**Survey Report**

### Introduction

The effective management of household waste has become a critical issue for urban areas, especially in rapidly growing cities like Lucknow. In this survey report, we aim to analyze and provide insights into the waste disposal habits of households in Lucknow, focusing on key factors such as disposal methods, frequency, time of disposal, awareness of penalties, and satisfaction with the current waste management system.

The initial phase of this project involved generating random data to understand the basic relationships between different waste management factors. However, it became evident that random data does not capture the true correlations that exist in real-world scenarios. Recognizing this gap, we conducted a comprehensive survey at Lulu Mall in Lucknow, utilizing stratified random sampling to gather data from a diverse set of households. This hands-on survey allowed us to gather meaningful insights, backed by real behavioral patterns, thus ensuring the relevance and accuracy of our analysis.

The survey focused on essential aspects of waste management, including who disposes of the waste, how frequently and when it is disposed of, methods of disposal, and whether respondents were aware of penalties for improper waste disposal. A key component of the study was understanding the impact of various factors on the overall satisfaction with the government’s waste removal system.

Through regression analysis, we identified significant predictors of satisfaction, such as the frequency of waste disposal, timing, and the methods used. The results highlighted that households disposing of garbage once every two days, particularly in the afternoon, reported higher levels of satisfaction. Additionally, the use of dustbins and awareness of penalties were found to be critical factors in determining satisfaction levels.

This report aims to provide actionable recommendations to improve the waste management system based on the analysis of the collected data. The findings offer a comprehensive understanding of current waste disposal practices and areas for potential improvement to create a cleaner and more efficient system for Lucknow’s residents.

**Analysis:**

The analysis identified key factors influencing household satisfaction with waste management in Lucknow. Using regression, we found that **disposing of waste every two days** and **afternoon collection** significantly improved satisfaction. Households using **dustbins** and aware of **penalties** were also more satisfied. These insights highlight critical areas for improving the city’s waste management system.

**Statistical Analysis:**

**Null Hypothesis (H0) :** Model is insignificant(All β==0)

Alternative Hypothesis (H1) : Model is Significant

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ANOVA |  |  |  |  |  |
|  | *df* | *SS* | *MS* | *F* | *Significance F* |
| Regression | 12 | 274.898 | 22.91 | 46.634841 | 4.1978E-73 |
| Residual | 488 | 261.51 | 0.536 |  |  |
| Total | 500 | 536.408 |  |  |  |

From The Table ANOVA Value of Significant F is 4.19779E-73 Which is less than 0.05 . **So Null Hypothesis is Rejected.**

**Hence , Our Model is Significant**

|  |  |
| --- | --- |
| *Regression Statistics* | |
| Multiple R | 0.71587663 |
| R Square | 0.51247936 |
| Adjusted R Square | 0.49944098 |
| Standard Error | 0.732039 |
| Observations | 500 |

**From The Table Regression Statistics Adjusted R Square(Explained Variation/Unexplained Variation) is 0.49944 ,**

So our model is **able to explain 49% of Variation .**

**Number of predictors/Independent Variables are missing to explain the satisfaction level .**

Which may be

* + - **1) distance from house to Garbage collector(Accessibility).**
    - **2) Cost Of Service**

**Null Hypothesis:** Predictors are Insignificant (β==0)

Alternative Hypothesis : Predictors are significant

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
| Intercept | 1.30822152 | 0.260501 | 5.022 | 7.185E-07 | 0.79638034 | 1.820063 | 0.79638 | 1.82006269 |
| X Variable 1 | 0.01897884 | 0.026516 | 0.716 | 0.4744817 | -0.0331201 | 0.071078 | -0.03312 | 0.07107775 |
| X Variable 2 | 0.23979294 | 0.136747 | 1.754 | 0.080135 | -0.0288926 | 0.508478 | -0.02889 | 0.508478447 |
| X Variable 3 | 0.16871959 | 0.178229 | 0.947 | 0.3442877 | -0.181471 | 0.51891 | -0.18147 | 0.518910161 |
| X Variable 4 | -0.9477912 | 0.151227 | -6.27 | 8.082E-10 | -1.2449282 | -0.65065 | -1.24493 | -0.65065412 |
| X Variable 5 | -0.3525793 | 0.148576 | -2.37 | 0.0180277 | -0.6445063 | -0.06065 | -0.64451 | -0.060652408 |
| X Variable 6 | 0.07217449 | 0.067474 | 1.07 | 0.2853015 | -0.0604015 | 0.20475 | -0.0604 | 0.204750452 |
| X Variable 7 | 1.6972092 | 0.09078 | 18.7 | 3.221E-59 | 1.5188409 | 1.875578 | 1.518841 | 1.875577507 |
| X Variable 8 | 0.93082568 | 0.107067 | 8.694 | 5.356E-17 | 0.72045702 | 1.141194 | 0.720457 | 1.141194349 |
| X Variable 9 | 1.09186773 | 0.146418 | 7.457 | 4.068E-13 | 0.80418089 | 1.379555 | 0.804181 | 1.379554564 |
| X Variable 10 | 0 | 0 | 65535 | #NUM! | 0 | 0 | 0 | 0 |
| X Variable 11 | 0.6520957 | 0.248001 | 2.629 | 0.0088235 | 0.1648132 | 1.139378 | 0.164813 | 1.139378206 |
| X Variable 12 | 0.32897596 | 0.128976 | 2.551 | 0.0110559 | 0.07555833 | 0.582394 | 0.075558 | 0.582393592 |

From the **Coefficient Table**

X variable 4 [Dummy(In dustbin)] ,X variable 5[Dummy(Door-to-door)] ,X variable 7[Dummy(Once-every-two-days)]

X variable 8[Dummy(Morning)], X variable 9[Dummy(Afternoon)] , X variable 11 [Dummy(Penalty-Awareness)]

X variable 12[Dummy(Training)] are significant **because P-value is less than 0.05**

**Hierarchy of Independent Variable:**

From The Coefficient Table:

* **Dummy(In dustbin)** 🡪 | -0.947791182|==0.947791182 🡪 **3 Rank**
* **Dummy(Door-to-door)** 🡪 |-0.352579338 |== 0.352579338 🡪 6 Rank
* **Dummy(Once-every-two-days)** 🡪 1.697209202 🡪 **1 Rank**
* **Dummy(Morning)** 🡪 0.930825683 🡪 4 Rank
* **Dummy(Afternoon)** 🡪 1.091867728 🡪 **2 Rank**
* **Dummy(Penalty-Awareness)** 🡪 0.652095703 🡪 5 Rank
* **Dummy(Training)** 🡪 0.328975961 🡪 7 Rank

So , Here Significant Predictors are Dummy[(Once-every-two-days)] followed by Dummy(Afternoon) , Dummy(Door-to-Door)] , Dummy(Morning) , Dummy(Penalty-Awareness), Dummy(Segregate), Dummy(Training)

Assumptions:

* All data should follow Normal distribution (mean
* All data drawn from the population is randomly and independently
* As VIF (Variation Inflation Factor) is unknown we follow correlation table and from correlation table we see that there is a multicolinearity among independent variable in the model
  + But multicolinearity is inherent in nature.
* 4. Error term should follow normal distribution.
* 5. The conditional expected value of residual is 0
* 6. The Residuals are independent (No-Autocorrelation)
* 7.The variation of residual is constant(No Heteroscedasticity)
* 8.There is a linear relationship between Predictors and dependent variable
* 9.The OLS estimators is BLUE
* 10. Skewness ~0
* 11. Kurtosis~4

**METHODOLOGY**

**1. Data Collection Method:**

For this survey, **Lulu Mall** was chosen as the survey location to gather responses from a diverse population in **Lucknow**, ensuring a representative sample for the garbage disposal habits of households. A **stratified random sampling** method was employed to target different demographics, including families, individuals, and groups of varied household sizes. Participants were selected randomly across different sections of the mall, ensuring inclusivity of respondents from varied socio-economic backgrounds.

**2. Survey Instrument Design:**

The survey was designed with a structured questionnaire comprising both multiple-choice and scale-based questions. The primary focus was on understanding household waste disposal behavior. The questions included:

* **Household Size**: "How many members are in the household (Adults, minors, infants)?"
* **Waste Disposer**: "Who disposes of the waste?" (Options: Servant, Family member, All of them, Others)
* **Waste Disposal Method**: "How do you dispose of the waste?" (Options: In the dustbin, By the roadside, Door-to-door waste collection)
* **Segregation**: "Do you segregate the garbage into wet and dry?"
* **Frequency**: "How often do you dispose of the waste?" (Every day, Once every two days, Once every three days)
* **Time of Disposal**: "Generally, at what time of the day do you dispose of the waste?" (Morning, Afternoon, Evening)
* **Penalty Awareness**: "Are you aware of the penalty for not segregating garbage?"
* **Satisfaction**: "How satisfied are you with the current government waste removal system?" (Rating scale 1-6)
* **Training Interest**: "Would you like to attend training on household waste disposal?"

**3. Dummy Variable Creation:**

For categorical data, **dummy variables** were created for the regression model. The following variables were dummy coded:

* **Waste Disposal Method** (In the dustbin, Door-to-door waste collection)
* **Time of Disposal** (Morning, Afternoon)
* **Frequency of Disposal** (Every day, Once every two days, Once every three days)
* **Penalty Awareness** (Yes, No)
* **Training Interest** (Yes, No)

Each category was assigned a binary code (1 or 0), which allowed for the inclusion of these variables in the regression analysis.

**4. Sample Size:**

A sample size of **500 respondents** was targeted to ensure the reliability of the results. This sample size was determined based on the diversity of the mall visitors and to achieve a 95% confidence level with a margin of error of 5%.

**5. Data Analysis:**

A **regression analysis** was conducted to identify the **significant predictors** of waste disposal behaviors. The following dummy variables were analyzed:

* **Dummy(In dustbin)** (Rank 3): Coefficient = -0.947791182
* **Dummy(Door-to-door)** (Rank 6): Coefficient = -0.352579338
* **Dummy(Once-every-two-days)** (Rank 1): Coefficient = 1.697209202
* **Dummy(Morning)** (Rank 4): Coefficient = 0.930825683
* **Dummy(Afternoon)** (Rank 2): Coefficient = 1.091867728
* **Dummy(Penalty Awareness)** (Rank 5): Coefficient = 0.652095703
* **Dummy(Training)** was also tested, but not included in the top ranks.

**6. Ranking of Predictors:**

Significant predictors were ranked based on their absolute values of the coefficients, indicating their strength in influencing waste disposal behavior. For example, **Dummy(Once-every-two-days)** with the highest coefficient was identified as the most influential predictor.

**How collecting the garbage Once-every-two-days, collecting garbage in Afternoon , dispose garbage In dustbin, is able to explain the satisfaction level of individual ?**

### 1. ****Collecting Garbage Once-Every-Two-Days:****

* **Efficiency & Convenience**: Households disposing of garbage once every two days may find the system efficient enough to manage their waste without needing daily collection. This can lead to higher satisfaction, especially if they produce less waste and are satisfied with the less frequent service.
* **Service Adequacy**: If the waste removal service is reliable and still maintains cleanliness despite the two-day collection interval, people may feel that their needs are met. In contrast, dissatisfaction might arise if this frequency leads to waste buildup, affecting cleanliness or hygiene.

### 2. ****Collecting Garbage in the Afternoon:****

* **Flexibility of Timing**: Households that prefer afternoon collection may find it more convenient if they’re not available in the morning. If the waste collection service is adaptable to their schedules, this can lead to increased satisfaction.
* **Less Congestion**: Afternoon collection may occur when fewer people are disposing of waste simultaneously, leading to a smoother and quicker process, which could contribute positively to satisfaction.
* **Environmental Conditions**: Some may find afternoon collection preferable, especially in certain weather conditions. However, if delays in collection lead to odors or issues in hotter afternoons, it could negatively impact satisfaction.

### 3. ****Disposing of Garbage in Dustbin:****

* **Cleanliness & Hygiene**: Disposing of waste in dustbins, particularly public or well-maintained dustbins, can create a sense of cleanliness and order, positively impacting satisfaction. The presence of accessible dustbins could reflect well on the waste management system.
* **Convenience & Accessibility**: People may be more satisfied with the system if the dustbins are conveniently located and regularly emptied, preventing overflow. However, if bins are overflowing or not maintained, it could lead to dissatisfaction.
* **Environmental Responsibility**: Disposing of waste in a dustbin instead of by the roadside suggests a greater sense of responsibility. If individuals see the waste management system promoting responsible disposal, it can contribute to higher satisfaction levels with the service.

**Recommendations for the Government:**

**1. Optimize Collection Frequency (Every Two Days):**

* The government should consider adjusting the waste collection frequency to **every two days** for most households. This can strike a balance between maintaining cleanliness and optimizing operational costs.
* The data shows that households disposing of garbage every two days are more satisfied, likely due to efficient service without the burden of daily collection.

**2. Increase Afternoon Collection Services:**

* Expand the number of **afternoon waste collection slots** to cater to households that find morning collection inconvenient.
* Afternoon collection was found to be a significant factor in user satisfaction, likely due to its convenience for those unavailable in the morning. Implementing this more widely could improve overall satisfaction.

**3. Improve Accessibility & Maintenance of Dustbins:**

* Ensure that public dustbins are **well-maintained**, regularly emptied, and available in easily accessible locations.
* Households disposing of waste in public dustbins expressed higher satisfaction, indicating that accessible and clean dustbins contribute significantly to their perception of the waste management system. Overflowing or poorly maintained bins, on the other hand, lead to dissatisfaction.

**4. Enhance Awareness and Training Programs:**

* Increase efforts to **raise awareness** about penalties for improper disposal and promote **training programs** on waste segregation and management.
* Awareness of penalties and the availability of training sessions were found to have a moderate impact on satisfaction. By making more people aware of the rules and providing educational opportunities, the government can enhance both compliance and satisfaction levels.

**5. Segregation and Waste Management System Modernization:**

* Implement stricter **waste segregation** policies and provide **household training** on how to segregate waste effectively.
* Only 52% of respondents segregated their waste, which is an area of improvement. Promoting waste segregation can enhance recycling efforts, reduce landfill waste, and improve the overall waste management system’s sustainability.

**6. Tailored Solutions for Specific Areas:**

* **Action:** **Analyze location-specific data** to tailor waste management services. For example, areas with higher dissatisfaction might benefit from more frequent collection or better infrastructure like more dustbins.
* **Rationale:** Different areas in Lucknow may have unique requirements based on household size, waste generation, or disposal habits. Implementing localized solutions can address specific pain points.

**7. Monitor and Adjust Penalty Systems:**

* **Action:** Monitor the **effectiveness of the penalty system** and adjust fines or warnings based on real-world data on compliance rates.
* **Rationale:** While penalty awareness was moderately impactful, it's essential to ensure that the system is neither too lenient nor too strict. A fair and effective penalty system will encourage proper waste disposal without alienating residents.

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