BIT 5424 – Semester Project – Virginia Tech Dinning Services

Project Findings and Discussion

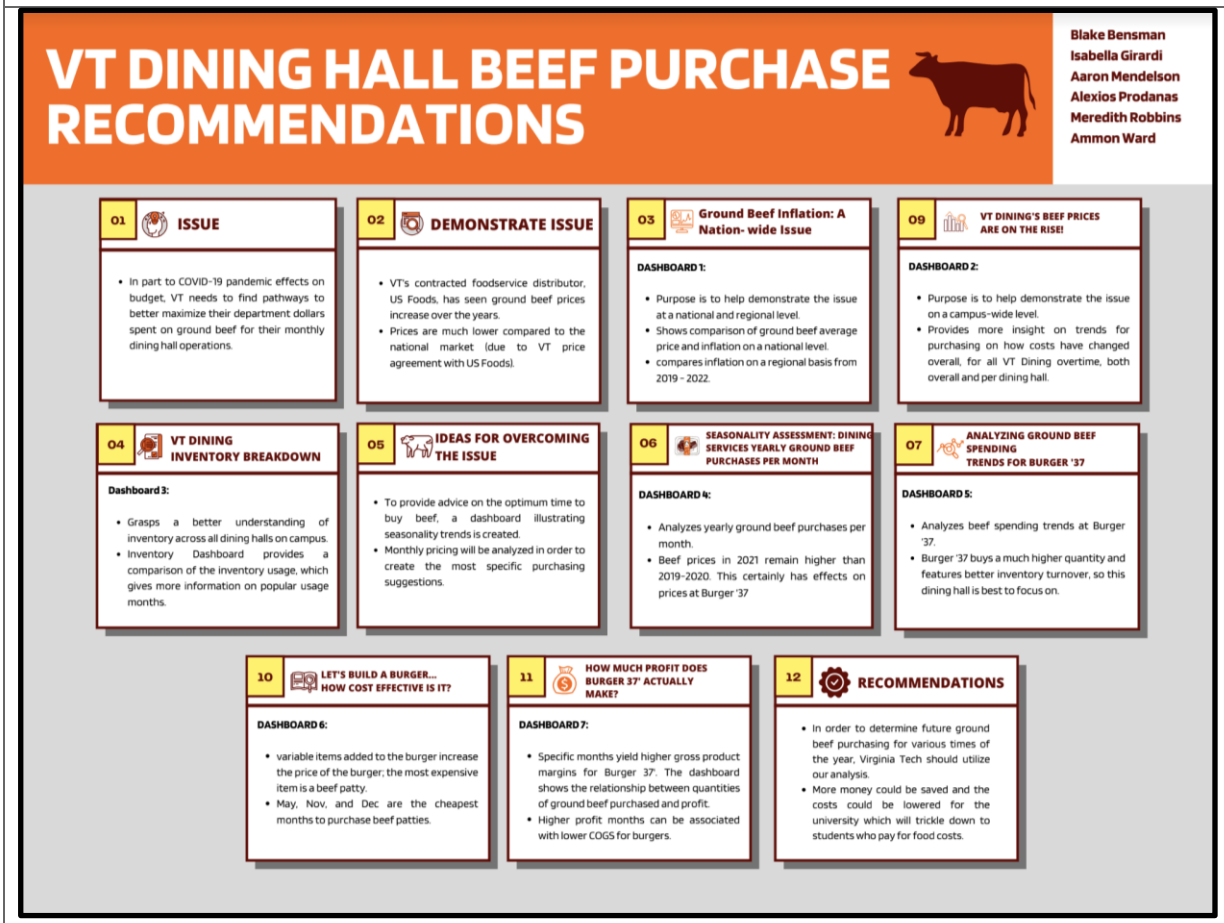
Semester project - Information

Group members

Isabella Girardi
Meredith Robbins
Ammon Ward
Alexios Prodanas
Blake Bensman
Aaron Mendelson

Explain your Big Idea

Project storyboard



The COVID-19 Pandemic shattered global supply chains; the fallout from the pandemic has caused a great deal of inflation which has caused nearly all consumer goods to become more expensive (The Atlantic). The price of ground beef has risen, which has a trickle-down effect on the price of on-campus dining at Virginia Tech. It is imperative that Virginia Tech

optimizes its purchasing decisions to reduce purchasing expenses by comparing bulk vs market ground beef purchasing.

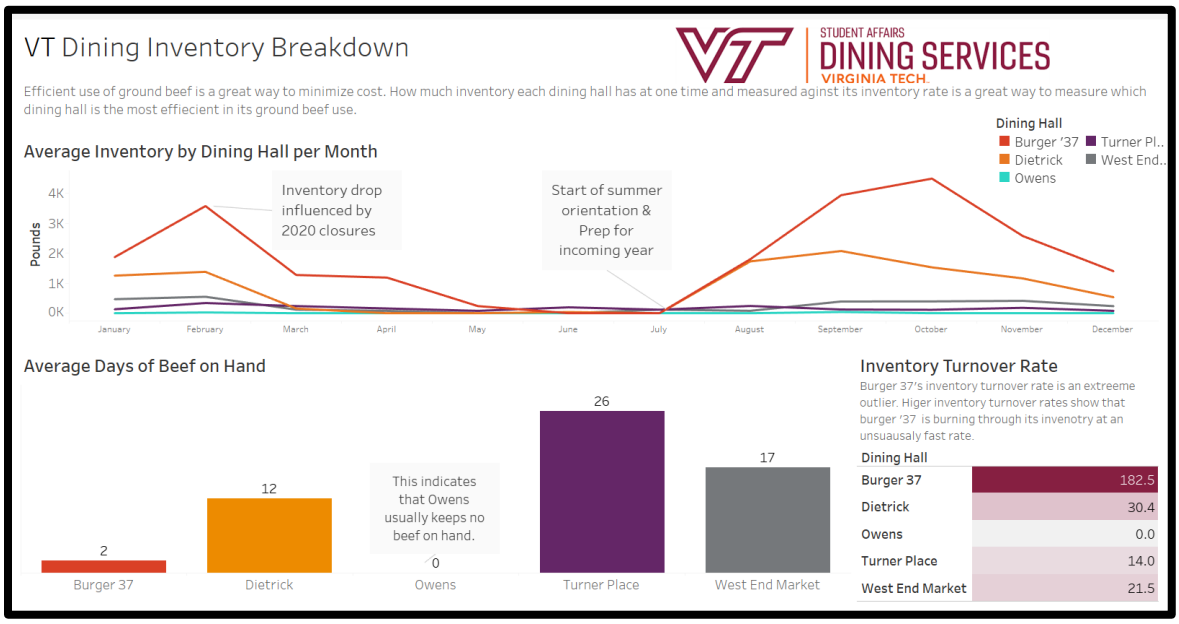
Dashboards were created to analyze trends in the price (and quantity for VT Dining) of beef purchases to better understand industry patterns, on a national/regional level and campus-wide. Inventory rates were then analyzed to better show which dining halls are operating at a more efficient rate. This can provide insights into making the most cost-beneficial decision. After analyzing these dashboards, it appears that Burger '37 is an outlier amongst all others. As the cost of beef continues to rise, it doesn't seem like consumption of beef at Burger '37 is slowing down. While the beef spending allocation is very similar between Burger '37 (39%) and West End (36%), Burger '37 buys a higher quantity and has better inventory ratios, so this dining hall is best to focus on. Of ground beef consumption at Virginia Tech, we will focus on this specific dining hall and make our primary recommendations with this in mind. It is clear that Burger '37 is operating the most efficiently and also contributes the most to beef spending. Burger '37 also has the most beef in inventory at one time and it burns through its inventory the fastest.

Now that purchasing and inventory trends are clear, some forecasting and seasonality analysis was conducted to develop ideas for overcoming the issue. A dashboard outlining seasonality trends was created to provide recommendations on the best time to buy beef. Beef has always been purchased at bulk in the beginning of each year with smaller incremental purchases throughout the school year. This is taken even further by analyzing current and future trends for Burger '37, specifically. Upon taking a closer look at monetary allocation and price forecasting analysis, there's evidence to suggest that prices will continue to rise incrementally. Monthly pricing was specifically analyzed to develop the most specific recommendations for purchasing.

Profit for Burger '37 is continuously rising throughout each successive school year. The months January, August, and December are the most profitable months for Burger '37: in that order. The months that produce the most profit tend to be associated with a lower cost of goods sold for hamburgers. Although it should be stated the VT dining does prioritize demand over price which can cause higher cost of goods sold.
When it comes to variable inputs that make up the cost of goods sold, beef patties by far are the costliest item. Typically, the cost of the beef patties varies by month. After conducting analyses, we determined that the cheapest months of the average cost of patties were in May, November, and October. Even though the recommended time to purchase patties is May, November, and October it is interesting to see that there is a difference in the data from purchasing pounds versus patties. In the beginning of the analysis, it shows that the recommended months to purchase beef in pounds is February, March, & April and it was indicated that some of the months not to purchase are August, November, & February, which is one of the months recommended for patties (Nov).

These insights will help Virginia Tech Dining lower their overall dining costs, which will have a net trickledown effect for students who dine on campus.

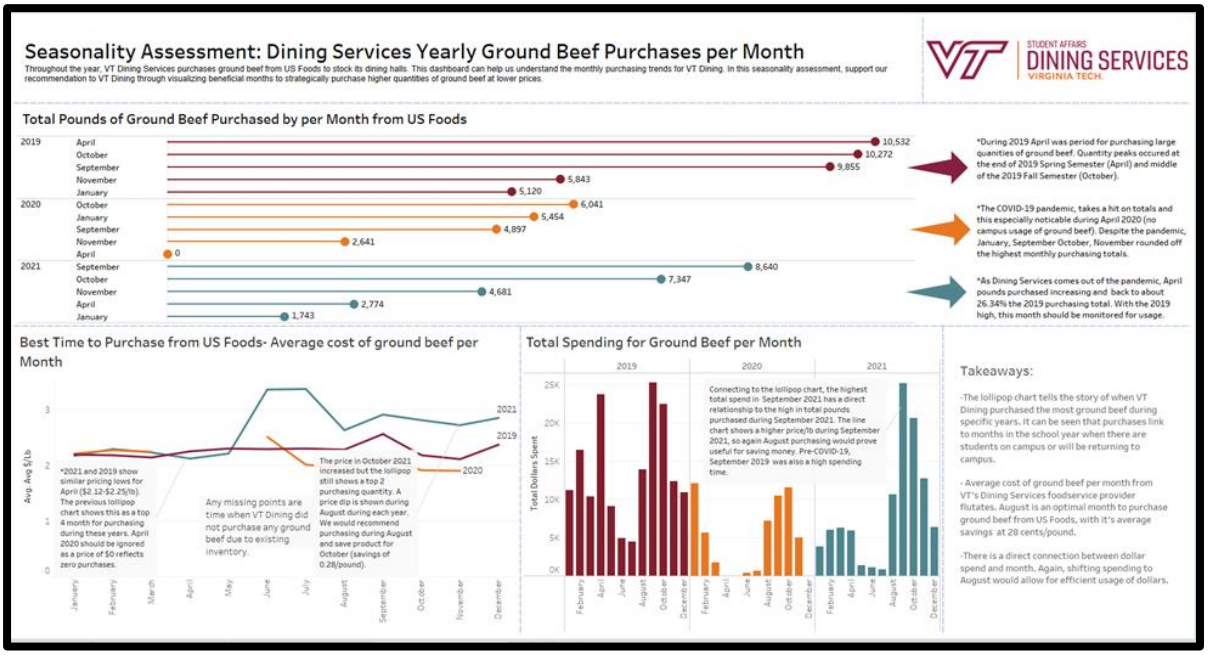
Dashboard 1 – Screen capture and commentary



The purpose of this dashboard is to visualize the inventory of ground beef to gain some better insight about how efficient Virginia Tech is maintaining its inventory. We hope this dashboard will be able to allow us to see which dining facility needs to make changes to its inventory schedule. We used a color-coded bar chart, line graph, and table visualizations to complete our analysis. This dashboard begins with a line graph which gives a general overview of inventory per month from 2019 to the February of 2022. Inventory is at its lowest levels during May, June, and July. This finding is not surprising given that it is during the summer holiday break. Inventory also drops again during December, as students go home for the winter holiday break. March and April tend to have lower inventory levels than what would normally be expected, due to the data being influenced by the COVID-19 closures starting in March of 2020. One thing that remains constant, is that Burger '37 continuously has a high level of inventory.

Across all dining halls, Burger '37 appears to have two significant outliers. The average number of days that it keeps beef on hand is two. West End, Turner, and Dietrick replace their inventories ranging from around every two to three weeks. It seems on average, Burger '37 is replenishing its inventory twice a week. Next, we wanted to use a standard chart to compare the inventory turnover rate, to see which dining facility is using their ground beef inventory the most efficiently. The inventory turnover rate will fluctuate between school years especially given the dynamics of the pandemic, however, Burger '37 continued to have an extremely high turnover rate. This means they are going through their beef supply extremely fast. This dashboard will help us tie in the entire story and will be further updated and utilized when making additional storage recommendations (We are currently waiting on getting additional storage data, so the plan is to incorporate that at the next Checkpoint).

Dashboard 2 – Screen capture and commentary

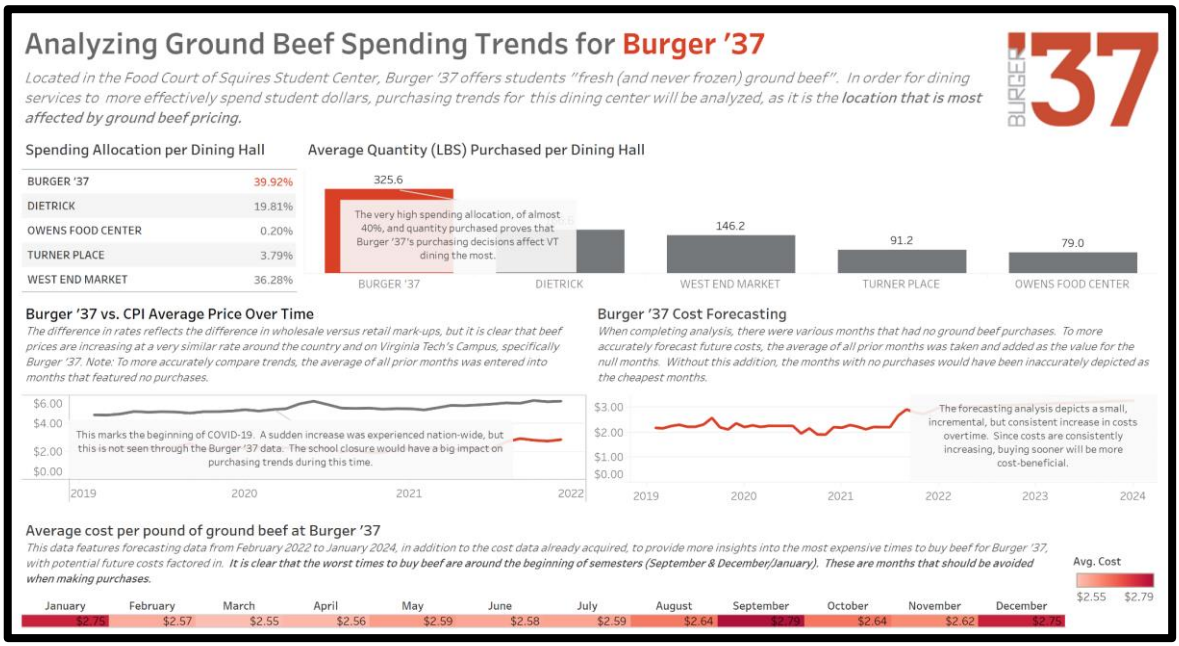


This dashboard explains the purchasing pattern of ground beef of VT dining related to specific months of the year. Throughout the year, Virginia Tech Dining Services purchases ground beef from US Foods to stock its dining halls. VT Dining is required to purchase 80% of its overall spend from US Foods, under agreements. This dashboard can help us understand the monthly purchasing trends for VT Dining. and what months to months to strategically purchase higher quantities of ground beef at lower prices.

First off, using a lollipop chart, we explore the highest quantity of ground beef purchased annually. This occurred during the same four months of January, April, September, November and October of years 2019, 2020 and 2021. This can help us to better understand the demand trend for ground beef in VT Dining halls per month. This important information when communicating with US Foods for structuring monthly purchases, which could lead to more efficient spending. Combining the information of the lollipop chart about quantity purchased and the line chart which represents the fluctuation of average monthly US Foods ground beef prices per month. Using this line chart visualization, we can advise VT Dining to recognize bulk purchasing opportunities during specific months with the lowest average ground beef costs.

The bar chart can clearly emphasize and illustrate that there are specific months which can be an outstanding opportunity to buy higher quantities at lower prices. Connecting to the lollipop chart, the highest total spend in September 2021 has a direct relationship to the high in total pounds purchased during September 2021. The line chart shows a higher price/lb during September 2021, so again August purchasing would prove useful for saving money, on a dining hall wide level. Pre-COVID-19, September 2019 was also a high spending time. These monthly assessments provide snapshots for the department with a look into how each of these variables interact with each other, storing higher quantities of ground beef during specific months of the year, and how it can lead them to better decision making when purchasing ground beef from US Foods.

Dashboard 3 – Screen capture and commentary



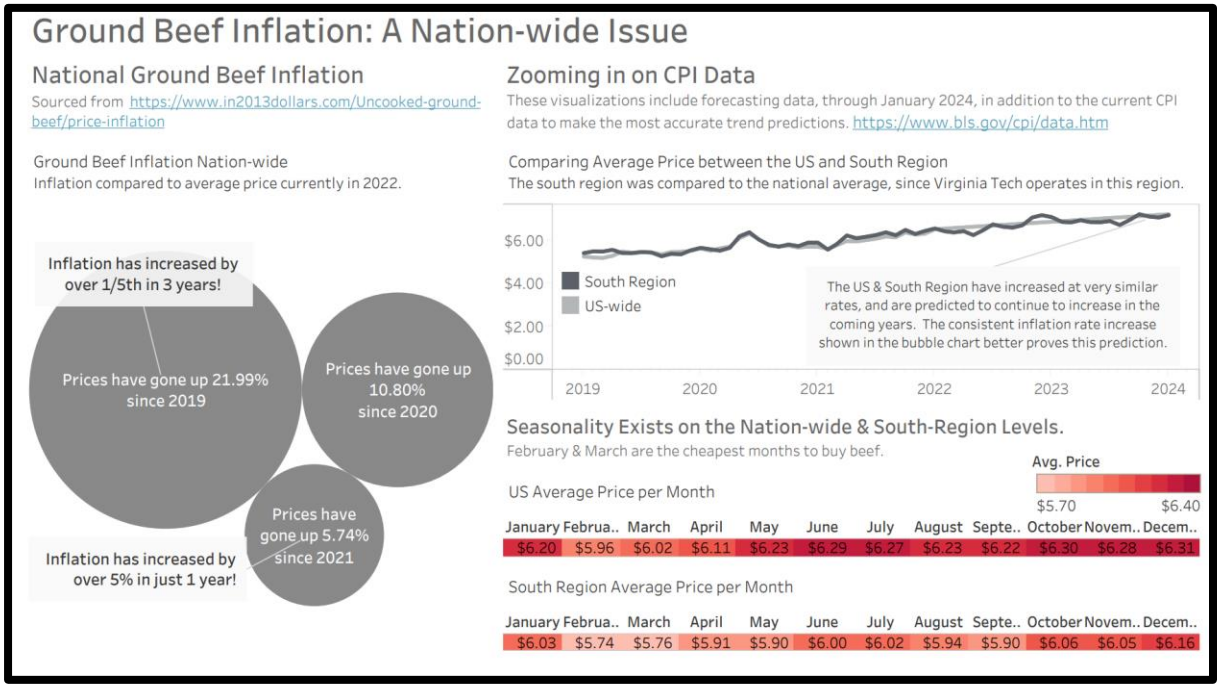
This dashboard puts Burger '37, the dining center with the most amount of ground beef purchased, under the microscope. This dashboard is a continuation of the exploratory dashboard created in Checkpoint A. During the exploratory analysis, we found that Burger '37 accounts for most of the ground beef purchases across campus, which makes sense, since they sell mainly burgers. Since Burger '37 holds the most stake in beef purchasing decisions, it is important to hone in on this dining hall's data separately, in order to make the most informed, specific purchasing recommendations.

First off, below the title, we start with a paragraph introducing Burger '37, what they serve and why we chose them to examine further (with the Burger '37 logo, linking to the website next to it). To support this, a table was created showing the percentage of spending that each dining hall accounts for. Next to this, a bar chart was placed showing how much ground beef each dining hall purchases. Providing these numbers give the audience an example of the impact that buying efficiently could have, as the more money dining services saves the better. Below these 2 charts, a line chart is provided showing how the rates that Burger '37 buys beef at compares to the CPI, along with a line chart that shows the cost the forecasted rate for Burger '37 through the beginning of 2024. When looking at the CPI comparison, it is clear that Burger '37's average cost/lb is increasing at a very similar rate to the CPI, country-wide data. This indicates that the price increases that VT Dining is facing has more to do with an industry shift than their supplier's pricing strategy, an important finding to note, as it can be useful in determining whether to re-sign contracts and better shows the supplier's fair pricing strategy. Forecasting shows that rates are most likely to continuously rise over time.

At the bottom we employ a highlight table to show the average rate for ground beef monthly. From this table, it is clear that the worst (most expensive) times to buy beef are near the beginning of semesters: December/January and September.

The vertical logic here is that Burger '37 is a very important dining hall to examine, and the figures showing the percentage of spending that it takes up reinforces Burger '37's importance. The horizontal logic is that by looking at these dining halls on a hall-by-hall basis, we can examine the impact of strategic buys and reinforces the need for this kind of analysis. Additionally, we keep the unit of analysis consistent with the other dashboards (analyzing in months) and employ a similar color scheme as well. Burger '37 is denoted in its logo color on many of these visualizations to help it stand out from the other comparisons.

Dashboard 4 – Screen capture and commentary



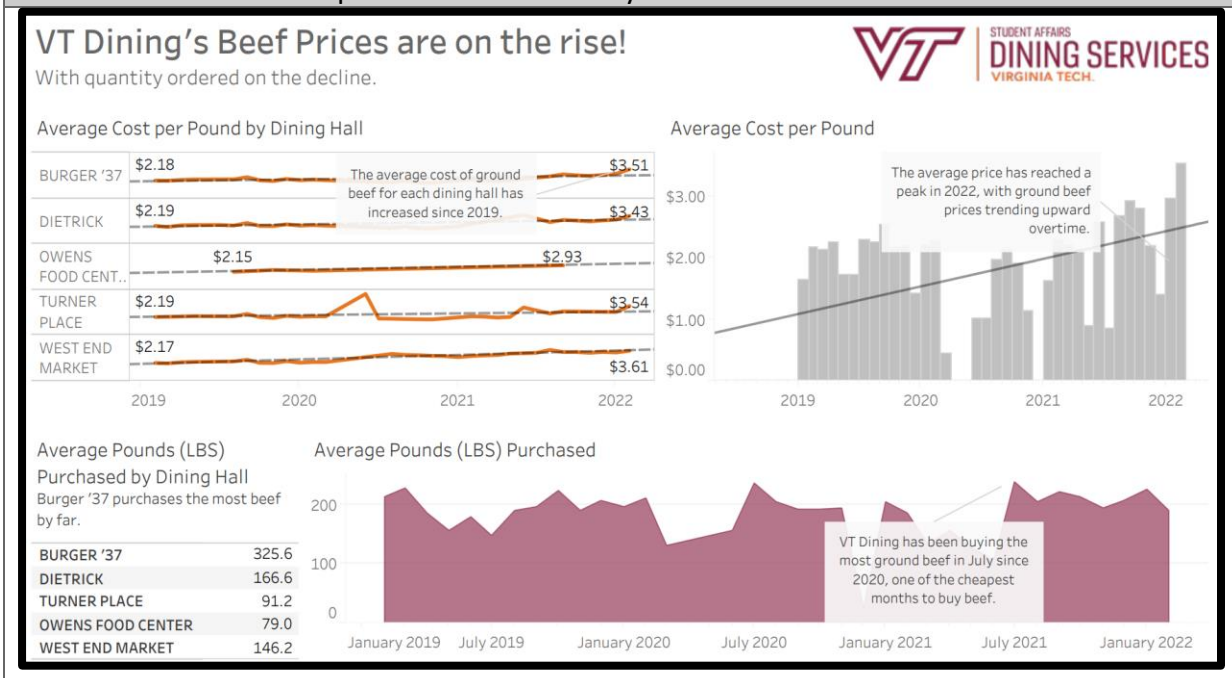
This dashboard shows the comparison of ground beef average price and inflation on a national level. The dashboard is essential for our group to observe ground beef pricing trends across the country. Analyzing country-wide/regional data before diving into VT Dining numbers will help to make connections and determine if some of the patterns we see are due to national factors or are specific to Virginia Tech.

First off, it's important to look at ground beef fluctuations. In order to determine when to best buy ground beef, we must understand any patterns that exist as the year goes on. Looking at this, we can help make tailored recommendations to target times when prices are the lowest. The bubble charts highlight the average price increase on a nation-wide level in 2019, 2020, and 2021 (vs 2022). This allows the reader to better understand the impact of inflation. It is clear that inflation of ground beef has increased a lot over the past three years. This consistent increase can tell us that we can expect this trend moving forward. Second, comparing the average price between the US and South Region gives us more context as to whether ground beef price increases are a national issue or a regional issue. Analyzing the south region allows our group to focus on the same region where Virginia Tech Dining Services is located.

If the nation-wide average features lower prices, it might be worth it to explore sourcing beef from another region. This adds a "look ahead" aspect for our readers and allows the reader to look at how the national vs. south region prices may fluctuate beyond 2022. Overall, the trends are the same for the nation-wide vs. south region, with prices in the south being slightly lower. To analyze regional patterns further, in regards to seasonality, the final visualizations show month over month comparison of the US Average Price per Month compared to South Region Average Price for Month. This adds to the story element bringing price from a macro to micro perspective. Macro begins with national, then goes to regional. We will continue to go to the more micro level as we focus on the dining halls and finally Burger '37. Seasonality trends are very important to consider to determine the cheapest times to buy beef, which is why this piece was included in the visualization. Deeper seasonality trends will be analyzed for VT Dining Services further into the story.

This dashboard will be shown as the first part of our story, to demonstrate the issue, as we start with the more macro "problem" of ground beef prices on a national and regional level. In all, this storyboard will allow us to provide a recommendation that considers national and regional pricing fluctuations. We realize that inflation will continue to be a factor when analyzing ground beef prices, but we feel that this CPI analysis will be useful for further pricing analysis.

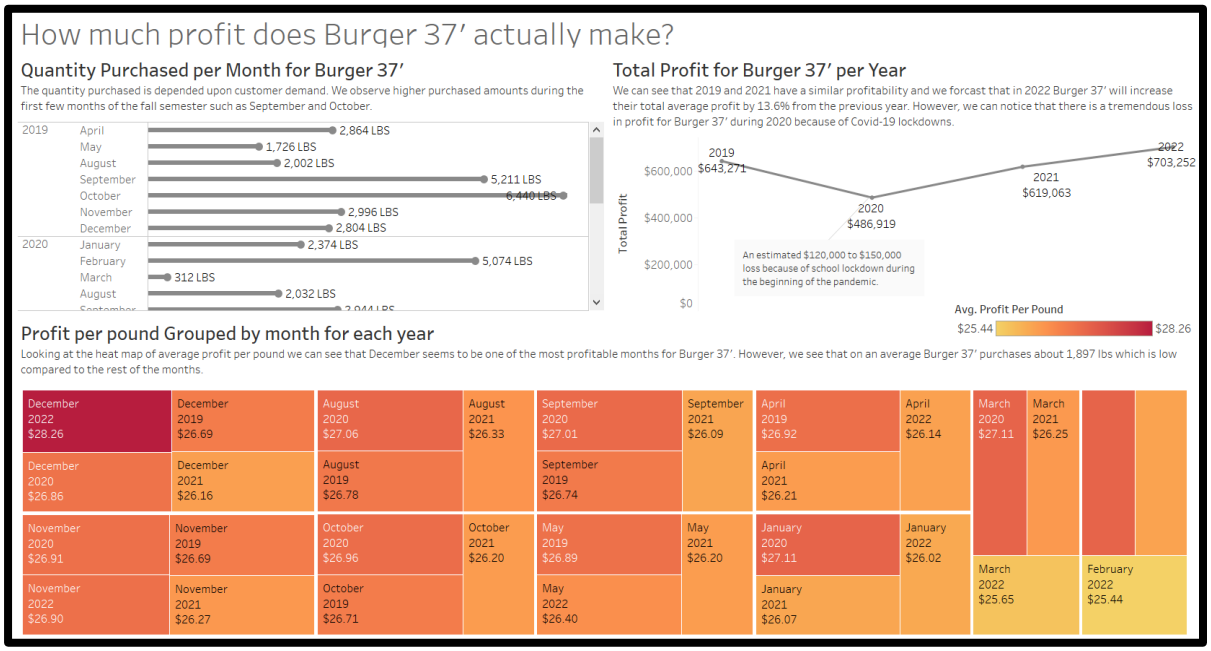
Dashboard 5 – Screen capture and commentary



This dashboard will be presented second overall, showing purchasing information for VT dining. This will give dining hall stakeholders more insight into their purchasing trends, along with how costs have changed overall, for all VT Dining ground beef purchases. The top 2 charts show that costs have increased for VT Dining overtime, both overall, and per dining hall. Showing the increase in costs, especially by how much, and the upward trend helps to corroborate any final recommendations in regards to purchasing. Having a set buying strategy will help to save VT Dining money and they will be able to allocate this savings toward initiatives to better help students. The bottom two visualizations go more into depth on the quantity of ground beef purchased. It is clear that Burger '37 goes through the most ground beef, making it one of the most influential dining halls for ground beef purchases on campus. Quantity for ground beef purchases tends to vary from month to month, due to the current strategy of purchasing based on demand, but it is important to note that the two peaks take place in the month of July, which happens to be one of the cheapest months to buy beef(as seen on the Burger '37 dashboard). These purchases represent "good" purchases for VT Dining, that result in better savings for the department, and they should take this pattern into consideration moving forward, possibly even increasing the quantity purchased in those months.

***IMPORTANT NOTE: The breaks in the bar chart indicate months where there were no purchases, these data points were excluded in order to better depict this, so there is no information to see, but the breaks still show in the graph.*

Dashboard 6 – Screen capture and commentary



This dashboard focuses on the profit that Burger '37 makes over both months and years. The main objective of this dashboard is to walk the reader through quantities of ground beef purchased per month of the year, total profit Burger '37 makes per year, and the average profit from a pound of ground beef made per month of a specific year. Why is all of this important? Like any business, Burger '37 must focus on strategic ways to make the best profit that they can. In order to do so, factors such as pounds purchased and time of year play a big role in its financial success.

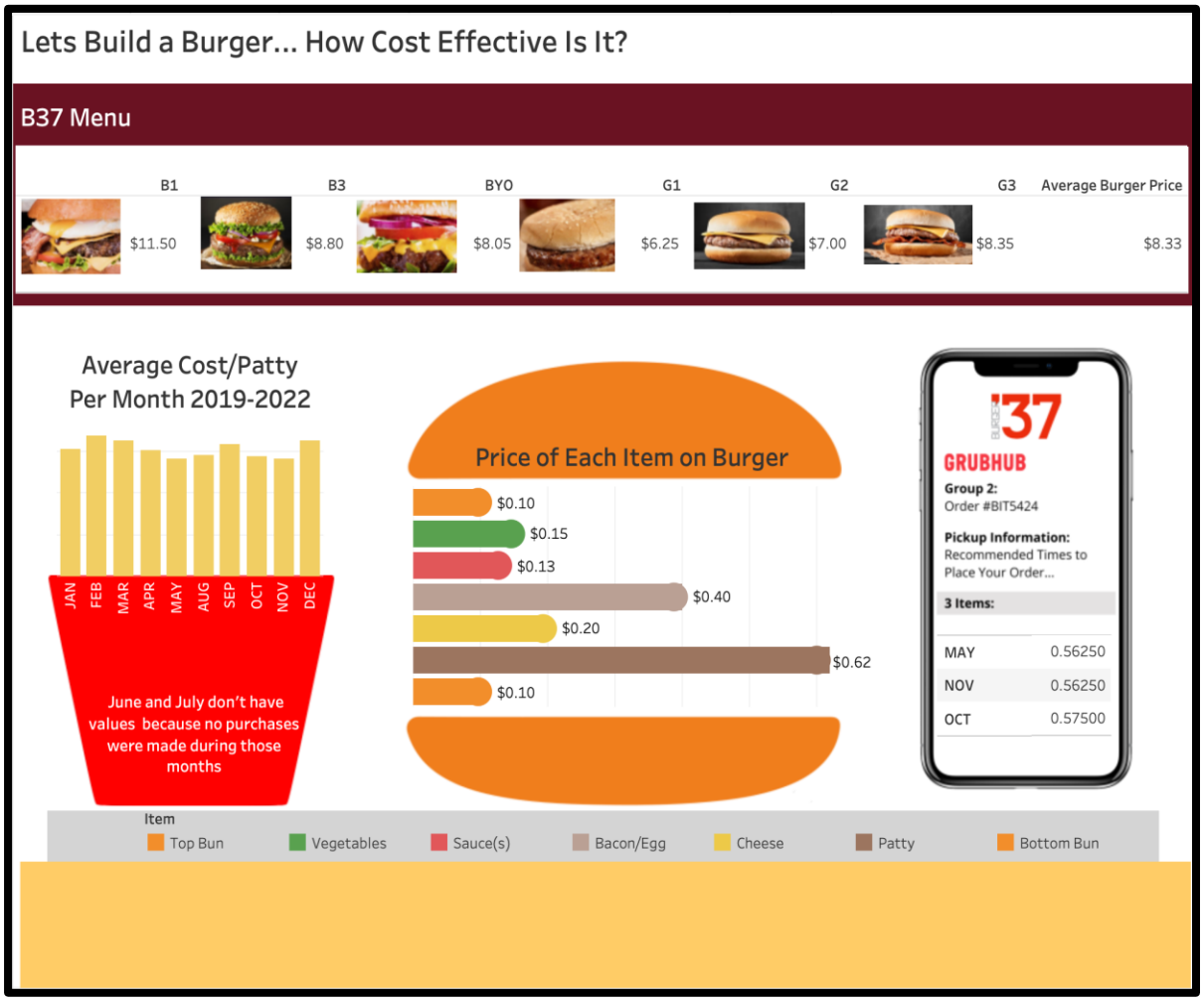
The dashboard begins with a focus on the quantity of ground beef purchased in pounds from US Foods each month in a given year. The quantity purchased is dependent on customer demand. We observe higher purchased amounts during the first few months of the fall semester, such as September and October. These are likely peak purchasing periods by VT Dining because students are just coming back from summer break and they are craving the delicious Burger '37 burgers! It's neat to see how the quantity of ground beef decreased during COVID-19 years and then has begun to rise again in recent years. The reader can definitely see the quantity lollipop chart has a storyboard in and of itself (putting the purchasing into context with the pandemic and high student occupancy on campus during fall/spring academic semesters).

Second, the visualization highlights the total profit for Burger '37 each calendar year. We can see that in 2019 and 2021 there is a similar profitability for Burger '37. 2020 is an off year with the COVID-19 lockdown, causing a loss in overall calendar year profits. Based on forecasting, we predict that Burger '37 will increase its total average profit by 13.6% (year over year percent change factored in). This dashboard is important because it shows the scale of the ground beef's profits for Burger '37.

Lastly, the final visualization shows profit per pound grouped by month for each year. In terms of profit earned per pound of ground beef, December seems to be the most profitable month overall. This could be due to the COGS (cheese, meat, etc.) being lower overall compared to previous months. Hence, yielding a higher profit per pound. Darker colors indicate a higher profit yield per pound. Some other factors that could impact the profit per pound include: fluctuating inflation and vendor availability of ground beef.

***IMPORTANT NOTES: All excluded months correlate to zero purchases during that specific month. This was due to variables such as the COVID-19 lockdown or summer closing periods for VT Dining. Second, it's important to keep in mind that customer demand for burgers drives sales. This explains why some periods have exponentially more pounds purchased than others. Sometimes VT Dining has to put demand over price to meet the needs of customers, which can cause higher COGS and lower profit margins. Forecasting was also used to finish out the 2022 year, to produce more accurate findings.*

Dashboard 7 – Screen capture and commentary



This dashboard takes a graphical analysis of how cost effective it is to assemble a burger at Burger '37. The main objective for this dashboard is to give the reader insight on when to order beef based upon the average cost of a patty. The dashboard begins with the top horizontal row showing the total cost of the current burgers that Burger '37 has and what the burgers look like. Then, a bar chart was used to display the average cost of a patty per month. The months with the lowest costs are May, November, and October; with the respective cost being $0.56, $0.56, and $0.57. Next, this dashboard explores the price of each item of a burger using lollipop charts. The variable inputs typically will cause the price of the burger as a whole to vary by a few cents depending on how much or how little the customer wants to add to his/her burger. Overall, the most expensive part of the burger is the patty itself. Finally, it is interesting to note that the months of May, November, and October have the cheapest average cost per patty, which is different from the cheapest months to buy per lb of ground beef. That being said, the differences here are only about 1 cent.

Even though the recommended time to purchase based off of this dashboard is May, November, and October it is interesting to see that there is a difference in the data from pounds to patties. In the beginning of the analysis, it shows that the recommended months to purchase beef in pounds is February, March, & April and it was indicated that some of the months not to purchase are August, November, & February, which is one of the months recommended for patties (Nov).

***IMPORTANT NOTES: All excluded months correlate to zero purchases during that specific month. This was due to variables such as the COVID-19 lockdown or summer closing periods for VT Dining. Second, it's important to keep in mind that customer demand for burgers drives sales. This explains why some periods have exponentially more pounds purchased than others.*

Dashboard Inspired by
https://public.tableau.com/app/profile/lilibeth.wolfe/viz/BobsBurgersRatings/BobsBurgers

Images from:
Grubhub (B1, B3, BYO, G1)
Adobe Stock Images (G2, G3)

Conclusions

What questions did your analysis answer?

1. What trends are there in beef pricing overtime?
    a. When is the best time to buy beef?
        i. Is beef cheaper, generally, at a different time of year?
        ii. What buying patterns are most cost beneficial (i.e. buying in bulk or incremental, based on need)?

Explain how the results of your analysis contributed to validate your story

What are the best months to buy beef?

When creating our seasonality, national trends, and Burger '37 dashboards, there were some months that stood out as "good" purchase times and "bad" purchase times, based on the average cost per pound of ground beef during the time period. Further analysis has validated this, which helps to validate our story by providing accurate recommendations for the best time to buy beef. Buying in the recommended months will most likely result in more savings for Burger '37, where buying in the months to avoid, will result in additional costs. Since there are months that are cheaper than others, buying more in bulk, while still maintaining the quality of the meat is recommended.

Months to buy:

- February, March, & April

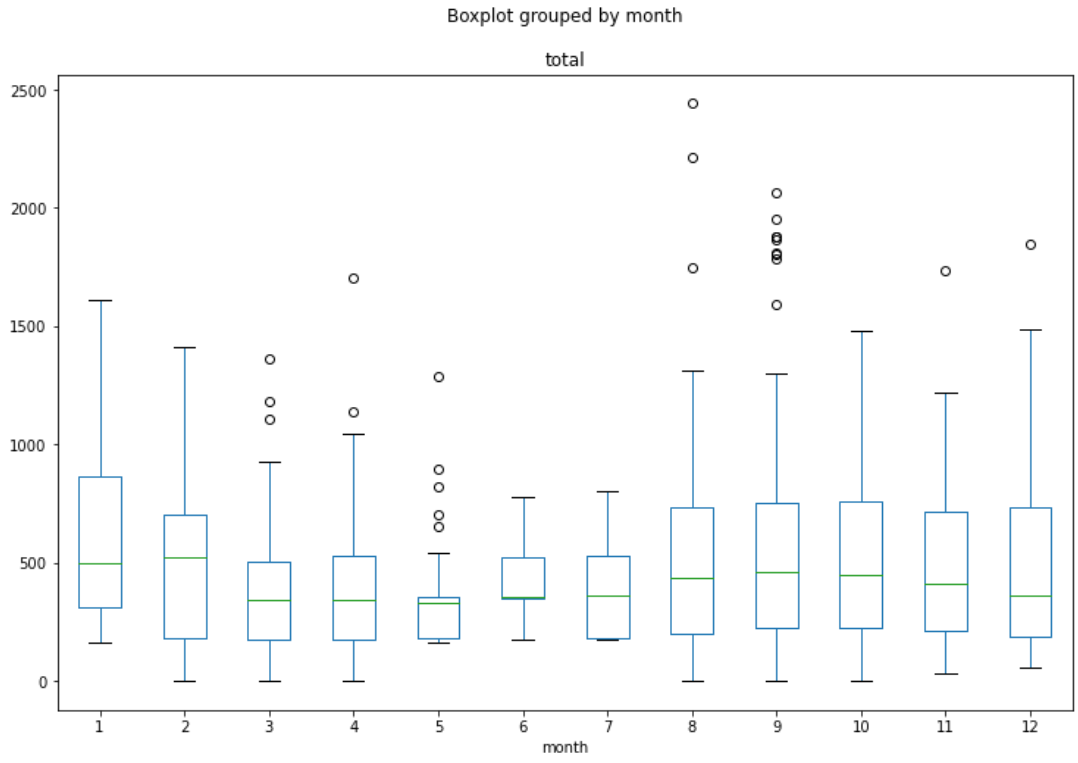
- These 3 months are some of the cheapest months to buy ground beef both on the national level, south-region level, and from a VT Dining/Burger '37 perspective. It is most cost-beneficial for VT Dining to buy in the cheapest months.

- August, November, & February (or months leading up to the beginning of semesters)
  - These three months are right before or right after the months with the higher average cost, so it is recommended to buy beef in these months before prices reach a high. Buying right before these peak months provides the convenience of some bulk purchasing, but is not too far in advance where the quality of the meat would deteriorate.

Months to avoid:

- January, September, & December

  - These months are right near the beginning of a semester, where demand will rise a lot quickly. Due to this, we've seen that these months have a higher cost per pound on average, when compared to other months, especially when looking at Burger '37. It is recommended to avoid buying during these times due to those increased costs. Buying when costs are higher will result in more monetary loss for VT Dining.



After examination from the python notebooks in Checkpoint B (see "ANOVA on Total Spent Using Month" above), as well as observations seen in various dashboards such as: the

"Ground Beef Inflation" and the "Burger 37" dashboards. We have identified the above months to help better inform VT Dining for the best months to purchase ground beef, as well as the key months to avoid when considering whether or not they are purchasing beef.

Recommendations

What is the estimated cost for implementing your recommendation(s)?

Recommendation	Cost comments
Purchase ground beef during February, March, April, and August.	There are no additional costs associated with buying at different times (should only feature savings from cheaper purchases). That being said, if beef is bought much farther in advance it could result in storage costs (described in row 3 below).
Avoid ground beef purchases during January, September, and December.	There are no additional costs associated with avoiding purchases during certain months. These months should be avoided because beef has historically been more expensive in these months, possibly due to the new semester and increased demand. Again, if beef has to be bought farther in advance to avoid these months storage costs could occur (described in row 3 below).
Pre-plan future purchases based on months with high demand from customers, in order to prepare for high profit generating months.	Planning farther in advance will result in the need for more freezer space and maintenance. This will result in increased storage costs. That being said, since the storage is internal at VT Dining, they would only have to pay for the electricity usage in the freezer (which is already in use anyway), so any incremental increase in electricity resulting in a cost increase would be very small, and not very relevant (discussed with Ben Marks - key stakeholder).
Consider optimal months to freeze ground beef for future months.	Purchasing bulk portions of ground beef during months with lowest cost have the potential to maximize inventory utilization and decrease cost of monthly beef purchases, but could lead to increased inventory cost (relatively small, not significant as described above).

Understand which months VT Dining can get the most profit per pound of ground beef sold.	Optimal purchasing price will vary between months (see comments at the top for recommended months), but there should be no additional monetary costs of implementing this suggestion.
Evaluating optimal months to spend on COGs (based on pounds of ground beef) to assemble B'37 burgers are May, October, and November.	The costs of inputs may be subject to price changes; however, these items are very inexpensive compared to beef. Again, buying at optimal times should only feature savings, but since the price is so low to begin with, it wouldn't be extremely significant.

When it is estimated the return of investment for the costs of your recommendation(s)?

Recommendation	ROI Comments
Purchase ground beef during February, March, April, and August.	This results in saving more money by cutting into windows where beef needed to be purchased at higher rates. The return will be seen immediately upon implementation, when VT Dining starts to purchase more in cheaper months.
Avoid ground beef purchases during January, September, and December.	This avoids the mistake of making a purchase in a month where beef prices are most high, which is the best optimization of students' money. The return will be instantaneous upon implementation, but will most likely not be noticed until purchasing analysis or book keeping is done to see how money was saved. This wouldn't be noticed as quickly as buying in optimal months, because when buying in optimal months you know right away it's cheaper, where this is less direct.
Pre-plan future purchases based on months with high demand from customers, in order to prepare for high profit generating months.	Burger '37 will know what quantity purchases need to be made, which will allow for allocation of resources to meet demand, ultimately resulting in less cost but more revenue. The return will be seen upon making those planned purchases.

Consider optimal months to freeze ground beef for future months.	Having the right balance between inventory usage and bulk purchasing during optimal months could lead to increased profits for Virginia Tech dining services. This return would be seen when cheaper purchases (that need to be frozen) are made.
Understand which months VT Dining can get the most profit per pound of ground beef sold.	VT dining could predict/forecast which months/times of school year will bring in the highest revenue. The return would be seen upon completing the purchases that are related to these predictions.
Evaluating optimal months to spend on COGs (based on pounds of ground beef) to assemble B37' burgers are May, October, and November.	A higher gross margin on sales per pound with each burger sold would be seen upon completion of a transaction order and analyzing Burger '37's profit.

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