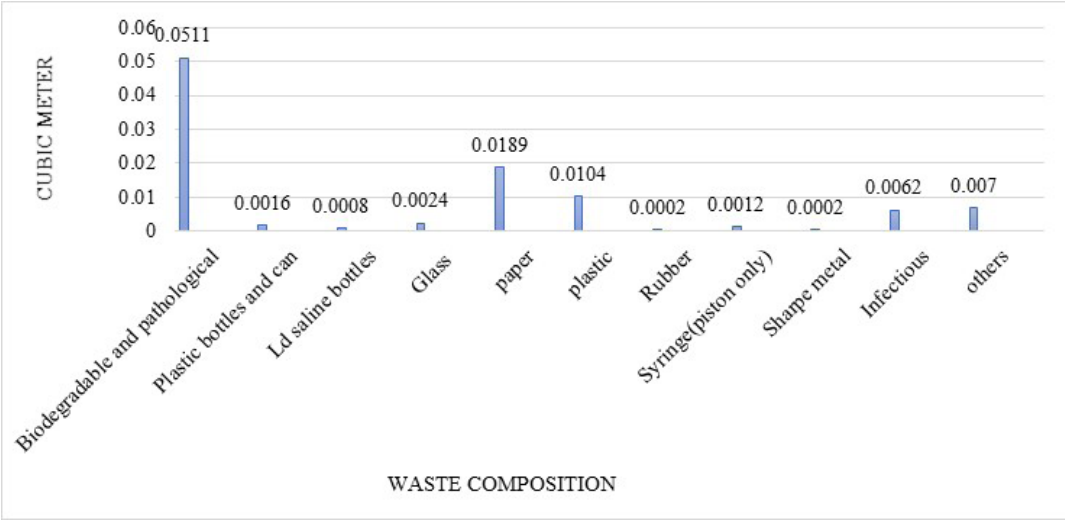


Figure 12: Average Volume in Cubic Meters

The highest average volume of waste generated was biodegradable waste at 0.0511 m2/day/hospital (51.09%), followed by paper at 0.0189 m2/day/hospital (18.92%) and plastic at 0.0104 m2/day/hospital (10.40%). Infectious waste accounted for 0.0062 m^3/day/hospital (6.22%). This data, shown in Figure 12, highlights the need to prioritize reducing biodegradable waste through composting and properly treating infectious waste to minimize environmental risks.

Occupational Health and Safety

A survey of hospital staff revealed that while 52% received training on waste management, only 57.14% practiced segregation and used personal protective equipment (PPE). About 30% of respondents reported needle-stick injuries in the past year, with 25% experiencing multiple incidents. This suggests a need for hospitals to prioritize staff safety, enforce regulations, and improve training in the use of PPE and proper needle disposal.

Waste Treatment and Disposal

Both institutions' general inability to store hazardous and non-hazardous waste led to mixed disposal. The office of Karnali, off-site waste separation increased the amount of hazardous material coming from both facilities. However, combined garbage was not properly stored at the Karnali Care International Hospital. The institutions did not have appropriate sharps burial pits. Prioritizing the construction of concrete burial pits is a cost-effective and environmentally responsible way to dispose of garbage.

Although separated garbage was sterilized in autoclaves at both hospitals, food and diapers were carried with municipal waste, increasing the potential of contamination. This process highlights the importance of proper segregation and treatment in reducing environmental and public health risks.

Cost Recovery from Recycling

Table: 4 Cost Recovery from Waste Generation through Recycling

S. N	Waste items	Average weight/ day(kg)	Unit cost	Total amount daily (NRs.)	Total amount monthly (NRs.)	Total amount yearly (NRs.)
1	Plastic bottle and cans	4.12	20	82.4	2472	29664
2	Ld saline bottles	2.07	25	51.75	1552.5	18630
3	Syringe(Piston only)	2.04	20	40.8	1224	14688
4	Metals	0.35	6	2.1	63	756
Total		8.58	71	177.05	5311.5	63738.00
Mean		2.15	17.75	44.26	1327.88	15934.50
Mode		2.06	20.00	46.28	1388.25	16659.00
Median		4.12	20.00	82.40	2472.00	29664.00
Standard deviation		1.54	8.18	33.17	995.02	11940.21

Table 4 shows the cost recovery from recycling the waste items, with an average weight of 858 kg per day generating approximately NRs. 177.05 daily, NRs. 5,311.50 monthly, and NRs. 63,738 annually. The highest share in the total recycled weight was plastic bottles and cans, while the lowest share of the total recycled waste value was from metals.

4. Discussion

The study found that there were significant gaps in the practices of hospital waste management in Birendranagar, Surkhet, regarding labeling, segregation, hygiene, and disposal systems (Patil et al., 2023). Karnali Province Hospital produced more waste than Karnali Care International Hospital, but neither hospital had hygienic disposal practices, and both had open, unhygienic waste storage systems(Paudel et al., 2023). The absence of labeled bins, periodic cleaning, segregation, and trained staff caused mixing up of hazardous and non-hazardous waste, which escalated health and environmental hazards (Forst, Nickels and Conroy, 2009; Sapkota, Gupta and Mainali, 2014b).

Despite these flaws, proper segregation activities significantly reduced hazardous waste—from 71.24% to 7.15% in KPH and from 65.79% to 12.94% in KCHR(Ibrahim, Kebede and Mengiste, 2023). However, persistent flaws in the form of unsafe storage, low-temperature incineration, and manual handling still posed contamination risks (Qi et al., 2014; Tao et al., 2024). Workers frequently reported needle-stick injuries and made minimal use of personal protective equipment, highlighting gaps in occupational health practices(Mengistu, Tolera and Demmu, 2021; Wong et al., 2025).

About 50% of hospital waste was biodegradable, and 18–26% consisted of paper. Recycling these materials could generate an estimated annual revenue of NPR 63,738 (Ahlawat et al., 2025) (Bharadwaj et al., 2020). The authors of the study recommend using labeled waste chambers, staff training, infrastructure improvements (autoclaves and burial pits), and beginning recycling programs for safe, sustainable, and efficient waste management (Attrah et al., 2022).

In addition to a geographic study area centered on one city and the economic feasibility analysis noted previously, the undertaking also had a range of practical limitations. Incomplete hospital records resulted in a variation in data quality. Consequently, it was also impractical to directly observe all aspects of the waste management process, especially the disposal stage. Mirroring sections of the data collection process, the present research included self-reported questions and responses that may also be biased.

5. Conclusion

The study explored waste management in hospitals in Birendranagar, Surkhet, and determined that there are serious deficiencies in practice, notwithstanding policy. Significant items of concern were found to be bins that did not have proper labeling, non-hygienic and inappropriate containers, and unsatisfactory separation of waste when transported. Staff failed to label over 60% of the bins and repeatedly ignored the proper use of color-coded containers in many wards. Facility staff often mishandled sharps and failed to use protective equipment, creating serious risks to health and the environment.

The quantitative data on waste generation highlighted the scale of the problem as well as the challenges posed by insufficient infrastructure and poor compliance. If both hospitals operated at full capacity, waste generation would rise significantly, requiring further planning to improve segregation, reduce hazardous waste, and enhance safe disposal.

This study adds to the larger body of literature about the ongoing gaps of operational compliance at secondary-level hospitals in developing regions. Ongoing monitoring, staff training, and improved infrastructure—such as clearly marked storage areas and functional treatment facilities—are essential for achieving sustainable hospital waste management. Future research of interest could explore affordable and scalable models of these changes.

6. Recommendation

The findings of this study illustrate the need for multiple policy recommendations and improvement in hospital waste management in Birendranagar, Surkhet. Health care authorities and hospital policymakers should take action to ensure people-centered and environmentally sustainable waste management practices are implemented that enhance public health and well-being. Actions should aim to improve infrastructure, monitor waste segregation, and provide regular and necessary training for staff.

It is important to create awareness among health professionals and the broader community around the proper handling of waste to encourage safe and responsible disposal practices. This study provides valuable information to improve waste handling in hospitals, as well as to enhance the knowledge base of developing countries like Nepal, providing a basis for future studies and policies.

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