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Exploring Food Waste and Sustainability Across Cities

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ABSTARCT:

Investigating Food Waste and Sustainability Across Cities examines food waste trends in 170 cities and how they influence sustainability. The research analyzes major indicators like population, income, types of food, festival and seasonal trends, NGOs, and intelligent technology. By utilizing Tableau dashboards and visual narrative, intricate patterns were simplified and interpretable. Findings show that richer cities lose more food, celebrations produce more waste, and most affected are perishable items like fruits and vegetables. While some of the smart technologies were not useful, NGOs had considerable effects in recovery and waste education. Results reflect a requirement for data-intelligence, people's involvement, and sustainable planning in complementing urban food systems.

Keywords: Food Waste, Urban Sustainability, Tableau, Smart Technologies, NGOs, Festivals, Data Visualization

INTRODUCTION:

One of the big challenges that face the world today is waste food. Every year, millions of tonnes of edible food is wasted while big portions of the population lack food and face general food insecurity. Apart from social and economic aspects, food wastage also significantly adds to huge environmental problems like emission of greenhouse gases, wasting of water, and depletion of other natural resources. As the population of urban areas keeps on increasing and cities develop as significant consumption centers, the issue of food wastage has become all the more important.

This paper, Exploring Food Waste and Sustainability Across Cities, is set to find out the spread of food waste in various urban cities and also determine the key variables that affect it.The study uses a dataset of 170 cities with minute data on city size, mean income levels, quantities of food waste, seasonal fluctuations, and externalities in the form of festivals, NGOs, and smart technologies.

To see and explore this data, Tableau has been used to create a set of interactive dashboards and a story interface. These visualization tools aid in pattern identification, comparison of the cities, and intelligent conclusions which may not necessarily be visible within raw data.

Through this paper, we aim to highlight the potential of data visualization in revealing actual world issues and enriching sustainable urban food systems. Through the investigation of drivers and trends of urban food waste, this project hopes to facilitate more informed policymaking, public knowledge improvement, and constructive change at local and global levels.

LITERATURE SURVEY

A number of recent articles have discussed reduction of food waste, urban sustainability, intelligent technology, and data visualization to better manage resources. As a whole, these articles provide the foundation for an understanding of the general state of food waste and how it can be addressed.

Yu et al. (2023) proposed FoodWise, a food waste management plan based on data visualization- and gamification-informed principles The on-campus experiment conducted in a university evidenced the capability of interactive dashboards and gamified mobile applications to shape behavior through increased awareness of individuals about their wastefulness patterns with food (Yu et al., 2023).[Link: https://arxiv.org/abs/2307.12882]

Nafiz et al. (2023) introduced ConvoWaste, a smart bin with artificial intelligence that employed Convolutional Neural Networks (CNNs) for automatic segregation and identification of waste items. The system, in laboratory tests, obtained 98% accuracy in classification, which demonstrated deep learning's ability to recycle and sort waste (Nafiz et al., 2023).[Link: https://arxiv.org/abs/2302.02976]

Fatorachian et al.(2025) explored how AI, IoT, and blockchain are used to manage food supply chain wastage. From UK companies, their study had found how these technologies introduced sustainability and reduced inefficiencies, particularly in smart city developments (Fatorachian et al., 2025).
[Link: https://www.mdpi.com/2071-1050/17/5/1996]

Fang et al. (2023) examined the application of machine learning in smart city technology, such as robotic bins, artificial intelligence sorting, and logistics optimization. What they found was how efficient such systems would be to utilize when managing city food waste and optimizing other urban sustainability solutions (Fang et al., 2023).
[Link: https://www.frontiersin.org/articles/10.3389/frsc.2024.1449404/full]

Royal Society of Chemistry (2025) highlighted a deep learning and IoT-supported infrastructure for waste recovery that was urban-focused. By organic waste real-time categorization, the system enhanced recovery and sanitation, suggesting that AI should be coupled with IoT for efficient urban waste management (RSC, 2025).[Link: https://doi.org/10.1039/D4FB00340C]

Gap Analysis

Latest research concentrates on intelligent technology like AI trash cans, IoT, or smartphone application garbage monitoring, but is typically confined to one location or laboratory setting. They hardly ever go out to city-to-city, festival impact, or the role of NGOs, and hardly any include interactive visual storytelling to give insights.

This research fills these gaps by comparing statistics on food waste across 170 cities and cross-comparing trends on lines of income, population, festivals, food groups, NGOs, and technology adoption. By making the provision in Tableau dashboards and stories, the research provides a reflective, comparative, and consciousness-raising approach beyond what previous studies could offer.

METHODOLOGY:

The study, "Exploring Food Waste and Sustainability Across Cities," mapped and examined food waste patterns in 170 cities to enhance the understanding of how factors such as income, population, festivals, types of food, smart technology, and NGOs affect urban food sustainability. The implementation of this study was carried out in some systematic steps:

1.Dataset Collection

Dataset "Food_Waste_Cities_1_to_170.xlsx" was utilized as the basis for analysis. It gave overall details regarding:

- City locations and coverage (range 1 to 170 cities)
- Population numbers and mean income levels
- Nature of food wasted (fruits, veggies, grains, etc.)
- Patterns of wastage seasonality, especially during celebrations
- Role and impact of NGOs and intelligent technologies in reducing wastages

Prior to migrating into visualization, the dataset's organization and its categorical variables were scrutinized in detail in order to make an estimate of what it can be reasonably visualized and contrasted.

2. Data Cleaning and Preparation

- As part of ensuring reliability, the data set went through a proper preprocessing phase, including:
- Removal of duplicate and null rows whenever the values were duplicate or missing
- Normalization of naming convention of technology, foods, and cities
- Type conversion of numerical attribute images (e.g., revenues, volume of wastes, populations) into their corresponding data types
- Computed fields included like per-capita waste and percentage change in waste during celebrations

All this made the dataset clean, tidy, and ready to be analyzed by Tableau.

3. Tool Choice Provision:

Tableau was employed as the core visualization tool as it can:

- natively support Excel-based data
- produce simple, interactive visualisation
- support dashboard development and storytelling
- support drag-and-drop for exploratory prototyping and deep analysis

Its ability enabled it to discover variable relationships but present results simply and in an engaging fashion.

4.Single Sheet Design

There were several visualization sheets in Tableau, each of which was designed to address a specific research question.

The core visualizations were:

- Income vs Food Waste – investigation into whether higher-income cities generate more waste
- Food Waste During Festivals – studies of waste peak at cultural festivals
- Types of Food Wasted – determination of which food categories (fruit, vegetables, grains, etc.) were most being wasted were being wasted the most
- Smart Technology vs Food Waste – verifying the effectiveness of technological interventions
- NGO Presence and Food Recovery – emphasizing NGOs' role towards waste conversion
- Population vs Food Waste – investigating whether rising populations have a corresponding level of waste

The visualizations such as bar charts, pie charts, heatmaps, maps, and area charts were used depending on the question type.

5.Dashboard Construction

Linked sheets were combined into dashboards to enable multi-dimensional analysis. Examples include:

- A combined effect dashboard of festivals, income groups, and food groups on waste generation

- A comparative city dashboard with and without smart technologies
- A geo dashboard of food waste intensity by region

Filters (e.g., city names, income), legends, and color coding were merged in an attempt to introduce additional interactivity and richer interpretation.

6. Storytelling with Tableau

Finally, a Tableau Story was prepared to guide users through the findings step by step.

IMPLEMENTATION

This paper was aimed at addressing seven real problem statements in food waste and sustainability, one for each individual aspect like festival waste, role of NGO, or effectiveness of smart technologies. Tableau was used to prepare separate visualization sheets for every problem. Various types of charts from bar graphs, pie charts, maps, and scatter plots were used to visualize the data. By organizing relevant fields in rows, columns, and filters methodically, the research was able to highlight significant trends and facilitate meaningful comparisons between cities.

The following seven problem statements were investigated:

1. Which countries are losing the most water in terms of waste food?
2. Are richer cities losing more and leaving the hungry behind?
3. Are cities losing more food during celebrations?
4. Which cities are utilizing their food waste and making it useful—and which aren't?
5. Which NGOs are best at reducing food waste?
6. Which smart technologies are creating the most waste?
7. How effective are smart technologies in reducing plate waste
8. Through such visual analyses, Tableau acted both as an analytical tool and a tool for telling stories, making it possible to reveal concealed patterns and present results in a understandable format.

RESULTS:

The essay was built around problem statements of utmost significance, all solved using data visualization.

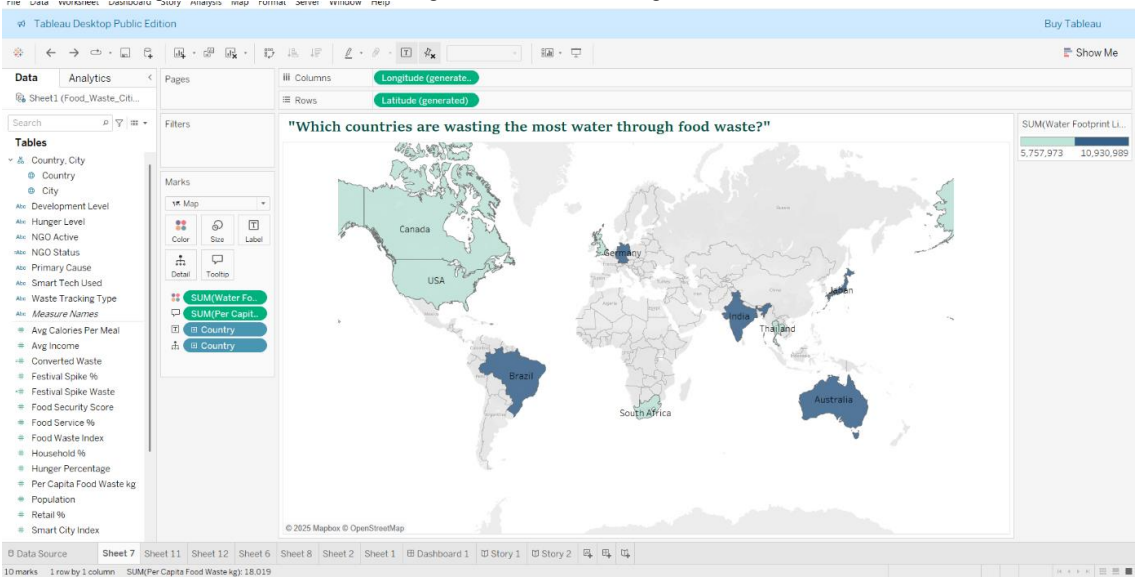
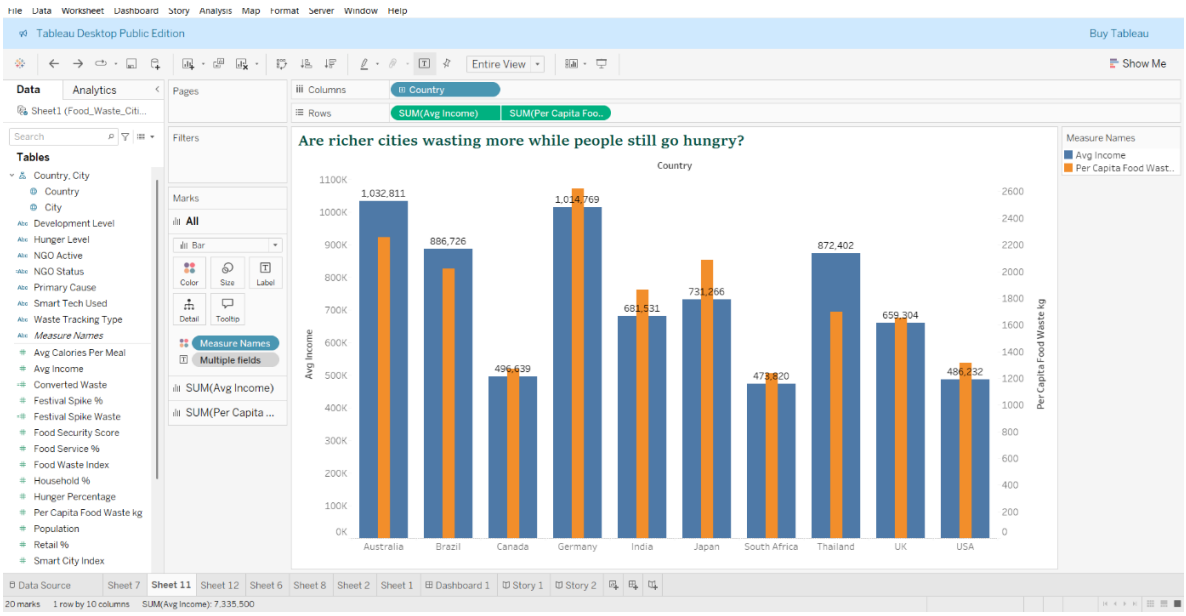


Figure:1

The first query asked: "Which countries are squandering the most water on food waste?"

The world map visualization showed that countries like Brazil, India, and Australia have the largest water footprint from food waste, while Canada and South Africa showed comparatively lower values. Darker areas on the map revealed that the environmental significance of wasted food displayed how water resources are lost along with wasted food.



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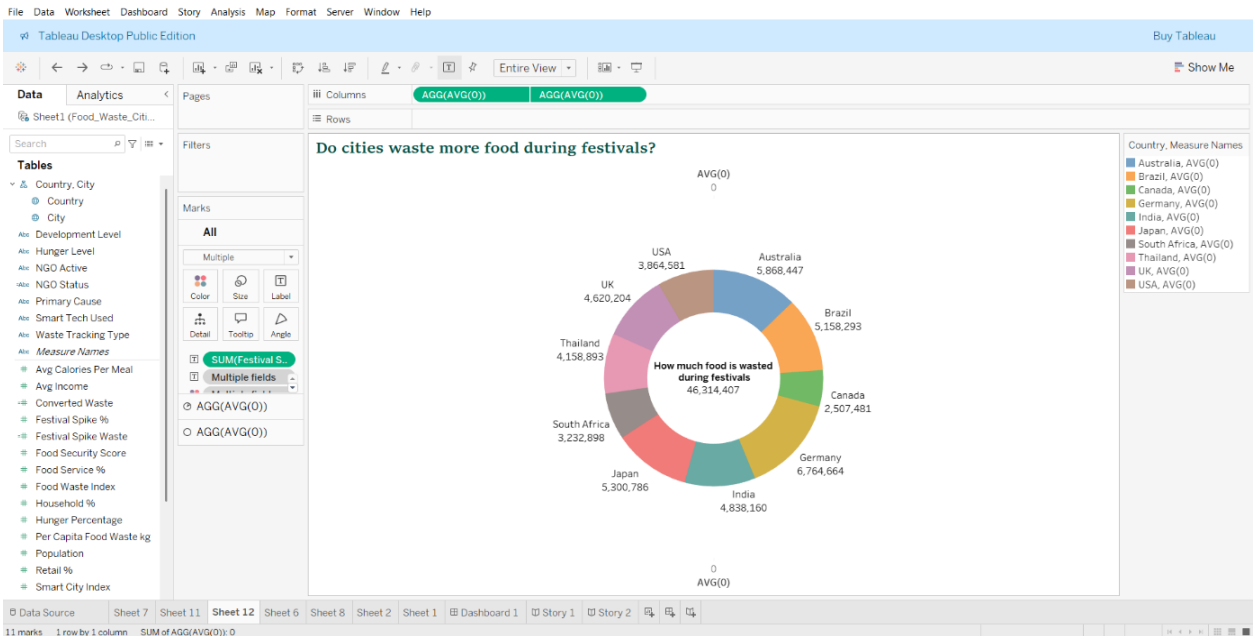
The second problem statement was: "Are richer cities wasting more while people still go hungry?" A bar-in-bar chart supported that wealthier cities such as Germany and Australia had high per capita food waste accompanied by high average incomes. At the same time, countries such as India and South Africa with lower average incomes also showed high food wastage, which reflected systemic inequalities and food system inefficiencies.



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The third research question was: "Do cities waste more food during festivals?" A donut chart clarified that the festivals caused much wastage. One of the highest increases was from Germany during the time of celebrations, with Canada having a lower spike. The cumulative food wastage that was created in all the countries while celebrating totaled over 46 million units, which showed the magnitude of cultural impact on sustainability.

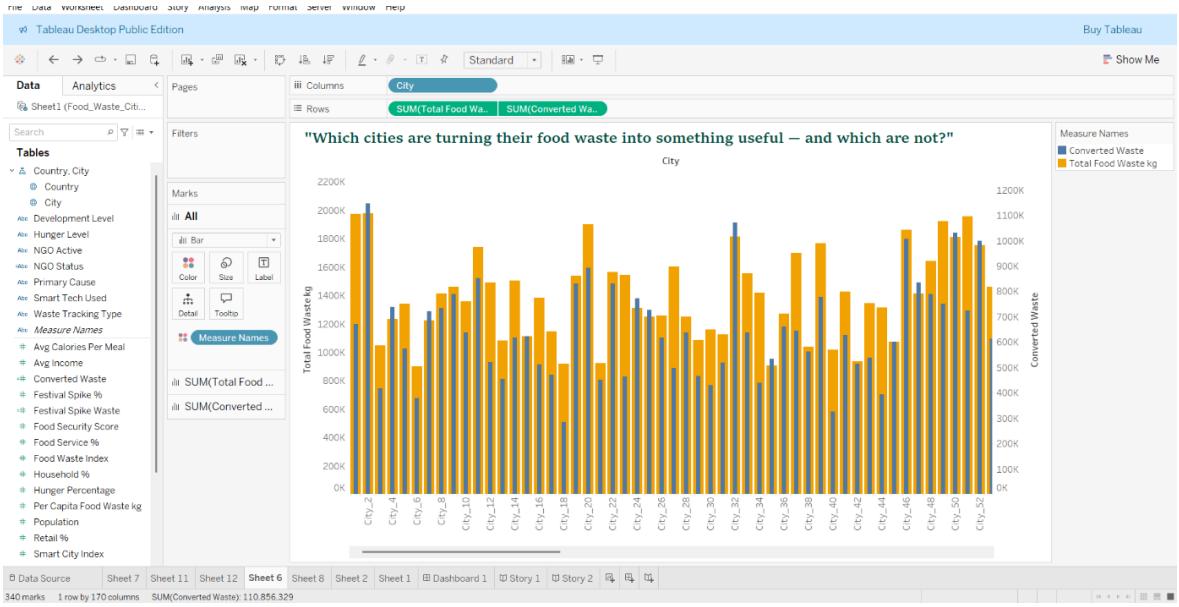
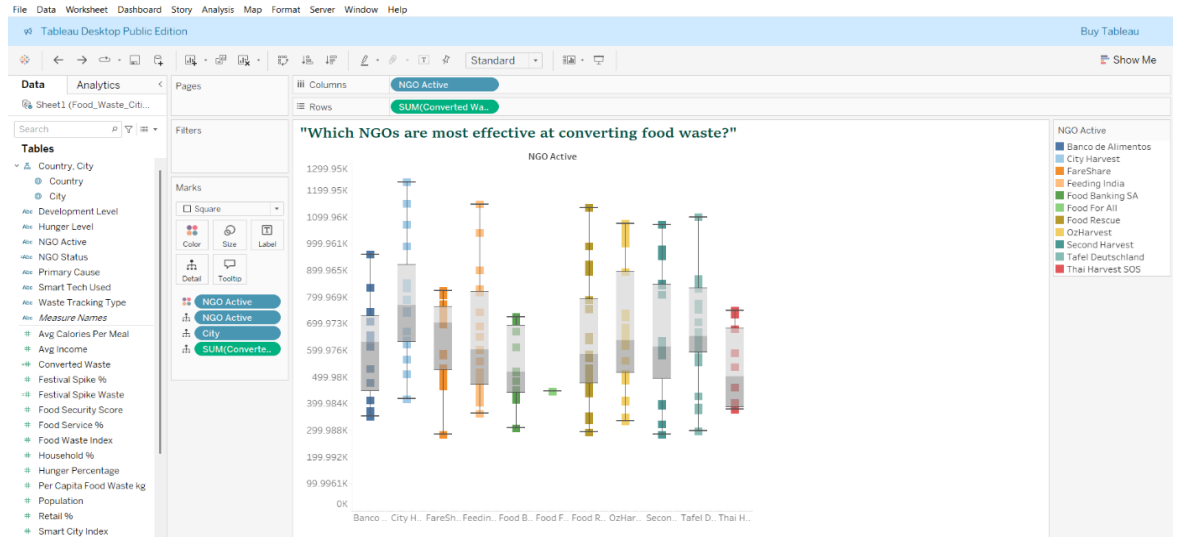


Figure:4

The fourth question resolved was: "Which cities are turning their food waste into something useful?" Comparisons in a bar-in-bar format showed that although there were cities which effectively turned a considerable amount of their total waste into compost or energy, others had a notable variance between waste produced and waste converted. Those cities with tall orange bars (high total waste) but with practically no blue bars (very low conversion) were found to be less resource-efficient.



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The fifth question probed: "Which NGOs perform best at converting food waste?" The box-and-whisker plots showed clear differences. Some NGOs, such as OzHarvest, consistently operated high conversion rates with reduced variability between cities and were thus more consistent. Others operated with greater ranges, which showed inconsistent performance relative to resources and environment.

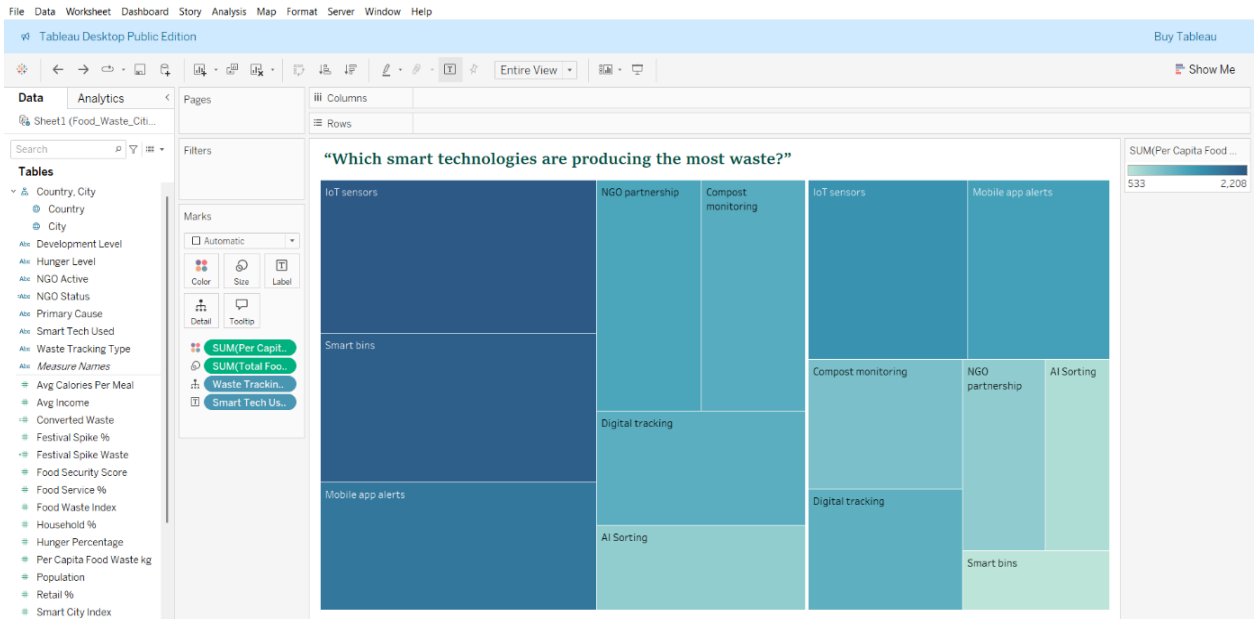


Figure:6

The sixth research question had been: "What intelligent technologies produce the most waste?" Treemap visualizations had suggested IoT sensors, smart bins, and some NGO-technology partnerships were associated with greater waste. In contrast, AI-based sorting technology and compost tracking technology were associated with lower waste, which could indicate less green performance.

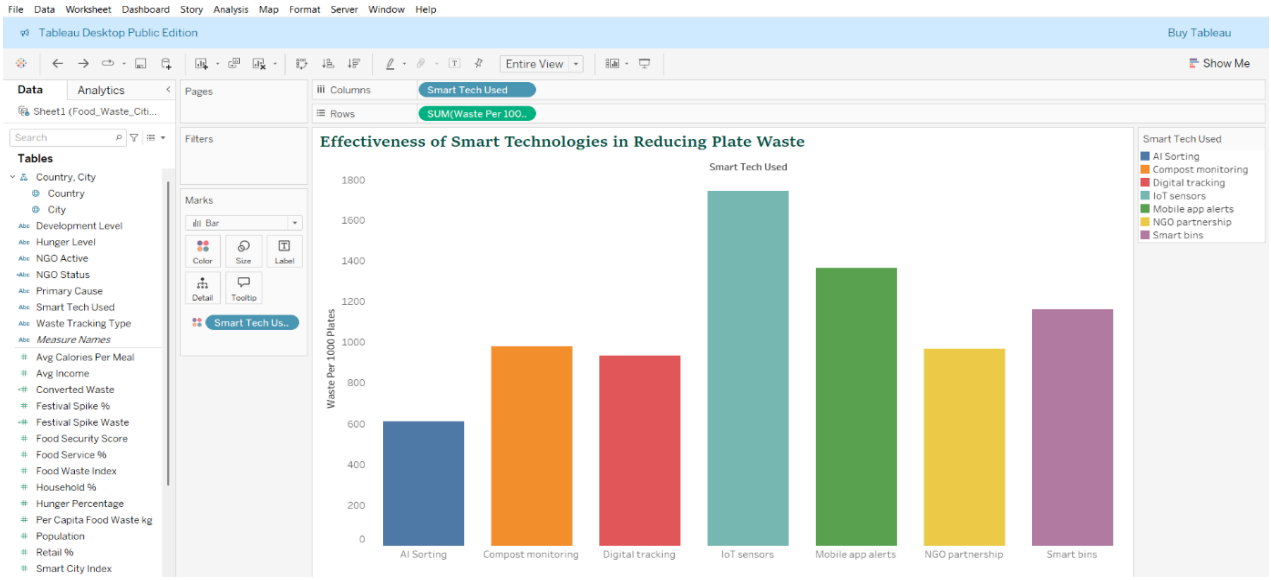
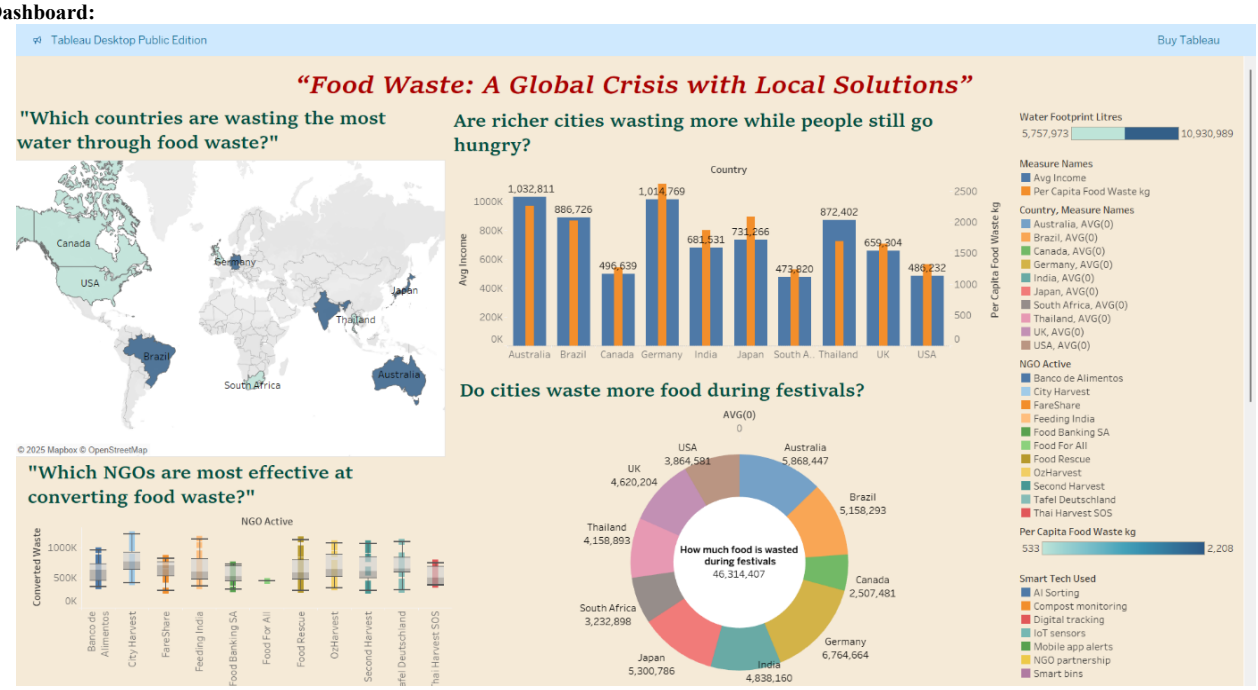


Figure:7

Lastly, the seventh problem statement interrogated: "Which smart technologies are most effective in reducing plate waste?" A bar chart comparison easily established that AI-based sorting technologies produced the lowest amount of plate waste per 1000 plates, demonstrating their efficiency, while IoT-based solutions were associated with the highest level of plate waste, pointing towards implementation issues and adaptability.

Dashboard:



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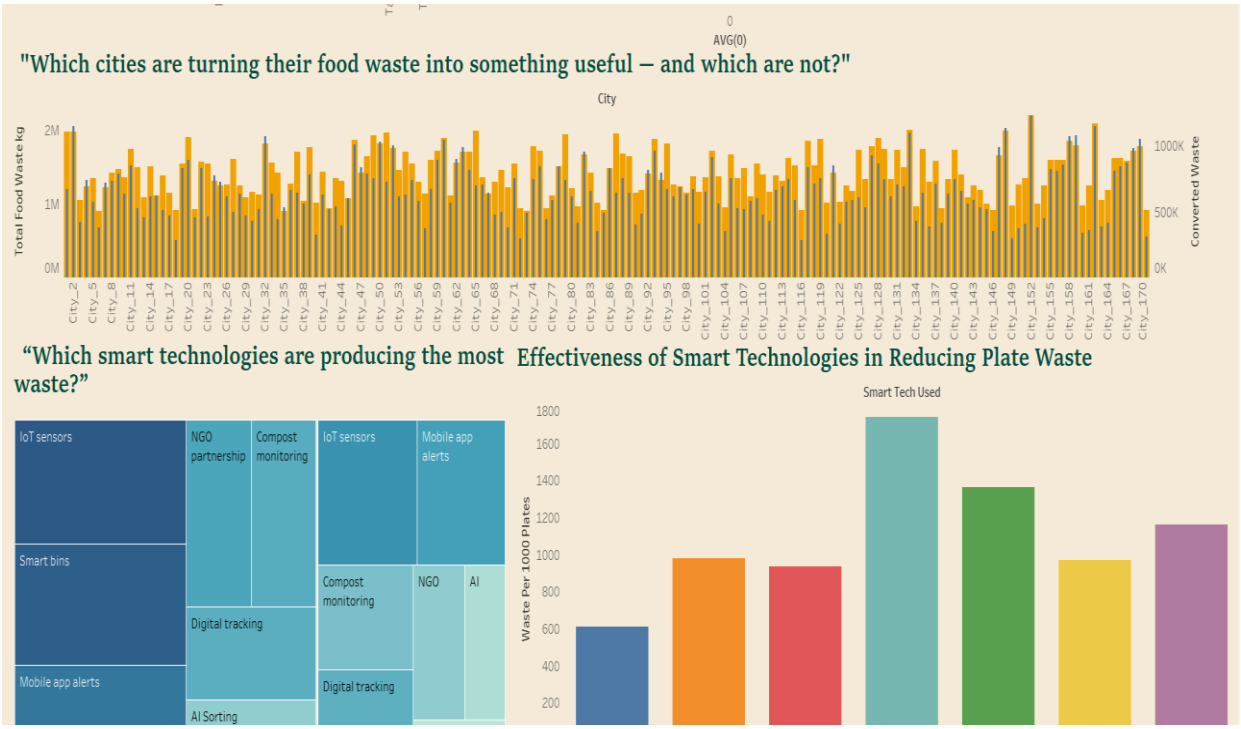

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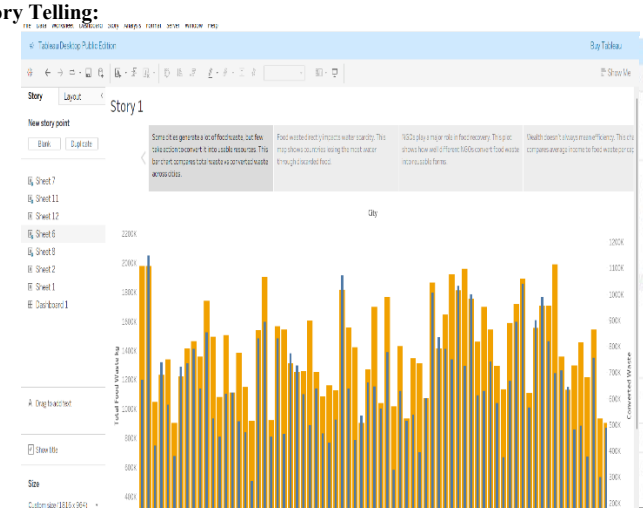
Story Telling:



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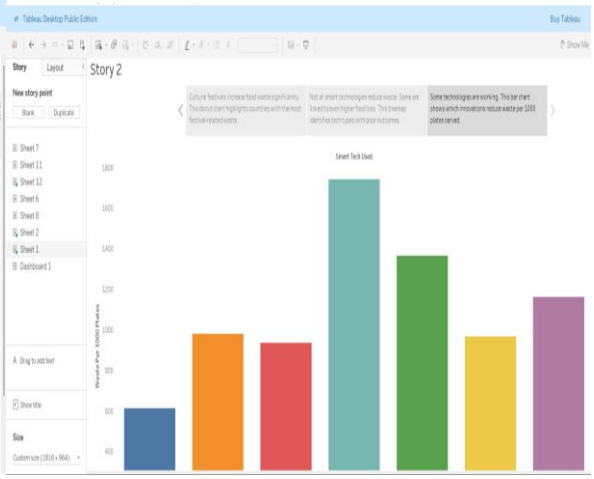

Figure:11

In total, these visual analyses validated that food waste is influenced by various dimensions—economic situation, cultural habits, perishability of produce, NGO efforts, and the influence of smart technologies. Tableau visualizations facilitated the easy interpretation of these insights, providing an unambiguous image of where waste is most critical and where interventions are most valuable.

DISCUSSION:

By means of this paper, patterns of food waste across various cities and the determinants were explored. The visual plots made using Tableau presented useful insights on the tale behind the numbers.

One notable fact was that the more affluent cities waste more food, even when large populations are hungry. This emphasizes that more money does not necessarily mean improved food management—food is still being wasted while others suffer from shortages.

The study also discovered that food waste rises during festivals. This could be attributed to massive preparation of foods and celebration, where extra food tended to be wasted. All such findings highlight the importance of improved planning, sharing mechanisms, or community drives during festive seasons.

Considering the impact of smart technologies, their impact was varied. In some of the cities, they decreased plate waste, while in others their impact was negligible or even contrary. This shows that technology cannot be relied upon single-handedly; their impact is based on proper implementation and their use.

On a positive note, NGOs were also found to play a critical role in resolving the problem. In a number of places, they have been able to transform food wastage into compost or animal feed and, in doing so, reduce environmental pollution and promote sustainability.

Another critical issue that was identified was the wastage of water. Because food production demands large quantities of water, food wastage also means wastage of water. In most countries, this is now a huge environmental problem, as lots of water are being indirectly lost through wastage of food.

In short, this article proves that less food waste is not achieved by simply throwing away less food. It necessitates transformations of consumer behavior, efficient utilization of smart solutions, and proactive engagement with NGOs and communities for long-term sustainability.

CONCLUSION

It is this paper's conclusion that wasted food is a rising issue in the majority of cities, very much reliant on factors such as incomes, festivals, lack of planning, and in some cases, lack of proper utilization of technology. Data visualization through the aid of Tableau allowed us to identify those cities facing the greatest challenges and which cities are practicing eco-friendly measures.

It is found that:

Waste more food in more affluent cities despite the prevalence of hunger.

More waste food is seen at festivals, illustrating the need for improved planning and awareness.

NGOs contribute by converting waste into useful materials such as compost and animal feed.

Use waste with intelligent technologies, as long as it is properly implemented and used.

This study demonstrates that data storytelling with images is a powerful method of building awareness and informing informed decision-making. In

demonstrating clean patterns and comparison, it provides insights powerful enough to mobilize action among people, communities, and local governments.

Lastly, analysis precedes observation of data—it needs to be followed by behavior modification, ethical usage of technology, and social activism to combat wastage of food and prepare for a more sustainable future.

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