Challenges And Solutions In Solid Waste Management In Nepalgunj: Integrating Community Participation, Public Awareness, And Infrastructure For Sustainability"

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Abstract
Solid waste management is a critical issue in Nepalgunj, a city in western Nepal, due to rapid urbanization, population growth, and inadequate infrastructure. This study aimed to identify the challenges and solutions of solid waste management in Nepalgunj, focusing on community participation, public awareness, and infrastructure. A quantitative research design was adopted, and data were collected through questionnaires distributed to residents. The study found that the primary sources of solid waste generation in Nepalgunj are household waste, industrial waste, and plastic waste. The lack of proper infrastructure and awareness about solid waste management were identified as significant challenges. The study also revealed that while the majority of respondents recognize the importance of managing solid waste responsibly, many are not aware of recycling or composting methods. Improper solid waste disposal poses significant health and environmental risks to Nepalgunj residents, including air and water pollution, respiratory illnesses, and water contamination.
To address these challenges, the study proposed practical solutions, including reducing waste at its source, separating recyclables, and building better waste facilities. Promoting waste minimization at the source through education, awareness campaigns, and incentives can significantly reduce the volume of waste generated. Waste management infrastructure, including waste collection, transportation, and disposal facilities, is essential for improving service delivery and reducing environmental pollution. Community involvement, government authorities' role, and implementing policies and regulations to reduce the use of single-use plastics and promote sustainable alternatives are crucial for effective solid waste management.
The study's key findings highlight the importance of community participation, public awareness, and infrastructure in solid waste management. The study's implications for action include setting up more bins for trash collection in crowded areas, providing separate bins for different types of solid waste to promote recycling, educating residents about the benefits and methods of composting at home, and advocating for policies and regulations to reduce the use of single-use plastics and promote sustainable alternatives.

Keywords: *Solid waste management, community participation, public awareness, infrastructure, Nepalgunj, recycling, composting, single-use plastics, sustainable alternatives.*

Introduction

Solid waste management is the systematic handling of waste materials generated by human activities, aiming to minimize its impact on public health and the environment. The main objectives are to reduce, reuse, recycle, and recover waste materials, which can be achieved through waste reduction programs, promoting sustainable practices, and enforcing proper waste disposal regulations. The process begins with waste collection, followed by transportation to treatment facilities or recycling centers, where waste is sorted, separated, and processed based on its composition. Recyclable materials like paper, plastics, glass, and metals are sent to recycling facilities.

In Nepalgunj, a city in western Nepal, solid waste management faces significant challenges due to rapid urbanization, population growth, and inadequate infrastructure. The city generates a large amount of solid waste daily, including household, industrial, and commercial waste, leading to environmental and health concerns if not managed properly. Limited resources, inadequate infrastructure, and lack of public awareness are the main challenges in managing waste effectively in Nepalgunj. Sustainable solutions that prioritize waste reduction, recycling, and proper disposal are essential to ensure a cleaner and healthier environment for its residents. Collaboration between the government, local authorities, and community stakeholders is crucial to make significant progress in waste management practices in Nepalgunj.

To improve solid waste management in Nepalgunj, several steps can be taken, such as investing in better garbage collection trucks and more bins, reducing waste at the source through waste minimization, educating people about the importance of separating waste for recycling, encouraging businesses to use eco-friendly packaging and products, and organizing community clean-up events and campaigns to raise awareness and involve everyone in keeping Nepalgunj clean and beautiful. By working together and making small changes, a significant difference can be made in waste management in Nepalgunj.

Nepalgunj sub Municipality is actively engaged in addressing environmental challenges through various initiatives:

Solid Waste Management: Efforts are underway to improve waste collection, segregation, and disposal. The municipality promotes recycling and composting to reduce landfill waste.The Sub-Metropolitan authority in Nepalgunj has been actively engaged in managing solid waste to ensure a cleaner and healthier environment for its residents. It has implemented several steps to effectively manage solid waste in the area. The authority has established organized waste collection services, including door-to-door collection from residential areas and scheduled pickups from commercial and industrial zones.

Public Awareness Campaigns: Educational programs are conducted to raise awareness about the importance of environmental conservation and sustainable practices.

Objectives of the Research

The primary objective of this research is to investigate the challenges and potential solutions associated with solid waste management in Nepalgunj. The research aims to:

- Identify the primary sources of solid waste generation in Nepalgunj.
- Understand the specific difficulties faced by Nepalgunj in managing solid waste.
- Propose practical solutions to improve solid waste management practices in Nepalgunj.

Literature reviews

Solid waste management is a critical environmental issue that necessitates a multifaceted approach to address its social, economic, and environmental implications. The literature underscores the importance of community engagement, decentralized waste management solutions, and sustainable policies to mitigate the challenges of solid waste management (Maharjan, 2019; Pokhrel, 2005).

Research indicates that urbanization significantly drives waste generation, necessitating integrated waste management approaches to address the escalating waste crisis in urban areas (Hoornweg & Bhada-Tata, 2012). Public education campaigns play a crucial role in fostering awareness and understanding of the 3Rs (reduce, reuse, and recycle). Educating the public about the benefits of waste reduction, reuse, and recycling is essential to address environmental challenges (Smith, 2018).

Innovative solutions for waste treatment and resource recovery, such as waste-to-energy technologies, have been explored as potential alternatives to traditional waste management practices (Kumar, 2020). The social and economic dimensions of waste management, including inclusivity and equity in waste management policies and programs, are also critical considerations (Maharjan, 2019).

The impact of plastic pollution on marine ecosystems is a growing concern. Policy interventions and public awareness campaigns are necessary to address this issue (Bajracharya, 2022). Effective waste management strategies can reduce environmental pollution and improve public health outcomes, emphasizing the importance of data-driven decision-making and policy implementation (Torretta et al., 2019).

Furthermore, research highlights the importance of waste segregation, recycling, and composting in reducing waste disposal in landfills and mitigating environmental pollution (Tchobanoglous et al., 2003). The role of informal waste pickers in waste management systems has also been recognized. Including them in formal waste management systems can improve waste collection and recycling rates (Medina, 2005).

The use of geographic information systems (GIS) and remote sensing technologies can enhance waste management planning and decision-making by identifying areas of high waste generation and optimizing waste collection routes (Chen et al., 2018). Applying circular economy principles in waste management can promote sustainable consumption patterns and reduce

waste generation (Geissdoerfer et al., 2017).

Community engagement is vital for successful waste management. Localized, decentralized waste management solutions can provide more effective and sustainable outcomes (Maharjan, 2019; Pokhrel & Viraraghavan, 2005). Strategies that involve local communities in the planning and implementation stages ensure that the solutions are culturally appropriate and widely accepted.

Economic incentives and regulatory frameworks play a significant role in promoting sustainable waste management practices. For instance, implementing pay-as-you-throw (PAYT) systems can encourage waste reduction at the source by charging residents based on the amount of waste they generate (EPA, 2016).

Technological advancements in waste management, such as smart bins equipped with sensors, can improve the efficiency of waste collection and segregation processes. These technologies can provide real-time data on waste levels, optimizing collection routes and reducing operational costs (Meyer et al., 2020).

In addition to waste-to-energy technologies, other resource recovery methods such as anaerobic digestion and composting can convert organic waste into valuable byproducts like biogas and compost, further reducing the burden on landfills and contributing to a circular economy (Li et al., 2013).

In conclusion, the literature emphasizes the need for a comprehensive and integrated approach to solid waste management. This approach should incorporate the principles of reduce, reuse, and recycle; promote sustainable consumption patterns and circular economy principles; and enhance public awareness and education. Effective waste management requires collaboration between governments, communities, and the private sector to develop and implement sustainable and inclusive policies and practices.

Research Methodology

This study aims to investigate the challenges and solutions for solid waste management in Nepalgunj. To achieve this objective, a quantitative research design was adopted to collect and analyze data.

Research Design: The research design employed in this study is a survey, which involves collecting data through questionnaires distributed to a sample of respondents. This design was chosen to measure the challenges and solutions for waste management in Nepalgunj.

Sampling

Due to resource and time constraints, convenience sampling was used to select participants for this study. Convenience sampling is a non-probability sampling method that involves selecting individuals or items based on their availability and proximity to the researcher. A sample size of 105 residents from Nepalgunj was selected for this study.

Population and Sample

The population of interest for this study is the residents of Nepalgunj. However, due to

limitations, a sample of 105 residents was selected to represent the population.

Data Collection

Data was collected through a questionnaire survey, which was distributed to the selected sample of residents in Nepalgunj. The questionnaire was designed to gather information on the challenges and solutions for waste management in Nepalgunj.

Data Gathering Procedures

The data collection process involved distributing the questionnaires to the selected sample of residents in Nepalgunj. The questionnaires were self-administered, and respondents were asked to provide their responses based on their experiences and perceptions of waste management in Nepalgunj.

Instruments

The data collection instrument used in this study was a questionnaire, which consisted of closed-ended and open-ended questions. The questionnaire was designed to gather both quantitative and qualitative data on the challenges and solutions for waste management in Nepalgunj.

Data presentation and analysis

This section presents and analyzes primary data using the statistical models described earlier. It is divided into three sections:
Presentation and Analysis: Results of the questionnaire survey are presented and analyzed.
Correlation Analysis: Correlation analysis is covered.
Concluding Remarks: Concluding remarks are based on the findings from the primary data analysis.

Respondents Profile

The respondent or the participants were collected from the questionnaire survey. The respondents were from the various age and gender. The research was conducted among the residents of the Nepalgunj. The table below shows the details of respondent profile.

Data Presentation

Table 1

Respondent Profile by Gender

Respondents' Character	**Frequency**	**Percent**
Male	50	47.62%
Female	55	52.38%

Total	105	100%

Source. Field Survey and Questionnaire; March, 2024

Here in the table 1, out of 105 respondents, 50 are male i.e. 47.62%. Similarly, 55 respondents are female i.e. 52.38%.

Table 2

Respondent Profile by Age

Age	**Frequency**	**Percentage**
Below 30	70	66.67%
Between 30-45	30	28.57%
Above 45	5	4.76%
Total	105	100%

Source. Field Survey and Questionnaire,March 2024

In table 2, there are 70 respondents below 30 age, 30 are between 30-45 years and 5 are above 45 years which are 66.67%, 28.57% and 4.76% respectively.

Data Analysis

Table 3

Improvement in Solid Waste Management

Response	**Frequency**	**Percentage**
Yes	30	28.57%
No	75	71.43%
Total	105	100%

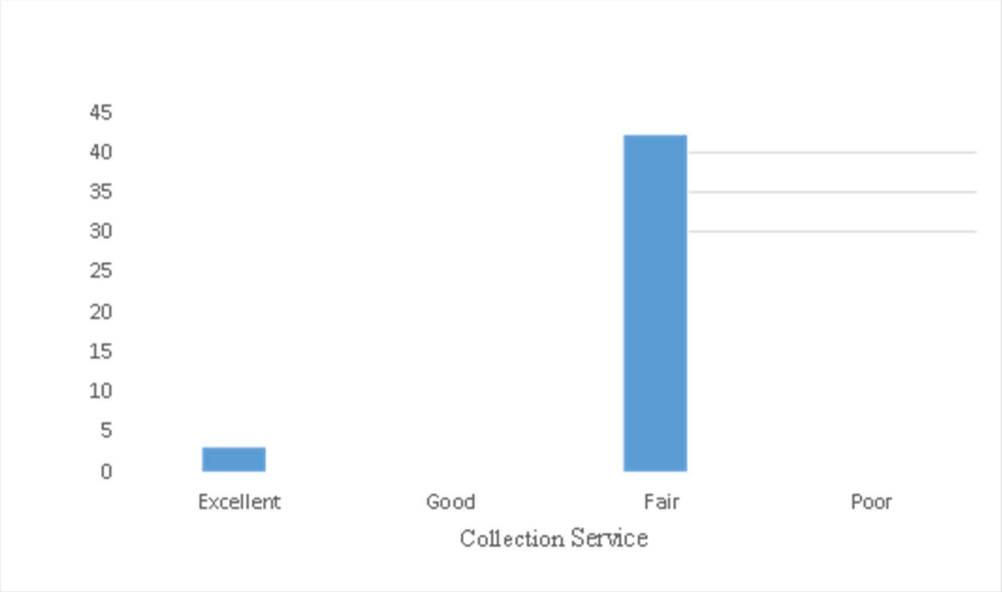
Source. Field Survey and Questionnaire, March 2024

From above table, among 105 respondents, 75 respondents said there is no improvement in solid waste management in Nepalgunj and remaining 30 respondents said there is some improvement in solid waste management in Nepalgunj, also in percentage 71.43% and 28.57% respectively.

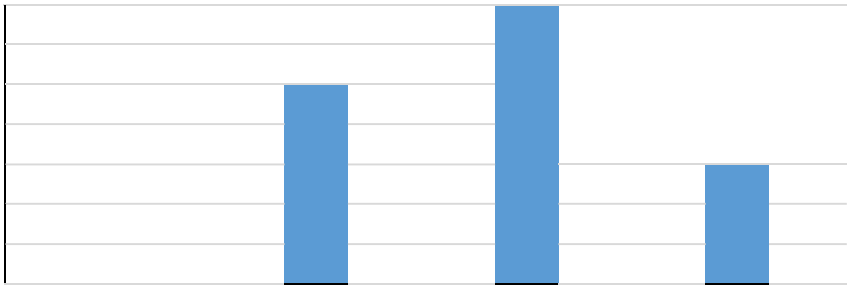
Table 4

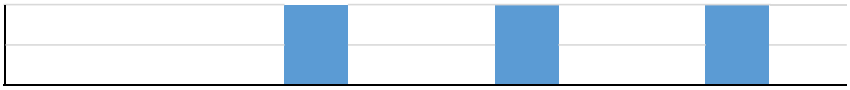
Solid Waste Collection Service

Responses	**Frequency**	**Percentage**
Excellent	3	2.86%
Good	35	33.33%
Fair	42	40%
Poor	25	23.81%
Total	105	100%



Source. Field Survey and Questionnaire,March- 2024





Frequency

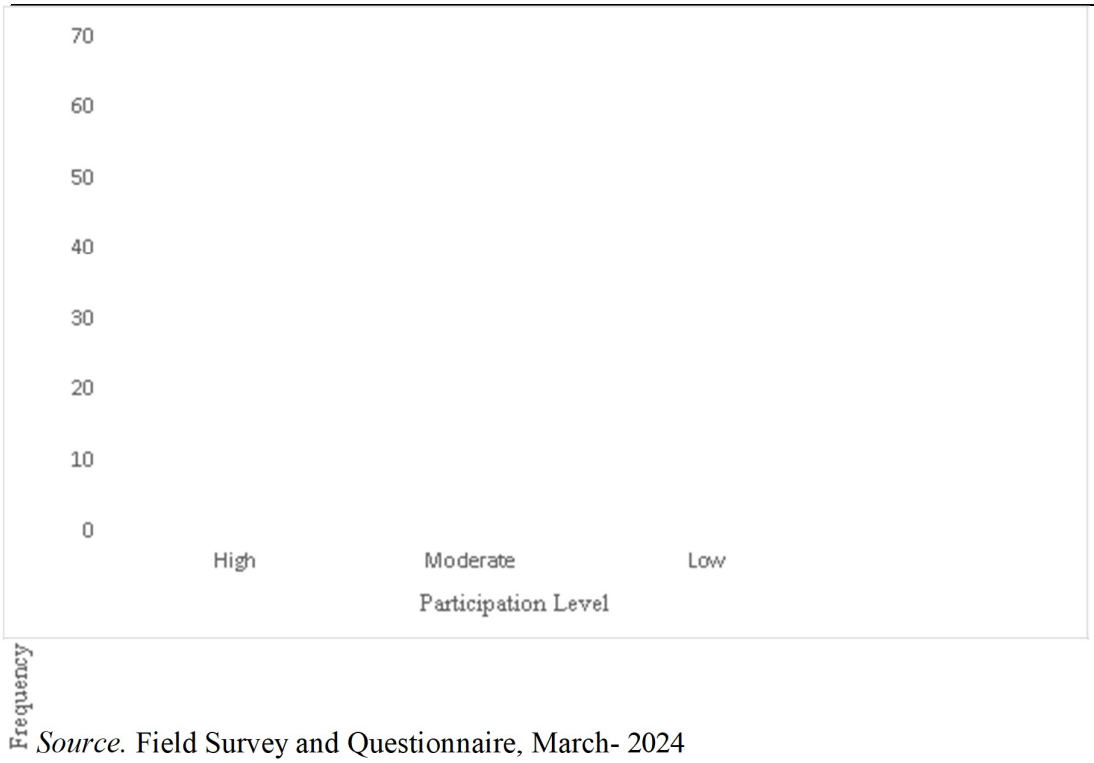
Figure 1. Solid Waste Collection Service

In above table and figure, among 105 respondents, 3 respondents said excellent for the current solid waste collection services, 35 respondents said good, 42 said fair and 25 said poor for the current solid waste collection services in Nepalgunj which is 2.86%, 33.33%, 40% and 23.81% respectively.

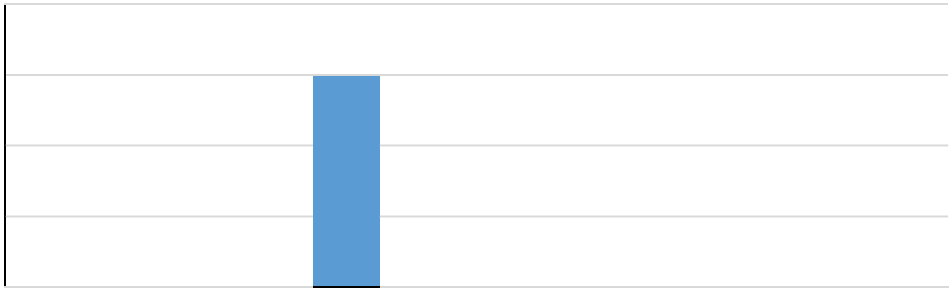
Table 5

Community Participation in Solid Waste Management.

Participation Level	Frequency	Percentage
High	16	15.24%
Moderate	59	56.19%
Low	30	28.57%
Total	105	100%



Source. Field Survey and Questionnaire, March- 2024



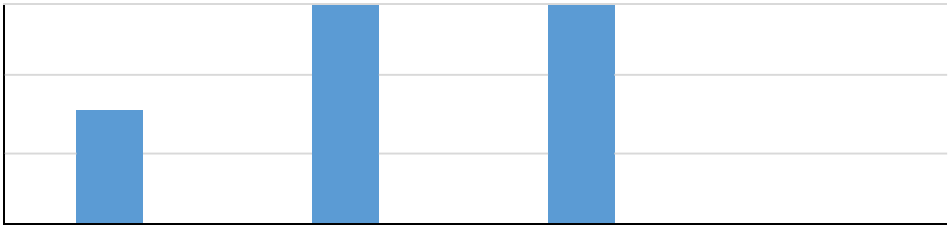


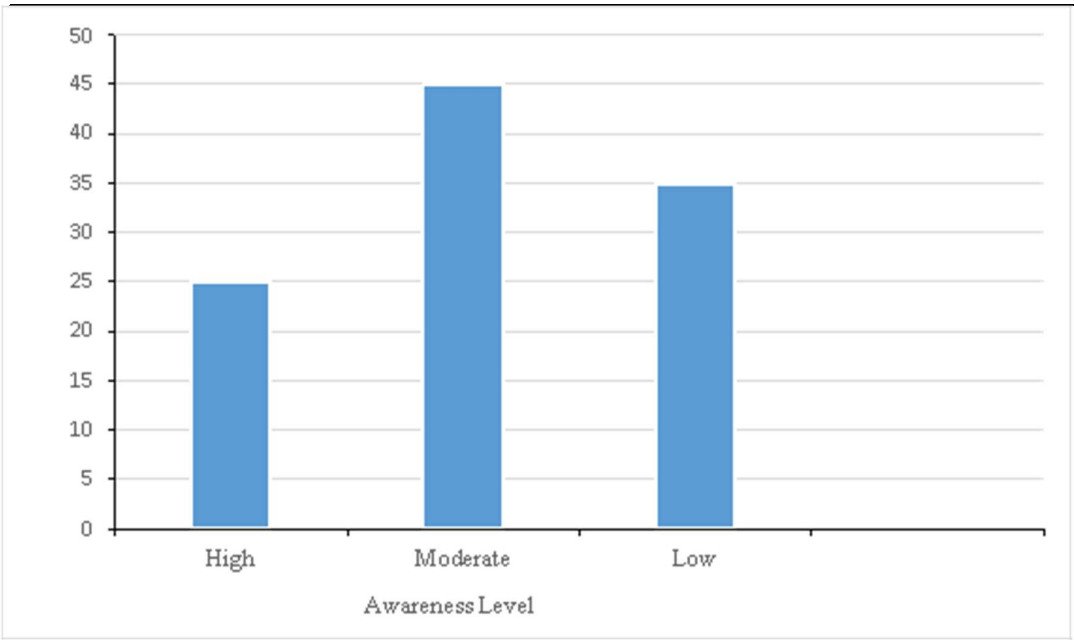
Figure 2. Community Participation in Solid Waste Management.

Above table and figure illustrates the level of community participation in solid waste management activities based on the responses of the respondents. Among 105 respondents, 16 respondents have high level of participation in the solid waste management activities, 59 respondents have moderate level of participation and 30 respondents have low level of participation in the solid waste management activities.

Table 6

Awareness Level of Proper Solid Waste Disposal Practices.

Awareness Level	**Frequency**	**Percentage**
High	25	23.81%
Moderate	45	42.86%
Low	35	33.33%
Total	105	100%



Source. Field Survey and Questionnaire 2024,March

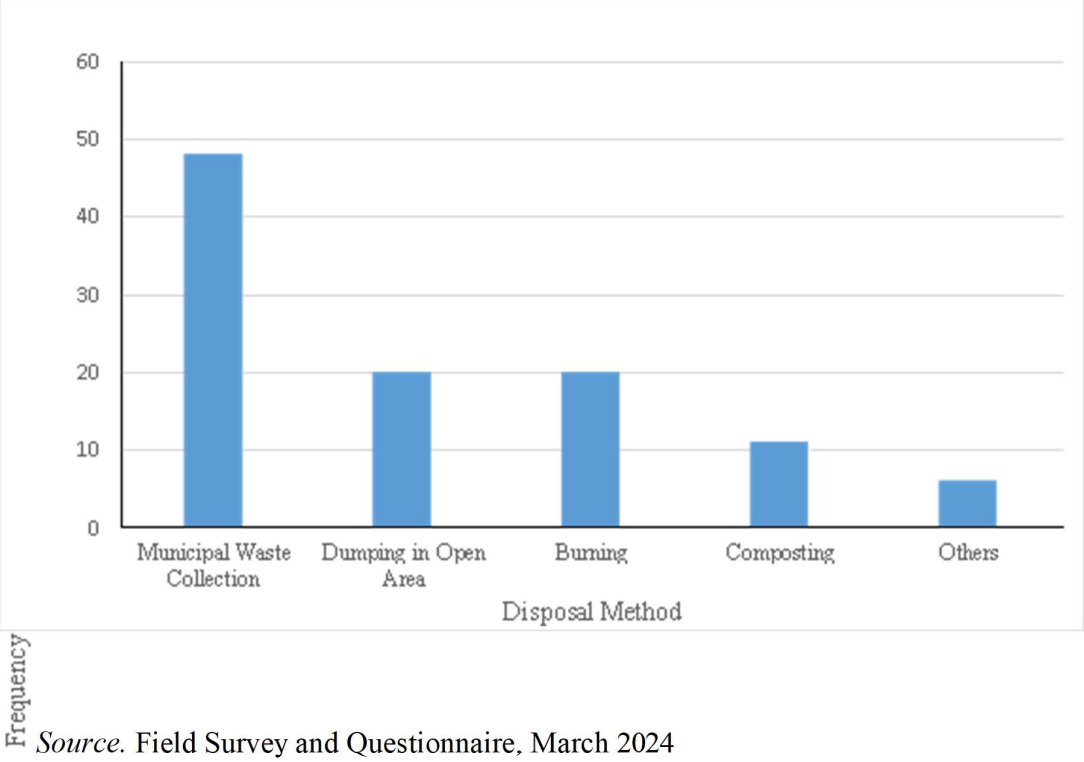
Figure 3. Awareness Level of Proper Solid Waste Disposal Practices.

Above table and figure illustrates awareness level of proper solid waste disposal practices based on the responses of the respondents. Among 105 respondents, 25 respondents are highly aware about the proper solid waste disposal practices, 45 respondents have moderate level of awareness and 35 respondents have low level of awareness about the proper solid waste disposal practices.

Table 7

Current Solid Waste Disposal Practices

Disposal Method	Frequency	Percentage
Municipal Waste Collection	48	45.71%
Dumping in Open Area	20	19.05%
Burning	20	19.05%
Composting	11	10.48%
Others	6	5.71%
Total	105	100%



Source. Field Survey and Questionnaire, March 2024

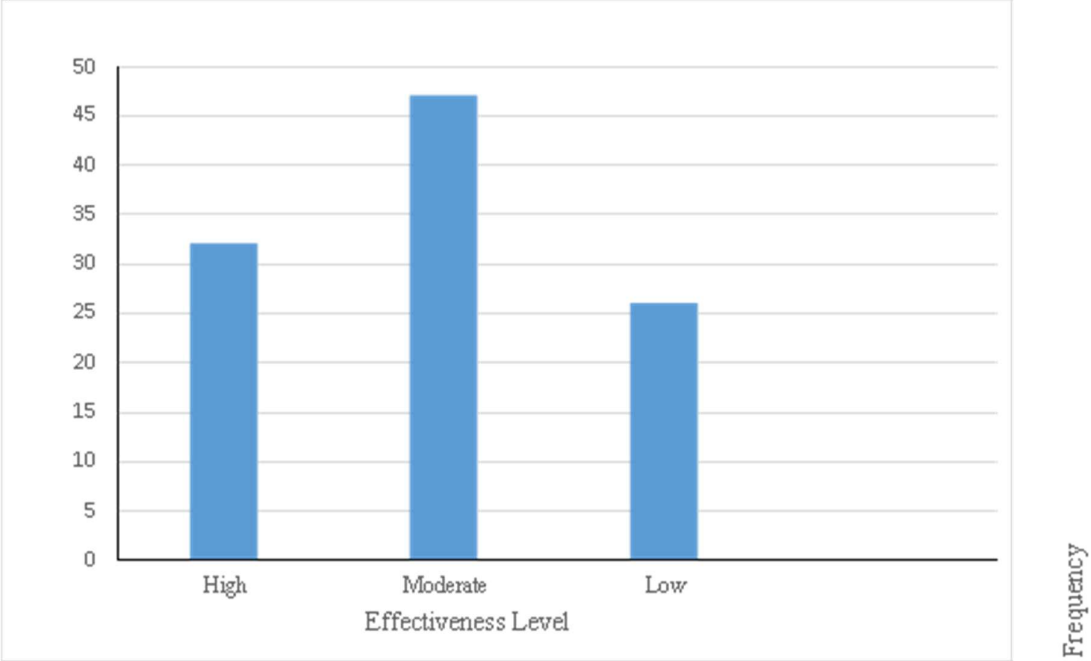
Figure 4. Current Solid Waste Disposal Practices

In above table and figure, 48 out of 105 respondents indicated using municipal solid waste collection services, 20 respondents reported dumping waste in open areas, 20 respondents mentioned burning waste as a disposal method, 11 respondents indicated composting as a waste disposal method and 6 of the respondents specified other solid waste disposal methods.

Table 8

Effectiveness of Public Awareness Campaigns.

Effectiveness Level	Frequency	Percentage
High	32	30.48%
Moderate	47	44.76%
Low	26	24.76%
Total	105	100%



Source. Field Survey and Questionnaire,March 2024

Figure 5. Effectiveness of Public Awareness Campaigns.

From above table and bar diagram, among 105 respondents, 32 respondents conclude that the awareness campaigns is highly effective, 47 respondents said there is moderate level of effectiveness of public awareness campaigns and 26 respondents conclude that the effectiveness level of public awareness campaigns is low.

Table 9

Support for Government Initiatives on Waste Reduction and Recycling.

Options	**Frequency**	**Percentage**
Strongly Support	50	47.62%
Support	45	42.86%
Neutral	10	9.52%
Oppose	0	0%
Strongly Oppose	0	0%
Total	105	100%

Source. Field Survey and Questionnaire, March2024

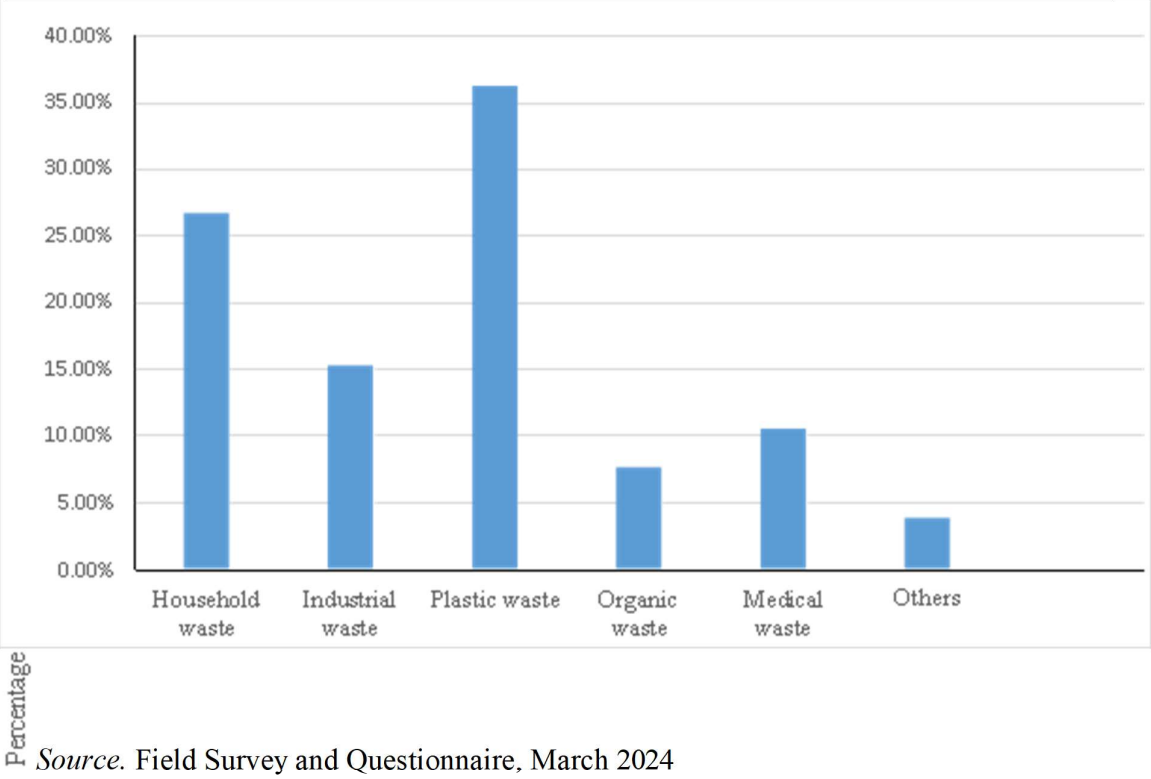
The table presents the responses of 105 individuals regarding their stance on government initiatives for waste reduction and recycling. Among the respondents, 50 expressed strongly support for these initiatives, 45 respondents indicated Support. A smaller subset of 10 respondents chose the neutral option, suggesting a lack of strong opinion or stance on the matter. There were no respondents who expressed both Oppose and strongly oppose options received zero responses.

Challenges of Solid Waste Management in Nepalgunj

Table 10

Types of Solid Waste Generated

Types of Waste	Frequency	Percentage
Households waste	28	26.66%
Industrial waste	16	15.24%
Plastic waste	38	36.19%
Organic waste	8	7.62%
Medical waste	11	10.48%
Others	4	3.81%
Total	105	100%



Source. Field Survey and Questionnaire, March 2024

Figure 6. Types of Solid Waste Generated

In above table and figure, most of the respondents i.e. 36.19% think plastic is the biggest challenge in Nepalgunj. 26.66%, 15.24%, 7.62%, 10.48% and 3.81% of respondents think

the biggest challenges of waste management in Nepalgunj is Household, industrial waste, organic waste, medical waste and other waste respectively.

Table 11

Impact of Poor Solid Waste Management on Environment.

Impacts	**Frequency**	**Percentage**
Pollution	48	45.71%
Health Hazards	50	47.62%
Habitat Destruction	4	3.81%
Others	3	2.86%
Total	105	100%

Source. Field Survey and Questionnaire, March 2024

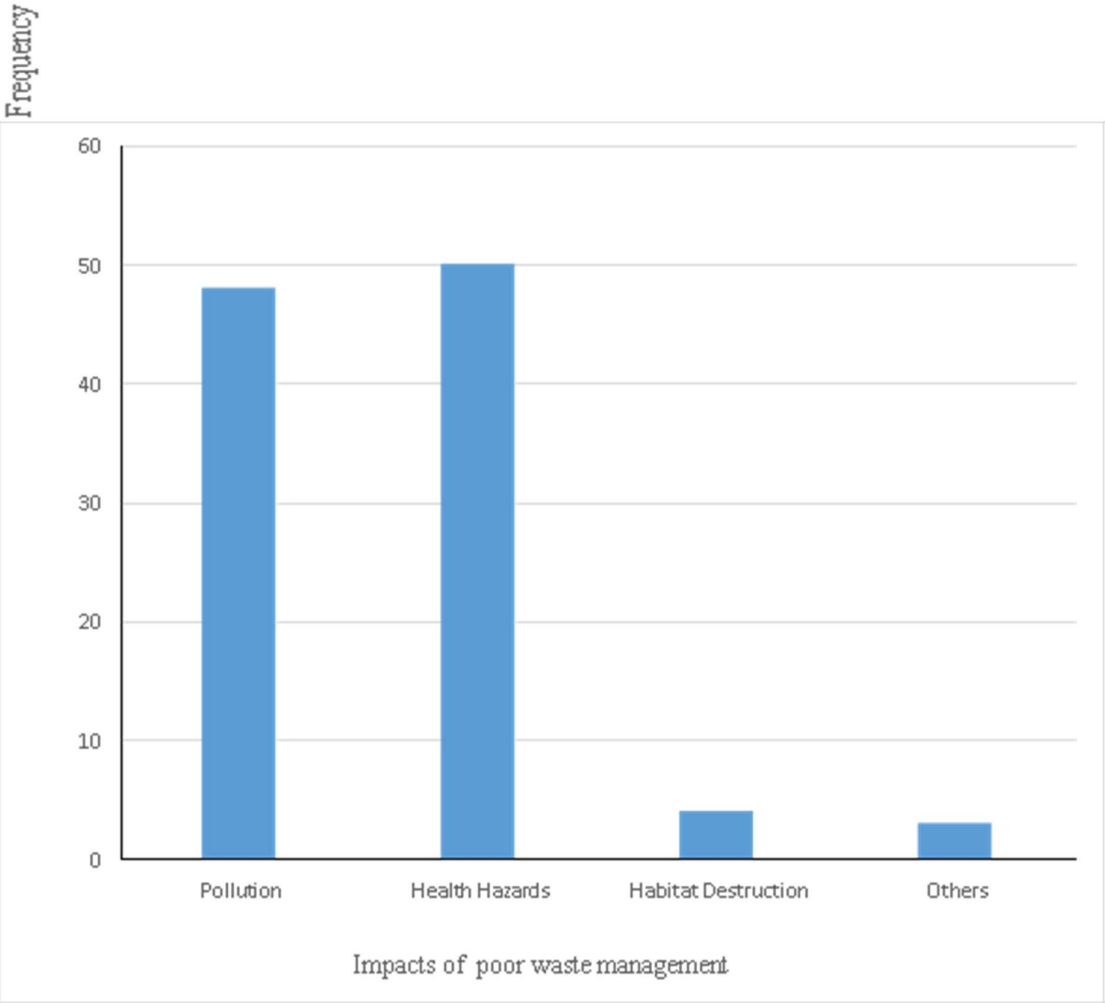


Figure 7. Impact of Poor Waste Management on Environment.

Above Table and Figure illustrates impact of solid waste management on environment based on the responses of the respondents. Among 105 respondents, 48 respondents said the poor solid waste management pollutant the environment, 50 respondents said the impact of poor solid waste management affects the health of the people, 4 respondents said that the poor solid waste management causes habitat destruction and remaining 3 respondent said there is also other impacts of poor solid waste management.

Table 12

Specific Solid Waste Management Difficulties Faced by Nepalgunj.

Difficult Aspects	**Frequency**	**Percentage**
Lack of Proper Infrastructure	32	30.48%
Limited Public Awareness	22	20.95%
Insufficient Funding	20	19.05%
Rapid Urbanization	16	15.24%
Lack of Community Involvement	11	10.47%
Others	4	3.81%
Total	105	100%

Source. Field Survey and Questionnaire,March 2024

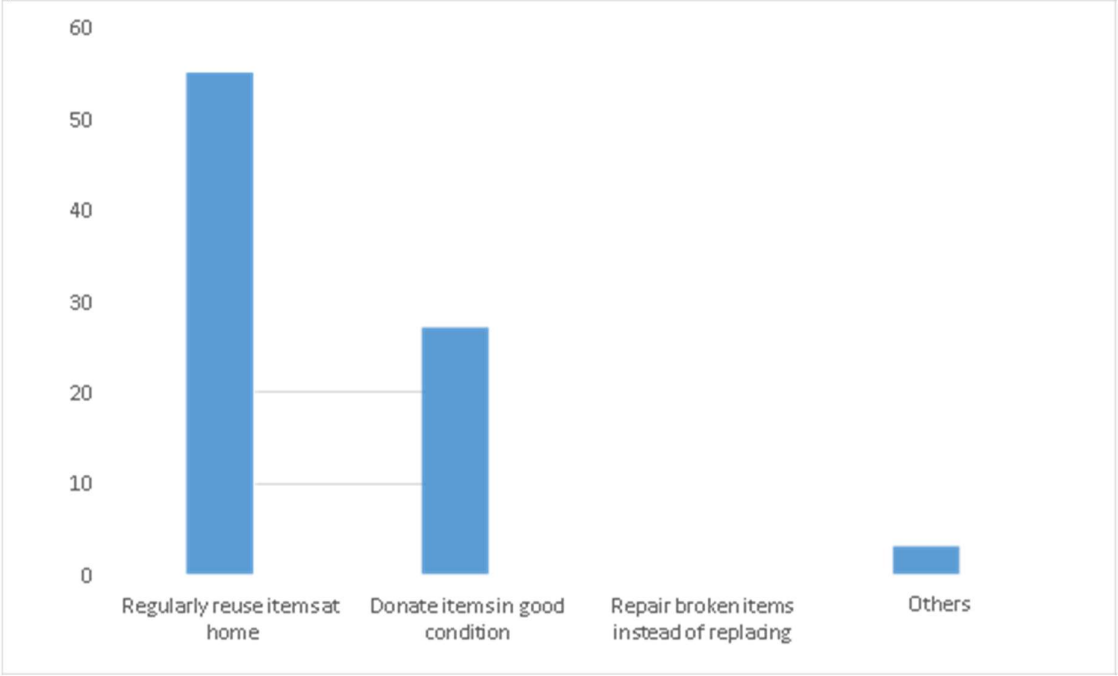
In the above table, 32 respondents identified lack of proper infrastructure as a major difficulty, 22 respondents mentioned a lack of awareness about solid waste segregation as a challenge, 20 respondents cited insufficient funding as a significant challenge in solid waste management, 16 respondents identified rapid urbanization as a difficulty in solid waste management, 11 respondents highlighted the lack of community involvement as a challenge and 4 respondents identify there also others difficulties in solid waste management.

Solutions or Efforts to Manage Solid Waste in Nepalgunj.

Table 13

Efforts to Reuse Items.

Options	Frequency	Percentage
Regularly reuse items at home	55	52.38%
Donate items in good condition	27	25.71%
Repair broken items instead of replacing	20	19.05%
Others	3	2.86%
Total	105	100%



Source. Field Survey and Questionnaire, March 2024

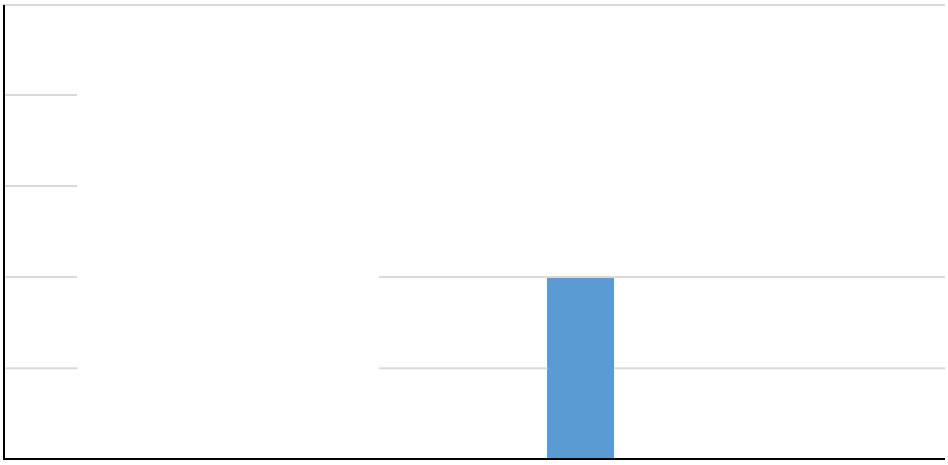


Figure 8. Efforts to Reuse Items

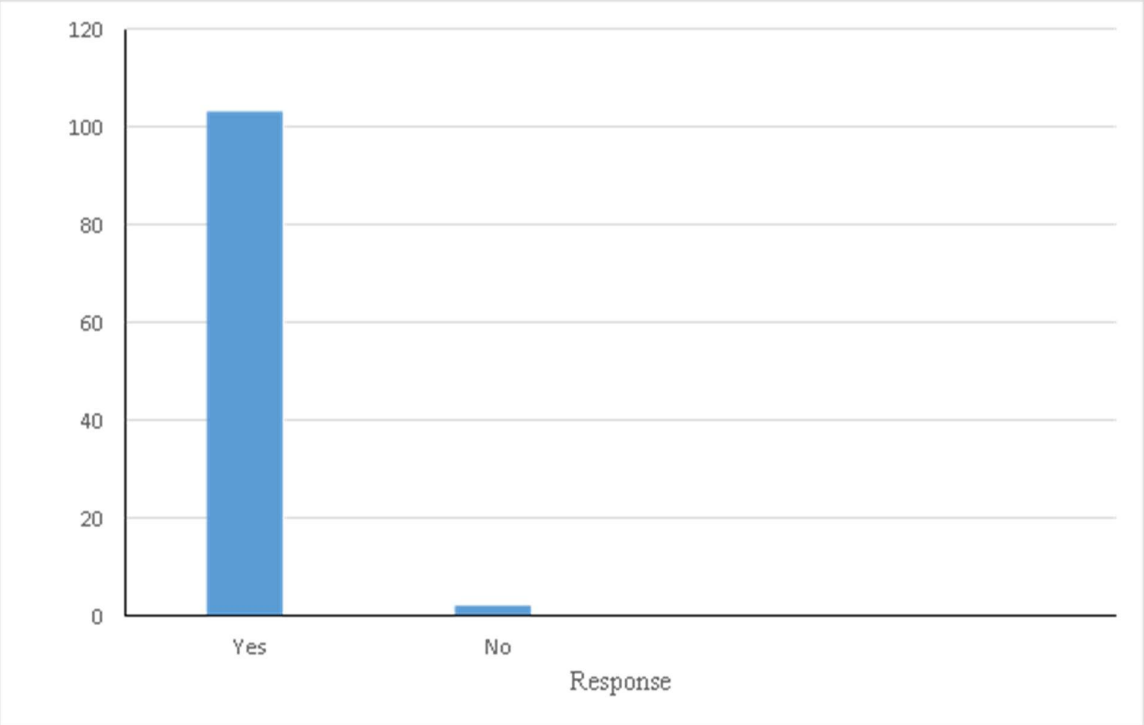
In table and figure, Respondents indicated various efforts to reuse items, among 105 respondents, 55 respondents are regularly reusing items at home, 27 respondents donate items in good condition, 20 respondents repair broken items instead of replacing and remaining 3 respondents are using other efforts to manage solid waste in Nepalgunj.

Table 14

Awareness of 3R Principles

Response	**Frequency**	**Percentage**
Yes	103	98.09%
No	2	1.91%
Total	105	100%

Frequency



Source. Field Survey and Questionnaire,March 2024

Figure 9. Awareness of 3R Principles

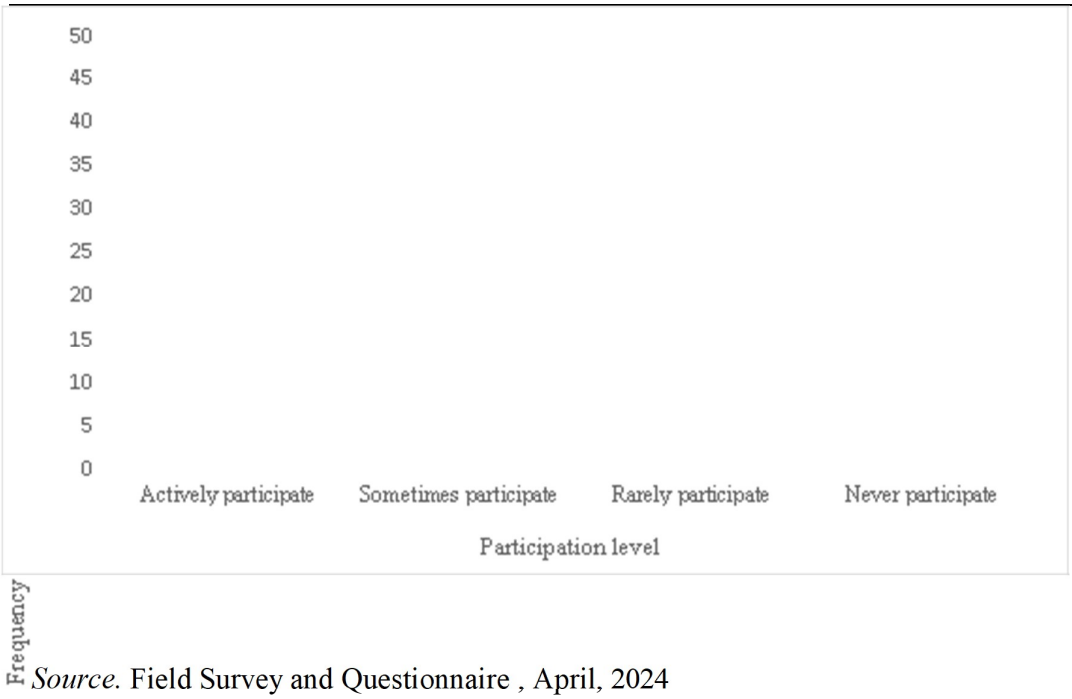
In above table and figure, Out of the 105 respondents surveyed, 103 indicated that

awareness of 3R helps to reduce or helps to manage the solid waste in Nepalgunj and 2 said that awareness of the 3R principles will not help to manage the solid waste instead of awareness and there should be laws with punishments to effectively manage solid waste.

Table 15

Participation in Solid Waste Segregation Programs

Participation	**Frequency**	**Percentage**
Actively participate	30	28.57%
Sometimes participate	45	42.86%
Rarely participate	20	19.05%
Never participate	10	9.52%
Total	105	100%



Source. Field Survey and Questionnaire , April, 2024

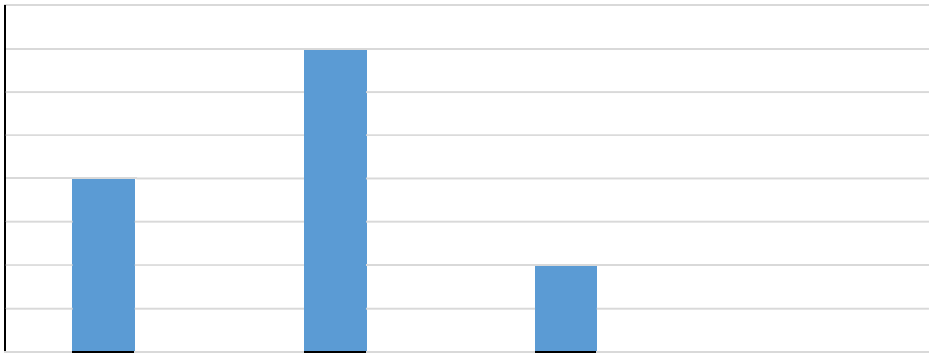


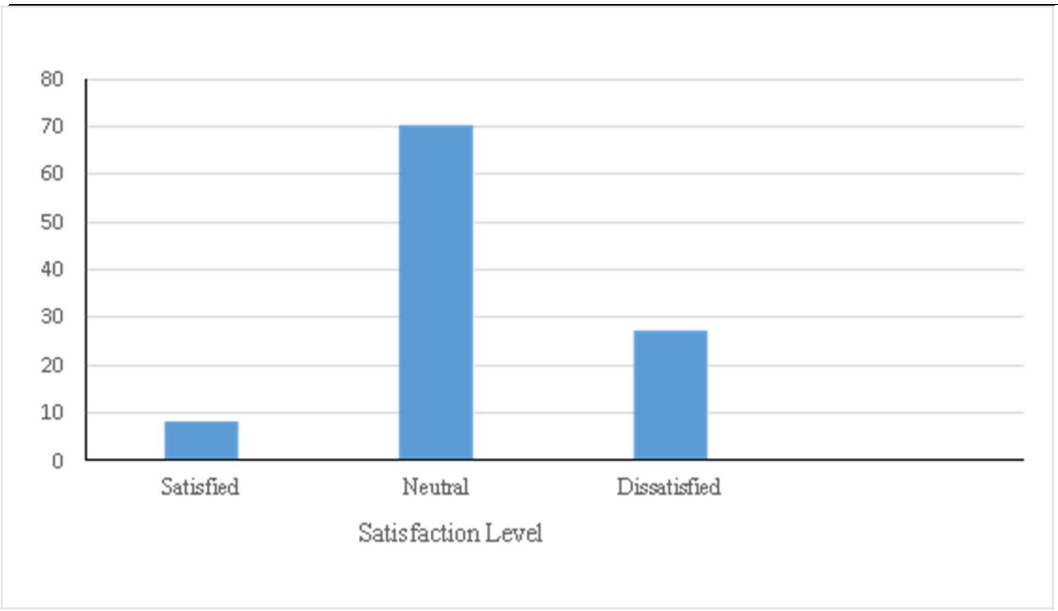
Figure 10. Participation in Solid Waste Segregation Programs

In above table and figure, Respondents provided varying levels of participation in solid waste segregation programs, with 30 actively participating, 45 sometimes participating, 20 rarely participating, and 10 never participating.

Table 16

Overall Satisfaction with Solid Waste Management Efforts.

Satisfaction level	**Frequency**	**Percentage**
Satisfied	8	7.62%
Neutral	70	66.67%
Dissatisfied	27	25.71%
Total	105	100%



Source. Field Survey and Questionnaire, April 2024

Figure 11. Overall Satisfaction with Solid Waste Management Efforts.

Above table and figure shows the overall satisfaction level of respondents with solid waste management efforts in Nepalgunj, showing the frequency and percentage of respondents expressing satisfaction, neutrality, and dissatisfaction. Among 105 respondents, 8 respondents are satisfied with the solid waste management effort, 70 respondents are neutral and 27 respondents are dissatisfied with the solid waste management efforts in Nepalgunj.

The findings of this study reveal a mixed picture of solid waste management in Nepalgunj. On the one hand, the majority of respondents (75 out of 105) feel that there has been no noticeable improvement in solid waste management in the area, and a significant proportion (40%) rate the solid waste collection services as only fair. This suggests a high level of dissatisfaction among residents with the current services. Furthermore, about a quarter of the respondents (30 out of 105) have low levels of involvement in solid waste management activities, which may contribute to the lack of improvement.

On the other hand, nearly half of the respondents (45.71%) are using municipal solid waste collection services, indicating a level of trust and confidence in the municipal authorities' ability to handle waste disposal effectively. Additionally, the majority of respondents (42.86%) have a moderate level of awareness about proper solid waste disposal, and almost half (48 out of 105) acknowledge that poor solid waste management contributes to environmental pollution. This suggests that there is a growing awareness of the importance of proper solid waste management among residents.

The study also found that respondents identify a range of waste types as significant challenges, including plastic waste, household waste, industrial waste, organic waste, and medical waste. Furthermore, a significant portion of respondents (25.71%) donate items in good condition, contributing to solid waste reduction and resource conservation. The majority of respondents (98.09%) believe that awareness of the 3R principles helps to reduce or manage solid waste in Nepalgunj, and a significant proportion (42.86%) sometimes participate in solid waste segregation programs.

However, the study also reveals some areas of concern. Only a minority of respondents (8 out of 105) express satisfaction with the solid waste management efforts in Nepalgunj, while the majority (70 out of 105) hold a neutral stance towards the efforts. This suggests that many individuals neither strongly approve nor disapprove of the current state of solid waste management in the area. Overall, the findings of this study highlight the need for improved solid waste management practices and increased awareness and education among residents to address the challenges facing Nepalgunj.

Conclusion

This research aimed to investigate the challenges of solid waste management in Nepalgunj and propose practical solutions. The primary sources of solid waste are household, industrial, and plastic waste, with household waste being the most significant contributor. To address this, community-based initiatives promoting waste reduction, segregation at source, and responsible consumption habits are essential.

The study found that the lack of proper infrastructure and awareness are the major challenges in solid waste management. Improper waste disposal poses significant health and environmental risks, including air and water pollution, respiratory illnesses, and skin infections. Weak enforcement of regulations and poor waste management practices also contribute to the problem.

To improve solid waste management, the study proposes practical solutions, including reducing waste at its source, separating recyclables, and building better waste facilities. Community involvement, education, awareness campaigns, and incentives can significantly reduce the volume of waste generated. Government authorities also play a crucial role in investing in infrastructure, enforcing regulations, and spreading awareness.

In conclusion, waste management is everyone's responsibility, and community involvement is

essential for success. By working together, we can make a real difference in keeping Nepalgunj clean and safe for all residents. Improving solid waste management practices is crucial for reducing pollution, protecting public health, and promoting sustainable development.

Action Implication

Based on the findings of this research, several action implications are recommended to address the challenges of solid waste management in Nepalgunj. Firstly, increasing the number of bins for trash collection in crowded areas and providing separate bins for different types of solid waste can promote recycling and reduce littering. Additionally, educating residents about the benefits and methods of composting at home can reduce organic waste and promote sustainable gardening practices.

Organizing workshops and seminars to educate the public about recycling and solid waste reduction can increase awareness and promote responsible waste management practices. Increasing the number of solid waste collection points and providing training programs for waste management personnel can enhance service delivery and reduce environmental pollution. Implementing fines and penalties for individuals and businesses found illegally dumping waste can deter such behavior and promote compliance with regulations.

Advocating for policies and regulations to reduce the use of single-use plastics and promote sustainable alternatives can reduce waste generation and promote eco-friendly practices. Implementing solid waste reduction targets for households and businesses can encourage behavior change and reduce waste generation. Promoting the use of biodegradable products and providing solid waste management resources for households can increase awareness and promote responsible waste management practices.

Promoting awareness of plastic bottle recycling and implementing incentive programs to encourage recycling can increase participation and reduce waste. Encouraging the reduction of waste at the source, promoting the reuse of items, and providing education and resources to ensure that residents and businesses understand how to properly prepare materials for recycling can increase recycling rates and reduce waste generation. Overall, a comprehensive approach that includes community involvement, education, infrastructure development, and policy implementation is necessary to address the challenges of solid waste management in Nepalgunj.

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