COMPREHENSIVE ASSESSMENT OF SECONDARY TRANSFER STATIONS IN RAJSHAHI CITY CORPORATION

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ABSTRACT

Rajshahi City has earned a global reputation for reducing harmful particles in the air. This city has already been awarded for being one of the cleanest cities of 2020 for its fresh air, clean roads, and green looks. As the population is increasing rapidly in this city like the rest of the country, solid waste management has already become a serious challenge for both the Rajshahi City Corporation and its residents. As a result, a decent number of secondary transfer stations (STSs) have been established to reduce unauthorized roadside waste dumping throughout the city. Although the current model of STS in Rajshahi City is inspired by other cities like Dhaka, the practice is far from being standard. This study focuses on the performance of the STS in terms of municipal waste management. To initiate this study, a survey was conducted where both general and technical information about the STS in Rajshahi City Corporation was collected. This study also shows a comparison between the ideal transfer stations and the stations established in Rajshahi City. This study indicates that the primary source of solid waste is households, attributed to the absence of industrial activities in the city. Consequently, the waste management process has been significantly simplified for the local authority. Additionally, the research underscores the absence of systematically planned waste collection coverage for each station. It emphasizes the importance of optimizing waste collection routes to enhance the overall efficiency of the process. This paper highlights the limitations of the existing STSs and provides suggestions to ensure better optimization of the whole process, starting from door-to-door waste collection to the transfer to the disposal site.

Keywords: *Secondary transfer station, challenges, solid waste management, Rajshahi City Corporation*.

1. INTRODUCTION

Bangladesh is the eighth most populous (DoS, 2022) (Cinzano et al., 2001) country with a population of 169.4 million according to 2021 and the fifth most densely populated country in the world having 1329 persons living in sq. km (Ara, 2013). Like other countries, Bangladesh is also facing similar adversity as the amount of waste generated from domestic and commercial activities is increasing day after day in the large cities including Rajshahi city. About 39.7% of the population is urban which covers Rajshahi's population (Hossain, 2023). Rajshahi is the 4th largest Metropolitan City of Bangladesh and one of the most prominent cities in the northern region of Bangladesh. The city was declared a City Corporation in 1991 with 284056 urban population that have reached 962,000 urban populations by the year 2023 (Zahur, 2007); (Faridatul& Jahan, 2014). Waste management is a big necessity for the municipality. Solid waste management becomes more imposing when the municipality consists of different classes of people (Ahmed et al., 2019).

Waste is an unavoidable by-product of human activities, economic development, urbanization, and improving living standards in cities, have led to an increase in the quantity and complexity of generated waste. The waste generation rate in the RCC area has increased from 100 tons to approximately 350 tonnes of solid waste every day while the amount increases to 400 tonnes during summer compared to 1994. However, the waste collection and management system has not improved significantly. Thus its proper management is a prerequisite (Ahmed et al., 2019).

The secondary transfer station is an intermediate point that includes picking up waste from community bins, waste storage depots, or transfer stations, storing them temporarily, and then transporting them to waste processing sites or to the final disposal site. STS has a remarkable significance in waste management systems. STS can effectively handle waste within a maximum radial distance of approximately 500m-550m(Rahman, 2015). The STSs play a crucial role in the collection system, contributing to (i) reduction in transportation costs; (ii) volume reduction through compaction of the waste; and (iii) flexibility in final processing/disposal facilities. (iv) increasing collection frequency (Cui et al., 2011; Yadav et al., 2016).

The STSs serve as junctions where smaller collection vehicles (primary) and larger collection vehicles (secondary) intersect(Yadav et al., 2017). However, larger collection vehicles prove to be more cost-effective than smaller ones for the extended transportation of Municipal Solid Waste (Eiselt, 2007)**.** Nhubu et al., (2021**)** highlight that STSs serve as essential infrastructure for transferring municipal solid waste (MSW) from light-weight carrying vehicles to heavy-weight carrying vehicles. The incorporation of both light and heavy vehicles in an MSW collection system leads to cost reductions compared to relying solely on primary waste collection vehicles.

Before selecting a location for a transfer station, it is crucial to consider various factors, including land use patterns, road conditions, access to the major transportation routes, rate of waste generation, space available for on-site roadways, and parking. Additionally, factors like space available for composting and recycling, future extension, and buffer space should also be taken into consideration(Zemanek et al., 2011). The selection of STS locations should also aim to minimize the overall cost of the MSW management system, similar to addressing other facility location problems(Owen & Daskin, 1998). Singh & Satija, (2020) mentioned in a study that land cost factors must be taken into consideration when constructing new Waste Transfer Stations and waste disposal plants. Daryabeigi Zand et al., (2019) suggest locating the STSs away from residential areas to reduce noise pollution. Tabassum, (2020)highlights the importance of considering the coverage area of existing Sanitary Transfer Stations (STS) when locating a new STS. This ensures the efficiency of the newly built facility and optimizes waste management operations.

Several studies have addressed the environmental impacts of Sanitary Transfer Stations (STSs) and proposed suggestions to improve the overall effectiveness of the process. Daryabeigi Zand et al., (2019)proposed the consideration of implementing specific waste collection times and operational hours to minimize concerns related to odor and pests. They also recommended enhancing STSs with

leachate treatment systems and refinement facilities systems for underground water resource protection. However, Singh & Satija, (2020) suggested that the sanitation staff and officials should undergo training provided by well-trained sanitation officials from other smart cities within the country or from other nations with successful waste management systems.

This study is based on a survey conducted within the STSs of Rajshahi City Corporation, focusing on data related to operational processes, spatial considerations, environmental impacts, and the workforce, among other aspects. The anticipated outcome of this research is to offer a critical understanding of the present physical and environmental status of the STSs in Rajshahi City. Furthermore, the paper proposes recommendations aimed at enhancing the current waste collection and management practices through STS, drawing comparisons between the existing STS in Rajshahi City and the ideal models.

2. METHODOLOGY

2.1 Study Approach

The research commenced with the establishment of clear objectives, achieved through an in-depth review of existing literature on STS. This comprehensive literature review not only defined STS and its characteristics but also elucidated the various ways STS could enhance operational efficiency and overall performance. Following this, the second phase involved conducting a field survey focused on STSs. The survey encompassed both general information, such as location and establishment year, as well as technical details like the number of personnel involved, environmental impact, types of waste handled, and the overall operational process. The study approach is shown in Figure 1.

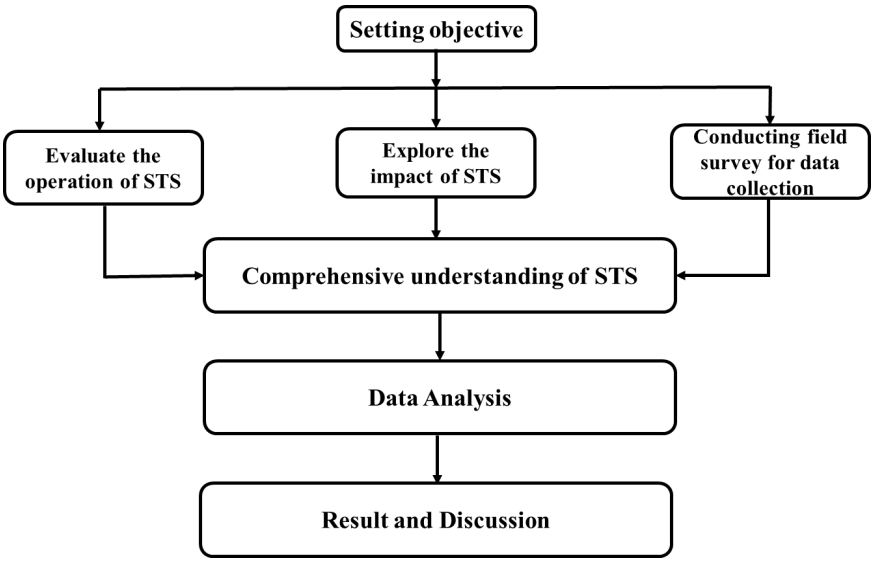

Figure 1: Study Approach

Subsequently, the collected survey data underwent rigorous statistical analysis. This analytical approach enabled the researchers to discern significant trends and patterns in the data, leading to insightful conclusions regarding the impact of STS on solid waste management within the city. Lastly, the research findings from the statistical analysis were thoughtfully discussed in light of the previously reviewed literature. Through this discussion, the research paper delved into the implications of the results and offered potential directions for future research in the realm of solid waste management and STS utilization as shown in Figure 1.

2.2 Location of the Study Area

Rajshahi, the center of the Rajshahi division is located in the North-western part of Bangladesh. Rajshahi City Corporation (RCC) is located between 24°20' and 24°24' north latitudes and in between 88°32' and 88°40' east longitudes. The topography of this metropolitan area is flat. Moreover, about 0.85 million people are living in Rajshahi City of 96.72 sq km area (WaterAid, 2018). This huge population daily produces about 420 tons of municipal waste of which a small portion is collected and disposed of in waste dumping sites. According to Rajshahi City Corporation, there were 20 function STSs at the time of the study as shown in Figure 2. Table 1 presents the operational STSs within Rajshahi City Corporation and their respective area coverage. Notably, the study revealed the absence of a defined route planning for waste collection from the source to the STS. However, during the survey, ongoing construction of additional STS infrastructure was found, such as the new STS near C&B, Rajshahi.

Figure 2: Secondary transfer stations in Rajshahi City Corporations

Table 1: List of the STS with their corresponding area coverage

Name of STS	Ward No.	Name of STS	Ward No.
Borokuthi	12,9,22,20	Court Walton	5
Terokhadia	2	New Degree College	7
RU	30	Adorsho School	27
RMC	13	Tikapara Eidgaon	20
Kazla	28	Madrasha Math	12
Sericulture	24	Kashiyadanga Fire Service Mor	13
Bondhogate	3,14,11,10	Match Factory	29
Near Mission Hospital	8	TTC College	15
Jamalpur/Captian Monsur Ali Park	19	Nowdapara Aamchottor	10
Veripara Mor	9	RMC Hospital	13

To ensure comprehensive coverage, the study focused on examining 12 out of 20 functioning transfer stations in the city. The data collected from these 12 stations formed the basis for the analysis and insights into the current state of STS and its impact on solid waste management in the area.

4. RESULTS & DISCUSSION

The survey of the STSs encompassed a thorough analysis of several key aspects related to waste management. These included the waste management process itself, assessing factors like environmental impact, workforce and safety protocols, storage capacity, and daily withdrawal rates in the STS facilities. Additionally, the study delved into the specifics of the vehicles employed in the waste management process, such as their type, capacity, total number, and frequency of trips they make. Through this analysis, the research sought to gain valuable insights into the efficiency and effectiveness of waste management practices at the STSs.

4.1 Waste Dumping

Based on the observations depicted in Figure 3, it is evident that the citizens of Rajshahi City Corporation dispose of their waste through various means. A significant portion of the total waste is improperly dumped alongside the road, constituting a substantial proportion. Additionally, approximately 43% of the total waste is deposited in designated dustbins, indicating some level of proper waste disposal practices.

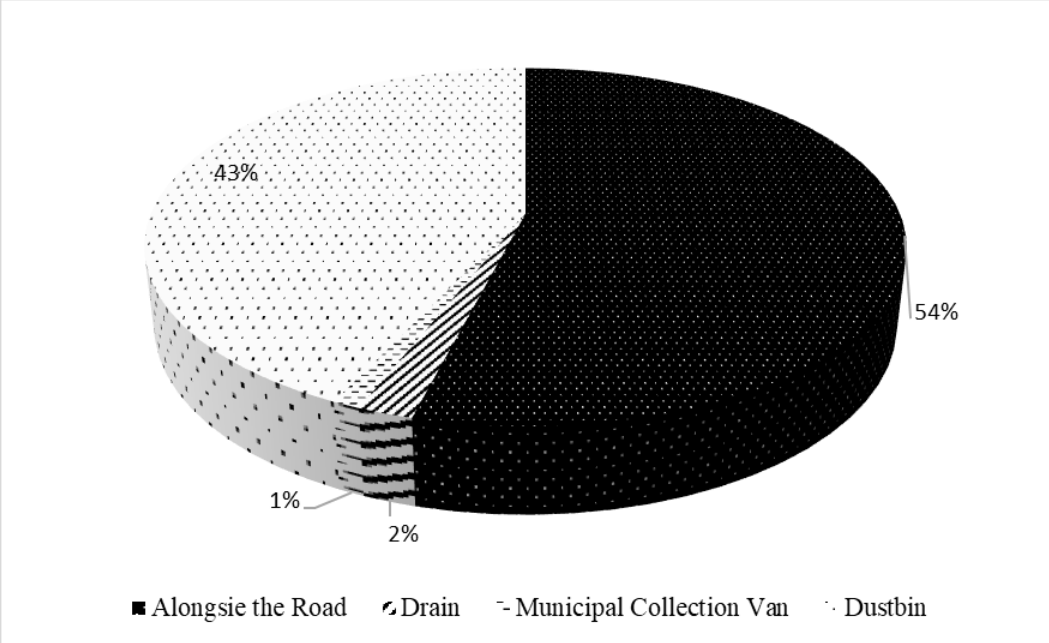

Figure 3: Waste dumping points used by the citizens of Rajshahi City Corporation

Moreover, the collection van is responsible for collecting a mere 1% of the overall waste, while around 2% of the total waste finds its way into drains, signifying potential environmental hazards. These findings highlight the need for more effective waste management strategies to mitigate improper disposal practices and ensure a cleaner and healthier environment for the city.

4.2 Sources of Municipal Solid Waste Generation

According to the pie chart in Figure 4, residential buildings stand out as the primary source of waste generation, contributing a significant 77.18% of the total Municipal Solid Waste (MSW). Following closely is the waste generated by institutions, accounting for 18.59% of the total waste produced.

The remaining portion of waste generation is attributed to municipal services and commercial establishments. These sources collectively account for the remainder of the MSW generated in the area. This data underscores the critical role of residential buildings in overall waste generation and emphasizes the need for targeted waste management strategies to address this substantial segment effectively.

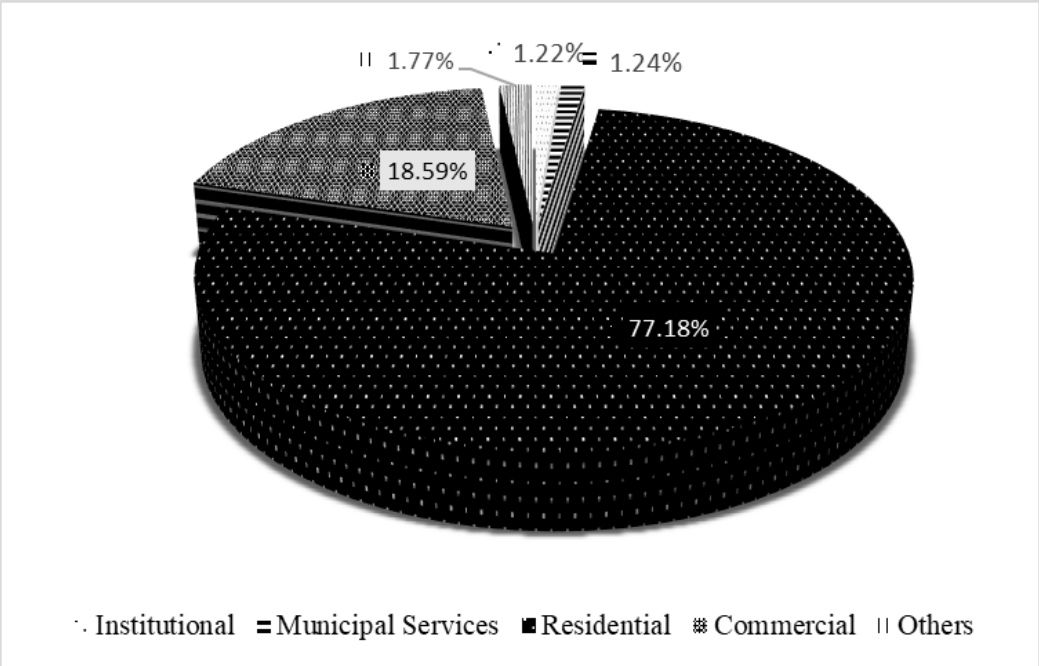

Figure 4: Contribution of different sources to MSW generation in Rajshahi City Corporation

4.3 Withdrawal Rate

Based on the data presented in Figure 5, it is evident that Ghora Chattar experiences a substantial daily waste deposition of approximately 80 tonnes. To manage this waste influx, the survey analysis reveals that around 20 vans, each with a capacity of 100 kg, deposit waste at the STSs for temporary storage. Subsequently, 14 hydraulic trucks with a capacity of 3 tons are employed during the nighttime to collect and transport the accumulated waste for permanent disposal. Similarly, in Borokuthi and Terokhadia, approximately 50 tonnes of waste are deposited per day. As for other STSs, the average daily withdrawal rate stands at approximately 30 tonnes. These figures emphasize the varying waste disposal demands across different locations, necessitating tailored waste management strategies to effectively handle the waste volumes and ensure efficient solid waste management throughout the city.

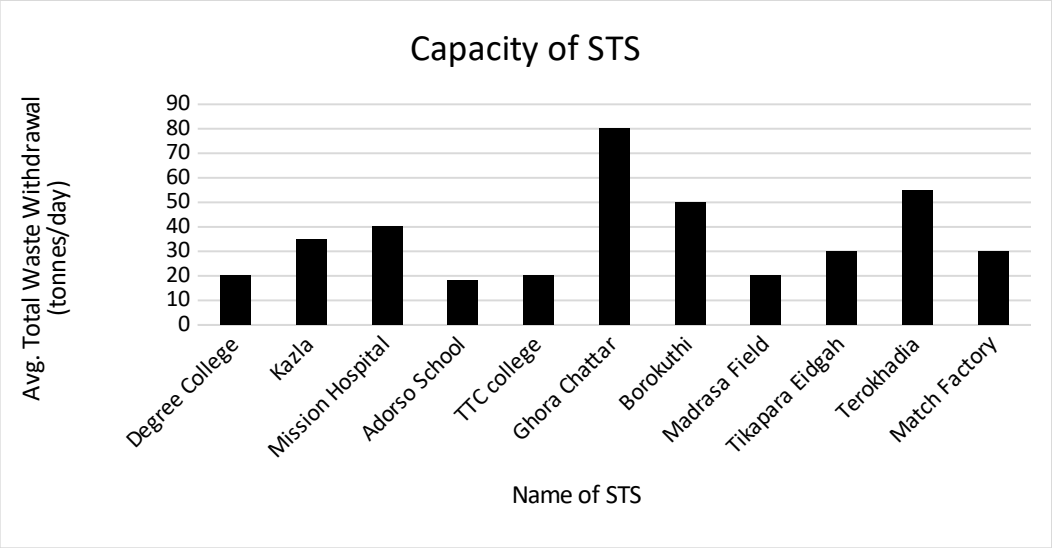

Figure 5: Withdrawal rate of STS

4.4 Number of Vehicles

From the information presented in Figure 6, we gain insights into the distribution of vehicles used for waste transportation. Ward Rickshaws emerge as the most widely used vehicles, constituting approximately 44.44% of the total. Following closely are Ward Wheelbarrows, accounting for around 22.22% of the usage.

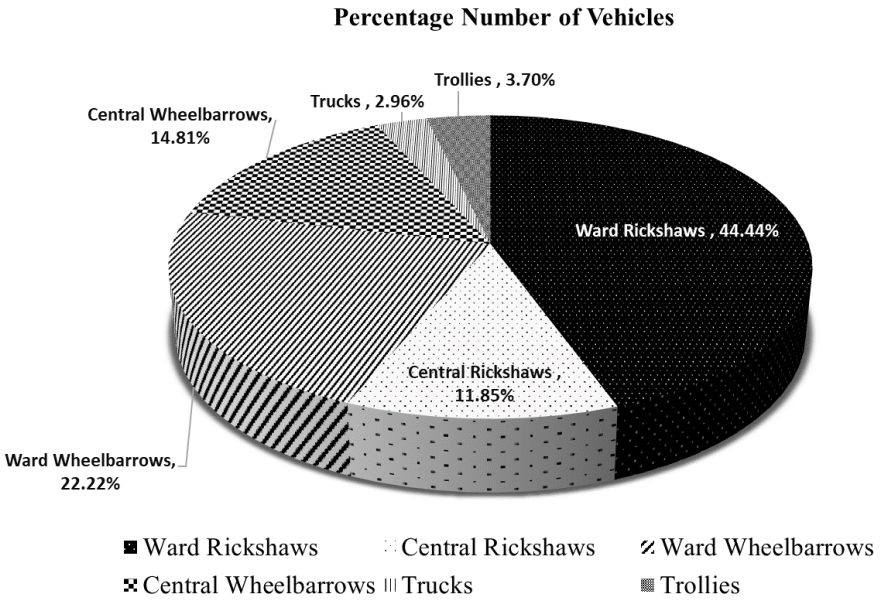

Figure 6: Number of Vehicles used in the waste collection process(Rakib Hasan et al., 2020)

On the other hand, trucks are utilized the least for waste transportation, representing the smallest percentage of approximately 2.96% among all the vehicles. This pie-chart analysis highlights the prevalence of Ward Rickshaws as the primary mode of waste carriage, indicating their popularity and efficiency in waste management operations within Rajshahi City. Meanwhile, trucks are comparatively less favored, potentially reflecting their limited use for waste transportation in the city.

4.5 Comparison between Ideal STS and Existing STS in Rajshahi City Corporation

To optimize the efficiency of solid waste transfer and transportation, transfer stations should adhere to certain essential criteria. These include strategic location, well-designed layout, stringent health and safety measures, environmental considerations, effective waste compaction, and meticulous record-keeping.

4.5.1 Location

The transfer station should strategically align with high-waste generation areas, optimizing proximity to urban or industrial centers to reduce transportation distances and costs. Adherence to local zoning laws, favoring waste management or industrial zones, prevents conflicts with residential areas. Optimal accessibility near major roads or rail lines enhances efficient waste transportation. Selection must avoid environmentally sensitive zones, conducting thorough impact assessments to ensure minimal ecological disturbance. Community engagement is crucial; involve residents early to address concerns, provide transparent information, and minimize visual and odor impacts for increased public support.

In Rajshahi, the transfer stations are strategically positioned to serve multiple wards efficiently. These stations are conveniently accessible from various modes of transportation and thoughtfully situated at a sufficient distance from residential neighborhoods. For instance, the Borokuthi STS is strategically located at the center of wards 9, 12, 20, and 22. Its placement away from residential areas ensures minimal impact on nearby homes, while its easy accessibility allows for seamless waste transportation using diverse transportation options.

4.5.2 Design and Layout

The layout should enable smooth traffic flow for waste vehicles and larger trucks, with designated inbound and outbound areas to minimize congestion. Defined zones for waste handling, sorting, recyclable storage, and temporary waste storage optimize recycling and prevent contamination. Adequate space is necessary for safe vehicle movement and to reduce the risk of accidents. Design features, like ventilation systems, control odors, and deter pests, creating a better work environment and minimizing community impact.

In Rajshahi, the transfer stations currently operate without sorting operations, leading to the direct disposal of waste in large quantities. Upon disposal, the waste is immediately transferred to transfer trucks. However, due to the lack of available machinery, waste compaction is impossible, resulting in higher transportation costs. However, the transfer stations undergo daily cleaning after waste disposal. Safety measures such as proper lighting and pedestrian walkways are in place to ensure a secure environment. Despite these efforts, there is room for improvement, and upgrades are necessary to enhance the efficiency of waste operations. Among the transfer stations, the Bondhogate Transfer Station stands out as it fulfills all design considerations, making it a model facility for smoother waste management operations. Upgrading the other stations to meet similar design standards can significantly improve waste-handling processes and overall effectiveness.

4.5.3 Heath and Safety Measures

Ensuring the right fit of personal protective equipment (PPE) is vital for health and safety at a transfer station. Workers handling waste need appropriate gear like gloves, safety goggles, masks, or respirators to safeguard against injuries, exposure to hazardous substances, and respiratory issues from dust or fumes. Comprehensive training is key, covering potential hazards, waste handling, separation, equipment use, and emergency procedures. Ongoing education reinforces safety practices. STSs handling hazardous materials require careful handling, storage, segregation, and clear labeling. Emergency response plans, fire safety measures, strategically placed extinguishers, marked exits, and trained teams ensure preparedness—waste containment systems and proper ventilation control environmental risks, creating a safer workplace.

At the transfer stations in Rajshahi, the employees working do not consistently wear safety gear. Only a few workers can be seen wearing rubber gloves and thick-soled boots. Furthermore, there is no observation of safety equipment being used by workers who transport garbage from generation locations. Since these transfer stations do not handle hazardous waste, additional safety equipment like Personal Protective Equipment (PPE) or a separate area for hazardous waste processing is unnecessary. Once all the waste produced during the day is loaded onto vehicles, the transfer stations undergo daily cleaning. They do not engage in any storage operations, as daily trash is promptly transported to disposal sites at night. Specific officials or supervisors are responsible for overseeing all tasks at the transfer stations. The transfer stations in Rajshahi are located far from residential areas, and waste disposal occurs at night. Consequently, these measures effectively control odors and dust. Additionally, the transfer stations are properly lined with concrete to prevent leaks and spills. Among the transfer stations, the Bondhogate Transfer Station provides some safety equipment, while other stations seem to lack interest in using safety equipment consistently.

4.5.3 Lacking in STS System

The lack of STS system is summarised as follows in brief with necessary suggestions for future development:

1. The absence of specific regulations regarding waste collection coverage for each station can lead to ward overlap issues, resulting in inefficiencies, wastage of resources, and workforce redundancy. Properly planned collection routes and optimization strategies can address these challenges.

2. While some transfer stations have sufficient infrastructure, many still require improvements to enhance the waste-handling process. Proper drainage and leachate facilities are essential for effective solid waste management, and their incorporation should be a priority.

3. The location of each STS is crucial for optimizing waste management processes, involving collection routes and workforce management. Decisions on location selection should prioritize efficiency and suitability rather than just space availability.

4. The lack of compaction facilities at all STS leads to frequent waste collection trips. Introducing proper compaction facilities could significantly reduce the number of trips and result in cost savings.

5. The absence of on-site composting and recycling facilities in Rajshahi City limits recycling options, leading to significant waste transportation to the disposal site. The city should focus on developing more recycling opportunities and facilities.

6. The study highlights the lack of measures to address fly and odor issues at the STS, indicating insufficient attention to environmental impacts.

7. Training for workers related to waste collection and transfer is inadequate, and the study found no signs of using safety equipment, posing risks to worker safety and health.

8. The transfer station in Bondho Gate sets an example for other stations with its efficient waste handling procedures, use of advanced tools and equipment, and optimized management. For the development of a sustainable waste management system, several crucial criteria must be taken into account, which is currently absent in the current practices of Rajshahi City Corporation. These criteria include analyzing the land use pattern, providing sufficient space for onside roadways, queuing, parking, and allocating space for recycling and composting activities.

5. CONCLUSION

The survey of STSs in Rajshahi City Corporation has provided valuable insights into waste management practices. It reveals that a significant portion of waste is improperly dumped on roadsides and dustbins, with only 1% collected by the waste collection van supervised by the city corporation. While the current number of transfer stations seems sufficient for waste generation, the

rising population indicates the need for additional stations. However, concerns arise regarding the location selection of new transfer stations, as the focus appears to be more on space availability than suitability and efficiency. Optimizing waste collection routes and considering coverage across transfer stations can greatly enhance waste management practices. In terms of infrastructure, transfer stations in Borokuthi and Bondho Gate exhibit superior waste collection capacity and more advanced equipment, serving as benchmarks for other stations to upgrade. However, certain transfer stations with high withdrawal rates lack adequate infrastructure, leading to waste dumping issues and posing environmental threats, particularly exemplified by the transfer stations near Adarsha School.

Overall, the study underscores the importance of comprehensive planning and infrastructure development to ensure effective waste management in Rajshahi City. Implementing suitable location strategies, optimizing waste collection routes, and upgrading transfer station infrastructure are essential steps toward a sustainable and efficient waste management system for the growing city.

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