Optimizing Inventory Management for Gas Stations: A Data-Driven

Project 28 (Team 10 for Section 55)

Aoran Zhao, Shiyu Yang, Jiaxun Li, Yuchun Wu

1. Introduction:

The aim of this project is to explore the provided dataset, provide descriptive statistics, visualize the inventory replenishment pattern, and suggest a better inventory policy that can save gas stations money. The analysis will involve evaluating how well gas stations manage their inventory, identifying areas for improvement, comparing the amount of money saved to the maximum potential savings, and exploring the benefits of increasing tank capacity and ordering fuel on specific days of the week.

1.1 Background

The gas station industry involves purchasing fuel in bulk and selling it to customers. Gas stations typically offer various types of fuel, and each type is stored in one or more tanks located underground. The number of tanks and their capacity are determined by factors such as available space, city regulations, proximity to suppliers' reservoirs, and demand. The frequency and quantity of fuel replenishment can have significant consequences on the survival and profitability of the gas station. Frequent replenishment in small quantities reduces the cash tied up in the fuel inventory, while larger and less frequent deliveries may qualify for a quantity discount offered by the supplier.

1.2 Hypothesis

We used the fuel price and purchasing order data to evaluate how well we manage our fuel tanks' inventory and order fuel. By visualizing the inventory evolution trajectory, we can gain insights into our inventory management practices and identify areas for improvement. After overlooking the data set, we generalized several hypotheses based on the question we should answer in the report in project description:

1. Gas stations that order fuel in larger quantities save more money than those that order fuel in smaller quantities. The gas station can have improvements in their inventory manage strategy by decreasing the refill frequency.
2. The quantity discounts offered by the fuel supplier incentivize gas stations to order larger quantities of fuel.
3. Higher tank capacity and lower fuel consumption are indicators of effective inventory

management practices, as they suggest that the station is maintaining a higher safety inventory. Conversely, lower tank capacity and higher fuel consumption indicate riskier inventory management practices, as the station is likely maintaining a lower safety inventory.

4. Gas stations that replenish their tanks less frequently save more money than those that replenish their tanks more frequently.

1.3 Result

We found that the current refill strategy of gas stations is suboptimal in maximizing discounts despite high refill frequency. We developed a model to determine the best refill strategy for each gas station location based on historical data analysis, and were able to generate the best refill day and quantity for each tank to ensure the best discount and generate the highest possible savings. The output of the model showed that Location1 has the highest potential for savings, followed by Location2, Location4, Location8, Location6, Location5, Location3, and Location7, in descending order of savings potential.

2. Methods

2.1 Data Description and data cleaning

The datasets chronicle over a year's fuel purchases (by the gas station owners) and sales at all city gas stations. Data processing involves several important steps to ensure the accuracy and consistency of the data. Before doing the data cleaning, we have our first glance the dataset and combined two separated datasets, Fuel_Level_Part_1 and Fuel_Level_Part_2.

The first step is to check for missing values in all data sets, and handle them accordingly. The method we choose to handling them is deleting them directly. it appears that the majority of null values are present in the invoice table, where important data is stored. In order to address this issue, the decision was made to delete any rows that contained missing data, which should help ensure that all relevant information is accurate and complete. As for the combined fuel level, there were only two missing values, which were deemed to be insignificant given the small number of missing values. Therefore, it was determined that these missing values could be safely ignored without compromising the integrity of the overall data set. By taking these steps, it is hoped that the resulting data set will be as accurate and reliable as possible, while still being practical to work with given the available resources.

The paragraph describes a data cleaning process where the data is checked for null and duplicate values. After deleting the null values, the data is checked for duplicates, but none are found. However, upon further analysis, it is discovered that there are some incorrect location IDs that are outside the scope of the current analysis. To ensure the accuracy of the data for the current project, these location IDs are removed from the dataset. This is an essential step in data preparation, as it ensures that the data used for analysis is of the highest quality and relevance.

In data cleaning and preprocessing, it's essential to ensure consistency in naming conventions of column headers. In this case, the next step involved cleaning the column names by converting all characters into capitalization form and removing all the spaces with underscores ('_'). This process can be achieved using list comprehension. By using list comprehension, we can iterate over each column name and apply the necessary transformations to clean them up.

In the data analysis process, it is often necessary to group or categorize data according to specific criteria. In this case, we have four tank types, namely P (Premium gas), G (Gas), D (Diesel), and U (Unleaded gas). However, since the tank type P is only present in one tank, we can ignore it for the purposes of analysis. Additionally, we can consider fuel types G and U as essentially the same thing, as both refer to gas. Therefore, to ensure consistency in our data, we can replace all occurrences of fuel type U with G. This process will help to simplify the data and make it more manageable for analysis purposes, while also ensuring that we do not double-count or misinterpret information based on different fuel type labels.

2.2 Find Inflation Rates to Establish Our Model

In our plan for the data visualization part of fuel level, we would Canada's monthly inflation rates from Jan 2017 to Aug 2019, create a small new dataset with these rates, and join it with our existing data to caculate the cumulative inflation rates.

To calculate the average daily consumption for each tank, we will use the tank capacity attribute. This information will allow us to estimate how much fuel is being consumed on a daily basis in each tank.

The request is to thoroughly understand the inventory management practices, cost structure, and overall efficiency of the fuel inventory management system. This is achieved by analyzing fuel price and purchase order data to evaluate how well the fuel tanks are being managed and ordered. The inventory evolution trajectory is visualized to show the changes in inventory levels over time. The effective and risky inventory management practices at different locations are identified, and potential cost savings are estimated by comparing the saved money with the maximum potential savings from optimizing the purchasing strategy. The monthly inflation rate in Canada is identified and used to create a small new dataset. The potential cost savings of increasing the capacity of existing fuel tanks are estimated, and the locations that will benefit the most are determined. Lastly, the best day of the week to order fuel is discussed. Overall, this approach provides a comprehensive analysis of the fuel inventory management system and identifies areas for improvement to increase efficiency and cost savings.

2.3 Detailed Model Step By Step

We aim to establish the optimal model to identify a better refilling fuel strategy that yields greater discount savings than the current approach. To build this model, we first divided all tank fuel levels into different data frames based on their daily, monthly, and yearly consumption and plotted them accordingly. We then calculated the daily average consumption and based on historical data, determined that the total model period is 990 days (33 months * 30 days).

Next, our model is based on the daily average consumption, and we assume that we refill the tank to full after x days, where x ranges from 1 to capacity / daily consumption (i.e., the number of days after which the tank will be empty). For example, if the tank capacity is 40,000 and the daily consumption is 4,000, then x ranges from 1 to 10, as the tank will be empty after 10 days.

We then calculate the refill quantity for each x based on the daily consumption and determine the discount and savings accordingly. Since x varies, refill quantity and discount also vary. By varying x (e.g., from 1 to 10), we calculate the optimal total savings over the entire model period of 990 days. This enables us to determine the best refill days, refill quantity, and threshold (i.e., capacity minus refill quantity) for each fuel type at each gas station, leading to the biggest and best total discount savings.

Finally, we use the previously calculated cumulative inflation rates to discount all values to ther present value as of January 1, 2017. The net present value (NPV) is calculated by dividing the current month's savings by the cumulative inflation rate for that month, resulting in NPV savings. This enables us to determine the total discounted savings for each tank, which helps us identify the optimal strategy for our model.

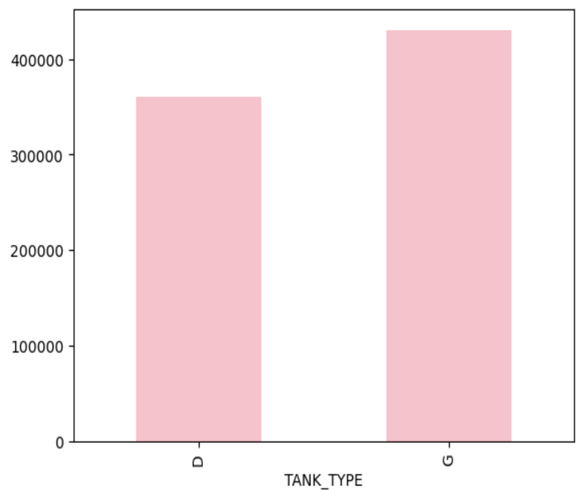
3. Results

3.1 Visualization

After cleaning and modifying the data, it is important to analyze and visualize the results.

- ➢ **Firstly,by using the DF_TANKS information, we created visualizations showing the combined capacities of all gasoline and diesel tanks across all locations.**

We can see from the accompanying graph (shown in **Figure 1**) that gas tanks typically have more capacity than diesel tanks. This finding has significant ramifications for our analysis because it implies that gasoline fuel may be more essential to our clients' operations than diesel fuel, necessitating the use of a more focused and effective strategy to maximize savings. Additionally, we can make use of this knowledge to spot any fuel usage imbalances between gasoline and diesel and change our model as necessary to provide the greatest results for locations to refill their fuels.



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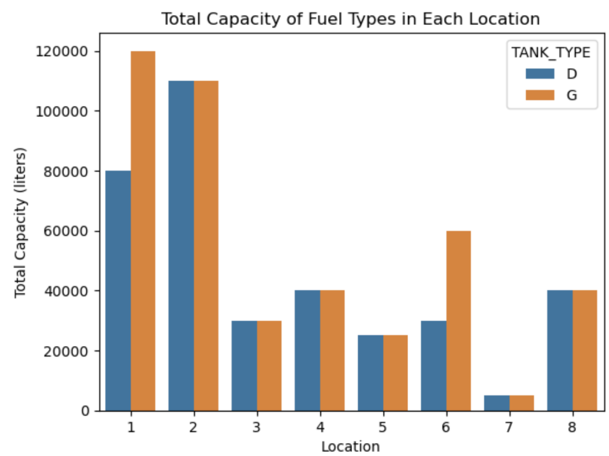


[2]

- ➢ **Next, we analyzed the Location table and examined the graph of total fuel capacity for each fuel type at every location in Figure 2.**

This investigation gave us important information about the trends and patterns of fuel usage at the various sites of our clients. We discovered that there were considerable differences in the fuel capacity between various places, with some having a far larger capacity for particular fuel types than others. We were able to locate possible prospects for improving the refilling approach and maximize savings by detecting these inconsistencies. Also, this study assisted us in creating a more focused strategy for fuel procurement, enabling us to address the unique demands of each location while lowering costs and decreasing waste.

From **Figure 2**, we can see the capacity for gasoline at LOCATION 1 is the highest, while the capacity for gasoline at LOCATION 7 is the lowest, according to the graph showing the total fuel capacity for each location. Given that most locations have the same capacity for both diesel and gasoline, it is crucial to create a thorough fuel procurement strategy that takes into consideration the particular requirements and

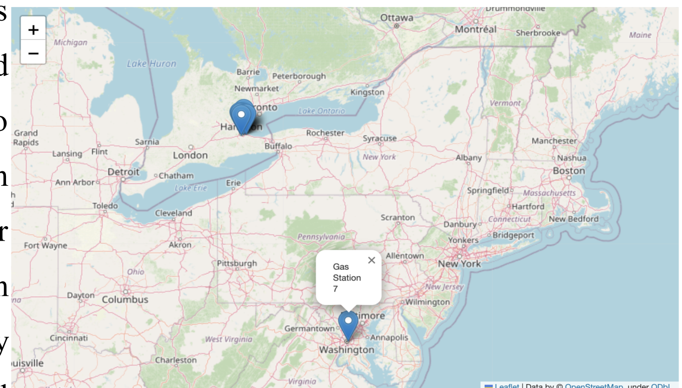
[1] Figure 1 Total Capacity of Gasoline and Diesel Fuel Type for All Locations

[2] Figure 2 Total Capacity of Fuel Types in Each Location

needs of each location. There are certain exceptions to this tendency, it is important to note. Particularly at LOCATION 1 and LOCATION 6, the capacity for gasoline is substantially higher than that for diesel, underscoring the necessity to modify our refilling strategy to better match the particular fuel consumption patterns at these locations.

The fact that LOCATION 2 has the highest overall capacity of any of the identified locations also suggests a potential increase in fuel consumption there. Comparatively speaking, LOCATION 7 has a lesser capacity than the other sites, which may be because there is less of a need for gasoline there.

We also plotted the position of each gas station on a map (shown in **Figure 3**) to better comprehend the[3] impact of location on fuel capacity. Our analysis assisted us in identifying geographic patterns and trends in gasoline consumption, which enabled us to build a more targeted and efficient refilling approach that maximized savings for our clients. Overall, our analysis of the location table provided us with significant insights into the complicated interplay between fuel consumption patterns, location, and capacity, allowing us to design a more data-driven and successful fuel procurement strategy.



Apart for gas station 8, it appears that most of the gas stations are crowded together based on the map (which is labeled as gas station 7 on the map since it is counted from 0). This could imply that gas station 8 is in a less-frequently visited location by cars, and hence has a lesser demand for fuel.

Finally, depending on the customer needs of each area, we may need to change the frequency of refills. We can build a more effective plan for refilling fuel and optimizing discount savings by taking into account aspects such as location, demand, and capacity.

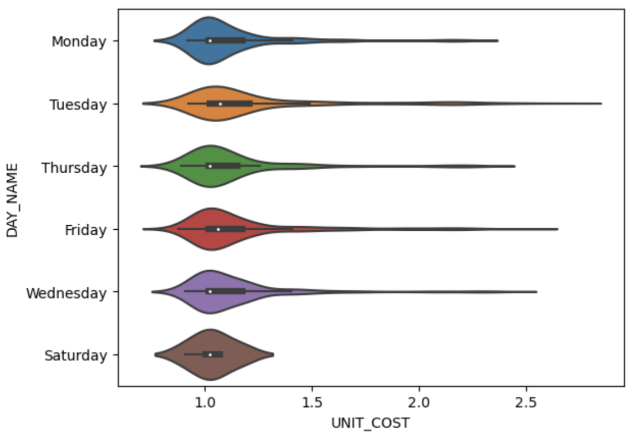
- **In our analysis of DF_INVOICE, we looked into various factors such as the invoice date, fuel type, quantity of fuel purchased, and unit cost.**

Visualizing the unit cost of each gasoline type is critical in understanding each gas station's pricing strategy (shown in **Figure 4**). We were able to acquire a more accurate picture of the unit cost for both gasoline and diesel by dividing the data into six days per week, removing Sundays when most gas stations are closed. The violin and bar plots helped us comprehend the distribution and average unit cost of each fuel type.

[3] Figure 3 The Map of Acutal Location for Each Gas Location

Importantly, the violin plot for gasoline in **Figure 4** has a continuous shape from Monday through Friday, implying that gas stations may have a regular pricing strategy throughout the week. Nonetheless, the maximum unit cost of gasoline fell dramatically on Saturdays, suggesting that gas stations may modify their pricing on weekends to attract more consumers.

This knowledge can help firms that rely on gasoline to operate their cars change their fuel purchase schedules to take advantage of cheaper costs on Saturdays. Also, gas station operators may utilize this data to enhance their pricing strategies and increase sales by altering prices during periods of low demand.



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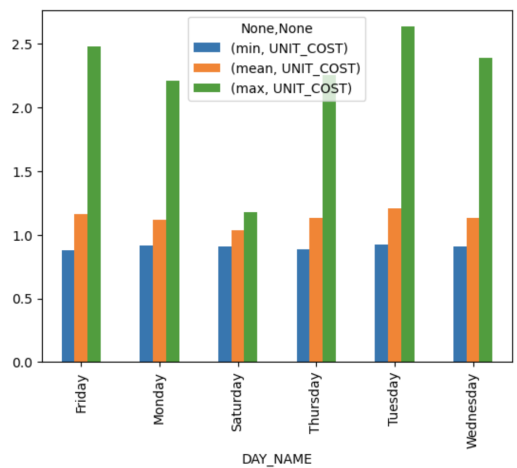

[5]

The bar plot in **Figure 5** allows us to reach similar conclusions. The consistent pattern of mean and minimum values implies that gas stations have a generally steady pricing strategy for gasoline, with little price variation. This allows consumers to better manage their refilling time and money, and it also allows gas stations to build consistent sales plans and pricing tactics. Furthermore, the bar plot shows that the minimum value on Saturdays is much lower than that on other weekdays, which may be attributable to the fact that Saturdays are weekends with decreased customer demand. As a result, gas stations may modify their prices to attract more consumers.

We also looked at the unit cost trend shown in **Figure 6** and discovered that there was a price rise in gasoline around days 2400-2500 (between March and April of 2019). When we look at the unit price of gasoline from Monday to Saturday, we can see that the costs are typically stable throughout the week, with no particular day having the lowest price.

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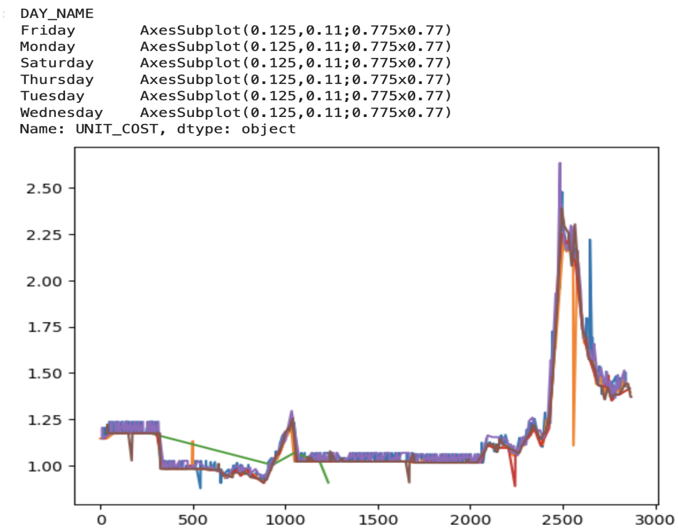
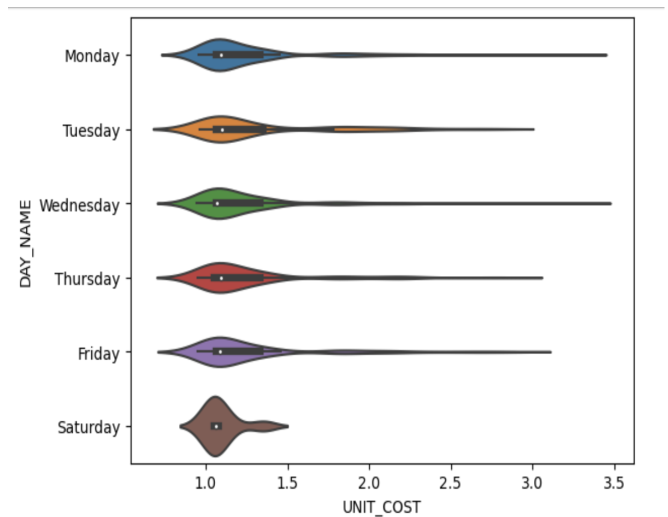
[4] Figure 4 violin plot of unit cost of gasoline fuel in different day (Monday to Saturday).

[5] Figure 5 bar plot of minimum,mean,maximum of unit cost of gasoline fuel in different day

The trend of gasoline price increases over a certain time period provides significant information for both consumers and gas stations. Customers may budget appropriately, and gas stations can alter their pricing tactics to optimize earnings while remaining competitive. The steady cost for fuel throughout the week implies that gas stations are using a stable pricing strategy.[6][7]





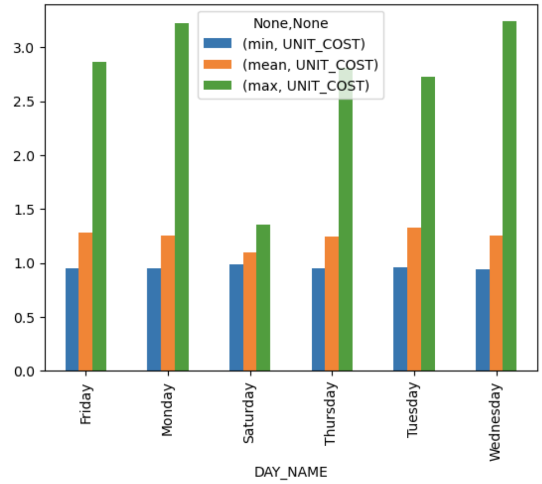
Turning to the invoice data for diesel,we found that the violin plot in **Figure 7** from Monday to Friday maintained a consistent shape, while on Saturday, there were more points clustered around 1.1 unit cost compared to the weekdays which may indicate a potential price plan by gas stations to entice more consumers. The absence of invoices when the unit cost is high on Saturdays, on the other hand, shows that gas stations may be acquiring fuel on weekdays when prices are high to reduce their expenditures. This data may help gas stations determine their inventory and pricing plans, as well as help consumers comprehend diesel pricing patterns.

Our bar plot in **Figure 8** also confirms this observation, as it shows that the maximum unit cost for gasoline on Saturdays is significantly lower than that of the weekdays.

We discovered that the price rise for diesel in **Figure 9** happened around days 2400-2500 (late March 2019), which is comparable with gasoline. When we look at the unit price of fuel from Monday to Saturday, we can see that the costs are typically stable throughout the week, with no single day having the lowest price.

[6] Figure 6 The trend of gasoline unit cost change for each type day from Jan 2017 to Aug 2019

[7] Figure 7 violin plot of unit cost of diesel fuel in different day (Monday to Saturday).



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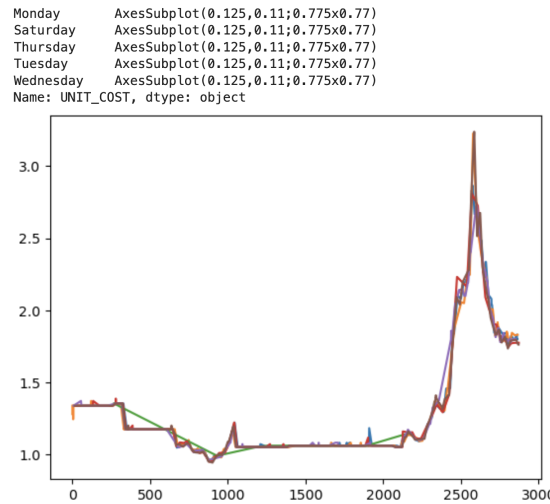
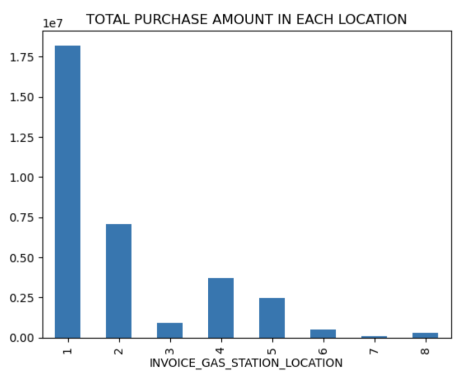


[9]

In terms of which site has spent the most for fuel shown in **Figure 10**, we can observe that locations 1 and 2 have greater buy amounts, while locations 4 and 5 have intermediate purchase amounts. Location 3, location 6, location 8, and position 7, on the other hand, have relatively modest purchasing amounts. The largest purchase amount is at location 1, while the lowest buy amount is at location 7. This data can help each gas station better understand their clients' purchase habits and alter their marketing efforts accordingly. Additionally, we examined the gross purchase cost and the amount purchased shown in **Figure 11** and discovered that the considerable price rise in March-April 2019 caused a discrepancy between the amount purchased and the gross purchase cost.



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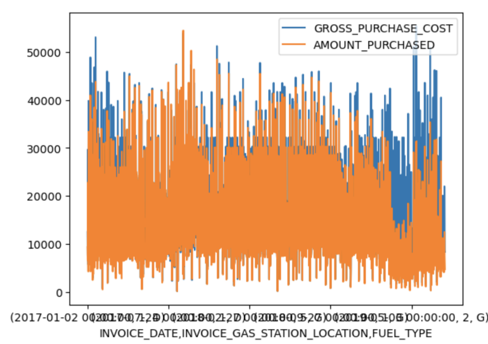
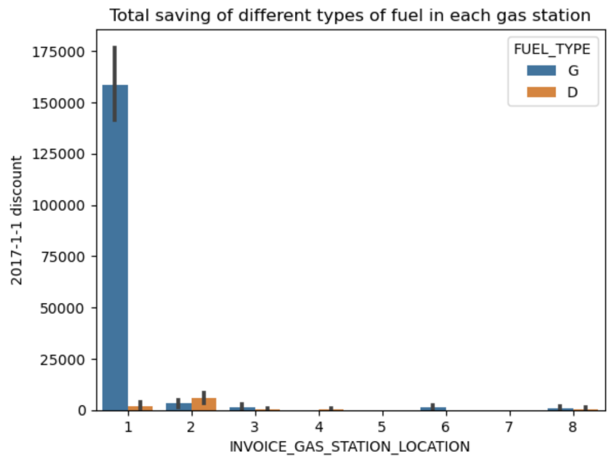


[11]

We then estimated the overall savings for each tank and plotted it shown in **Figure 12**, taking inflation into consideration. To make the savings more relevant, we adjusted the savings from after January 1,

[8] Figure 8 bar plot of minimum,mean,maximum of unit cost of diesel fuel in different day
[9] Figure 9 The trend of diesel unit cost change for each type day from Jan 2017 to Aug 2019
[10] Figure 10 Total Purchase Amount of Each Location
[11] Figure 11 Total Purchase Amount of Each Location VS Gross Purchase Cost During Jan 2017 to Aug 2019

2017, using the inflation rate supplied by Statistics Canada. After correcting for inflation, the tables below (**Figure 12** bar plot version) displays the savings amounts for each gasoline type and region as of January 1, 2017.



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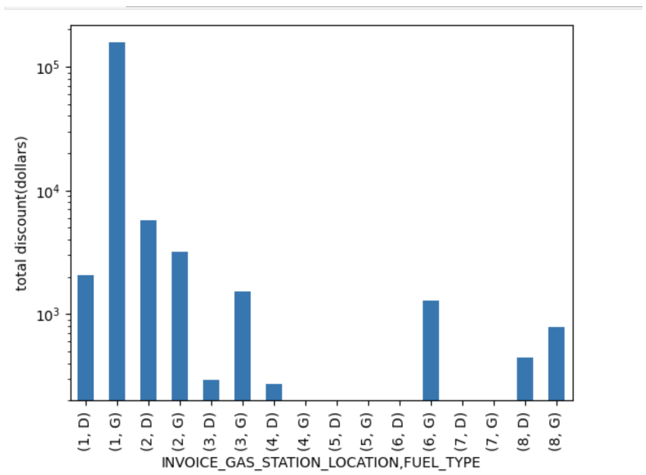


[13]

From a business analysis standpoint, the information displayed in this visualization in **Figure 12** is critical for finding areas where the company's profitability may be improved. The corporation may alter its pricing strategy and perhaps improve revenue by determining the locations and gasoline kinds that have the most substantial discounts.

The gas fuel type at location 1 has a significantly bigger discount than the other sites, indicating that there may be an opportunity to change the pricing strategy and boost profitability. The diesel at location 2 also has a rather significant discount, implying that there may be potential to raise the price or alter the discount to enhance profitability.

Overall, the evidence indicates that the organization might benefit from rethinking its pricing approach and implementing changes to enhance profitability. The organization may boost sales and improve its bottom line by finding the most important discounts and areas for development.

To compresses the data and makes it easier to see the patterns, we generate a plot with a logarithmic scale for the y-axis shown in **Figure 13.** It is clear that locations 5 and 7 offer no discounts at all, and these locations' inventory strategy has to be significantly improved. We can see that the discounts for locations 1 and 2 are rather large when compared to the other locations by compressing the data. The absence of discounts at locations 3, 4, 5, 6, 7, and 8 suggests that inventory management and pricing methods might

[12] Figure 12 Total discount savings (value at 2017.01.01) of each fuel type in each location

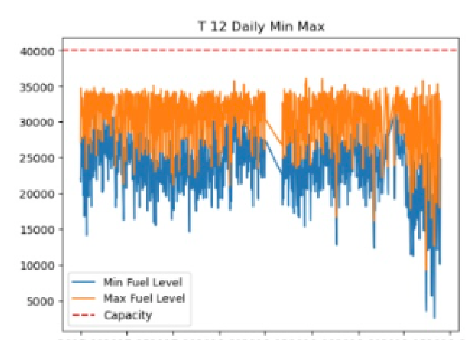
[13] Figure 13 logarithmic plot of Figure 13 (total discount savings of each fuel in eac location considering inflation rates

be improved significantly. The data shows that a more optimal strategy to gasoline purchase and inventory management offers a large potential for cost reductions.

- **For Fuel_Level Table (after connecting two tables), we wanna know which location has more risky safety inventory strategy from historical data, and which is more efficient?**

To determine which locations manage their inventory effectively and save money, we can look at the maximum and minimum fuel level over time for each location and can see the trend of average fuel level during the time (in **Figure 14** for tank 10 and all graphs shown in **Appendix 1**). Locations that maintain a regular and steady fuel level throughout time might be regarded as effective in inventory management.
As a result, we can examine the stable fuel level points for each tank in Appendix 1 and compare them to the capacity, as well as the range of the fuel level distribution for most tanks. **Figure 15** depicts the fuel level distribution, capacity, and computed percentage of steady fuel level in capacity for each tank at each gas station, allowing us to assess the effectiveness of the safety inventory approach for each tank.
Figure 15 shows how we calculate the safety inventory level for each tank based on the percentage of regular fuel level in each capacity and the difference between the range lower level and range upper level (over 70% indicates effectively, 65%-70% means normal, and less than 65% means unsafe).
We can see that in Location 2, gasoline tank 16 and diesel tank 19 have the highest proportion of consistent fuel level in capacity, up to 86%, while most of the other tanks have a percentage more than 65%. This shows that Location 2 has efficiently controlled its inventory and maintains a greater level of safety inventory.
Nevertheless, most tanks in Locations 4 and 6 have a little greater safety inventory, indicating that their safety inventory procedures are successful. The general situation at Location 1 is likewise favorable. But, when it comes to riskier inventory management techniques, we discover that Location 8 has one.
Furthermore, we can also take another approach by comparing the average fuel level to the safety inventory level for each location. Location Where the fuel level continuously exceeds their safety inventory level are effectively lowering the danger of stockouts while avoiding overstocking and associated expenditures. We cannot view the safety inventory level for each tank due to the constraints of the present project data, thus we did not analyze it in our report.

[14]



[14] Figure 14 The daily minimum and maximum fuel level for tank 12

Safety Inventory Strategy For Historical Data									
TANK_LOCATION	TANK_TYPE	Tank_ID	Regular and Steady Fuel Level	Capacity	Percent(steady level/capacity)	RANGE_LOWER(most numbers contain)	RANGE_UPPER (most numbers contain)	Difference of the range	Safety Inventory Level
1	G	T 10	22000	40000	0.55	16000	33000	17000	Risky
1	G	T 11	21000	40000	0.53	15000	34000	19000	Risky
1	D	T 12	30000	40000	0.75	21000	34500	13500	Effectively
1	G	T 14	29000	40000	0.73	23000	35000	12000	Effectively
1	D	T 15	30000	40000	0.75	25000	35000	10000	Effectively
2	G	T 16	60000	70000	0.86	55000	62000	7000	Effectively(best)
2	D	T 17	25000	40000	0.63	20000	33000	13000	Risky
2	G	T 18	27000	40000	0.68	23000	33000	10000	Normal
2	D	T 19	60000	70000	0.86	55000	65000	10000	Effectively(best)
3	G	T 20	20000	30000	0.67	15000	26000	11000	Normal
3	D	T 21	20000	30000	0.67	15000	25000	10000	Normal
4	G	T 22	29000	40000	0.73	25000	34000	9000	Effectivly
4	D	T 23	27000	40000	0.68	25000	34000	9000	Normal
5	D	T 24	17000	25000	0.68	13000	21000	8000	Normal
5	G	T 25	15000	25000	0.60	11000	20000	9000	Risky
6	G	T 26	21000	30000	0.70	17500	26000	8500	Effectively
6	G	T 27	20000	30000	0.67	15000	25000	10000	Normal
6	D	T 28	22000	30000	0.73	19000	26000	7000	Effectively
7	G	T 29	3000	5000	0.60	2000	4500	2500	Risky
7	D	T 30	3500	5000	0.70	2500	4500	2000	Effectively
8	D	T 31	25000	40000	0.63	15000	35000	20000	Risky
8	G	T 32	25000	40000	0.63	10000	35000	25000	Risky

[15]

3.2 Strategy & Solution

After conducting hypothesis testing and analysis, our team discovered that the current refill strategy of various gas stations is suboptimal. Despite the high frequency of refills, it does not result in maximizing discounts. Thus, we developed a model to determine the best strategy that would allow each location to obtain the best discount savings. Our approach involves analyzing the consumption of each tank by plotting daily, monthly, and yearly consumption and calculating the average daily consumption of each tank. The figures in **Appendix 2** illustrate the daily, monthly, and yearly fuel levels for each tank.

Based on our analysis and modeling, we were able to develop the best refill strategy for each gas station location. Our approach involved analyzing the historical refill data to determine if the current refill schedule was reasonable. From there, we generated the best refill day and quantity for each tank to ensure the best discount and generate the highest possible savings based on our model. By optimizing the refill strategy in this way, we are confident that each gas station location will be able to maximize their savings and ultimately provide better value to gas stations in each location. The following is our output based on the model:

[15] Figure 15 The Table of Safety Inventory Situation for each tank in each location

Results- Best strategy to get most discount for each tank

TANK_LOCATION	TANK_TYPE	Tank_ID	Best_refill_Days	Discount per liter ($)	Best_saving	Best_refill_quantity	Best_saving_after_npv
1	G	T 10	9	0.03	90270.86	39512.50	94628.30
1	G	T 11	6	0.03	140435.31	37827.69	150988.93
1	D	T 12	6	0.03	142160.73	38292.45	152844.03
1	G	T 14	9	0.03	98469.36	39785.60	95282.34
1	D	T 15	11	0.03	71489.65	38512.94	61489.64
2	G	T 16	30	0.04	65453.43	69420.30	73890.82
2	D	T 17	15	0.03	72024.81	38801.24	61949.94
2	G	T 18	18	0.03	45053.50	39440.78	31485.51
2	D	T 19	30	0.04	67069.58	69440.72	73912.56
3	G	T 20	52	0.03	16344.64	29777.69	15061.23
3	D	T 21	55	0.03	14191.80	29625.98	14303.98
4	G	T 22	15	0.03	56436.14	39904.34	63711.14
4	D	T 23	15	0.03	62535.05	37900.03	60511.07
5	D	T 24	18	0.02	21159.20	24578.86	13080.85
5	G	T 25	11	0.02	30719.43	24823.78	26422.38
6	G	T 26	239	0.03	3592.07	29933.89	24455.84
6	G	T 27	90	0.03	9790.02	29996.37	27844.24
6	D	T 28	397	0.03	1796.78	29946.40	22967.07
7	G	T 29	1	0	0.00	4991.31	0.00
7	D	T 30	1	0	0.00	4991.55	0.00
8	D	T 31	330	0.03	2754.98	39979.74	38699.52
8	G	T 32	99	0.03	8027.62	39732.65	33723.96

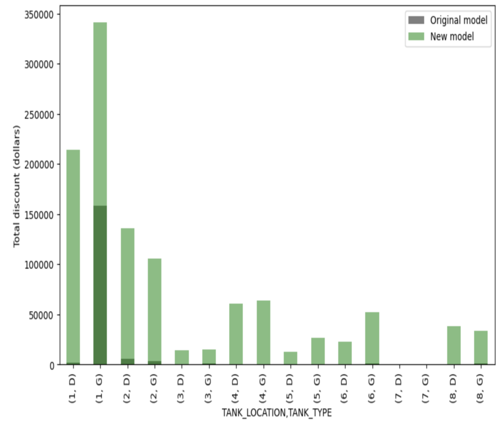
[16]

Based on the table, it can be seen that Location1 has the highest potential for savings. This may be due to the fact that location1 has a large capacity and consumption, with a best refill day range of approximately 6-11 days. Location2 comes in second with a similar capacity to location1 but a lower consumption rate, resulting in a best refill day range of approximately 15-30 days. Location4 has a decent saving potential as well, with a purchase and capacity ranking third among all locations, with a best refill day range of approximately 15 days. Location8 can achieve a high discount by extending the refill days, with the best refill days for its two tanks being 330 and 99 days, respectively. Location5 and location6 follow, with Location6 also extending refill days to reach high discounts, and location5 having a relatively balanced purchase and capacity resulting in a best refill day range of 11 and 18 days. Location3 has a relatively low consumption rate, resulting in a larger best refill day. Finally, location7 does not have any significant savings compared to the other locations, possibly due to its extremely low capacity and consumption.

[16] Figure 16 The Results for best discount savings strategy for each tank in each location

Original savings for each location VS Best discount savings using the model					
TANK_LOCATION	TANK_TYPE	Original savings value at 2017.01.01	Best discount savings considering inflation rates	Difference between original value to model value	Increasing percent after using best strategy
1	D	2052.62	214333.67	212281.06	10342%
	G	158426.97	340899.57	182472.60	115%
2	D	5763.38	135862.50	130099.13	2257%
	G	3187.55	105376.33	102188.79	3206%
3	D	293.54	14303.98	14010.44	4773%
	G	1509.47	15061.23	13551.76	898%
4	D	273.53	60511.07	60237.54	22022%
	G	0.00	63711.14	63711.14	6371114%
5	D	0.00	13080.85	13080.85	1308085%
	G	0.00	26422.38	26422.38	2642238%
6	D	0.00	22967.07	22967.07	2296707%
	G	1288.81	52300.07	51011.27	3958%
7	D	0.00	0.00	0.00	0
	G	0.00	0.00	0.00	0
8	D	443.67	38699.52	38255.85	8623%
	G	790.33	33723.96	32933.63	4167%

Note: when caculating the increasing percent,if original value is 0 but it owns best value,we set original vaule to 1. [17]



[18]

4. Conclusion

Since our goal is suggesting a better inventory policy that may save these gas stations a significant amount of money, the report highlights that the current refill strategy of gas stations is not optimized for maximizing discounts and developed a model that uses historical data analysis to determine the best refill strategy for each gas station location, allowing them to generate the best refill day and quantity for each tank to maximize savings. The output of the model showed that Location1 had the highest potential for savings, while Location7 had the least potential. By optimizing the refill strategy in this way, each gas station location can maximize their savings and provide better value to each gas station. The findings of this report can be used to improve the refill strategy of gas stations and potentially reduce the overall cost of fuel for consumers.

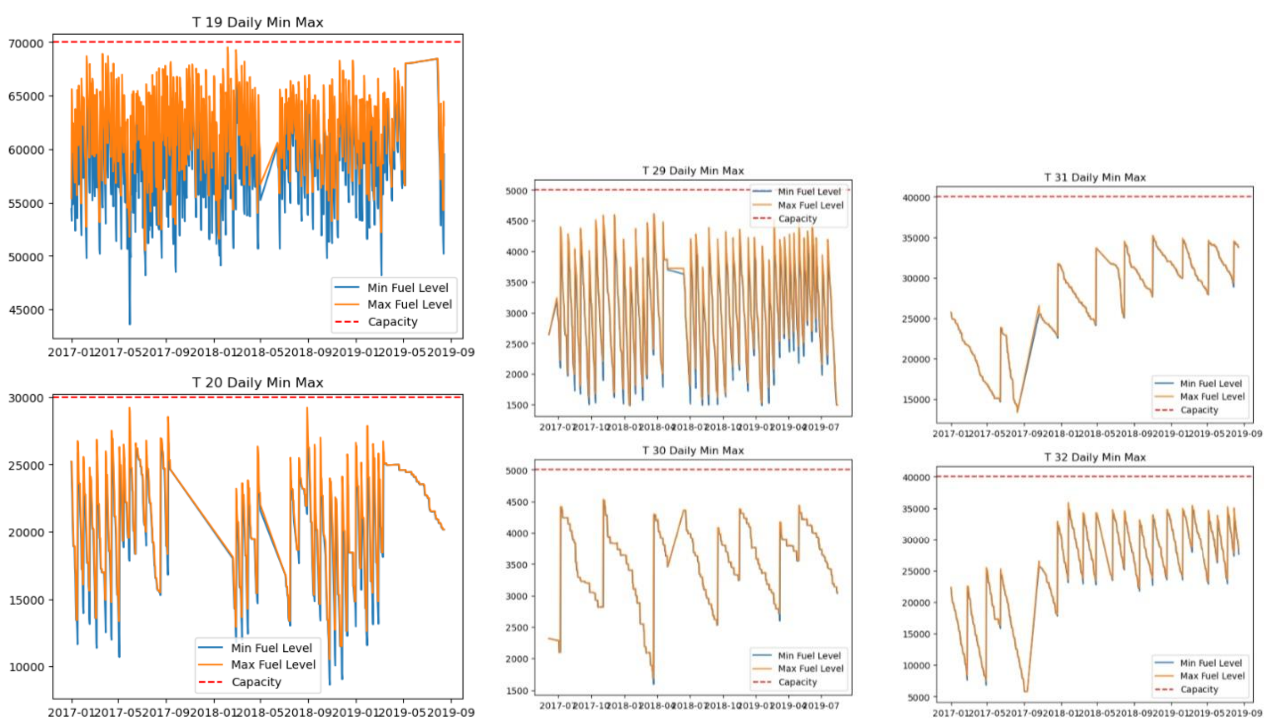
[17] Figure 17 The list of Comparison of discount savings between original data and the results after modeling
[18] Figure 18 Bar plot of Comparison of discount savings between original data and the results after modeling

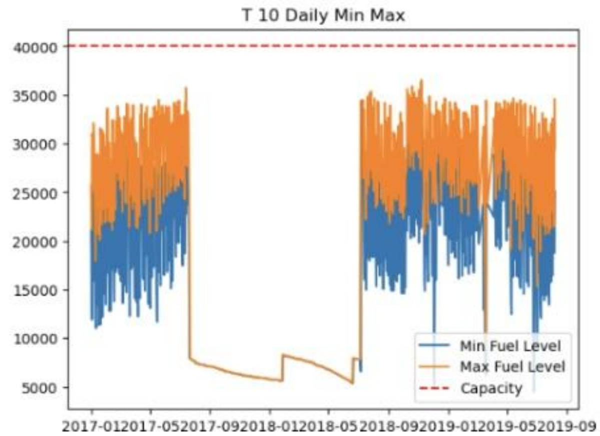
Reference:

1. Statistics Canada. (n.d.). Table 18-10-0259-01 Monthly consumer price index, Canada. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1810025901&cubeTimeFrame.startMonth=01&cubeTimeFrame.startYear=2017&cubeTimeFrame.endMonth=12&cubeTimeFrame.endYear=2019&referencePeriods=20170101%2C20191201
2. Bozarth, C., & Handfield, R. (2006). Introduction to operations and supply chain management. Prentice-Hall.
3. Cachon, G. P., & Terwiesch, C. (2018). Matching supply with demand: An introduction to operations management (4th ed.). McGraw-Hill Education.

Appendix：

1. The trend of each tank minimum and maximum fuel level for each day

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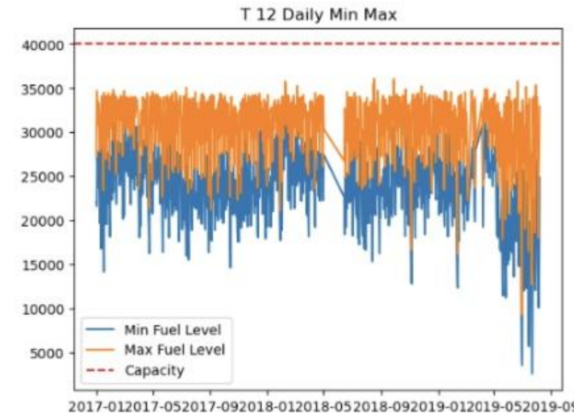
40000
35000
30000
25000
20000
15000
10000
5000
Min Fuel Level
Max Fuel Level
Capacity
2017-012017-052017-092018-012018-052018-092019-012019-052019-09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35000
30000
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Min Fuel Level
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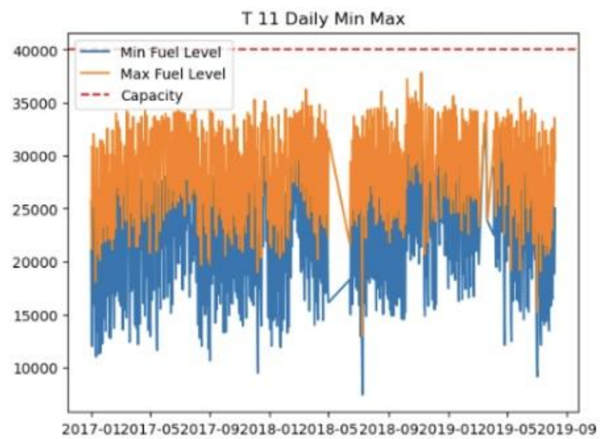
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25000
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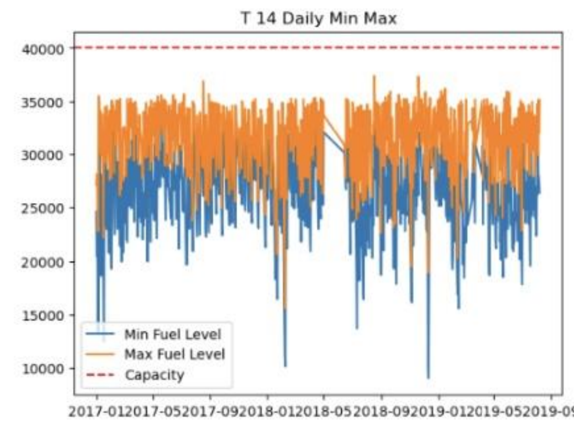
15000
10000
Min Fuel Level
Max Fuel Level
Capacity
2017-012017-052017-092018-012018-052018-092019-012019-052019-09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30000
25000
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15000
10000
Min Fuel Level
Max Fuel Level
Capacity
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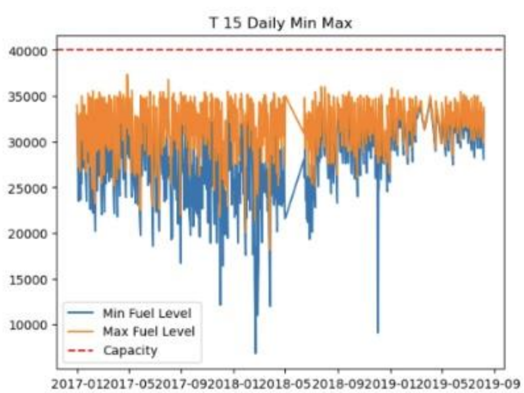
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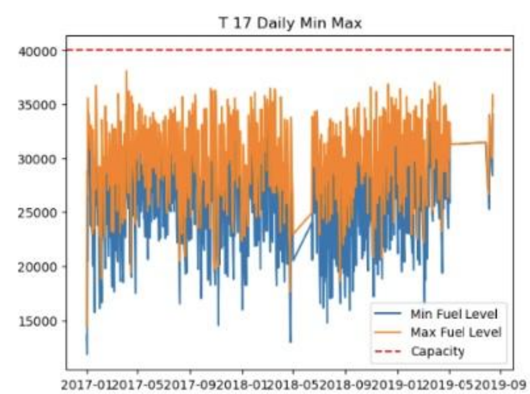
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Min Fuel Level
Max Fuel Level
Capacity
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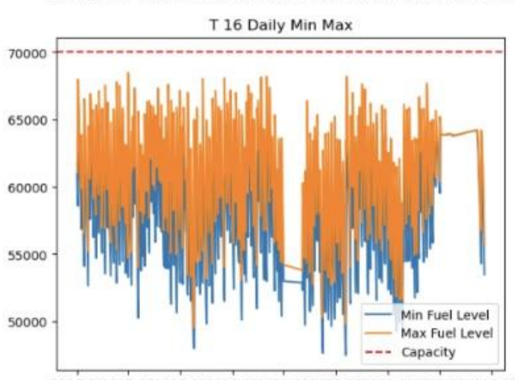
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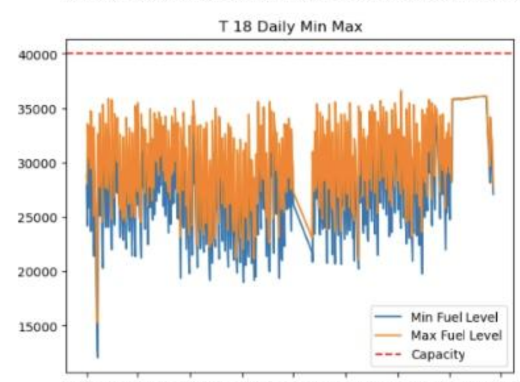
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Capacity
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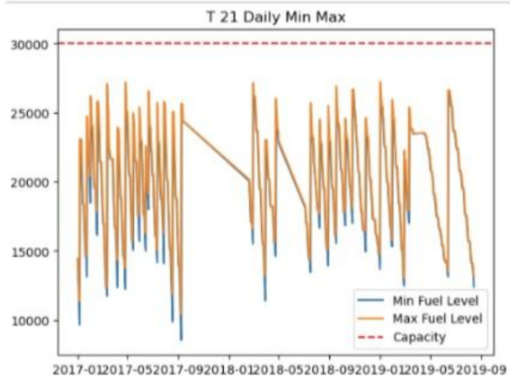
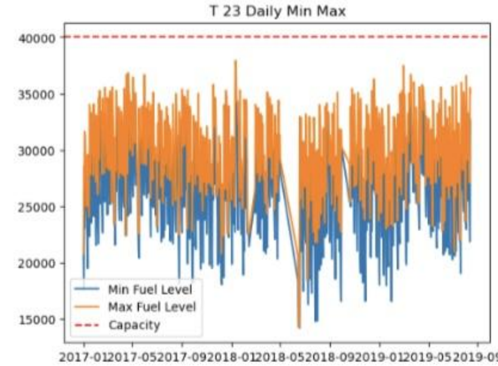
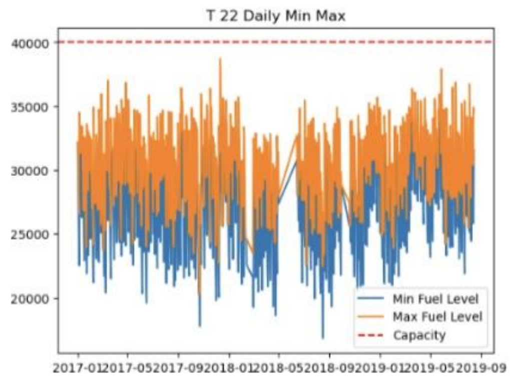
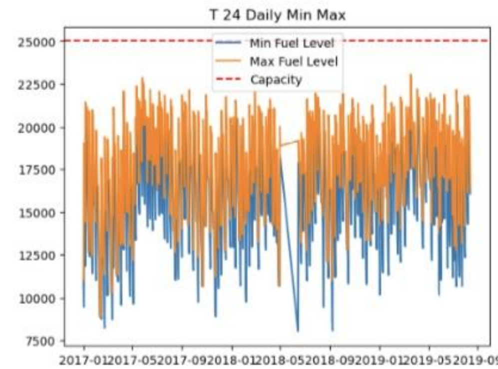
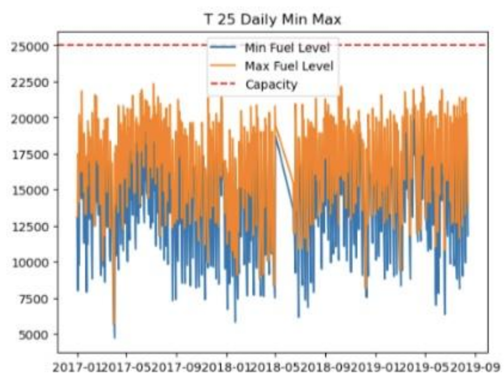
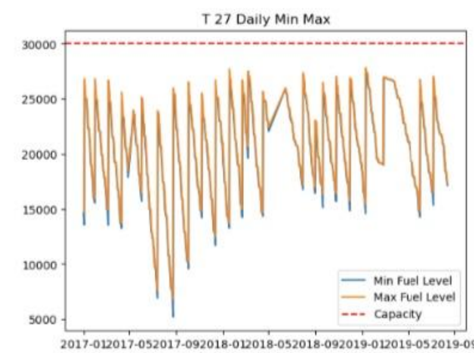


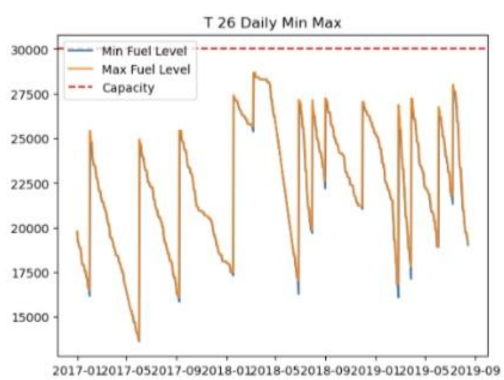


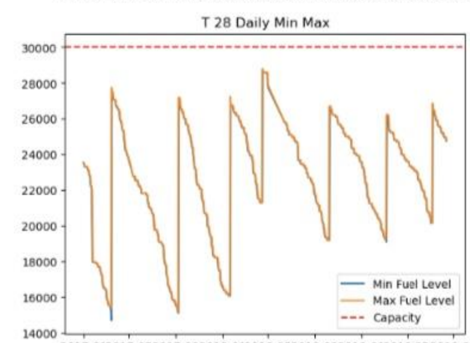




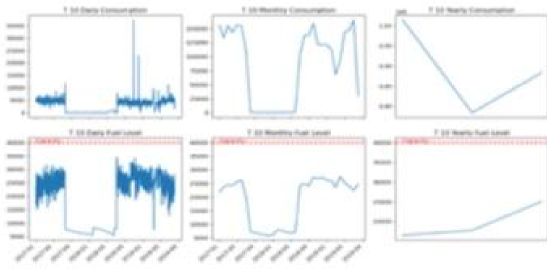








2. Figures for the daily, monthly, and yearly fuel levels for each tank.



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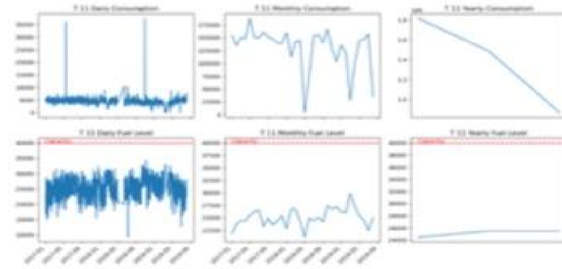

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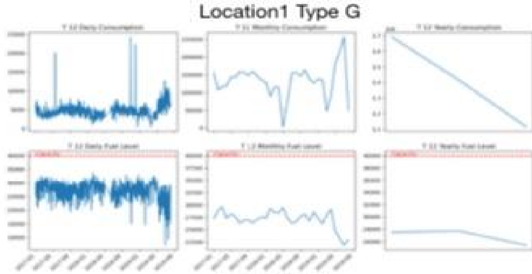

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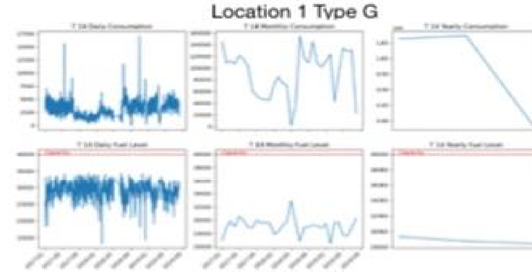

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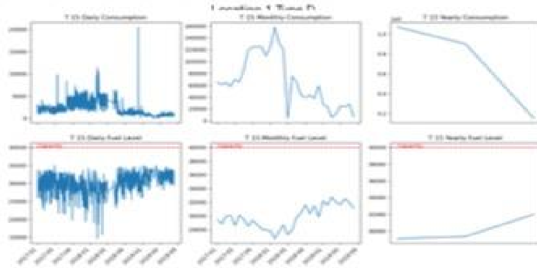

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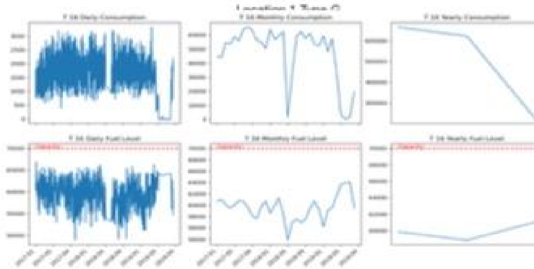

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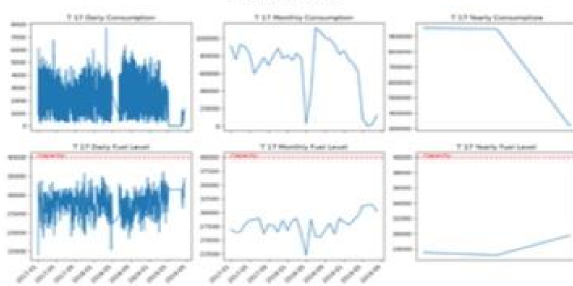

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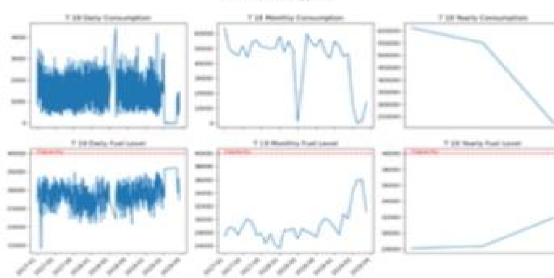

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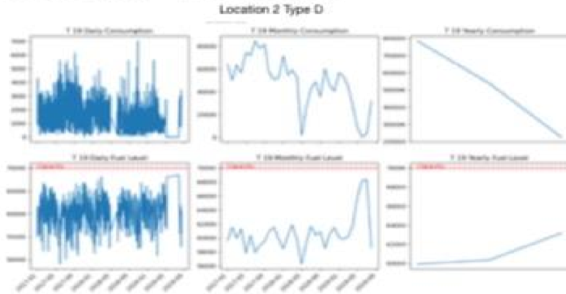

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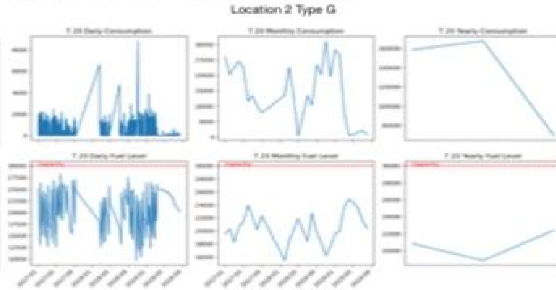

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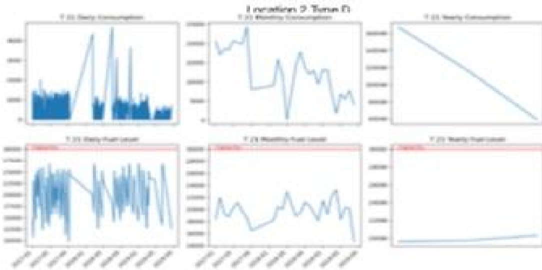

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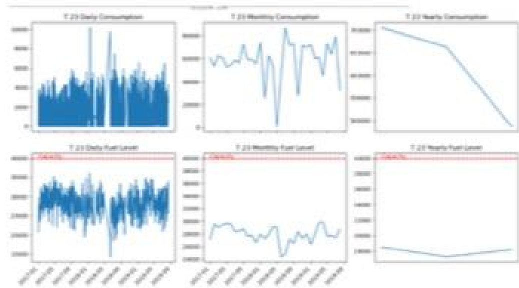

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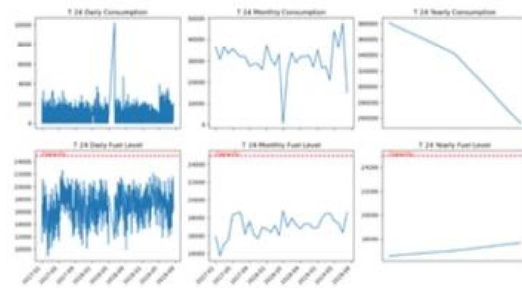

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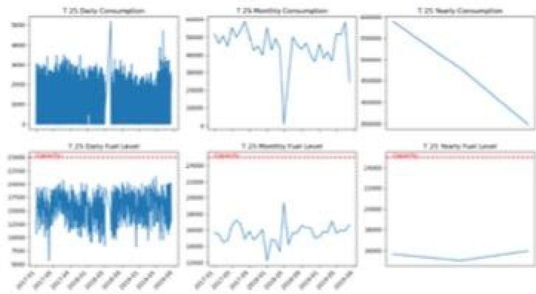

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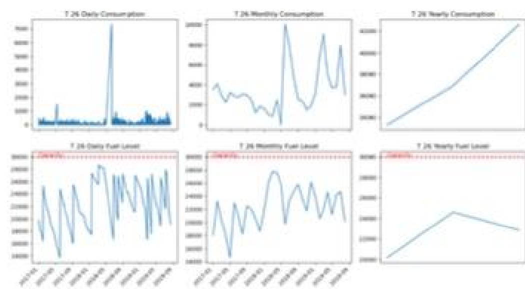

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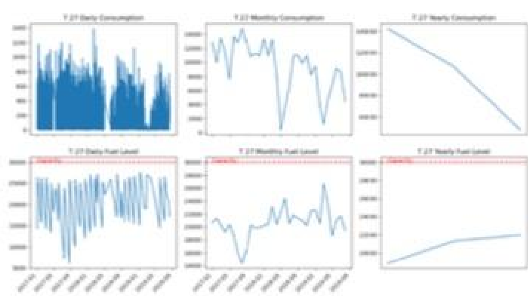

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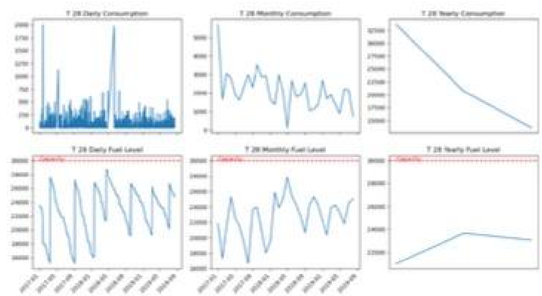

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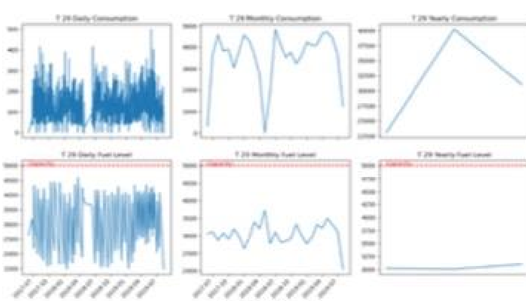

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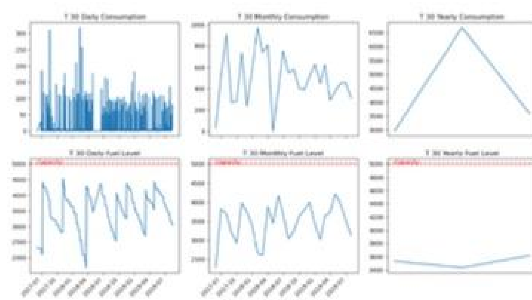

Location 7 Type D

Location 8 Type D

Location 8 Type G