IT2856 Business Analytics Project: Final Report Food Waste

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Contents

1 Executive Summary

The **business objective** is to use data analytics to find the causes and solutions of food waste to reduce food waste. Our **problem statement** is 'How can food waste be improved in the US?' We focus on different sub problems to tackle the main problem statement. Our **sub problem statements** are 'How can the U.S. improve the household food waste situation?', 'How can food wastage in the U.S. food service sector be improved?', 'How can food wastage in the U.S. retail sector be improved?' and 'How do U.S. states differ in food waste management?' By finding solutions for sub factors, we can reduce the food waste in the US. The **hypothesis** for households is that waste is primarily driven by consumer behavior like over-purchasing and confusion about date labels and can be reduced through targeted education and tools. The hypothesis for food service is that by identifying the problems and causes in each sub sector we can find solutions to reduce food waste. The hypothesis for retail is that Food wastage in the U.S. retail sector is primarily driven by supermarkets and grocery stores due to causes like date label confusion. By targeting high-impact, cost-effective solutions especially on SMEs, it can significantly reduce food waste while improving financial performance and generating positive social benefits like higher employment. The hypothesis for States is that by drilling down what creates the difference between states, we can identify what is the most impactful sector to address and solve for it.

Sector 1: Households
Business Scenario: American households bear the highest financial cost of food waste. This occurs silently in refrigerators and pantries due to a lack of planning, confusion and ingrained habits. This directly impacts family budgets and national waste streams.
Insights Discovered & Recommendation: The first dashboard shows residential households produce the largest share of U.S. food waste and that the biggest wasted categories are prepared foods, produce, and dairy/eggs; drilling down, spoilage and plate/leftover waste are the dominant causes. After understanding the cause reason, the second dashboard evaluates the potential solutions by tons diverted, CO_2 reduction and net financial benefit (with an adoption-rate slider for realistic scenarios) and identifies consumer-focused solutions such as consumer behaviour change campaigns (meal planning, portion control, leftover reuse), standardized date labeling, and composting. Comparing implementation cost and financial benefit, the analysis recommends piloting consumer behaviour change campaigns first (highest diversion per dollar and strong CO_2 savings), then scaling complementary measures like date-label reform and expanded composting to close the remaining gap.

Sector 2: Food Service
Business Scenario: For restaurants, food waste is a direct hit to profitability. Inefficiencies in kitchen prep, over-ordering and large portion sizes that customers can't finish translate into thousands of dollars in discarded food and missed opportunities for cost savings.
Insights Discovered & Recommendation: Using the first dashboard, it shows that full service restaurants, limited service restaurants and lodging has the most food waste. Drilling down, the varied menu sub sector category in full service restaurants has the most food waste while burgers and coffee cafe sub sector category in limited service restaurants have the most food waste. The majority of food waste is prepared food. After understanding 'where' and 'what', the second dashboard suggests that the majority of food waste comes from full service restaurants due to plate waste. In the third dashboard, filtering to full service

restaurants and a varied menu, the top 5 solutions are portion sizes, centralized composting, co-digestion at waste water treatment plants etc. After comparing the financial needed to implement and financial benefit for the business, the analysis suggests implementing “Portion Sizes”. This solves the main contributor of the food waste in the food service sector. By using the dashboards, different sub sectors can also find solutions to reduce food waste.

Sector 3: Retail

Business Scenario: Grocery retailers operate on thin margins and face a constant battle with perishable inventory. The pressure to maintain perfectly stocked shelves with cosmetically flawless produce leads to significant waste, especially for Small-to-Medium Enterprises (SMEs) that lack the resources of large chains to manage it sustainably.

Insights Discovered & Recommendation: The first dashboard allows me to do the root cause analysis enabling deeper insights into the underlying factors of food wastage. The pie chart shows that out of all the sub-sectors in retail supermarkets and other grocery stores have the highest amount of excess food wastage. The stacked bar chart shows that large-sized companies are able to to use sustainable food waste diversion methods for most of their food waste like donating, composting or animal feed. This shows that large-sized companies have the resources to implement sustainable food waste diversion methods unlike small-to-medium sized companies (SMEs). Lastly, the treemap shows that the causes for food waste in retail is mainly date label concerns, mistakes and malfunctions and spoiled food. Therefore, we know the root cause of high food wastage in the retail sector is because supermarkets and other grocery stores of SMEs do not have the resources to implement solutions to reduce food waste mainly caused by date label concerns, mistakes and malfunctions and spoiled food. The second dashboard highlights each solution by showing the total food wastage it reduced, its profitability, and the number of meals diverted and the jobs created through each solution. Throughout all three visualizations solutions like, Markdown Alert Applications, Intelligent Routing and Dynamic Pricing stood out. These solutions not only reduced significant amounts of food wastage but also generated high profitability and created substantial employment opportunities for society. Thus, I recommend these solutions should be implemented in supermarkets and other grocery stores of SMEs to reduce food wastage for date label concerns, mistakes and malfunctions and spoiled food.

Sector 4: U.S. States & Policy

Business Scenario: The national goal of reducing food waste is hindered by a patchwork of state-level policies and infrastructure. Some states are equipped to divert waste while others lack the facilities or economic incentives, creating a significant efficiency gap that requires a targeted policy response.

Insights Discovered & Recommendation: The first dashboard shows that there is an efficiency gap between states, and identifies how “better off” states with higher income and higher urban populations tend to generate more food surplus. However, this alone does not solve for why there is an efficiency gap between states. So, by selecting benchmark states (The highest and lowest surplus to supply ratio states for each of the income groups) and drilling them down based on how many tons of food waste they send to each of the various destination types, we identify that differences in how farm-level food waste is handled is the most impactful difference maker, suggesting that infrastructural differences are behind the efficiency disparity between states, and should be targeted. In the second dashboard, solutions are ranked based on how much farm-level food waste they can divert annually,

with the 3 best solutions involving making “ugly” food more acceptable and attainable, as well as to inform producers on how to safely and efficiently donate food.

2 Project Plan

Project team organization
Team Leader: Tan Xin Hui
Team Members: Ke Xuan, Harika, Shayn

Project schedule and task allocation (Gantt chart)

PLAN	SEM 1				
	Apr	May	Jun	Jul	Aug
Find problem statement & sub problem statement & find data					
Finish proposal and slides					
Find data, clean data, make chart and create dashboard					
Improve individual dashboard and integrate everyone's dashboard, turn it to story					
Report & Reflection					

Apr- May Wk6 Proposal Presentation
Jul-Aug Wk16 Data Preparation, Modelling and Evaluation
Aug Wk 18 Final Presentation

Task Allocation
24 April - Ask everyone to comeup with their problem statement and find data

1 May - Assign proposal(group) parts to each individual

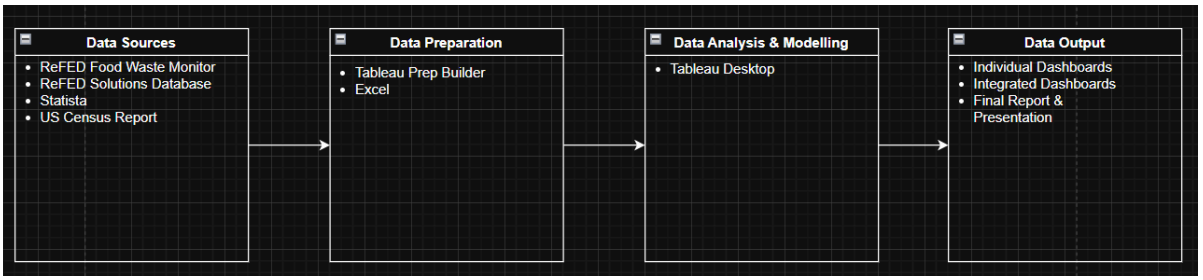
3 July - Ask everyone to come with dashboard

14 August - Refine our own dashboard and combine on tuesday

Software tools used for development
Excel, Tableau

3 Data Understanding and Modelling - Group

3.1 System Architecture Diagram



3.2 Data details

Member Name: Xin Hui

1. **Dataset Name & Link:** State Food Surplus Detail (Link:https://insights-engine.refed.org/food-waste-monitor?break_by=subsector&indicator=tons-surplus&sector=foodservice&view=detail&year=2023)
   Description: This dataset contains US food waste from 2010-2023. File type: csv

   Columns: Dimensions: Year, state, sector, sub_sector, sub_sector_category, food_type, food_category, *tons_surplus, tons_supply, us_dollars_surplus, tons_waste, tons_uneaten ,tons_donations, tons_industrial_uses, tons_animal_feed, tons_anaerobic_digestion, tons_composting, tons_not_harvested, tons_incineration, tons_land_application, tons_landfill, tons_sewer, tons_dumping, surplus_upstream_100_year_mtco2e_footprint, surplus_downstream_100_year_mtco2e_footprint, surplus_total_100_year_mtco2e_footprint, surplus_upstream_100_year_mtch4_footprint surplus_downstream_100_year_mtch4_footprint, surplus_total_100_year_mtch4_footprint, gallons_water_footprint, meals_wasted*
   * Italic are Measures

   Transformation performed: filter year (2019-2023), filter sector (keep only food service), remove not used data field (tons_not_harvested, tons_incineration, tons_land_application, tons_landfill, tons_sewer, tons_dumping, surplus_upstream_100_year_mtco2e_footprint, surplus_downstream_100_year_mtco2e_footprint, surplus_total_100_year_mtco2e_footprint, surplus_upstream_100_year_mtch4_footprint surplus_downstream_100_year_mtch4_footprint, surplus_total_100_year_mtch4_footprint, gallons_water_footprint, meals_wasted), change data type (alphabet to decimal)
   How is the data related to your problem? : I used this dataset for my first dashboard which finds out the distribution of food waste in each sub sector, sub sector category and food type.

2. **Dataset Name & Link:** Food Surplus Cause Summary (Link: https://insights-engine.refed.org/food-waste-monitor?break_by=subsector&indicator=tons-surplus&sector=foodservice&view=detail&year=2023)
   Description: This dataset contains US causes of food waste from 2010-2023. File type: csv

Columns: Dimensions: Year, sector, sub_sector, food_type, cause_group, cause_name, *tons_surplus_due_to_cause, us_dollars_surplus_due_to_cause tons_inedible_parts, tons_not_fit_for_human_consumption*
* Italic are Measures

Member Name: Xin Hui
Transformation performed: filter year (2019-2023), filter sector (keep only food service), remove not used data field (sector, us_dollars_surplus_due_to_cause, tons_inedible_parts, tons_not_fit_for_human_consumption) , change data type (alphabet to decimal)
How is the data related to your problem?: I used this dataset for my second dashboard which finds out the causes of food waste in each sub sector and food type.

Member Name: Harika
Transformations performed: Remove unnecessary fields, remove null data, rename all the columns to ensure that the names are eligible and understandable to the everyday users and apply a filter to sector so only Retail-specific causes of food wastage remain
How is the data related to your problem?: I used this for my treemap to identify the root cause of food wastage in the retail sector in the US.

3. **Dataset Name & Link:** Solutions Detail (Link: https://insights-engine.refed.org/solution-database?dataView=total&indicator=us-dollars-profit)
Description: This dataset contains potential solutions for US food waste. File type: csv
Columns: Dimensions: solution_group, solution_priority_action_area, solution_name, sub_sector, sub_sector_category food_type, *annual_tons_diversion_potential, annual_100_year_mtco2e_reduction_potential, annual_100_year_mtch4_reduction_potential, annual_gallons_water_savings_potential, annual_meal_equivalents_diverted jobs_created, annual_us_dollars_cost, annual_us_dollars_gross_financial_benefit, annual_us_dollars_net_financial_benefit*
** Italic are Measures*

Member Name: Xin Hui
Transformations performed : exclude null, filter sector, remove not used field (state & sector)
How is the data related to your problem? : I used this dataset for my third dashboard which finds out the solutions of food waste in each sub sector, food type and sub sector category

Member Name: Harika
Transformations performed: Remove unnecessary fields, apply a filter to sector so only Retail-specific solutions remain & rename all the columns to ensure that the names are eligible and understandable to the everyday users.

How is the data related to your problem?: I used this for my last dashboard on all my visualizations. It helped me find solutions for the retail sector through data on the amount of food waste reduced, profitability and jobs created for each solution.

Member Name: Harika

4. **Dataset Name & Link:** Documentation_Retail_FoodDestinations (Link:https://insights-engine.refed.org/food-waste-monitor?view=overview&year=2023)
   Description: This dataset contains the food waste destinations in grocery retailers (large-sized companies)
   File type: xlsx

   Columns: refed_food_department, donated, animal_feed, anaerobically_digested, composted, sewer, landfilled, biomaterial_processing, combusted, land_application, refuse_discards, trash, Total

   Transformations performed: Remove columns that show 0% for their all specific food waste diversion methods

Member Name: Harika

5. **Dataset Name & Link:** FoodWholesaleAndRetail (Link:https://insights-engine.refed.org/food-waste-monitor?view=overview&year=2023)
   Description: This dataset contains high and low excess food waste estimations for each sub-sector in retail
   File type: xlsx

   Columns: Name, NAICS Code Description, NAICS Code, Excess Food Estimate, Low (tons per year), Excess Food Estimate, High (tons per year), Unique Identifier

   Transformations performed: Remove unnecessary fields (Address, City, County, State, Zip Code, Phone, Website), remove all the nulls & create a calculated field for Average Excess food [Excess Food Estimate, Low (tons per year) + Excess Food Estimate, High (tons per year) / 2]

   How is the data related to your problem?: To show the Average Excess food for each sub-sector in the retail sector to find out which sub-sector produces the most amount of average excess food.

Member Name: Shayn

1. **Dataset Name & Link:** ReFED_US_State_Food_Surplus_Detail (https://insights-engine.refed.org/food-waste-monitor?break_by=destination&indicator=tons-surplus&view=detail&year=2023)
   Description: Contains information in regards to food waste across the U.S. States
   Columns: year, state, sector, sub_sector, sub_sector_category, food_type, food_category, tons_surplus, tons_supply, us_dollars_surplus, tons_waste, tons_uneaten, tons_donations, tons_industrial_uses, tons_animal_feed, tons_anaerobic_digestion, tons_composting, tons_not_harvested, tons_incineration,

tons_land_application, tons_landfill, tons_sewer, tons_dumping, surplus_upstream_100_year_mtco2e_footprint, surplus_downstream_100_year_mtco2e_footprint, surplus_total_100_year_mtco2e_footprint, surplus_upstream_100_year_mtch4_footprint, surplus_downstream_100_year_mtch4_footprint, surplus_total_100_year_mtch4_footprint, gallons_water_footprint, meals_wasted
Transformation Performed: Filtered for only 2023 data, Created calculated fields (Disposal Total, Recovery Total, Recycling Total, Uneaten Rate, Landfill Rate, Diposal Rate, Recovery Rate, Recycling Rate, Waste to Supply, Surplus to Supply), filtered for only tons_surplus > 0
How is the dataset related to your problem?: It contains information as to how much food is supplied, in excess and wasted in each state, as well as the different destinations this food is lost at.

2. **Dataset Name & Link:** ReFED_US_Food_Waste_Solutions_Detail (https://insights-engine.refed.org/solution-database?dataView=total&indicator=us-dollars-profit)
   Description: Contains information about different solutions for food waste in different sectors
   Columns: solution_group, solution_priority_action_area, solution_name, sector, sub_sector, sub_sector_category, state, food_type, annual_tons_diversion_potential, annual_100_year_mtco2e_reduction_potential, annual_100_year_mtch4_reduction_potential, annual_gallons_water_savings_potential, annual_meal_equivalents_diverted, jobs_created, annual_us_dollars_cost, annual_us_dollars_gross_financial_benefit, annual_us_dollars_net_financial_benefit
   Transformation Performed: Filtered for only Farm sector
   How is the dataset related to your problem?: Provides solutions for farm-level food waste and how impactful they can be.
   How is the dataset related to your problem?: Provides solutions for farm-level food waste and how impactful they can be.
3. **Dataset Name & Link:** DECENNIALCD1182020 (https://data.census.gov/table/DECENNIALCD1182020.P2?q=Urban+and+Rural&tp=true)
   Description: Contains information about the total population for each state, splitting them by urban and rural population.
   Columns: Total, Urban, Rural
   Transformation Performed: Renamed columns appropriately and changed type from string to Number (whole)
   How is the dataset related to your problem?: Contains information about how urbanized (developed) a state is, which can be used to correlate against food waste.
4. **Dataset Name & Link:** U.S. median household income 2023, by state (https://www-statista-com.nyp.remotexs.co/statistics/233170/median-household-income-in-the-united-states-by-state/)
   Description: Median household income across states in 2023.
   Columns: State, Median Household Income
   Transformation Performed: Removed District of Columbia and United States values

How is the dataset related to your problem?: Contains information about the median household income for all the states, which can be correlated to food waste.

Member Name: Ke Xuan

1. **Dataset Name & Link:** ReFED_US_Food_Surplus_Cause_Summary (Link: https://insights-engine.refed.org/food-waste-monitor?break_by=destination&indicator=tons-surplus&sector=residential&view=detail&year=2023) File type: .csv
   Description: Contains information on the cause of the U.S. food waste surplus from 2010 to 2023
   Columns: year, sector, sub_sector, food_type, cause_group, cause_name, tons_surplus_due_to_cause, us_dollars_surplus_due_to_cause, tons_inedible_parts, tons_not_fit_for_human_consumption
   Transformation Performed: Removal of null value from columns (year), Filtering of sector to only “Residential” when displaying the causes of food waste
   How is the dataset related to your problem?: Contains data for the overall food waste situation across all sectors in the U.S., which can be used to display the overall proportion among the sectors.
2. **Dataset Name & Link:** ReFED_US_Food_Surplus_Summary (Link: https://insights-engine.refed.org/food-waste-monitor?break_by=destination&indicator=tons-surplus&sector=residential&view=detail&year=2023) File type: .csv
   Description: Contains in depth data for the U.S. food surplus situation from 2010 to 2023
   Columns: year, state, sector, sub_sector, sub_sector_category, food_type, food_category, tons_surplus, tons_supply, us_dollars_surplus, tons_waste, tons_uneaten, ton_not_fit_for_human_consumption, tons_inedible_parts, tons_donations, tons_industrial_uses, tons_animal_feed, tons_anaerobic_digestion, tons_composting, tons_not_harvested, tons_incineration, tons_land_application, tons_landfill, tons_sewer, tons_dumping, surplus_upstream_100_year_mtco2e_footprint, surplus_downstream_100_year_mtco2e_footprint, surplus_total_100_year_mtco2e_footprint, surplus_upstream_100_year_mtch4_footprint, surplus_downstream_100_year_mtch4_footprint, gallons_water_footprint, surplus_total_100_year_mtch4_footprint, meals_wasted
   Transformation Performed: Filter sector to “Residential” only, Change data type of “year” to Number(Whole) type, Removal of null from columns (year), Removal of irrelevant field (tons_anaerobic_digestion, tons_sewer, tons_dumping, surplus_downstream_100_year_mtco2e_footprint, surplus_upstream_100_year_mtch4_footprint, tons_animal_feed)
   How is the dataset related to your problem?: Contains the data for the different variation of environmental impact due to food waste (water and land), which can be used to draw relation towards the bringing abouts of reducing food waste and its benefits.
3. **Dataset Name & Link:** ReFED_US_State_Food_Surplus_Detail (Link: https://insights-engine.refed.org/food-waste-monitor?break_by=destination&indicator=tons-surplus&sector=residential&view=detail&year=2023) File type: .csv
   Description: Contains data for the food waste among the U.S. states

Columns: year, state, sector, sub_sector, sub_sector_category, food_type, food_category, tons_surplus, tons_supply, us_dollars_surplus, tons_waste, tons_uneaten, tons_donations, tons_industrial_uses, tons_animal_feed, tons_anaerobic_digestion, tons_composting, tons_not_harvested, tons_incineration, tons_land_application, tons_landfill, tons_sewer, tons_dumping, surplus_upstream_100_year_mtco2e_footprint, surplus_downstream_100_year_mtco2e_footprint, surplus_total_100_year_mtco2e_footprint, surplus_upstream_100_year_mtch4_footprint, surplus_downstream_100_year_mtch4_footprint, surplus_total_100_year_mtch4_footprint, gallons_water_footprint, meals_wasted
Transformation Performed: Removal of null from columns (year), Filter sector to "Residential" only
How is the dataset related to your problem?: This contains the information regarding the total us_dollars_surplus due to food waste, which can be used to draw relation on the impact of reducing the food waste, as well as, the factors (economic burden) to look out for when finding for potential solutions.

4. **Dataset Name & Link:** ReFED_US_Food_Waste_Solutions_Detail (Link: https://insights-engine.refed.org/food-waste-monitor?break_by=destination&indicator=tons-surplus&sector=residential&view=detail&year=2023) File type: .csv
Description: Contains information on the potential solutions and the tons that potentially can be diverted
Columns: solution_group, solution_priority_action_area, solution_name, sector, sub_sector, sub_sector_category, state, food_type, annual_tons_diversion_potential, annual_100_year_mtco2e_reduction_potential, annual_100_year_mtch4_reduction_potential, annual_gallons_water_savings_potential, annual_meal_equivalents_diverted, jobs_created, annual_us_dollars_cost, annual_us_dollars_gross_financial_benefit, annual_us_dollars_net_financial_benefit, *% Waste Eliminated, US Dollar Cost, Tons Diverted, Adoption Rate %*

* Italic refers to the new calculated field
* Italic and underlined refers to the parameters created
Transformation Performed: Filter sector to "Residential" only, Removal of unnecessary columns (sub_sector, sub_sector_category), Removal of all null values from columns, Change data type of "State" to state/province, Create new calculated for incorporation with the parameter created "Adoption Rate %"
How is the dataset related to your problem?: This data contains several solution from their solution groups, which can be used to observe factors such as the potential tons diverted, economic benefit from the solutions, potential environmental impact reduction, etc.

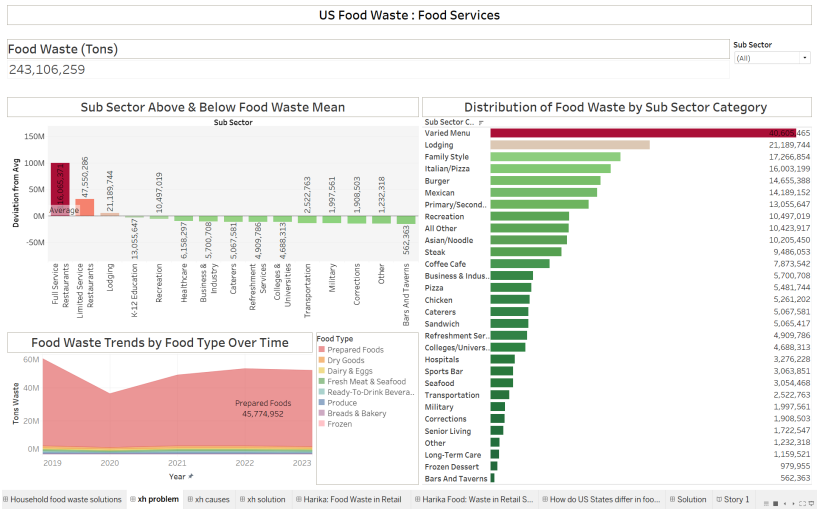
4 Data Understanding and Modelling - Individual

4.1 Dashboard(s) - Xin Hui

Sub Problem Statement - How can food wastage in the US food service sector be improved? The hypothesis for food service is that by identifying the problems and causes in each sub sector we can find solutions to reduce food waste.

First Dashboard - Find out where and what has the highest amount of food waste in food service sector

1)Sub Sector Above & Below Food Waste Mean Chart



The first dashboard identifies the sectors with the most significant waste generation. It features a distribution deviation graph, which uses a calculated field (SUM([tons_waste]) - WINDOW_AVG(SUM([tons_waste]))) to benchmark each sector against the sector average (set to zero). Sectors above average are highlighted in red while those below are in green. The visualization immediately identifies Full Service Restaurants, Limited Service Restaurants and Lodging as the top contributors of food waste in the food service sector as the bars are in red which shows it is exceeding the average. It is linked to my hypothesis because it highlights which sub sector to focus on so users can filter the sub sector in the third dashboard to find the top 5 solutions and find out which solution is the best to implement for that sub sector based on the financial benefit and financial amount of implementing that solution. The special feature is the distribution deviation graph, making avg = 0 and using red green diverging.

2)Distribution of Food Waste by Sub Sector Category Chart

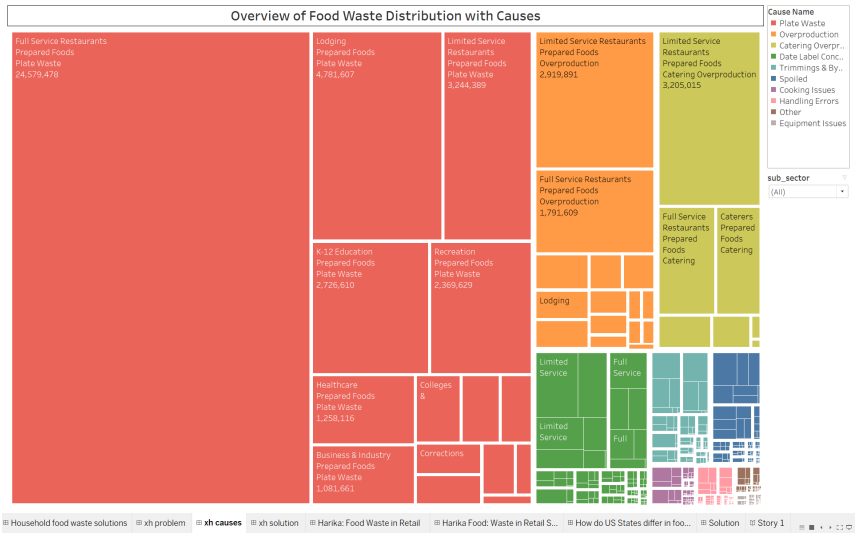
Only full service restaurants, limited service restaurants and healthcare have a sub sector category. After understanding full service restaurants and limited service restaurants have the most food waste, I can drill down into their sub sector category. After drilling down, the 'Varied Menu' sub-category has the most food waste (highlighting in red) in full service restaurants while ‘Burger' and 'Coffee Cafe' have the most food waste (highlighting in red) in limited service restaurants. It is linked to my hypothesis because it highlights which sub sector category to focus on so users can filter the sub sector category in the third dashboard to find the top 5 solutions and find out which solution is the best to implement for that sub sector based on the financial benefit and financial amount of implementing that solution. The special feature is the sub sector filter at the top right side of the dashboard and using red green diverging.

3)Food Waste Trends by Food Type Over Time Chart

A stacked area chart shows that most food waste is prepared food followed by dry goods etc and these high food waste have persisted consistently over time. It is linked to my hypothesis because it highlights which food type to focus on so users can filter the food type in the third dashboard to be more specific to find the top 5 solutions. The special feature is the the stacked area chart is color in rainbow so users can easily refer to the legend beside and this graph is special because it shows the proportion of food type in the food waste as well as the food waste over time.

Second Dashboard - Understand the 'why'? Diagnoses the root causes behind these high food waste

4) Overview of Food Waste Distribution with Causes Chart



This is represented using a treemap. Different color rectangles show different causes while different size rectangles show how much food waste is being wasted. So, the bigger the rectangle, the more the food wastes. This chart shows that plate waste is the primary contributor, followed by overproduction and catering overproduction etc. We can see that full service restaurant prepared food plate waste contributed to the most food waste.(Largest rectangle) Using the filter on the right, I can focus on any sub sector I want to focus on. For instance, filtering the data to focus on full service restaurants, immediately highlights that their main challenges are plate waste, overproduction, catering overproduction etc, providing a clear target for intervention. linked to my hypothesis because it highlights which sub sector to focus on so users can filter the sub sector in the third dashboard to find the top 5 solutions. The special feature is that the stacked area chart is colored in rainbow so users can easily refer to the legend beside and it provides a big specific overview including sub sector, food type and causes.

Third Dashboard - Actionable solutions tailored to each sub-sector & food type & sub sector category

5) Top 5 Solutions Chart

To filter the best 5 solutions for each sub sector, sub sector category, and food type, I created a calculated field RANK_UNIQUE(SUM([Annual Tons Diversion Potential])) and apply to both top 5 solutions and solution vs cost chart. Using the filter at the side of the dashboard, the user can filter the most concerning sub sector/ sub sector category and even more specifically adding the food type to find the top 5 solutions. For example filtering to full service restaurants and varied menus, the top 5 solutions are portion sizes, centralized composting, co-digestion at waste water treatment plants etc. It is linked to my hypothesis because it shows the solutions which helps to improve food waste in the food service sector in the US. The special feature is the filters (sub sector, sub sector category, food type) at the side of the dashboard which can help to filter different the top 5 solutions for specific sub sector, sub sector category and food type.

6) Solutions vs Cost Chart

The dual axis bar chart on the right further aids decision-making by comparing the financial investment required for each solution against its potential financial benefit. From this, the boss in a full service restaurant can conclude that implementing portion sizes can not only divert food waste the most but is also the most financially advantageous solution to pursue, as the green bar (financial benefit) exceeds the red bar (investment cost) the most. It is linked to my hypothesis because it suggests the best solution to implement which helps to improve food waste in the food service sector in the US. The special feature is the dual axis bar chart. I use both bar charts and change the color. Red represents the amount that needs to be implemented and green represents the financial benefit after implementing it. By resizing the green bar chart to become smaller, the dual axis bar chart becomes a very good chart to compare easily at one glance.

7) Key performance indicator (KPI) cards

Users can filter by a specific solution to see other benefits each solution provides by clicking on the solution which includes the amount of food waste diverted, the total meals saved, jobs created and the amount of water saved. It is linked to my hypothesis because it suggests other benefits of the solution which help users decide which solution to implement which helps to improve food waste in the food service sector in the US. The special feature is that it is represented in KPI cards for easier to see the numbers and it is not very essential to represent it in the chart as it is just an additional benefit that users might want to know.

4.2 Analytics model(s) - Xin Hui

The first dashboard shows **descriptive analytics**. The analysis directs attention to the most critical areas such as Full Service and Limited Service Restaurants, Varied Menu and Burger/Coffee cafe and Prepared Food has the most food waste. This precise focus is the critical first step for any effective intervention in the third dashboard.

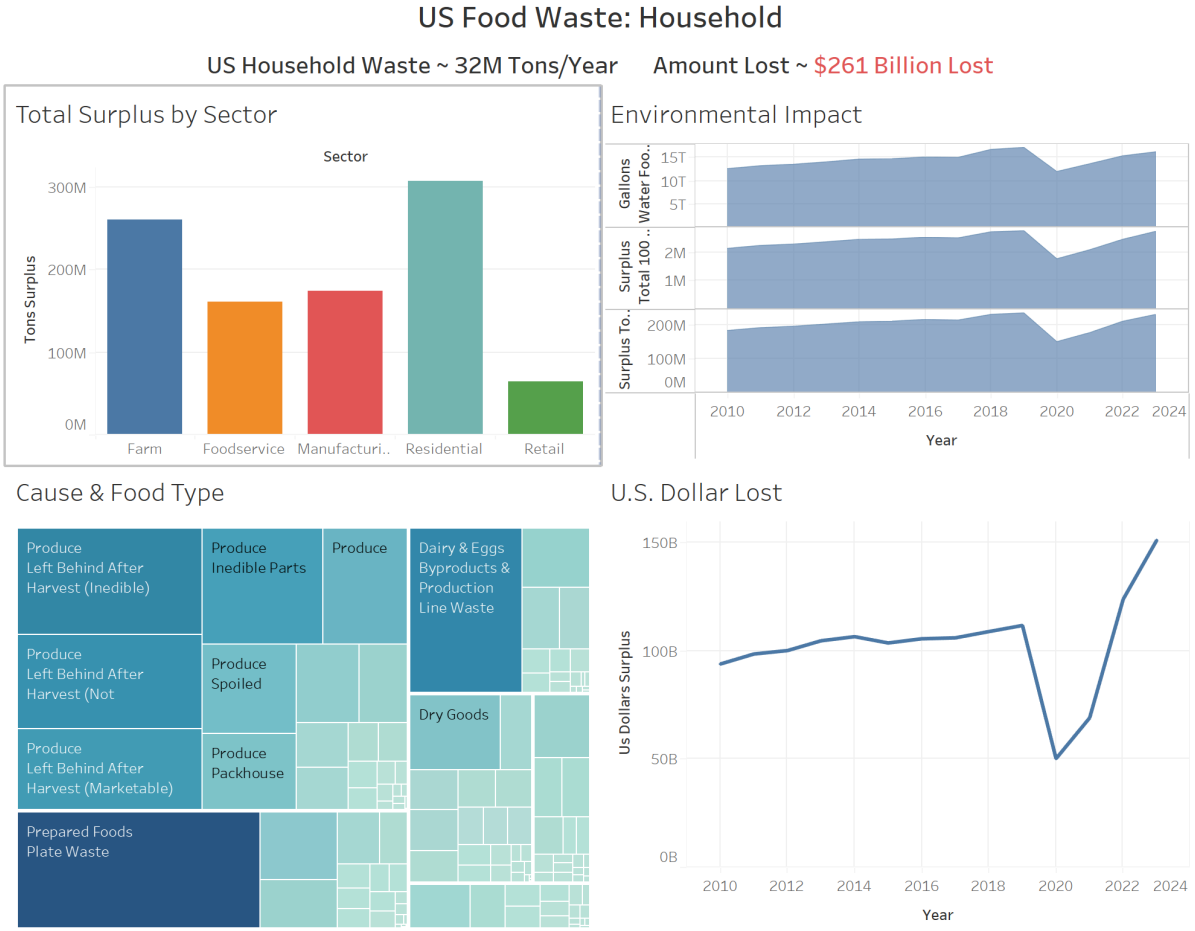
The second dashboard shows **diagnostic analytics**. Understanding that the problem is largely due to plate waste and overproduction directly informs the type of solutions that will be most effective. It ensures that the recommended solutions are not just generically "good for reducing waste" but are specifically targeted to surgically remove the largest identified root cause. This maximizes the return on investment and effort by ensuring resources are channeled into the most effective type of intervention.

The third dashboard shows **prescriptive analytics**. This is where my analysis delivers ultimate value. It directly answers my sub-problem statement of how food wastage in food services in the US be improved. The prescriptive model provides a clear, actionable and justified recommendation. For a Full Service Restaurant sub sector & Varied Menu sub sector category, the analysis suggests to implement "Portion Sizes" as the primary solution. It is the most effective at diverting waste and offers the greatest financial benefit (green bar > red bar). It also addresses the root cause of "Plate Waste" identified in the diagnostic phase.

4.3 Dashboard(s) - Ko Ke Xuan

Sub-Problem Statement: How can U.S. improve the household food waste situation?

Dashboard 1: Current state of household food waste in the U.S.



These 2 headline numbers immediately frame the sub-problem: they quantify the scale of household food waste in both physical (tons) and economic ($) terms. They link to the hypothesis by establishing the baseline that household-level reductions can yield large national benefits.

1) Total Surplus by Sector

The bar chart identifies which sectors contribute the most to food surplus and waste. It shows that the residential/household sector produces the largest share, at approximately 32 million tons annually, significantly higher than other sectors such as foodservice, manufacturing, or retail. This finding supports the hypothesis by establishing that the households are the main contributor towards the U.S. food waste problem, making households the key target for solutions.

2) Environmental Impact

The area chart demonstrates how food waste correlates with the resource wastage such as water, energy, and land use. Over time, environmental impacts have been steadily increasing, showing that current waste management practices are insufficient. This is further supported by the sudden steep dip in 2020, with reasons such as COVID-19 in place. With a

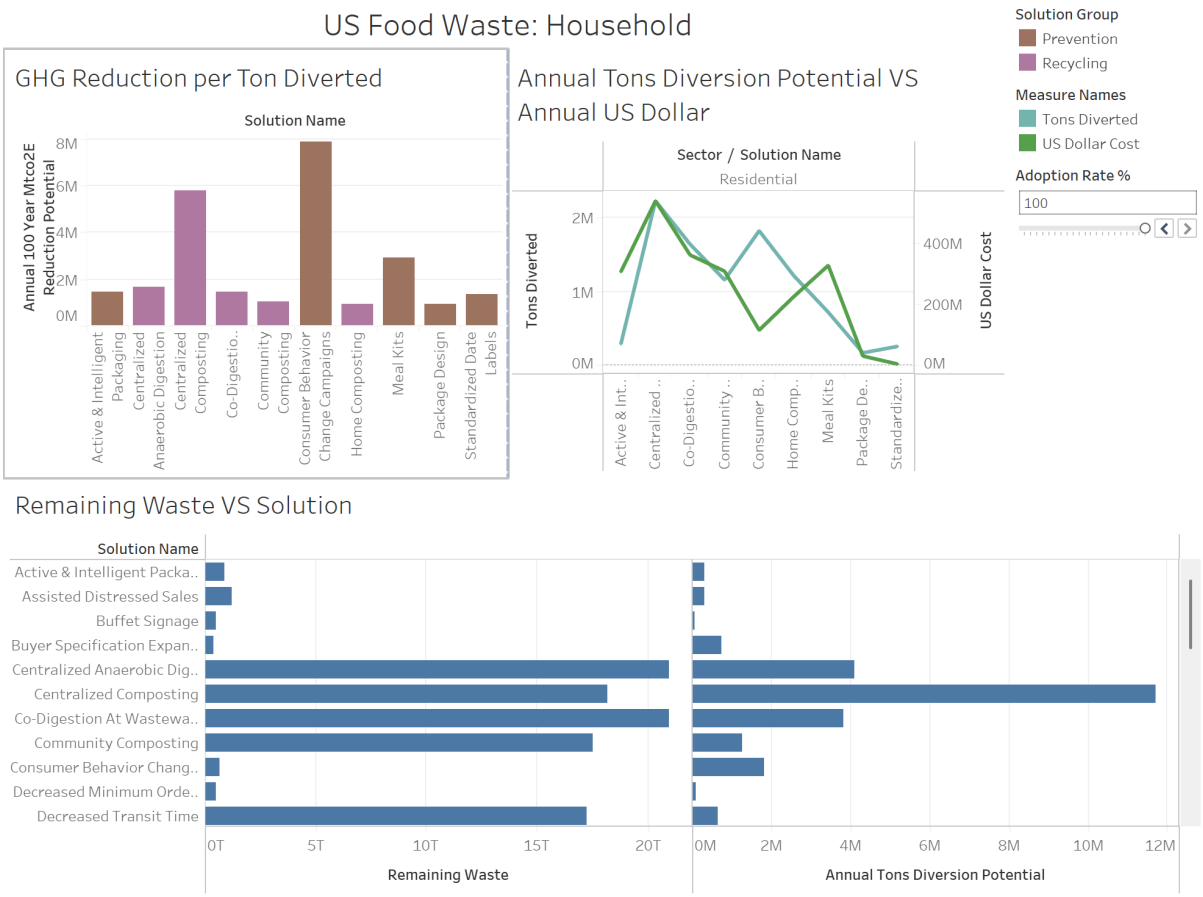
steep increase afterwards, further explaining the change in consumer practices/ behaviour. This supports the hypothesis as reducing household waste will also reduce environmental footprints which is a key motivation for policy and behaviour change. It also includes an overlay or tooltip that shows “$MTCO_2e$ per ton” to illustrate environmental efficiency differences across solutions later.This visualisation supports the need for interventions at the household level, as reducing waste directly mitigates environmental harm.

3) Cause & Food Type
The treemap dives deeper into why food waste happens and which food categories are most affected. Categories such as prepared foods, diary, and eggs dominate household waste, while causes include spoilage and improper storage. Understanding these underlying causes allows policymakers to design better targeted solutions to tackle the problem of household food waste. This tells us where to target interventions.

4) U.S. Dollar Lost
This line chart highlights the economic loss for the U.S. in terms of the food waste expenditure per year, showing losses rising to $150 billion annually in recent years. With economic cost in place, future solutions have to be cost effective and/or the cost of the solution needs to bring out the largest impact with cost being minimal. This visualisation strengthens the case for interventions by emphasizing the financial benefits of reducing food waste.

Overall, Dashboard 1 helps to set the current situation and context for the household sector in U.S., further identifying households as the primary source of waste. This highlights out the key causes and affected food types, and quantifies both the environmental and economic impacts. This helps to set the guide to exploring targeted solutions in Dashboard 2.

Dashboard 2: Solutions to reduce U.S. household food waste



Potential diversion and values are modeled estimates from **ReFED – Food Waste Solutions (Insights Engine)**. Values represent modeled national potential if solutions are implemented at scale, derived from pilot programs, academic studies and industry trials.

1) GHG Reduction per Ton Diverted

The bar chart shows the potential environmental impact of each solution by measuring greenhouse gas reductions. Solutions such as consumer behaviour change campaigns and centralised composting demonstrate the largest potential to cut emissions. With 2 main solutions groups of recycling and prevention, prevention solutions often yield more CO_2e reduction per ton than some recycling options. This supports the hypothesis by showing that not all reductions are equal, some household solutions reduce emissions more per unit of waste avoided.

2) Annual Tons Diversion Potential vs Annual U.S. Dollar

The dual-axis line chart compares the waste reduction potential of each solution with the economic cost they bring. For example, solutions like Consumer Behaviour Change Campaigns display the second highest diversion potential and one of the lowest economic costs to implement it. However solutions like Centralised Anaerobic Digestion offer the highest diversion potential, but the cost to implement it is also the highest. With factors that were discussed in the previous dashboard of economic burden that the U.S. is experiencing, this visualisation helps to choose the cost efficient ones with comparison to the impact that can be brought out.

An “Adoption Rate” parameter was implemented into this visualisation to demonstrate realism. With factors such as adoption may not be 100% all the time, the dashboard uses

Adjusted measures so the visuals update immediately. This slider recalculates the “Adjusted Tons”, “Adjusted $”, and “Adjusted CO2” across the entire dashboard. This models partial adoption rather than assuming full uptake.

This analysis supports the sub-problem statement by highlighting which interventions deliver the greatest impact per dollar invested, making them more practical for implementation at scale.

3) Remaining Waste vs Solution
The bar chart complements this by showing how much waste remains after implementing each solution. It illustrates that no single solution can fully eliminate food waste, but a combination of multiple interventions significantly reduces the gap between current waste levels and the achievable potential. This visualization reinforces the importance of adopting a multi-pronged strategy to effectively address household food waste.

Overall, Dashboard 2 provides a data-driven framework for selecting effective interventions. It links directly to the hypothesis by demonstrating that implementing targeted household-level solutions not only reduces waste but also delivers economic and environmental benefits.

4.4 Analytics Model(s) - Ke Xuan

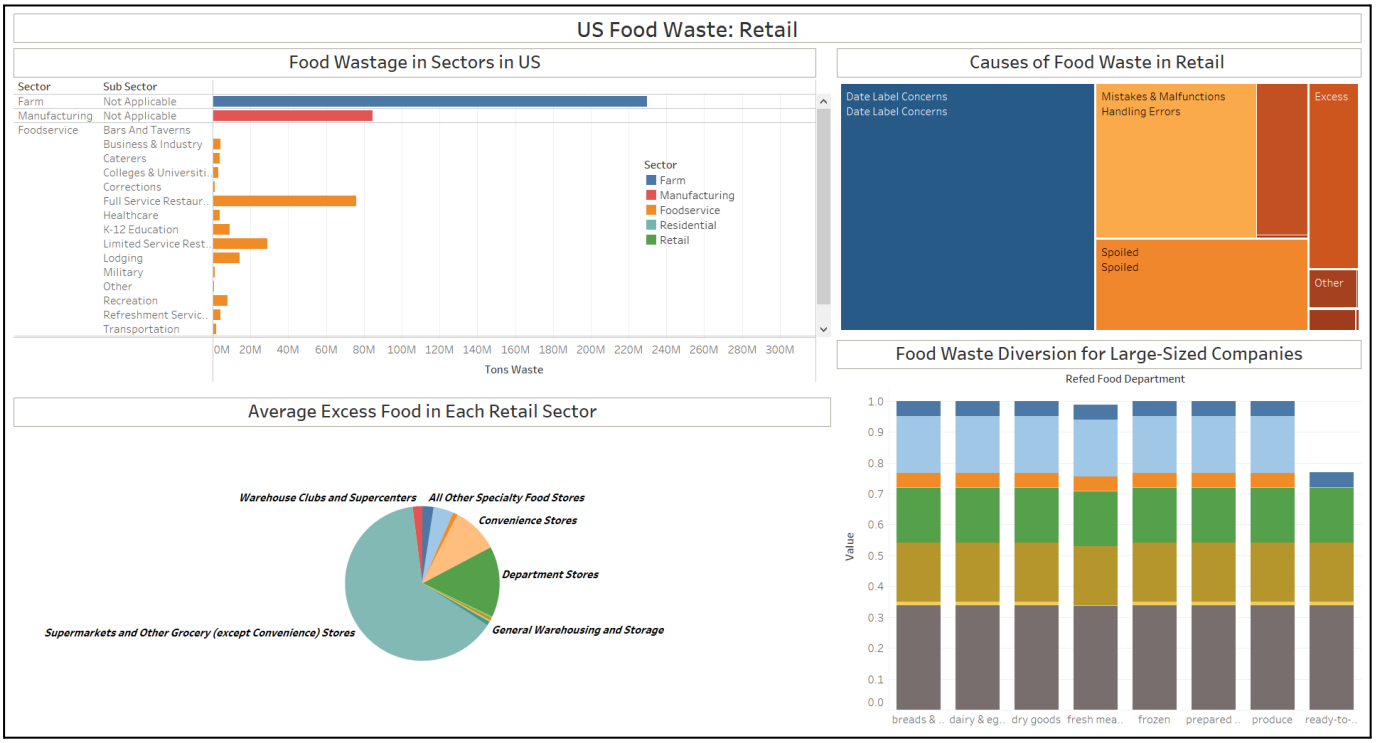
The first dashboard uses both descriptive and diagnostic analytics. It describes the current state of household food waste in the U.S., showing that residential households contribute the largest share of the national total, with over 32 million tons wasted annually. It also breaks down which food categories (prepared foods, produce, dairy, and eggs) dominate household waste and explores why this waste occurs, highlighting key causes such as spoilage.. This understanding can help to provide the context and foundation for targeted interventions, ensuring that the recommendations focus on the most critical problem areas.

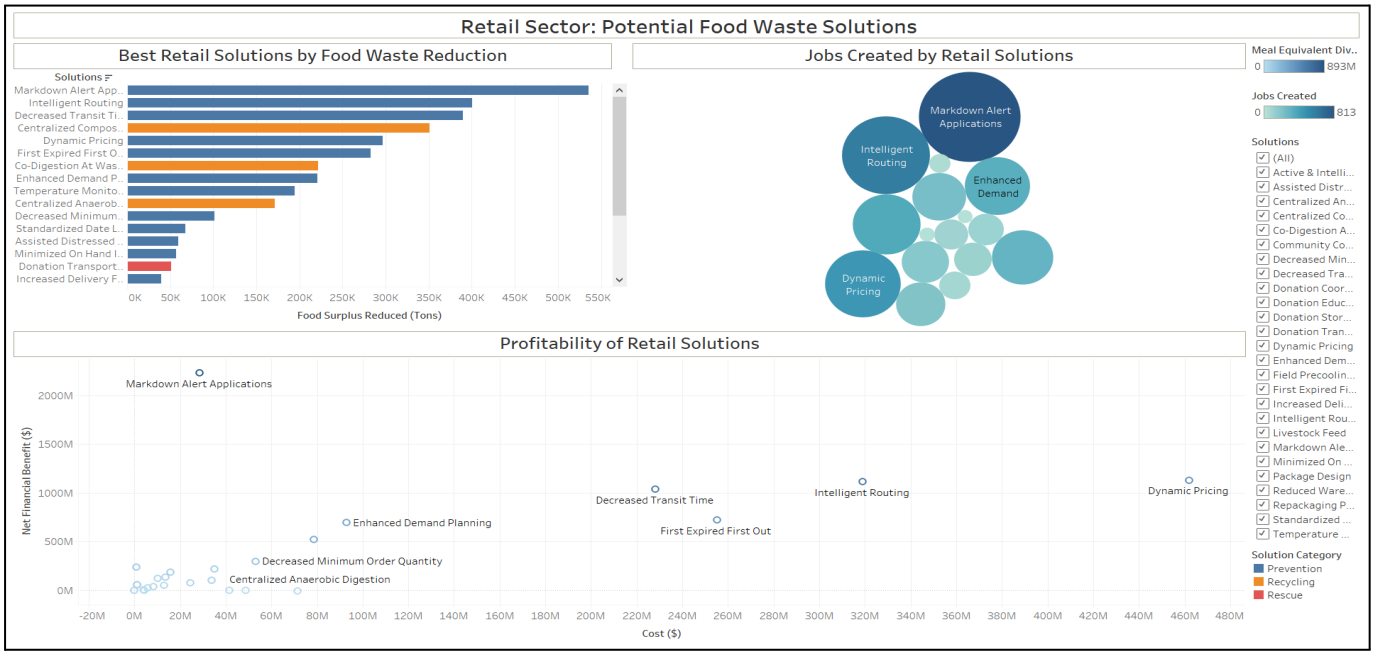
The second dashboard applies prescriptive analytics to evaluate and recommend solutions that can most effectively reduce household food waste. Using data from ReFED, it compares solutions across three key dimensions: annual tons diverted, CO2 reduction per ton, and net financial benefit. It includes an adoption slider parameter that demonstrates a dynamic modelling to project the impact of solutions under different uptake rates (e.g., 25%, 50%, 100%). Based on this analysis, solutions such as consumer behavior change campaigns, composting, and standardized date labeling stand out as the most impactful for reducing household food waste. These recommendations directly address the root causes identified in the first dashboard, for example, consumer education targets over-purchasing and plate waste, while composting mitigates unavoidable spoilage.

Together, the 2 dashboards transition from understanding the current problem to recommending a targeted, data-driven solution. This approach ensures that interventions are not generic but precisely aligned with the largest sources and causes of food waste, thus maximising both environmental and economic benefits.

4.5 Dashboard(s) - Harika

- **Sub-Problem Statement:** How can food wastage in the U.S. retail sector be improved?
- **Hypothesis:** Food wastage in the U.S. retail sector is primarily driven by supermarkets and grocery stores due to causes like date label confusion. By targeting high-impact, cost-effective solutions especially on SMEs, it can significantly reduce food waste while improving financial performance and generating positive social benefits like higher employment.





Dashboard #1: US Food Waste: Retail Sector			
Visualization	Purpose/Objective/Message	Link to Hypothesis	Recommendations
Food Wastage in Sectors in US (Bar Chart)	This bar chart compares the amount of food waste generated across different sectors in the United States, including retail, residential, foodservice, manufacturing, and farms. By providing a sector-level overview, the chart helps identify where the majority of food waste originates and highlights retail as one of the main contributors to food waste in the US.	This chart supports the hypothesis by showing that retail is one of the main contributors to overall food waste in the U.S. Identifying retail as a major source validates the focus on supermarkets and grocery stores for targeted interventions.	By focusing on one sector, retail, it would be easier to implement more targeted and effective solutions to that sector. By finding their root causes it can lead to significant reductions in the food wastage in the retail sector.
Average Excess Food in Each Retail Sector (Pie Chart)	To find out which sub-sector in the retail sector produces the most average excess food. This pie chart shows us that Supermarkets & other grocery stores are the largest contributor to the most average excess food waste. This emphasizes where food waste reduction efforts should be prioritized for maximum effectiveness.	The chart confirms that supermarkets and grocery stores are the main drivers of food wastage in the retail sector. This aligns directly with the hypothesis that targeting these sub-sectors will generate the most meaningful reductions in waste.	Prioritize waste reduction solutions in supermarkets and grocery chains to achieve the largest impact with the least amount of effort.
Food Waste Diversion for Large-Sized Companies (Stacked Bar Chart)	This stacked bar chart shows us the food diversion for large-sized companies according to their food departments. For all the food departments, 33.83% of food waste goes into the trash. The rest of the food waste goes into sustainable food waste diversion methods like animal feed, composting, donating, anaerobically digested land application. This shows that large companies are able to reduce most of their food waste through sustainable methods because they have a lot of resources. This allows them to put aside their resources into sustainability methods and programs which	This visualization highlights that large retailers already have more resources for sustainable waste diversion, while SMEs lack similar capabilities. It supports the hypothesis that solutions must be cost-effective and tailored for SMEs in order to achieve sector-wide improvements.	Focus on implementing solutions with high profitability to create a win-win outcome. Such solutions would reduce food waste in SMEs and also provide them with financial incentives. This ensures sustainability efforts are both practical and rewarding for SMEs.

Dashboard #1: US Food Waste: Retail Sector			
	small-to-medium sized (SMEs) are unable to do so. Thus, when coming up with solutions we need to target only SMEs and provide them with more cost effective solutions.		
Causes of Food Waste in Retail (Treemap)	The treemap highlights the major causes of food waste in the retail sector, showing their relative contribution to total surplus food wasted. It visually emphasizes that date label concerns account for the largest share, followed by spoilage, mistakes, and handling errors. By illustrating the scale of each cause proportionally, the visualization helps identify the most critical areas where interventions will have the greatest impact. This enables stakeholders to understand not just that waste exists, but why it occurs, supporting more effective and targeted waste-reduction strategies.	The treemap illustrates that date label concerns, spoilage, and handling errors are the leading causes of food waste. This links directly to the hypothesis by showing that addressing these root causes will significantly reduce waste in supermarkets and grocery stores.	Address the leading causes of retail food waste by implementing targeted solutions. Focus on the top 3 causes date label concerns, mistakes & malfunctions specifically handling errors and spoiled food. By prioritizing these root causes, retailers can significantly reduce waste at the source and achieve more sustainable operations.

Dashboard #2: Potential Food Waste Solutions			
Visualization	Purpose/Objective/Message	Link to Hypothesis	Recommendations
Best Retail Solutions by Food Waste Reduction (Bar Chart)	This bar chart ranks the potential retail solutions by the amount of food surplus they can reduce in descending order. It highlights solutions, such as markdown alert applications, intelligent routing, and decreased transit time, that have the largest impact on waste reduction. By comparing solutions side by side, it becomes clear which strategies deliver the most significant reductions, guiding decision-makers on where to	This chart provides evidence for the hypothesis by identifying high-impact solutions (Markdown Alert, Intelligent Routing, Decreased Transit Time) that can be applied in supermarkets and SMEs to reduce food waste significantly.	Focus on implementing solutions with the highest amount of food reduction like markdown alert applications, intelligent routing, and decreased transit time. These solutions will reduce the highest amount of food waste for SMEs the fastest making it highly effective. By adopting these solutions, SMEs can cut waste at scale, improve operational efficiency, and move toward more sustainable business practices

Dashboard #2: Potential Food Waste Solutions			
	prioritize resources.		
Profitability of Retail Solutions (Scatter Plot)	The scatter plot compares the cost of implementing each solution with its net financial benefit. It also shows the meals equivalent diverted. Thus, it does not only help evaluate the environmental impact but also shows whether it is financially viable.	The scatter plot connects to the hypothesis by showing that certain solutions not only reduce food waste but also improve financial performance, reinforcing the claim that targeted strategies can deliver both economic and sustainability benefits.	Prioritize solutions that deliver strong financial returns compared to their implementation costs, such as markdown alert applications and dynamic pricing. These solutions generate the highest amounts of financial benefit and reduce a lot of food wastage as seen in the bar chart of 'Best Retail Solutions by Food Waste Reduction' .
Jobs & Impact of Retail Solution (Bubble Chart)	This bubble chart visualizes the broader social impacts of retail food waste solutions by showing jobs created. This bubble chart emphasizes that effective solutions can deliver benefits beyond cost savings. It helps communities, strengthens food security, and promotes long-term sustainability.	This visualization links to the hypothesis by showing that effective retail solutions do more than reduce waste. They also create jobs and strengthen communities. This supports the idea that solutions provide social as well as environmental and financial benefits.	Select solutions with a high number of jobs created like Markdown Alert Application and Intelligent Routing. These solutions not only reduce food waste and have a high profitability rate but also generate wider social benefits. By prioritizing such interventions, retailers and policymakers can strengthen local economies, support employment opportunities, and build community resilience while addressing sustainability goals.

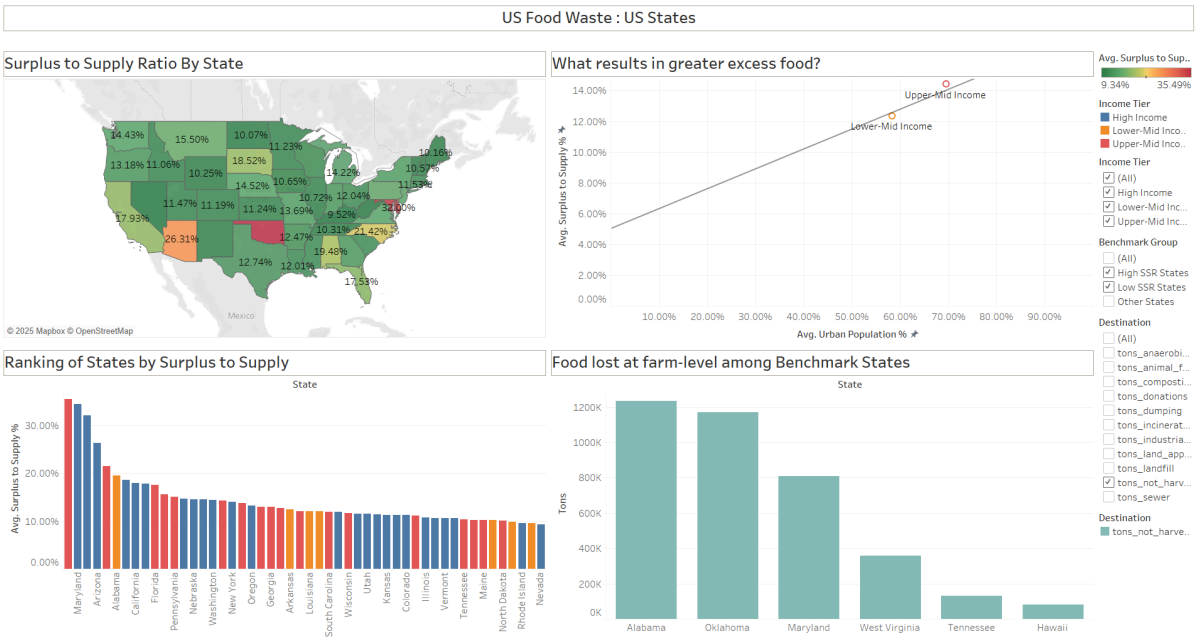
Special Features: For the first dashboard, I used clear storytelling flow to show the cause and effect of high food wastage in the retail sector. I showed the scale of food waste in retail, identifying its root causes, and then demonstrating how large companies divert waste across food categories, while also highlighting which retail sub-sectors contribute the most. This progression moves the audience from understanding the problem and its causes to seeing the current responses and priority areas for action.The special features for the second dashboard is that it has a global filter. Therefore, it is easy for users to compare each solution against the amount of food wastage reduced, profitability and the number of jobs created easily. For both dashboards, I ensured to use an array of chart types to get my point across easily and efficiently.

4.6 Analytics Model(s)- Harika

Visualization	Analytics
Food Wastage in Sectors in US (Bar Chart)	**Descriptive Analytics** is used to show how much food waste comes from each sector, highlighting retail as one of the main contributors. This supports the hypothesis that supermarkets and grocery stores drive food waste. Based on this insight, solutions should be targeted at retail for maximum effectiveness.
Average Excess Food in Each Retail Sector (Pie Chart)	**Descriptive Analytics** reveals that supermarkets and grocery stores generate the highest average excess food. This confirms the hypothesis that these sub-sectors are the main drivers of retail food waste. Therefore, waste reduction solutions should be prioritized in supermarkets and grocery stores.
Food Waste Diversion for Large-Sized Companies (Stacked Bar Chart)	**Diagnostic Analytics** shows that large companies manage waste better because they have more resources for sustainable diversion methods, while SMEs struggle. This supports the hypothesis that SMEs need targeted support. The recommendation is to have high profit solutions tailored for SMEs.
Causes of Food Waste in Retail (Treemap)	**Diagnostic Analytics** identifies root causes such as date label confusion, spoilage, and handling errors. This validates the hypothesis that addressing these issues can reduce waste in retail. The recommendation is to implement clear labeling, better training, and stronger inventory/handling practices.
Best Retail Solutions by Food Waste Reduction (Bar Chart)	**Prescriptive Analytics** ranks solutions by their waste reduction impact, highlighting markdown alerts, intelligent routing, and decreased transit time. This supports the hypothesis by showing which solutions can reduce waste fastest in SMEs. Thus, prioritizing these high-impact solutions first.
Profitability of Retail Solutions (Scatter Plot)	**Prescriptive Analytics** compares solution costs with net financial benefits, showing that solutions are both profitable and effective. This links to the hypothesis that solutions can improve financial performance while reducing waste. The recommendation is to invest in solutions with strong returns.
Jobs & Impact of Retail Solution (Bubble Chart)	**Prescriptive Analytics** highlights that certain solutions also create jobs and divert meals, proving they deliver social as well as environmental and financial benefits. This supports the hypothesis that solutions generate positive community impact. Select solutions that balance waste reduction, profitability, and job creation to reduce overall food wastage in the retail sector.

4.7 Dashboard(s) - Shayn

Sub-Problem Statement: How do U.S. States differ in food waste management outcomes?
Hypothesis: By drilling down what creates the difference between states, we can identify what is the most impactful sector to address and solve for it.
US Food Waste: US States

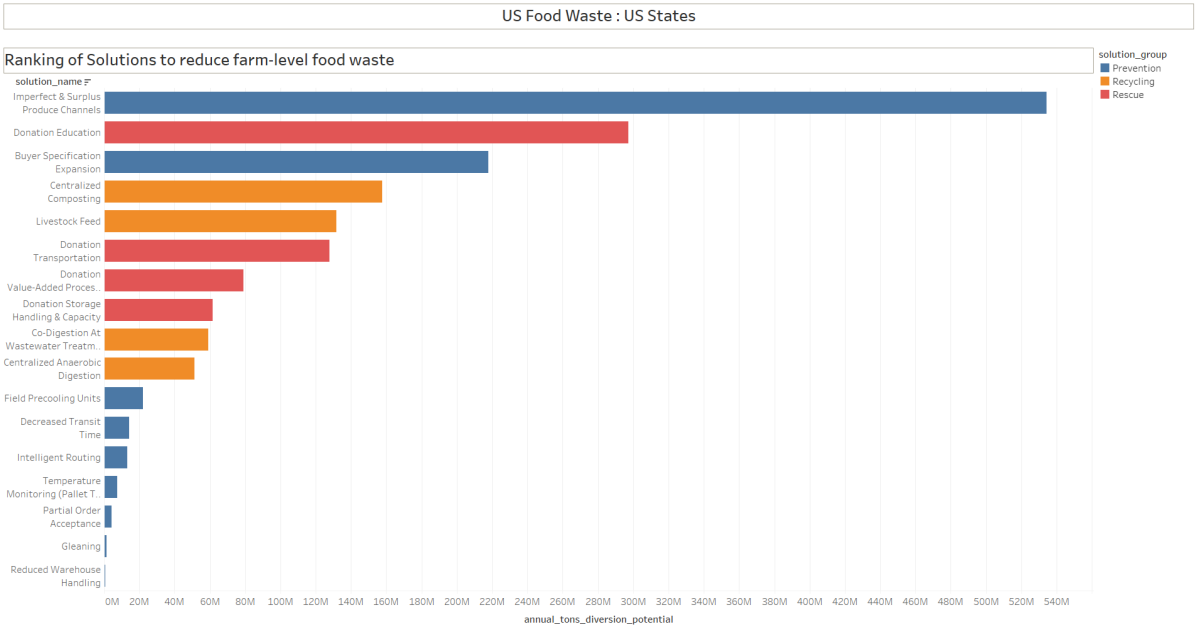


1. Surplus to Supply Ratio By State: The purpose of this visualization is to identify the differing levels of efficiency for all the US States. This suggests that whilst we already know that some states will have higher food surplus due to factors such as population, economic welfare and urbanization, they are not relative to how efficiently each state handles food supply, with states such as Delaware being more inefficient than states that actually generate more food waste like California. This suggests that there might be an additional hidden factor creating the efficiency gap between states.
2. What results in greater excess food?: The purpose of this visualization is to identify if some of the previously mentioned factors (Economic welfare, Urbanization) have some kind of correlation with a state's efficiency in handling food surplus. By grouping the states into income groups, and correlating them against surplus to supply ratio and urban population percentage, we can identify that in general, states with progressively higher median income (better welfare) will also tend to have higher urban population percentages (more developed) as well as to be more inefficient with how they handle food. This suggests that due to being “better off” people in these states can afford to buy food more readily, and also at higher rates. This results in there being more food being generated, and thus food wasted. But whilst this visualization showcases the “Why?” behind food waste efficiency, it still does not quite yet demonstrate how so, but still gives a bit of a hint that the welfare of a state might have something to do with it.
3. Ranking of States by Surplus to Supply: The purpose of this dashboard is to check how much median income actually plays a part in the efficiency for the states. Whilst it was proven in the previous visualization that in general, being better off results in greater surplus to supply, when not grouped up by income levels, US States still show differing levels of surplus to supply across the board, with there being states

from each income group towards both ends of the board. This suggests that whilst welfare does matter, it does not play a complete part behind the differing surplus to supply for the states. However, using this, we can identify benchmark states, being the most and least efficient states of each income group, comparing them to find the critical factor behind the difference in efficiency between states.

4. Food lost at farm-level among benchmark states: This dashboard was initially created to find a meaningful reason behind the surplus to supply ratio for the benchmark states. I filtered only for the benchmark states: Oklahoma, Maryland & Alabama (Highest SSR for each income group) as well as West Virginia, Hawaii & Tennessee (Lowest SSR for each income group). To compare them, I also filtered for the different destination types of food waste, such as surplus that was donated or went to landfill. Ultimately, I reached the conclusion that the most impactful difference between a high surplus to supply and low surplus to supply state would be food lost at the farm-level, with the 3 benchmark states for higher surplus to supply losing significantly more food at the farm-level than their counterparts. Thus, it can be concluded that solving food waste at the farm-level is most crucial to making states more efficient in food waste management.

US Food Waste: US States Solution



To figure out the best way to solve farm-level food waste, I created a ranking of all the proposed farm-level solutions based on how much food waste they can potentially divert annually. Based on this, the best 3 solutions are Imperfect & Surplus Produce Channels (Focus on getting undesirable/imperfect food through alternative channels to ensure they are bought and thus not wasted.), Donation Education (Educating producers & retailers on how to donate food safely & efficiently, ensuring that food goes up the supply chain.) and Buyer Specification Expansion (Broadening what is considered to be acceptable food, to counteract the wastage of perfectly good food for consumption due to rigid standards.)
Special Features:

- Interactive filters by state, income group, and waste destination.
- Benchmark comparison view to contrast “most” vs. “least” efficient states.

4.8 Analytical Model(s) - Shayn

Descriptive Analytic
Used in the Surplus-to-Supply Map and State Ranking charts. These describe what is happening by summarizing historical inefficiency across states. They provide the baseline context for identifying problem areas.
Diagnostic Analytics:
Used in the Scatter Plot and Farm-level Benchmark Comparison. These go deeper into why inefficiencies occur, by linking them to socio-economic factors (income and urbanization) and by revealing that weaker farm-level infrastructure drives higher losses.
Prescriptive Analytics:
Applied in the Solutions Ranking chart. This recommends what actions should be taken by prioritizing farm-level interventions with the highest diversion potential.
Link:
Ultimately, the models show how differences in income, urbanization, and farm-level infrastructure explain why U.S. states differ in food waste management outcomes. Descriptive analytics identify the inefficient states, diagnostic analytics explain the root causes, and prescriptive analytics provide targeted recommendations such as prioritizing preventive solutions and donation programs.

5 Problems Encountered

Following our proposal, we faced several challenges. Some teammates were unable to substantiate their sub-problem statements due to insufficient data which led us to narrow our focus specifically to U.S. food waste, changing the group problem statement as well.

During the data preparation phase, we struggled to combine and clean the datasets in Tableau Prep because the extremely high volume of rows caused performance issues. While preparing for the Week 16 presentation, we were concerned that our charts would appear similar as they were built from the same data fields. When we realized the charts were indeed overlapping, we chose to represent the essential data using a different chart type rather than remove it as it was critical to our problem statement.

After the Week 16 presentation, we faced the challenge of our dashboard failing to fully prove our problem statement. We attempted to find more data from other platforms such as finding solutions from other countries that are successfully implemented but there is not such data. Therefore, we continued to use the ReFED dataset as it provides valuable insights into potential solutions for US food waste.

6 Future Enhancements

We can design our dashboard better by including a background to the dashboard to make it more interesting & unique. Furthermore, we can make each of our dashboards more organized. Some people mentioned certain factors but some did not. This is because the dashboard was done individually based on the assignment, without any review of the work done. This made the story unorganized and for users to be confused. In the future, we can improve the dashboards by implementing a more consistent and logical structure. This will allow users to discover insights more easily across different sectors such as household, food service, retail and U.S. states.

7 Conclusion

For the food service sector, by leveraging the dashboards, the analysis shows that full service restaurants, limited service restaurants and lodging are the primary sources of food waste, with the varied menu and burgers/coffee cafe sub-sectors being the largest contributors, coming mainly from prepared food and plate waste. People can filter specific sub-sectors, sub-sector categories and food types to find solutions to reduce food waste. After evaluating the top solutions against financial implementation costs and benefits, the most effective strategy for full service restaurants, lodging, bars & taverns, business and industry, corrections, healthcare, military, recreation and transportation is "Portion Sizes," while "Markdown Alert Application" is optimal for limited service restaurants, "Waste Tracking" for colleges/universities and refreshment services and "K-12 lunch improvements" for K-12 education.

For the household sector, with the use of the 2 dashboards, the analysis shows that residential households are the primary source of U.S. food waste, costing the economy roughly $261B annually; the largest wasted categories are prepared foods, produce, and dairy/eggs, driven mainly by spoilage, and plate/leftover waste. Filters can be applied by the users to display the food type and cause to pinpoint the highest-leverage targets for intervention. Given the scale of economic loss, recommended solutions must deliver high

ROI and low implementation cost; after evaluating the top solutions against modeled annual tons diverted, CO_2 reduction and net financial benefit (and allowing for realistic uptake via the adoption-rate slider), the most effective first-stage strategy is consumer behaviour change campaigns because they deliver the highest diversion per dollar and strong CO_2 benefits; standardized date-labeling and expanded composting are recommended complementary measures to capture additional avoidable and unavoidable waste respectively.

For the retail sector, the first dashboard confirms that supermarkets and other grocery stores of SMEs do not have the resources to implement solutions to reduce food waste mainly caused by date label concerns, mistakes and malfunctions and spoiled food. Through the second dashboard, I identified solutions that directly address these challenges and proved which solutions worked. Across all visualizations, the top three solutions are Markdown Alert Applications, Intelligent Routing, and Dynamic Pricing. These solutions reduced high amounts of food wastage, had high profit per solution and created a lot of jobs. With these solutions having high profitability, SMEs will have the resources they need to reduce food wastage. Additionally, creating a large number of jobs through these solutions will help society flourish. Markdown Alert Applications reduces date label concerns and spoilage by notifying staff to discount items nearing expiration. Intelligent Routing minimizes mistakes, delays, and spoilage by optimizing delivery routes and schedules. Dynamic Pricing lowers date label confusion and spoilage by adjusting prices to encourage faster sales of near-expiry items. This demonstrates that these solutions effectively address key problems such as date label concerns, operational errors, and food spoilage. Therefore, the outcomes of the analysis align with the project's expectations by confirming that targeted, resource-efficient solutions can reduce food wastage while delivering profitability and social benefits.

For US states, it can be concluded that factors such as income and urbanization play a part in how developed a state is, and thus how wasteful it is, as well as that farm-level food waste is the most critical sector behind the efficiency in food management between the states. The top 3 solutions would be to direct unwanted food to customers through alternate channels, educating providers and retailers on how to safely and efficiently donate food, as well as to broaden what consumers perceive to be acceptable food. Thus, by identifying that farm-level food waste is what results in the states having different food waste management outcomes, we can implement farm-level solutions to change it.

Thus, the outcome of the analysis fits the project expectation by finding all the solutions for different sectors (household, food service, retail and US states) to help to reduce the overall US food waste.