# BDM FINAL SUBMISSION

# Food Waste Reduction Analysis at Abhyam Hotel: A Comprehensive Approach

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# Final submission for BDM Capstone Project

The offered drive connection contains all the important documents and multimedia. It includes

- Short video and photo with manager
- Hotel images
- Cleaned data
- Letter from organization

**LINK :-  DRIVE FOLDER OF ALL IMPORTANT DOCS AND MULTIMEDIA**

# 1. Declaration Statement

I am undertaking a project titled "Food Waste Reduction Analysis at Abhyam Hotel: A Comprehensive Approach." I extend my sincere gratitude to Abhyam Hotels for providing essential resources that facilitated the execution of this project.

I affirm that the data presented and analyzed in this project report is authentic and accurate to the best of my knowledge and abilities. The data has been meticulously collected from primary sources and rigorously examined to ensure its reliability.
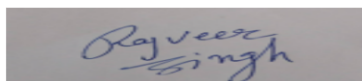
Furthermore, I confirm that all methodologies employed for data collection and analysis are thoroughly detailed within this report. The results and conclusions derived are a true reflection of the findings based on comprehensive analytical procedures.

I am committed to upholding the principles of academic honesty and integrity and am open to any further verification or scrutiny of the data included in this project report.

I understand that this project is intended for individual completion and must not involve collaboration with others. I affirm that all work has been solely conducted by me. Should plagiarism be detected at any stage, I acknowledge the possibility of disciplinary action from the appropriate authorities.

I recognize that the recommendations made in this project report are framed within the context of an academic project undertaken for the BS Degree Program at IIT Madras. The institution does not endorse any claims or statements made within this report.

Signature of Candidate:

Name: Rajveer Singh Dhaliwal

Date: 12/08/2024

## 2. Executive Summary and Title

### 2.a  Title :-

Food Waste Reduction Analysis at Abhyam Hotel: A Comprehensive Approach

### 2.b  Executive Summary :-

This report presents an in-depth analysis of food waste management at Abhyam Hotel, a well-established hospitality venue that has been serving customers since 2016. The primary objective of this project is to identify and address the key inefficiencies in the hotel's purchasing, inventory management, and storage practices that contribute to significant food waste. The analysis spans a six-month period, with a particular focus on the recurring problem of food spoilage, especially with perishable items such as vegetables.

The study uncovers several critical factors leading to food waste at Abhyam Hotel. Among these, over-purchasing, inadequate storage methods, and a disconnect between inventory levels and actual customer demand emerge as the predominant causes. The frequent spoilage of vegetables, which are typically purchased on a weekly basis, is a major concern. The analysis highlights that items such as tomatoes, potatoes, and onions are particularly prone to waste due to their short shelf life and improper storage practices.

  To conduct this analysis, Python was utilized for data processing and statistical examination, while Excel was employed for creating visualizations that clearly communicate the findings. The study explores trends and correlations in the waste data, with a specific focus on the factors contributing to the high wastage of vegetables. The results indicate that by aligning procurement strategies more closely with actual customer demand, and by implementing improved storage solutions, the hotel could significantly reduce food waste.

The report concludes with a series of actionable recommendations aimed at enhancing the operational efficiency and sustainability of Abhyam Hotel. These recommendations are rooted in data-driven insights and are designed to minimize food waste, thereby contributing to both cost savings and environmental sustainability. The suggested strategies include better forecasting of demand, more precise purchasing practices, and the adoption of advanced storage techniques to extend the shelf life of perishable items. By implementing these measures, Abhyam Hotel can improve its overall food management practices, reduce waste, and enhance its reputation as a responsible and sustainable business.

# 3. Detailed Explanation of Analysis Process/Method

## 3.a Descriptive Analysis :-

The primary goal of the descriptive analysis was to establish a comprehensive understanding of the current state of food waste, inventory, and purchasing patterns at Abhyam Hotel. Descriptive analysis serves as the foundation for any data-driven investigation by summarizing the essential characteristics of the dataset, including measures of central tendency (mean, median, mode), dispersion (standard deviation, range), and the overall distribution shape. This foundational knowledge is critical for identifying general patterns, detecting outliers, and setting the stage for more complex analyses.

The descriptive analysis was conducted using Python, leveraging powerful libraries such as `pandas` and `numpy` to manage and analyze large datasets effectively. These libraries were employed to calculate key descriptive statistics. The `pandas` library facilitated the importation, cleaning, and organization of the data, making it suitable for analysis. For instance, using **`pandas.DataFrame.describe()`**, a summary of statistics was generated, providing quick insights into the mean, standard deviation, and range of each variable.

In addition to these automated summaries, specific calculations were performed where necessary. The mean and median were compared to understand the central tendency, while the standard deviation and range helped assess the variability within the data. These statistics were critical in understanding the general patterns of waste generation, particularly in relation to different food categories such as vegetables, grains, and pulses.

To complement the Python-based analysis, Excel was utilized to create summary tables that visually represented the key statistics. These tables included conditional formatting and data bars to emphasize particularly high or low values, making it easier to identify outliers and trends at a glance. The combination of Python's computational power and Excel's visualization capabilities provided a robust and comprehensive overview of the data.

Descriptive statistics are an essential first step in data analysis, offering a clear and concise summary of the dataset. By calculating and interpreting these statistics, it became possible to identify initial patterns, anomalies, and areas of interest that warranted further investigation. For instance, understanding the variability in vegetable waste quantities provided a basis for exploring why certain items were wasted more frequently. The choice of Python for this analysis was driven by its efficiency in handling large datasets, while Excel's intuitive interface made the summary tables accessible to a broader audience, including non-technical stakeholders.

### 3.b Trend and Correlation Analysis :-

The objective of the trend and correlation analysis was to delve deeper into the data, specifically focusing on how food waste evolved over time and how it was related to other factors such as purchasing habits and inventory levels. This analysis was particularly crucial in understanding the frequent waste of vegetables at Abhyam Hotel, as these items were identified as being prone to quick spoilage due to their perishable nature and weekly purchasing schedule. By identifying trends and correlations, the analysis aimed to uncover underlying patterns and factors contributing to food waste, thereby guiding more targeted interventions.

The trend analysis began with the extraction of time-series data from the dataset, which included variables such as purchase dates, inventory levels, and waste quantities. Using Python, these data points were plotted over time to visualize the evolution of waste patterns. The `matplotlib` and `seaborn` libraries were particularly useful in generating these visualizations, with line plots illustrating the fluctuations in waste quantities over weeks or months.

Python's `**corr()**` function was employed to compute Pearson correlation coefficients, which quantify the strength and direction of the relationships between variables. For instance, the correlation between inventory levels and waste quantities was examined to determine whether over-purchasing might be leading to increased waste. Similarly, correlations between purchasing frequency and waste were analyzed to see if certain food items were more prone to wastage due to their purchasing patterns.

To enhance the clarity of these trends and correlations, Excel was used to create trend lines and charts. These included line charts showing the progression of waste over time, as well as scatter plots with trend lines to depict the correlations between variables. Excel's built-in trendline feature allowed for the addition of linear, polynomial, or moving average trend lines, depending on which best represented the data. These visualizations made it easier to communicate complex relationships and patterns to stakeholders.

Trend analysis is a powerful tool for uncovering temporal patterns in data, helping to identify periods of high or low waste and linking these to specific events or behaviors. In the context of Abhyam Hotel, this analysis was crucial for understanding why vegetables, in particular, were frequently wasted, highlighting the need for better inventory management. The use of correlation analysis provided additional insights by revealing how various factors, such as purchasing practices and inventory levels, were interrelated and contributed to waste. By employing Python for the statistical analysis and Excel for visualization, the approach effectively combined the strengths of both tools, ensuring that the findings were both accurate and easy to understand.

## 3.c  Visualizations and Reporting :-

The final step in the analysis process was to present the findings in a manner that was both clear and actionable for stakeholders at Abhyam Hotel. The goal was to translate the statistical insights into visual representations that could guide decision-making processes, particularly in relation to reducing food waste.

Excel was the primary tool used for creating the visualizations and final reports. The choice of Excel was motivated by its accessibility and ease of use, making it an ideal platform for creating interactive charts and graphs that could be easily shared with stakeholders. The visualizations included:

**Trend Lines:-** These were used to illustrate the changes in waste quantities over time, highlighting periods of significant increases or decreases in waste.

**Pie Charts:-** These charts displayed the distribution of waste across different food categories, such as vegetables, grains, and pulses, making it easier to see which items contributed most to overall waste.

**Bar Graphs:-** These compared the quantities of food purchased with the quantities wasted, providing a visual representation of the efficiency of inventory management.

These visualizations were designed to be interactive, allowing users to explore the data by adjusting filters or selecting specific time periods. This interactivity was crucial for stakeholders who needed to drill down into the data to answer specific questions or explore different scenarios.

Effective communication of data insights is as important as the analysis itself. Without clear and accessible visualizations, even the most rigorous analysis can fail to drive action. Excel's user-friendly interface and powerful charting capabilities made it the ideal choice for this task. The visualizations created in Excel not only made the data more comprehensible but also highlighted the key findings in a way that was easy to understand for non-technical stakeholders. By focusing on the high wastage of vegetables, these visualizations supported the recommendations for better inventory management and informed decisions on how to minimize waste going forward.

## 3.d  Tools Used :-

**Python (pandas, numpy):-** These libraries were essential for data cleaning, integration, and statistical analysis. Python's ability to handle large datasets and perform complex calculations efficiently was crucial for the success of the analysis.

**Excel:-** Excel was used extensively for creating interactive visualizations and dashboards. Its charts and graphs were instrumental in effectively communicating the findings to stakeholders, ensuring that the data was not only accurate but also actionable.

The methods employed in this analysis were carefully selected to meet the specific objectives of the project. Descriptive statistics provided a clear summary of the data, helping to identify key patterns and areas of interest. Trend and correlation analyses offered deeper insights into the underlying causes of food waste, particularly for perishable items like vegetables. Finally, Excel's visualization capabilities ensured that these insights could be effectively communicated to stakeholders, enabling data-driven strategies to reduce food waste at Abhyam Hotel. By combining the strengths of Python and Excel, the approach was both thorough and accessible, ensuring that the analysis was not only rigorous but also practical and actionable.

# 4. Results and Findings

## 4.a Waste Quantity (category wise)
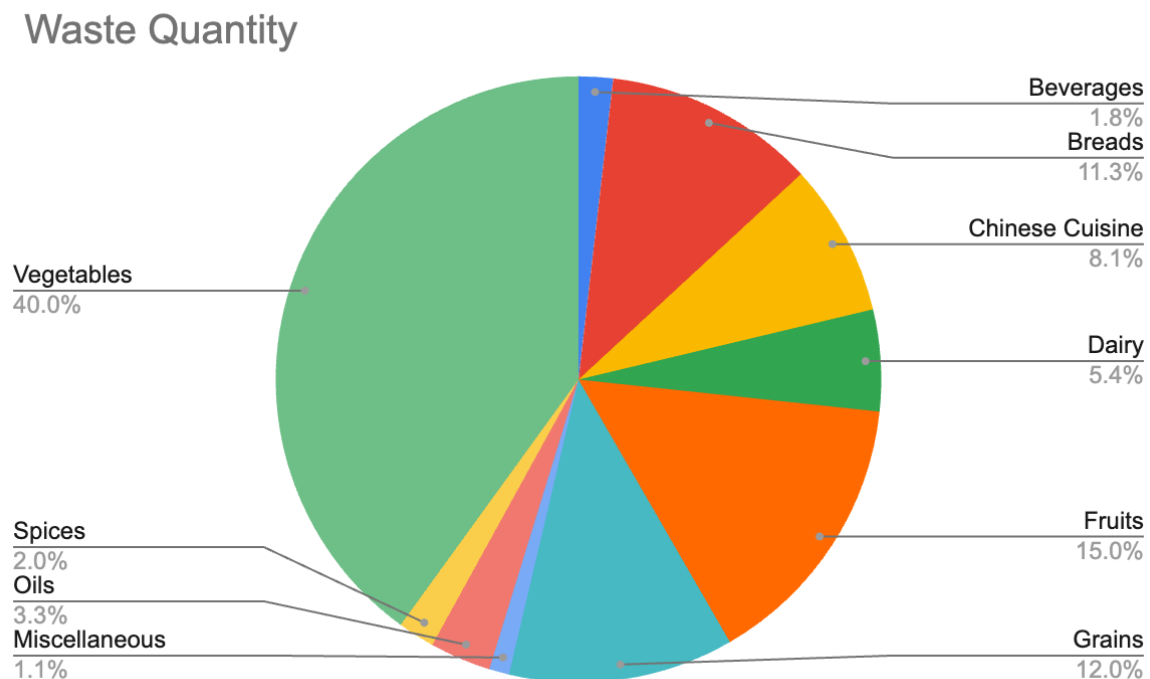


**Vegetables (40.0%):**
The largest contributor to food waste, accounting for 40% of the total waste. This indicates a need for better inventory management, optimized procurement, and improved storage practices.

**Fruits (15.0%):**
Fruits constitute the second-largest portion of waste, suggesting potential issues with overstocking, spoilage, or a mismatch between supply and demand.

**Grains (12.0%):**
Grain waste is significant at 12%, which could be due to improper portion control or misaligned menu planning.

**Breads (11.3%):**
Bread waste is also substantial, implying either overproduction or inadequate preservation methods leading to spoilage.

**Chinese Cuisine (8.1%):**
Waste from Chinese cuisine dishes accounts for 8.1%, which might indicate a lack of popularity or excess preparation.

**Dairy (5.4%):**
Dairy waste, while lower, still represents 5.4% of the total, possibly due to over-purchasing or spoilage.

**Oils (3.3%):**
Oil waste is minimal at 3.3%, likely related to kitchen practices or leftover portions.

**Spices (2.0%):**
Spices make up a small fraction of the waste (2%), possibly due to over-measuring or spoilage from prolonged storage.

**Beverages (1.8%):**
Beverage waste is minimal, suggesting efficient usage and management.

**Miscellaneous (1.1%):**
This category includes various small-scale wastes that do not fit into other categories, contributing 1.1% to the total waste.

The significant waste in vegetables, fruits, and grains points to areas for improvement in procurement and storage practices.
Targeted strategies to reduce waste in these categories could involve adjusting order quantities, enhancing storage conditions, and refining portion sizes or menu offerings to better match demand.

## 4.b waste quantity of each item in different categories

The graphs below illustrates the waste quantity of each item in different categories
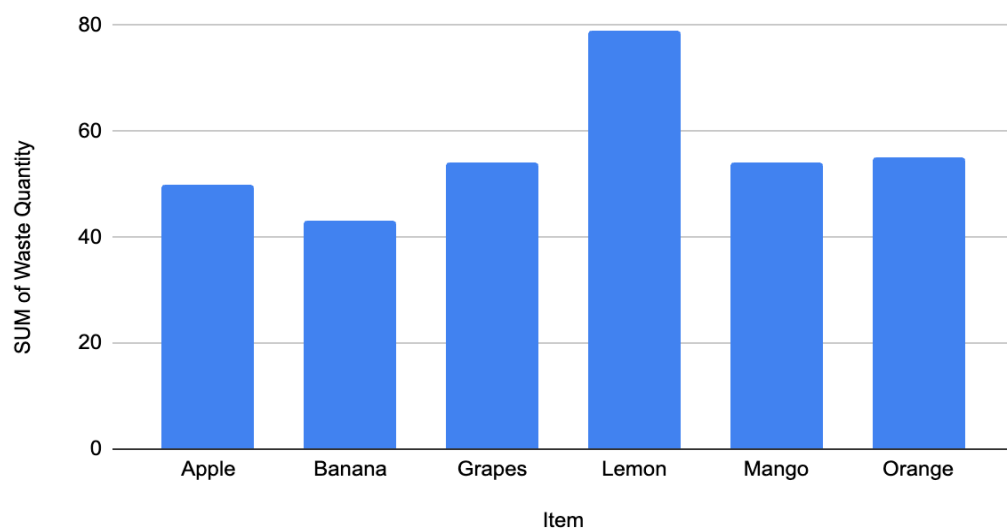
### 4.b.i  Grains

**Waste Quantity vs. Item(Grains)**
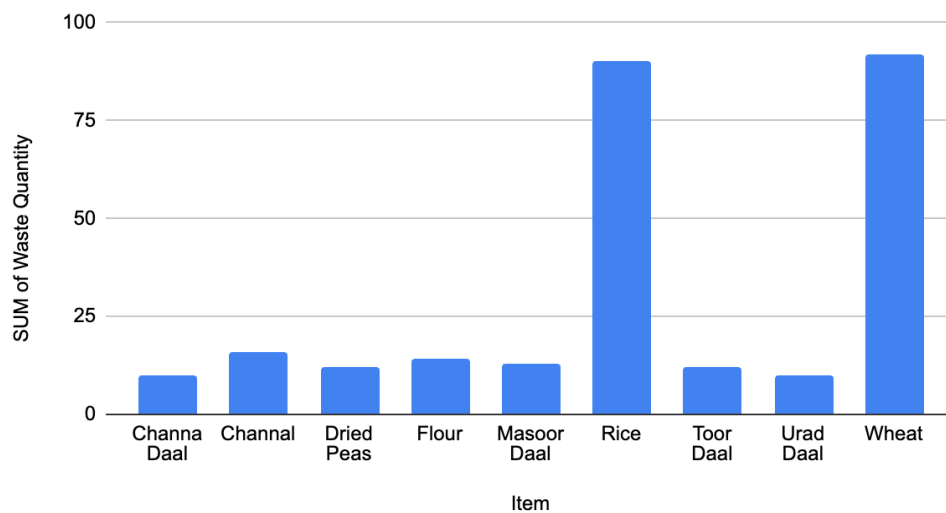


- In the grain category, both rice and wheat are wasted in notably large quantities, with each exceeding 75 kg in waste. This significant loss highlights an area that requires immediate attention for waste reduction.
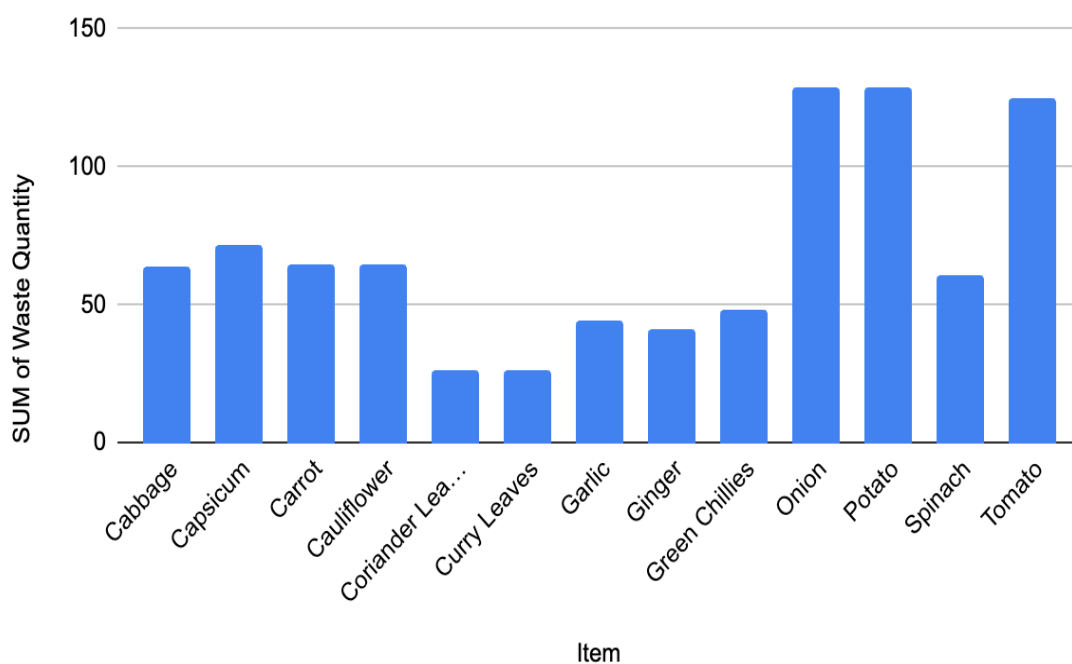
### 4.b.ii  Fruits

**Waste Quantity vs. Item(Fruits)**

- In the fruits category, nearly all types of fruits are experiencing significant waste, with losses exceeding 40 kg. This widespread waste across various fruits suggests inefficiencies in inventory management and consumption patterns.

**4.b.iii. Vegetables :-**

## Waste Quantity vs. Item(Vegetables)



- In the vegetables category, the waste is particularly pronounced in tomatoes,onions, and potatoes, each of which is wasted in excess of 100 kg. These three vegetables are the primary contributors to waste in this category and should be the focus of waste reduction efforts.
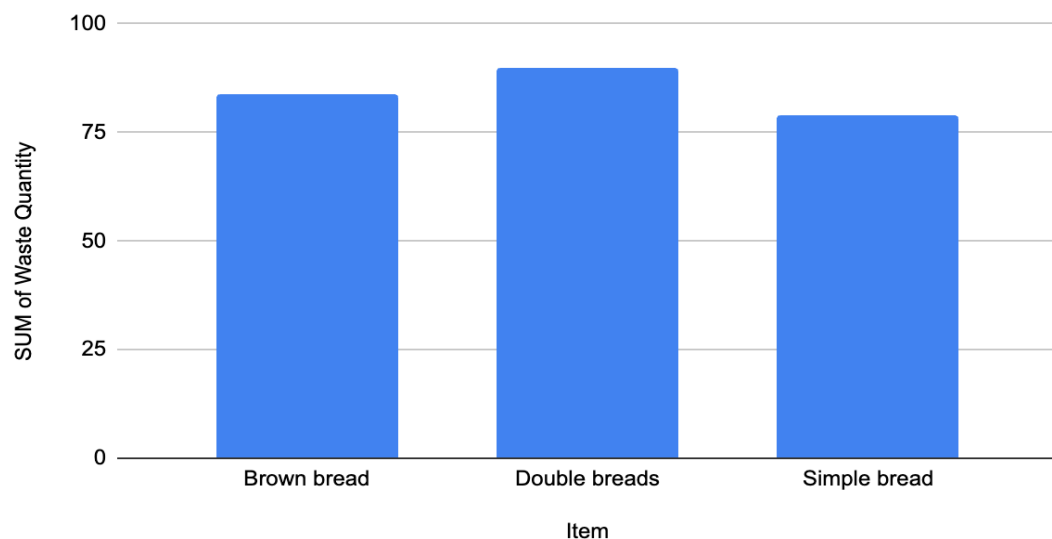
## 4.b.iv Spices

### Waste Quantity vs. Item(Spices)
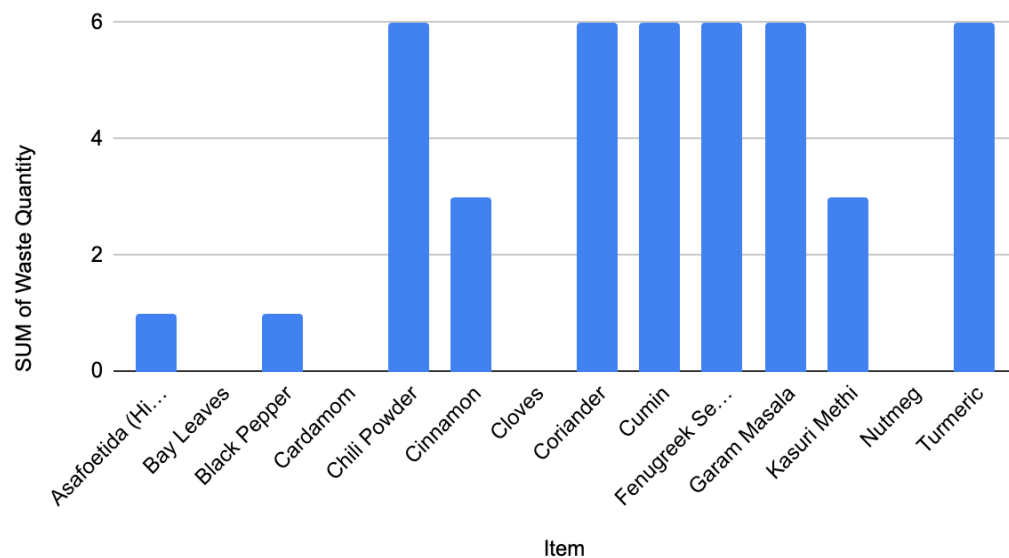


- In the spices category, most spices are being wasted at a consistent rate of around 6 kg. While this may seem smaller in comparison to other categories, the cumulative effect of this waste over time is significant and should not be overlooked

## 4.b.v. Breads

### Waste Quantity vs. Item(Breads)

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- In the bread category, it has been observed that every variety of bread is experiencing significant waste, with more than 75 packets being discarded for each type. This widespread waste across all bread varieties points to a need for closer monitoring of demand and more precise inventory control to reduce these losses.

## 4.b.vi. Diary



Waste Quantity vs. Item(Dairy)
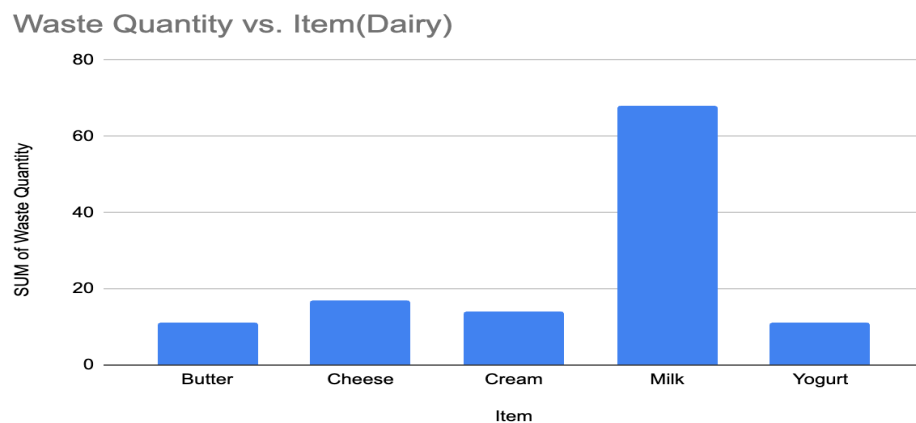
- In the dairy category, milk is being wasted at an alarming rate, with over 60 liters being discarded overall. This breaks down to approximately 10 liters of milk wasted each month, indicating a consistent pattern of excess that requires attention. Addressing this issue through better forecasting and storage practices could significantly reduce waste in this category.

Overall, the data points to specific items within each category—grains, fruits, vegetables, and spices—that are contributing heavily to waste. Targeted strategies to address these areas could lead to substantial improvements in waste reduction and resource management.
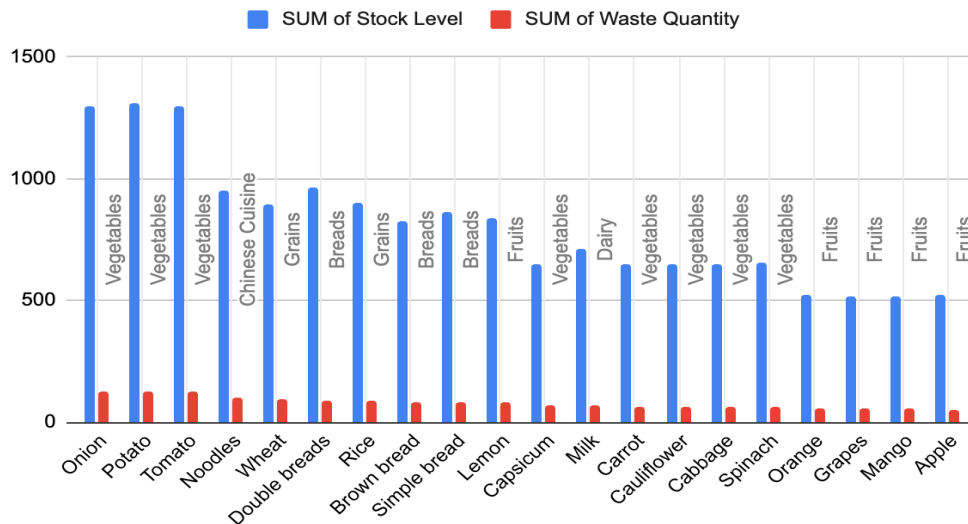
**The graph above illustrates the comparison between Stock Level and Waste Quantity of TOP 20 items**

- The graph provides a comparison between stock levels and waste quantities for the top 20 items, offering valuable insights into the efficiency of inventory management.

- The data reveals that, for each of these items, a consistent 4-6% of the stock ends up being wasted. This recurring pattern across multiple items is indicative of underlying inefficiencies in the current inventory management processes.

- The observed waste percentage, though seemingly small, adds up significantly when considering the overall stock levels. This consistent waste across various items underscores the importance of addressing these inefficiencies.

- The pattern highlighted by the graph strongly suggests that there is a pressing need for improved inventory management strategies. Without intervention, this level of waste will continue to erode profitability and resource efficiency.

- By refining inventory management practices, it is possible to reduce waste, ensuring that a greater proportion of stock is utilized effectively. This approach could lead to more sustainable and cost-efficient operations in the long run.

- Need for improved inventory management to reduce waste and increase profitability

# 4.c.i [Pareto chart for quantity ordered](#)



Pareto Chart for Quantity Ordered
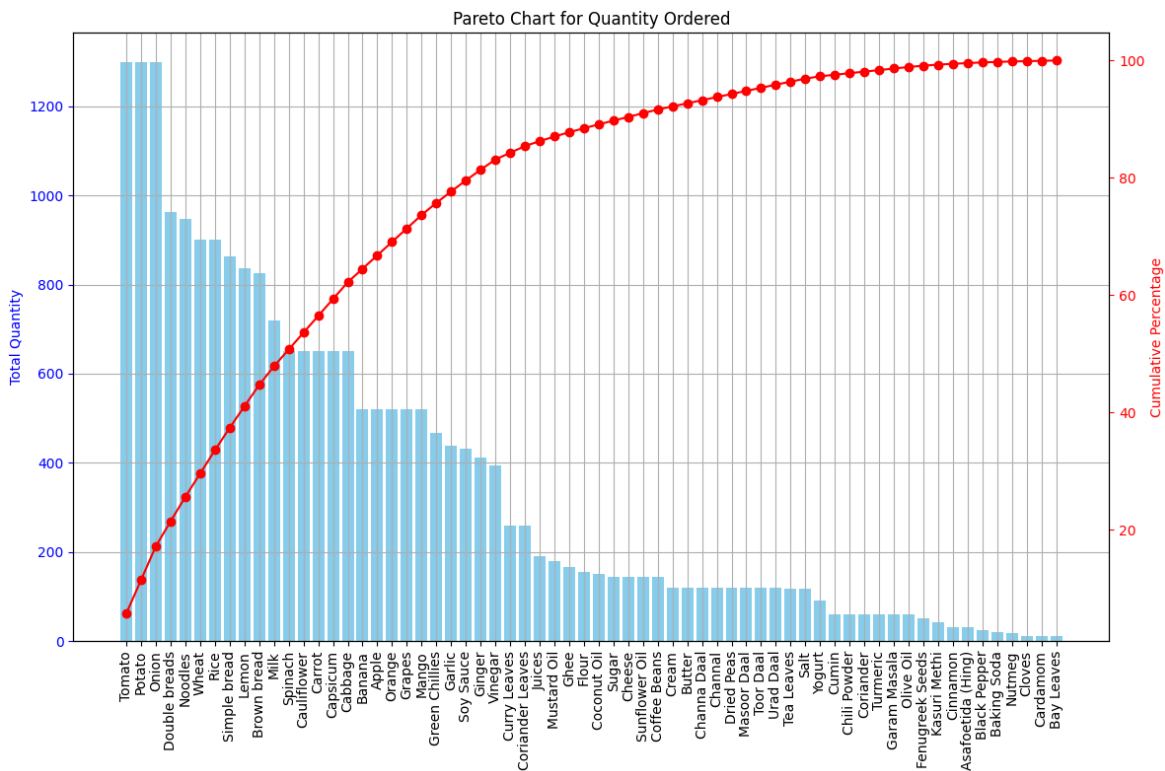
**Major Items Ordered:**

- The chart shows that a significant portion of the total quantity ordered is concentrated in a few key items. Tomatoes, potatoes, and onions are the leading items, with the highest quantities ordered. These are essential ingredients, likely used in a wide variety of dishes, which explains their prominence on the chart.

**Cumulative Impact:**

- The red cumulative percentage line shows that a small number of items make up the bulk of the total quantity ordered. For example, just the top few items account for around 50% of all quantities ordered, as indicated by the steep initial rise in the cumulative percentage curve.

**Order Concentration:**

- The left side of the chart is dominated by a small number of items with high quantities ordered, while the right side shows a long tail of many items with much smaller quantities. This indicates that most of the ordering is concentrated on a limited set of items.

**Key Focus Areas:**

- Given that a few items represent the majority of the quantity ordered, focusing on the procurement and inventory management of these items—such as tomatoes, potatoes, onions, breads, noodles, and rice—could lead to more efficient purchasing practices and potentially reduce overstocking and waste.

**Long Tail of Items:**

- The many smaller bars on the right side of the chart represent items that are ordered in much smaller quantities. While these items are less impactful individually, careful management of these can still contribute to overall efficiency.

**Strategic Procurement:**

- The chart suggests that by focusing on the top contributors, Abhyam Hotel can optimize their ordering process. This might include reviewing usage patterns and adjusting order sizes to better match actual demand, reducing the risk of overordering and subsequent waste.

**Correlation with Waste:**

- High-order items like tomatoes, potatoes, and onions also contribute heavily to waste.

## 4.c.ii Pareto chart for wastage
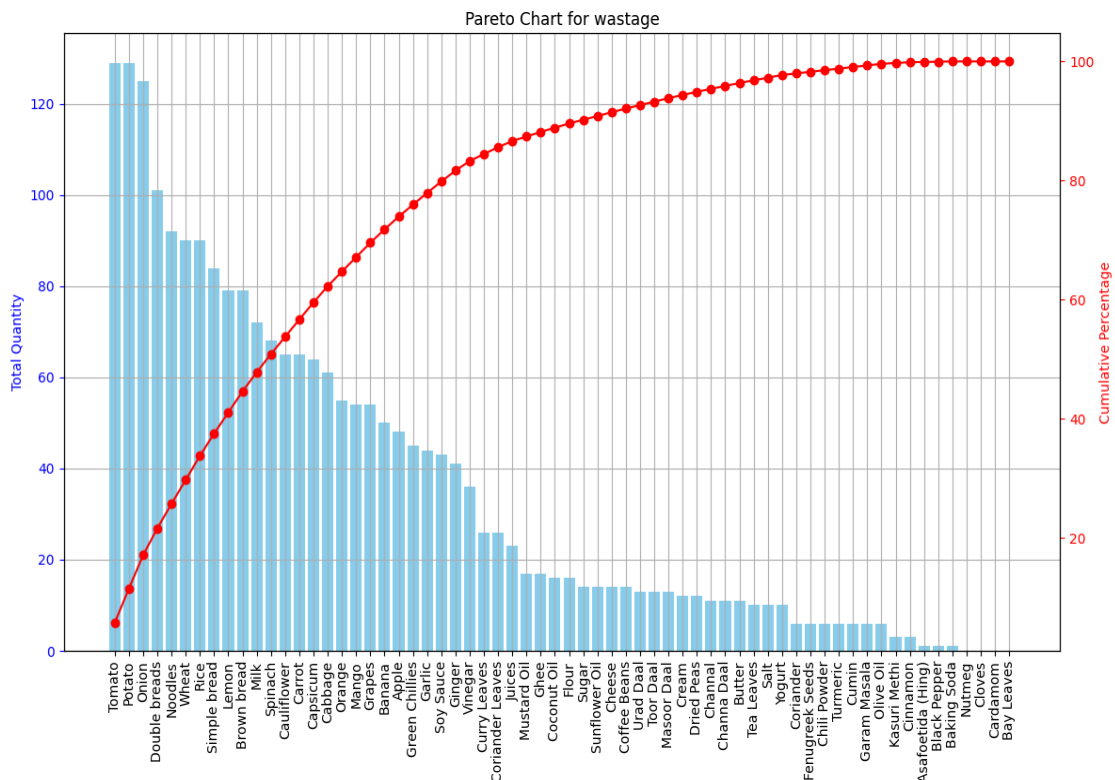
**Key Contributors to Waste:**

The chart clearly shows that a significant portion of the total quantity of waste is concentrated in a few key items, particularly tomatoes, potatoes, and onions. These items represent the largest bars on the chart, indicating their substantial contribution to overall waste.

**Cumulative Impact:**

The red cumulative percentage line indicates that a small number of items contribute to a large percentage of the total waste. For instance, just the top few items account for nearly 50% of the total waste, as evidenced by the steep incline at the beginning of the curve.

**Waste Concentration:**

As the chart moves from left to right, the cumulative percentage line starts to flatten, indicating that the remaining items contribute less significantly to the overall waste. Items on the right side of the chart, such as Bay Leaves, Cardamom, and Nutmeg, contribute minimally to the total quantity of waste.

**Focus Areas for Waste Reduction:**

Given that a few items (mainly those on the left side of the chart) contribute to the majority of the waste, efforts to reduce food waste should focus on managing and optimizing the use of these high-contribution items, such as tomatoes, potatoes, onions, double breads, noodles, and rice.

**Long Tail of Items:**

The numerous smaller bars towards the right side of the chart represent a "long tail" of items that individually contribute very little to the waste. While these items are less impactful individually, their collective management can still lead to some reductions in waste.

**Strategic Resource Allocation:**

The chart suggests that by focusing on the top contributors, Abhyam Hotel can make significant strides in reducing overall food waste. Resources should be strategically allocated to address the waste in these high-impact areas.

# 5 . Interpretation of Results and Recommendation

## 5.a Interpretation of Results :-

The analysis of food waste at Abhyam Hotel shows some clear problems, especially with items that spoil quickly, like vegetables. The main issues are that the hotel is buying too much, not storing food properly, and not matching what's in stock with what is actually ordered. The hotel buys a lot of vegetables each week, but many end up going bad before they can be used. Tomatoes, potatoes, and onions are the most commonly wasted items because they spoil quickly and aren't stored well.

This constant waste suggests that the way the hotel currently manages its stock isn't working to prevent food from going bad. The data shows that when the hotel has too much of something, more of it ends up in the trash, meaning they're regularly buying more than they need.

Fruits and dairy products are also being wasted a lot. Fruits make up 15% of the total waste, which means the hotel might be ordering too much or not storing them properly, leading to spoilage. Dairy, especially milk, is also being wasted because the hotel is buying more than it can use before it goes bad. To fix this, the hotel should consider ordering smaller amounts more often, so they only get what they need.

The waste from Chinese dishes and grains like rice and wheat suggests that the hotel might be making too much or that these items aren't as popular with customers. Even though oils, spices, and other small items don't make up a large part of the waste, they're still being wasted regularly. This points to a bigger issue in how the hotel manages its stock

## 5.b <u>Recommendations</u> :-

Based on these findings, several recommendations are proposed to reduce food waste and improve operational efficiency at Abhyam Hotel:

**Align Procurement with Demand**:- Implement more accurate demand forecasting techniques to ensure that the quantity of food purchased more closely matches actual customer needs. This could involve analyzing historical sales data to predict future demand and adjusting purchase quantities accordingly.

**Improve Storage Practices**:- Invest in better storage solutions to extend the shelf life of perishable items like vegetables. This could include temperature-controlled storage, improved inventory rotation practices, and more frequent checks on the condition of stored items to prevent spoilage.

**Regular Inventory Audits:-** Conduct regular audits of inventory levels to ensure that stock is being managed effectively. This would help in identifying overstocked items before they spoil, allowing for timely adjustments in purchasing and storage.

**Employee Training:-** Provide training for staff on best practices in inventory management and food storage. Educating employees on the importance of these practices can help reduce waste and ensure that food is stored and used efficiently.

**Data-Driven Decision Making:-** Continue utilizing data analysis tools like Python and Excel to monitor food waste trends and make informed decisions. Regular analysis of waste data can help in identifying new patterns or issues as they arise, allowing for proactive management.

By implementing these recommendations, Abhyam Hotel can significantly reduce its food waste, leading to cost savings and a more sustainable operation. The focus on aligning procurement with actual demand and improving storage practices is expected to have the most immediate impact, particularly in reducing the waste of highly perishable items like vegetables.

## 5.c Result and Recommendation Table

| Results | Recommendations |
|---|---|
| **Vegetables**: Vegetables account for 40% of total waste, with tomatoes, onions, and potatoes being the most wasted. | Adjust ordering quantities based on actual usage,<br>Invest in better storage solutions, |
| **Fruits**: Fruits make up 15% of the waste, indicating potential overstocking and spoilage. | Align fruit purchases more closely with demand. Implement first-in, first-out (FIFO) storage methods to ensure older stock is used first. |
| **Grains and Breads**: Over 75kg or packets of grains and bread are wasted, suggesting poor preservation. | Enhance preservation methods, like proper sealing and temperature control, to extend shelf life. |
| **Dairy:** Over 60 liters of milk are wasted, showing consistent over-purchasing or inadequate storage. | Purchase dairy products in smaller, more frequent batches based on actual usage patterns. Improve refrigeration and monitor expiration dates closely. |
| **Oils, Spices, and Miscellaneous Items**: These items have lower waste but still show consistent losses. | Fine-Tune Kitchen Practices, Train staff on accurate measuring techniques to reduce waste. Regularly review and adjust storage practices to ensure these items are kept in optimal conditions. |
| **Stock vs. Waste**: 4-6% of the top 20 items' stock ends up as waste, indicating inefficiencies in inventory management. | Optimize Inventory Levels. Conduct regular audits to identify and correct inefficiencies. |
| **Key Items**: High waste in essential items like tomatoes, potatoes, and onions indicates poor balance between ordering and usage. | Targeted Waste Reduction: Focus on reducing waste in these key items by improving storage conditions, training staff on proper handling, and continuously monitoring usage patterns. |