Analyzing solid waste management practices for the hotel industry

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Abstract. The waste management agenda is significant, and it requires administrative attention, guidance, and public awareness on a priority basis. Effective waste management impacts social, economic, and ecological concerns. The purpose of this research was to survey methods for managing solid waste in the hospitality sector. To reduce their negative effects on the environment, stay in compliance with regulations, and make their guests happier, hotels must have efficient waste management systems. Some important practices involve carrying out waste audits, reducing waste at its source, recycling, composting, and managing hazardous waste properly. To show their dedication to environmental protection and ethical business practices, hotels may optimise their waste management through staff training, stakeholder involvement, and continuous improvement in initiatives. By adopting these practices, we can lessen the amount of trash that ends up in landfills and assist in rendering the hotel business more sustainable. There is significance difference between presence of garden and restaurant on solid waste generation rate.

The information presented in this article is crucial for waste management planning and resource allocation in many different types of contexts, including residential, industrial as well as hotels.

Keywords:- Solid waste management, practices, hotel industry, sustainable, data sampling

1. Introduction

Many types of garbage are produced by industrial operations, and some of these wastes are considered dangerous. Industries will not be able to continue operating in the future unless hazardous waste is properly and continuously dealt of. India is home to a vast array of eateries and hotel chains [1]. A large amount of trash is produced by these motels. About 25-30% of the overall trash comes from eateries and lodging establishments. A constant problem for the hotel sector is the amount of trash that is produced by normal operations. at addition to paying for trash collection and disposal, hotels must also set aside precious floor space at the rear of the building to hold and sort trash. Additional worries include the potential dangers to human health and the level of noise produced during garbage compaction and collection [2-5].

A lot of the trash that hotels produce comes from the kitchen and the housekeeping departments. The former produces a lot of food scraps and packaging, while the latter produces more metal cans, glass bottles, corks, and cooking oils. Hotel gardens (including everything from grass and hedge clippings to motor oils, pesticides, paints, and preservatives) and offices (including everything from toner cartridges, paper, and cardboard garbage) also contribute to the overall amount of waste [6]. Additionally, the hotel's ongoing repair and remodeling efforts add to the property's trash. Currently, hotels gather trash from surrounding eateries and dispose of it themselves [7]. The large amount of food waste that is deposited at these collection sites becomes combined with various types of dry and moist trash, resulting in an unsightly appearance of filth and odor. The majority of four- and five-star hotels have their own garbage disposal systems that send trash to landfills via private companies [8].

Based on studies of hotel garbage in a few wards, it is estimated that 70 to 75% of the waste is biodegradable. When disposed of at collection places, this waste becomes combined with all the other types of waste. There is a mixing of all
types of non-biodegradable garbage at the disposal site, including that which is collected directly by private contractors. A large portion of the garbage that hotels generate comes from their rooms, kitchens, and other areas where guests stay. Without proper investigation into waste management, the hospitality industry would continue to pose a threat [9-12].

The waste management agenda is significant, and it requires administrative attention, guidance, and public awareness on a priority basis. Effective waste management impacts societal, economic, and ecological concerns in when compared to other industries, hotels utilize a disproportionate number of resources and add significantly to landfill growth [13]. One major advantage of recycling and reusing is the amount of energy and natural resources saved by not having to throw away precious items in landfills. In an effort to reduce the use of single-use plastics, hotels might set an example by providing visitors with recyclable cutlery or cutlery; this would give them another option than using single-use plastics. Reusing food scraps and other culinary waste as a natural fertilizer and soil conditioner is a great way to recycle food scraps and other food waste [14]. It is becoming more and more difficult to dispose of garbage, making waste management in hotels crucial. Additionally, the company sees it as a prudent move. It may save a tonne of money on supplies by being frugal with their use. Given this background, it's clear that the hospitality sector needs solid waste management strategies. The correct management of garbage in the hospitality business depends on accurately classifying the kinds and amounts of trash generated by each department [15-18].

Now, the hospitality sector is engaging in wasteful activities. Inadequate managerial and technical abilities, incorrect collection, bad route planning, underestimating trash creation rates, and an absence of appropriate facilities all contribute to the problem of poorly collected and transported municipal solid waste [19]. This research aims to describe the many forms of trash produced by restaurants and hotels, identify their origins, assess their negative impacts on human and environmental health, and examine the present state of hotel waste management practices. Hotels contribute significantly to the daily metric tons of solid waste that are sent to landfills from a variety of sources; however, with good management, most of this garbage may be recovered and repurposed [20]. All living things, including humans, are vulnerable to the air pollution and unpleasant smells caused by this untreated solid waste. Proper management of this garbage through means such as reduction, reuse, recycling, and energy generation can help us solve the dilemma [21].

2. Materials and Methods

2.1 Study Area

Bhopal, placed within the coronary heart of India, stands as greater than just a geographical center—it embodies a rich tapestry of records, subculture, and modernity. Serving as both the executive hub of Bhopal department and district and the capital of Madhya Pradesh, it holds a pivotal role within the vicinity's socio-financial panorama. Aptly nicknamed "The City of Lakes," Bhopal's serene attraction is described via its abundance of shimmering lakes, both herbal and man-made, which considers its panorama, providing respite from the bustling urban life. Renowned for its environmental focus, Bhopal stands as a testament to sustainable urban improvement, earning accolades as certainly one of India's most environmentally friendly towns [22]. Bhopal's historic roots run deep, tracing lower back to its days as the capital of the princely country of Bhopal, flourishing under the rule of the Nawabs due to the fact around 1707. Even after India won independence in 1947, Bhopal retained its importance, transitioning seamlessly into the executive capital of Madhya Pradesh. The city's adventure through time is marked by sizeable milestones, inclusive of the division of the Sehore district in 1972 to create the brand new district of Bhopal, reflecting its evolving administrative and territorial identity.

Economically vibrant, Bhopal boasts a robust commercial panorama, with a large number of large and medium-sized businesses flourishing in and around the town. Together with Indore, it is one of the nation's essential economic and monetary centers, using boom and prosperity inside the location. This financial dynamism is in addition complemented by way of a numerous range of lodging alternatives catering to the desires and alternatives of traffic, reflecting Bhopal's reputation as a burgeoning visitor vacation spot [23]. In essence, Bhopal encapsulates the essence of India's past, gift, and destiny, seamlessly blending culture with modernity, and supplying a glimpse into the kingdom's multifaceted identity. As it keeps to adapt and develop, Bhopal remains a beacon of resilience, progress, and cultural richness, inviting site visitors to immerse themselves in its enchanting appeal and colourful spirit.

2.2 Sampling Method

In the context of hotel waste management, it's essential to comprehensively address the diverse array of waste streams generated by the various facets of hotel operations. The solid waste output of a hotel encompasses everything expelled from the establishment, spanning from guest rooms to gardens, restaurants to kitchens, laundry facilities to offices, and beyond. The study shows that each of these areas contributes to the overall waste footprint of the hotel, necessitating a systematic approach to waste segregation and disposal [24-26]. Specific protocols are being made compulsory by the Legislation for waste management, dictating the separation of biodegradable and inorganic waste. So in accordance with these regulations, hotels typically designate separate receptacles or areas for the disposal of each waste type. There are certain biodegradable waste, such as food scraps and organic materials, is typically designated for the green trash category,
While inorganic waste, including plastics, metals, and other non-biodegradable materials, is directed to the orange trash category. Also, it can be observed that the overall volume of waste produced by hotels can vary significantly based on factors such as occupancy rates, seasonal fluctuations, and the scale of hotel operations. In the recent time, plastic bags or buckets are commonly used to contain smaller waste items, facilitating ease of collection and disposal [27].

The review on the various papers found that in order to assess and manage hotel waste effectively, there are certain sampling procedures which are often employed. For example, if any sampling procedure was conducted during the first two weeks of December 2022, there will be first week involved in the preparatory activities, which will include training on sampling methodologies, with verification of measurement techniques, and finally the establishment of a sample strategy. Following this procedure, the second week shall involve waste collection efforts from about 50 hotels, keeping the focus on organic and inorganic waste making sure that they are being collected separately [28]. Efficient waste collection and transportation logistics are crucial components of hotel waste management. In the described scenario, bicycles were utilized to transport collected waste from multiple hotels to a treatment facility. This approach can offer a cost-effective and environmentally friendly means of waste transportation, particularly in urban areas where traffic congestion and emissions are concerns [29]. It is possible for hotels to bring a reduction in their environmental impact by implementing the method that involves complete trash segregation after efficient collection and then following disposal procedures. It can be concluded that good waste management techniques are critical for hotels seeking to reduce environmental impact, that comply with legislation, and continue to uphold their commitment to sustainability [30].

2.3 Questionnaire Method

For the research work through questionnaire, fifty hoteliers or hotel managers were requested to gather data on the properties, the existing solid waste management processes at their establishments, and were also asked to mention the obstacles to improved solid waste management [31]. During data collection the data on the hotels' types, levels of service, and facility elements were gathered. The questionnaires, made possible to verify and inquire about the hotels' waste segregation, reduction, recycling, and composting initiatives. Finally, the implementation of initiatives with the goals of material reuse and trash reduction constitutes waste reduction practice in the hospitality industry. This includes reusing one-sided printed paper in offices or unused food from bars and restaurants for animals are two examples. In this study the third week of the survey followed interview of fifty hotel operators or hotel managers to gather detailed information on existing solid waste management practices on their properties and identify barriers these actions are not effective. The purpose of the interviews was to collect information on various factors including types of hotels, level of service offered and leisure facilities [32-35]. Researchers using policy questions were able to ask about research management strategies, nutrient separation, reduction, revision and food construction in industry. An important aspect of waste reduction includes the development of waste recycling systems and the use of reduced waste.

3. Results and Discussion

3.1 Solid waste generation rate

To find the rate of solid waste creation, graphic approaches were employed. Table 1 reveals the average solid waste production rate per guest in a hospitality setting, with cardboard and paper being common waste types. Kitchen and food waste is significant, with organic materials like ceramics and chemicals producing higher rates. This highlights the importance of waste management and reduction strategies. Graphic techniques have been employed to research the charge of strong waste creation in hospitality settings, with particular emphasis on waste kinds inclusive of cardboard, paper, kitchen and meals waste, natural substances, ceramics, and chemical substances. These waste kinds had been recognized as commonplace individuals to the general waste circulate in hospitality establishments. By using photo processes together with bar charts, pie charts, or line graphs, researchers can visually constitute the relative contributions of every waste type to the general solid waste circulate. This visual illustration helps a better knowledge of waste era patterns and aids in the identification of key regions for waste control and reduction techniques.

<table>
<thead>
<tr>
<th>Waste type</th>
<th>Solid waste generation rate, Kg/guest/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardboard</td>
<td>2.5</td>
</tr>
<tr>
<td>Paper</td>
<td>1.7</td>
</tr>
<tr>
<td>Tissues</td>
<td>0.5</td>
</tr>
<tr>
<td>Kitchen and food waste</td>
<td>3.8</td>
</tr>
<tr>
<td>Ceramic</td>
<td>6.1</td>
</tr>
<tr>
<td>Chemicals</td>
<td>4.2</td>
</tr>
<tr>
<td>Wood</td>
<td>5.5</td>
</tr>
<tr>
<td>Plastic</td>
<td>3.3</td>
</tr>
<tr>
<td>Metal</td>
<td>5.9</td>
</tr>
<tr>
<td>Nylon</td>
<td>4.4</td>
</tr>
<tr>
<td>PET bottles</td>
<td>5.5</td>
</tr>
</tbody>
</table>

Table 1: Solid waste generation rate
Cardboard and paper generate 2.5 kg and 1.7 kg of waste, respectively, while tissues have a lower rate of 0.5 kg. Kitchen and food waste is significant at 3.8 kg, while inorganic materials like ceramics and chemicals generate higher rates. The numbers shown here reflect the average daily solid waste generation for each guest across every waste category. This information is crucial for waste management planning and resource allocation in many different types of contexts, including residential, industrial, including hospitality.

Fig. 1: Variation of solid waste management rate

The bar chart in Fig. 1 shows waste generation rates for different materials, with cardboard and paper showing lower rates. Kitchen and food waste is the most significant, with ceramic waste peaks. Chemicals, wood, plastic, and metal have medium to high waste generation rates, indicating significant environmental impact. Nylon and PET bottles also show high waste management rates, highlighting the prevalence of synthetic material waste. The chart emphasizes the importance of targeted waste management and recycling strategies for each material.

3.2 Percentage contribution

Planning for trash management, allocating resources, launching recycling programmes, and working towards environmental sustainability all depend on having a firm grasp of such waste creation rates. The ceramics create the most garbage from hotels, while the tissues generate the least.

Fig. 2: Variation of percentage of solid waste management rate
The bar graph in Fig. 2 shows the percentages of solid waste management in the surveyed area, with cardboard, paper, and tissues contributing the least. Organic waste, such as kitchen and food waste, has a higher percentage, but not a dominant part. Ceramic waste has a high percentage, suggesting a unique waste profile. Chemicals and wood contribute significantly, with chemicals having a high percentage, indicating industrial or specialized waste management challenges. Common materials like plastic, metal, nylon, and PET bottles contribute significantly, emphasizing the importance of recycling and managing synthetic materials.

### 3.3 Segregation of Solid waste generation rate Based on Types of Hotels

To find the rate of solid waste creation, graphic approaches were employed. According to the data compiled in Table 2, there is a clear trend correlating the standard of the hotel with the quantity of waste generated per guest per day. Five-star hotels, known for their extensive range of luxury services and amenities, lead in solid waste production with an average of 52.8 kg per guest per day. In comparison, four-star hotels show a noticeable reduction in waste generation, producing 31.4 kg per guest, which is still substantial but significantly lower than their five-star counterparts.

<table>
<thead>
<tr>
<th>Hotel type</th>
<th>Solid waste generation rate, Kg/guest/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Five star hotel</td>
<td>52.8</td>
</tr>
<tr>
<td>Four star hotel</td>
<td>31.4</td>
</tr>
<tr>
<td>Three star hotel</td>
<td>29.7</td>
</tr>
<tr>
<td>Other hotel</td>
<td>19.2</td>
</tr>
</tbody>
</table>

This downward trend continues with three-star hotels, which generate slightly less waste at 29.7 kg per guest. The lowest waste production is observed in other hotels, which include budget and non-rated establishments, at 19.2 kg per guest per day. The method studied for trash generation rate mostly indicates the direct relationship between the quality of services and amenities which are being given by hotels and the associated solid waste output generated by them, which brings about the conclusion that that more luxurious accommodations tend to generate greater quantities of solid waste.

The bar chart in Fig. 3 illustrates the solid waste management rates for different categories of hotels, measured in kilograms of waste generated per guest per day. The data shows that five-star hotels have the highest waste generation rate at 52.8 kg, likely due to the luxury services and extensive amenities they offer. Four-star hotels generate less waste, with a rate of 31.4 kg, indicating a reduction in services and amenities compared to five-star establishments. Three-star hotels show a further decrease in waste generation, with a rate of 29.7 kg, aligning with more modest accommodations and services. Lastly, other types of hotels, which might include budget or non-rated establishments, have the lowest waste generation rate at 19.2 kg, reflecting the most basic service offerings and lower consumption by guests. This chart highlights the correlation between the level of luxury a hotel offers and the amount of solid waste it generates.

### 3.4 Factors that can affect solid waste generation rate

In this study there are two significant elements which are being focussed that could influence solid waste generation rates at a facility: first one is the existence of a garden and second is a restaurant. It is because these gardens may lead to production of green waste materials and the restaurants can generate food and packaging waste. In order to assess the impact of these parameters on the solid waste generation rate, the technique of ANOVA (Analysis of Variance) was
implemented. The process of ANOVA test analyses whether there are significant differences in means among three or more independent groups. Further the research aims to determine the over all contribution of a garden and a restaurant to solid waste output, that will be beneficial in the development of more effective waste management strategies.

Table 3: ANOVA results for the solid waste management with gardens and restaurants

<table>
<thead>
<tr>
<th>Variables</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>20.60</td>
<td>2</td>
<td>10.304</td>
<td>10.290</td>
<td>0.000</td>
</tr>
<tr>
<td>Within groups</td>
<td>419.38</td>
<td>497</td>
<td>35.525</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>439.98</td>
<td>499</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Table 3 presents the results of an ANOVA (Analysis of Variance) test, which analyzes differences among group by means in a sample. The sum of squares represents the total variation within the data, while the degrees of freedom (df) indicates the number of values in the final calculation of a statistic that are free to vary. The mean square is the average of the squared deviations, calculated by dividing the mean square between groups by the mean square within groups. The F-statistic, calculated by dividing the mean square between groups by the mean square within groups, determines if the group means are significantly different from each other. A p-value of 0.000 suggests that the group means are significantly different, as it is less than the common alpha level of 0.05, leading to the rejection of the null hypothesis that there is no difference between the groups. In summary, the ANOVA results indicate that there are statistically significant differences between the group means, as indicated by the F-statistic and the p-value.

Table 4: ANOVA of significance difference between presence of restaurant and solid waste generation rate

<table>
<thead>
<tr>
<th>Variables</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>37.42</td>
<td>2</td>
<td>21.431</td>
<td>17.414</td>
<td>0.000</td>
</tr>
<tr>
<td>Within groups</td>
<td>369.29</td>
<td>497</td>
<td>32.689</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>406.71</td>
<td>499</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The ANOVA test results in Table 4 show a significant difference between the means of the three groups analyzed. The sum of squares represents the variation within the data set, with the "Between groups" sum of squares being 37.42, and the "Within groups" sum of squares being 369.29. The total sum of squares is 406.71, representing the total variation in the entire dataset. The degrees of freedom (df) for the between groups are 2, indicating three groups, and 497 for the within groups. The mean square is calculated by dividing the sum of squares by the corresponding degrees of freedom, with the mean square between groups being 21.431 and the mean square within groups being 32.689. The F-statistic value is 17.414, indicating a highly significant result. The p-value associated with the F-statistic is 0.000, rejecting the null hypothesis that there is no difference between the group means. Thus, the data provide sufficient evidence to conclude a significant difference between the means of the three groups analyzed.

5. Conclusion

Hotel solid waste management is essential for three reasons: keeping the environment healthy, making guests pleased & staying in compliance with regulations. The hotel sector must use effective solid waste management techniques to reduce their environmental impact, meet regulatory requirements, and ensure guest satisfaction.

a. In order to promote resource conservation and environmental sustainability, hotels can greatly decrease the amount of waste deposited in landfills by executing strategies like waste audits, source reduction, recycling programmes, composting, donation initiatives, and proper hazardous waste management.

b. Hotels can show they care about the environment and do the right thing by their guests and stakeholders by investing in staff training, including them in continuous improvement, and improving their waste management methods.

c. It is observed that there is significance difference between presence of garden and restaurant and solid waste generation rate as p-value is less than 0.05.

d. Hotels might play their part for the environment and the future of the hospitality sector by making solid waste management their number one concern.

References


