Proj 302 Final Report

Purchase Planning Bakka oil ng ltd

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Internship
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ABSTRACT

  Bakka oil is a petrol filling station based in Abuja, Nigeria established over 15 years ago, it has built itself as a big player in its industry over the years. The branch i will work with is located in gwagwalada local government area.The purpose of this document is to form a three step process to planning the buying and selling of petrol in Bakka oil filling station in nigeria, based on the trends and possible risks that exist in nigeria. This system involves the use of historic sales data to predict future demand , then using integer optimization to find the optimal inventory and purchase from the present time to any future time based on constraints then we form risk mitigation strategies to help evaluate risk and know where efforts of mitigation should be placed and where we are left to accept the risk. This is to form a system that can be placed to structure activities moving forward for optimal profit and customer satisfaction.

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1. INTRODUCTION

The oil retail business is a profitable industry in Nigeria. It is usually characterised with high peaks and troughs which makes it difficult for businesses to plan in order to meet business goals. In addition to this, in July of 2023 the Nigerian government removed the subsidy which came with the change of administration. This change has led to petrol prices reaching an all-time high compared to recent years. Due to this businesses have to be precise about the amount of fuel purchased in order to be profitable. The goal of this project is to make a system that will help maximise profit for an oil retail business stationed in Nigeria, the project will be divided into three crucial parts. We first forecast demands using historical data then implement integer optimization to come up with an optimal order within certain constraints then we evaluate possible risks that may disrupt our production. Each step of this project is dependent on the previous step hence we will take one step at a time and get an optimal order quantity while meeting the customer demand. ("Nigerian Petrol Prices," 2023).

2. COMPANY INFORMATION

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Eartech Information technology founded in 2002 is a company based in Houston, Texas but has branches in istanbul. It specialises in the information technology industry as a consulting company which has found influence across different regions around the world. The high service level of eartech has led to relationships in over 17 countries including the middle east , europe and asia pacific , eartech specialises in the area of Enterprise resource planning (ERP) using tools such as SAP and microsoft dynamics , it also focuses on project management and devops using Azure. Eartech is still having a strong influence and forms relationships more and more with prominent companies.

51-200 employees in total

3. PROJECT BACKGROUND

3.1 Department information

The department directly related to my project is the ERP consultation department which is spearheaded by mr. Sameer , I worked closely with him in structuring this project and understanding the right approaches that should be taken. I also worked closely with some staff in the administration department from Bakka oil filling station to have a context of the entire situation of the company.

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3.2 Status of the project

Within the company there are a lot of learning opportunities in different fields , I got experience in devops , robotics for manufacture and in project management. At the beginning of my internship it was not the easiest task mapping out the different aspects of this project however as time went by with my training in project management i was able to combine it with my knowledge from university to form the ideal project for me. I started the project immediately and requested data from companies in nigeria. To perform this project for them.

3.3 Motivation

The key motivation for this is to reduce losses upon uncertainty.I have experienced the impact of uncertainty in the oil retail business. Supply chain disruption can cause millions of naira in one go and as inflation in Nigeria continues i believe it is best to have a well documented framework to be able to measure the impact of such uncertainty. it would be a good asset for any business hence this motivated me to go for this project.

3.4 Related literature
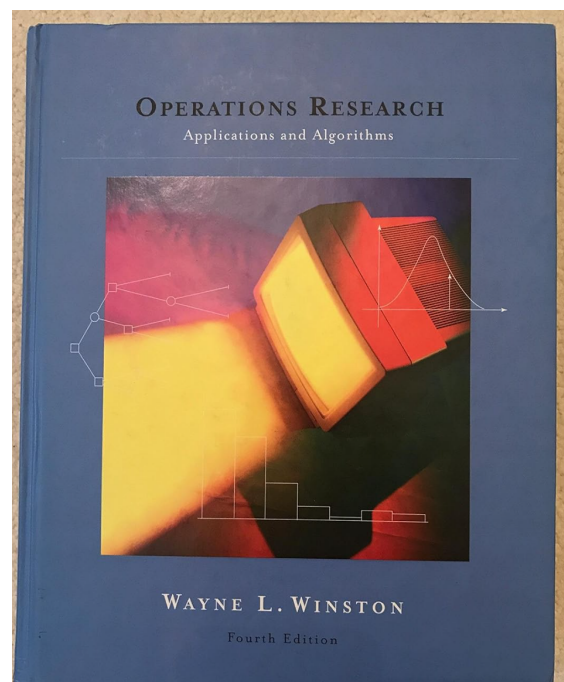
In this project several techniques will be used namely; Holt-winters exponential smoothing and integer optimization . Holt-winters exponential smoothing is an exponential smoothing method where trend and seasonality are taken into account when trying to forecast future values. Integer optimization is a technique used to optimise an objective function based on certain constraints , the solution of such a problem must all be in integers.

In this regard i benefited a lot of information on integer optimization and forecasting from

Operations Research: Applications and Algorithms (4th ed.) and I also benefited from *Practical Time Series Forecasting with R: A Hands-On Guide [2nd Edition.*

4. INTERNSHIP PROJECT

4.1 Project objective

  The objective of this project is to provide a system which the business can rely on in order to reduce the impact of uncertainty in the market. The aim is not merely to solve a specific problem but to create a frame for problems to come in the future. The system is also subject to improvement based on circumstances in the business activities. The system focuses on problems that the business can control and will not dive deep into problems that are beyond business capability to impact i.e governmental policy changes. The project will solve the problem of uncertainty in impact and response to uncertainty by providing a framework where the business can have an idea of demand, risk and possible profit.

4.2 My responsibilities

 I carried out the following activities;

- Meeting the company and understanding the context of their problem
- Collecting and cleaning data received
- Performing exploratory data analysis
- Forecasting future sales using holt-winters exponential smoothing
- Performing optimization within business constraints using integer optimization
- Assessing possible risk from the procedure and in nigeria as a whole
- Presenting the model to stakeholders

4.3 Methodology

Integer programming
  In order to understand integer programming we must first understand what an optimization problem is , an optimization problem is a problem that has a large number of possible solution where we are trying to get the best solution amount all possible outcome with this in mind integer programming is a tool used to solve optimization problems by picking the best possible solution,however, for integer programming as the name suggest we work with only integers in contrast with linear optimization where we work with both all values. Integer programming is solved by relaxation of linear programming solutions into only integer variables. In every integer programming problem we have an objective function to optimise either maximise or minimise and we then have a list of constraints which the optimal solution resides. The used model is derived from the salico problem in operations research by winston. (Winston, 2004)
Holt-winter exponential smoothing

Time Series for total
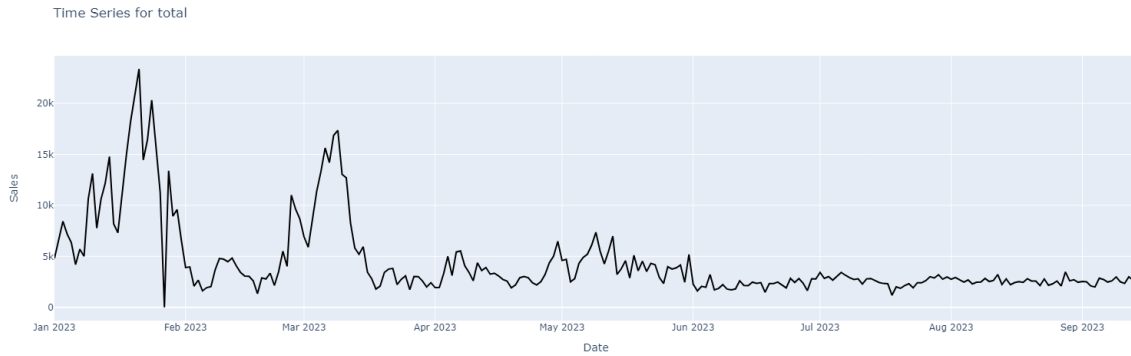
In order to understand exponential smoothing we must first understand what a time series is , above we see a time series plot with time on the x-axis and sales on the y-axis. Time series is a statistical tool used to see the change in an observed data in time. Its application is vast and can be used for almost any sector. Time series data has certain components which include;

The components of time series are divided into two systemic and non-systemic values.

1. **Systemic components:**

These are components that are predictable and occur in patterns.

Level: this is the average across of the data set.

Trend: these are long term movement or patterns that show the characteristics of the entire time series

Seasonality: these are repeating cyclic patterns that show in the time series.

2. **Nonsystematic components:**

These are components that are not predictable.

Noise: These are random differences that affect the data over time. These changes are not planned and are unpredictable.

Demand forecasting is a method where the components of a time series are studied and used to predict future demands. A well-known demand forecasting method called exponential smoothing, this is a method where exponentially decreasing weights are given to further past values and higher values are given to more recent values. There are multiple exponential smoothing methods including simple , holt and holt winters methods. In this project we will use the Holt winters method since it caters for data with trend and seasonality unlike the other methods. We assume our data has a trend and seasonality.

4.4 Expected outcome and deliverables

The outcome of the project is the system that comes out of solving the solution from the given historic data and circumstances of the business at the present point in time. The Deliveries of this project will include a full report that follows step by step on how to deal with uncertainty in the market and we will also provide the code Exploratory data analysis , demand forecast and integer programming so the company can implement it moving forward.

4.5 Details

The steps taken in this project include;

Data collection and cleaning

Data of the last 9 months was collected from the company, the data was then formatted into a more adequate form for process and analysis. This process of making data into the desired form is called data cleaning.The data was divided based on each petrol dispenser (pump) in the company. The company had eight dispensers however two of the dispensers were not functional hence we will only look at the performances of 6 and the general performances as well.

Exploratory Data analysis

This is the process of trying to draw insights from the data before we start processing it for our main objective. The intention in this project will revolve around mainly seeing the performances of each pump and the general sales of this company over the period of time. Some of the charts and metrics that were observed can be seen below .

The maximum sales of each pump in the data set given Is displayed below. This is not a robust method to look at the data set, however, it gives details about how high sales can go in the data set and we know how good each data point does on a weekly basis. We also display the top 10 totals sales below as well.
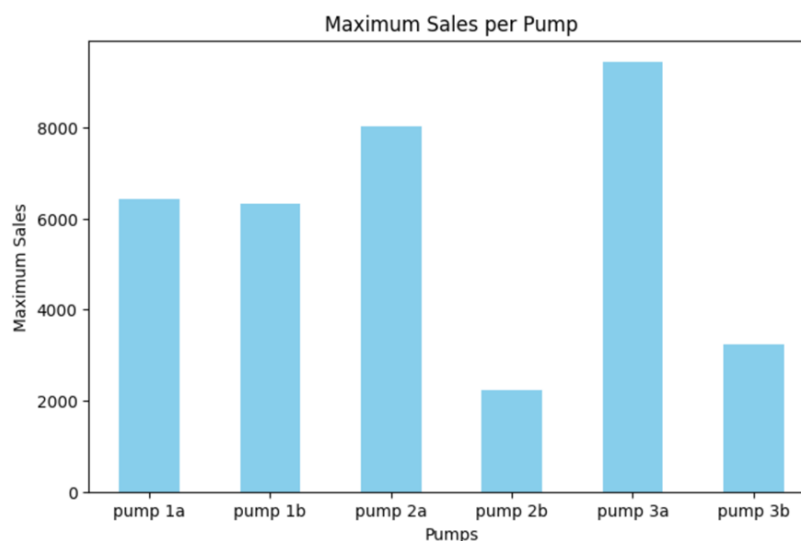
The distribution of average daily sales. This is the average of sales over the period specified. We calculate the average of sales by dividing the total sales by the number of inputs. The average sales are a measure of the centre where most data points fall around.

Average Sales per Pump
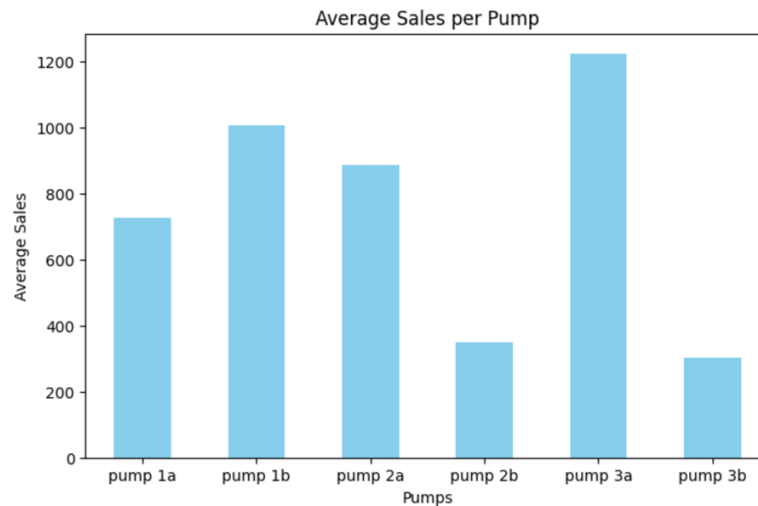
A measure of dispersion shows how much the data fluctuates around a centre which we showed previously. The dispersion will show us which data point is more consistent and stays closer to the centre i.e., which is our most stable pump.

Standard Deviation of Sales per Pump
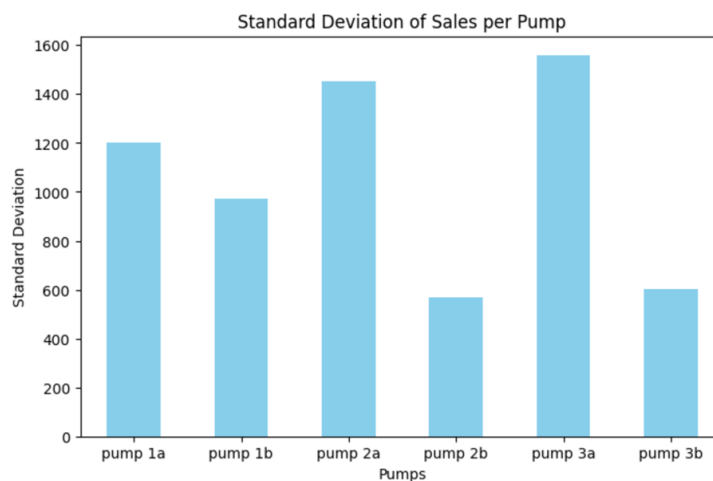
Scatterplot of each pump and of the overall totals sales

A scatterplot is good at giving a visual representation of every single point as well as it is good at looking at outliners in the data. And visualising the scatter of data in time. The scatterplot shows the total amount of sales each day.

Days vs total
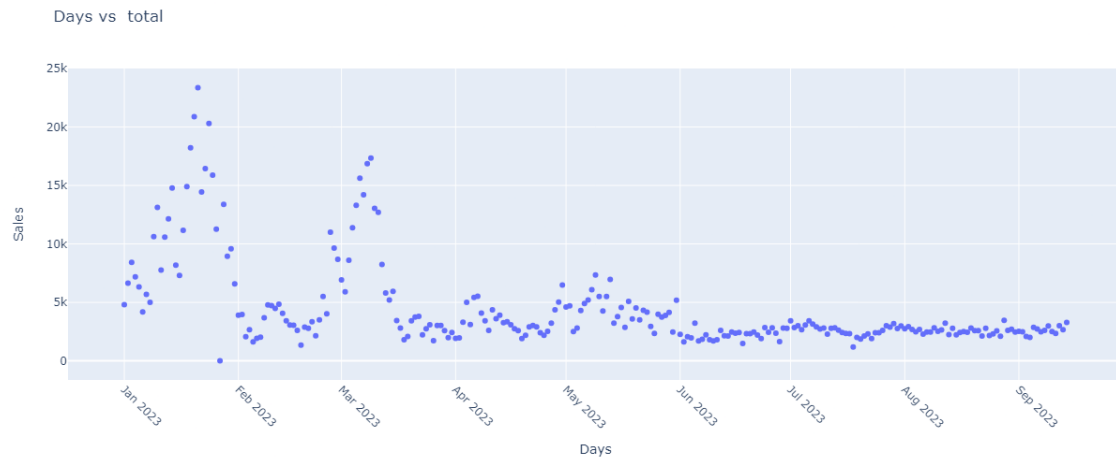
Demand forecasting

   After getting the data has been placed in the correct format now it can be used to forecast future sales using the Holt-winter exponential smoothing.Before showing the forecast here are some insights derived from the total daily sales time series. Below we can see the trend over time using both a straight line and a 7 window moving average.

Time Series Plot with Straight-Line Trendline

Time Series Plot with Trendline
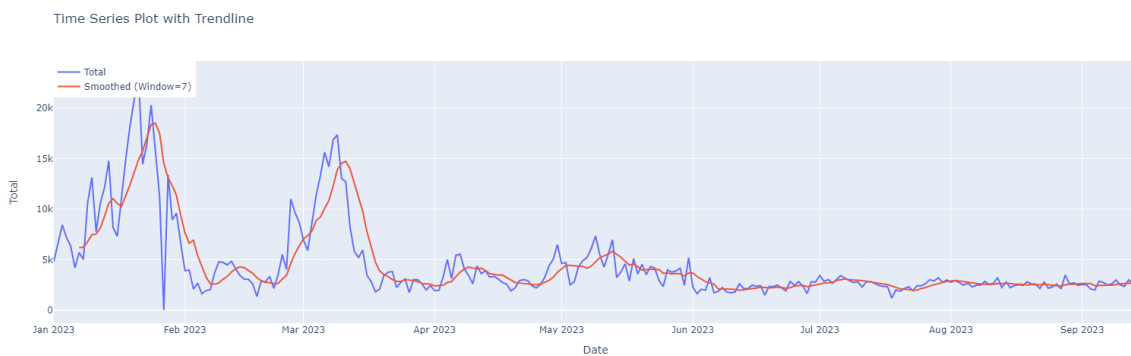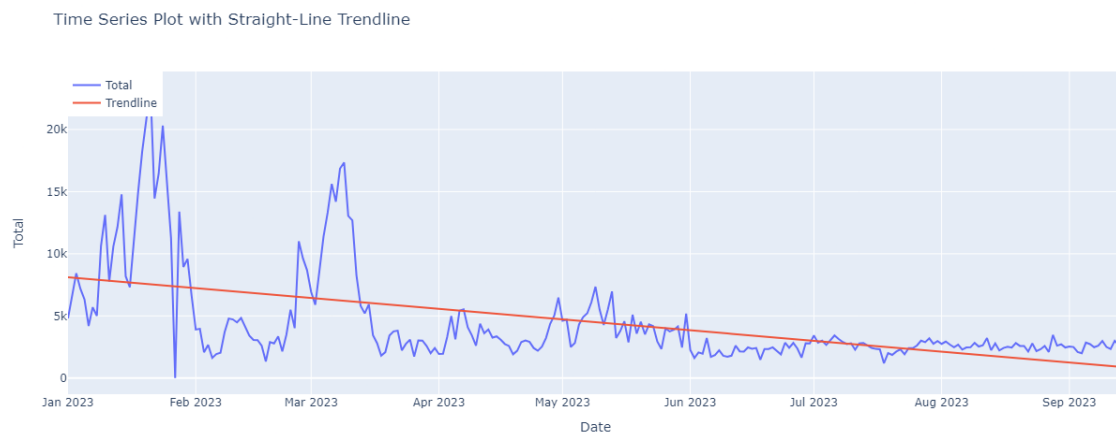
Above we see the time series for the daily sales of petrol in this company just from looking at the time series we can conclude the following:

1.   We have had a decreasing number of sales over time, but sales are very slowly moving back up.

2.   We will have to investigate the events that led to such a drop in sales and develop risk management techniques to avoid this in the future.

3.   We can say that sales are quite volatile and can have sudden peaks and troughs, we must also plan for this as well.

Using Holt winters exponential smoothing

$$S_t = \alpha \frac{y_t}{I_{t-L}} + (1-\alpha)(S_{t-1} + b_{t-1}) \qquad \text{OVERALL SMOOTHING}$$

$$b_t = \gamma(S_t - S_{t-1}) + (1-\gamma)b_{t-1} \qquad \text{TREND SMOOTHING}$$

$$I_t = \beta \frac{y_t}{S_t} + (1-\beta)I_{t-L} \qquad \text{SEASONAL SMOOTHING}$$

$$F_{t+m} = (S_t + mb_t)I_{t-L+m} \qquad \text{FORECAST}$$

(Shmueli & Lichtendahl Jr, 2016)

We develop a model that is close to the actual data in the data set.

Holt-Winters Model vs. Actual Values
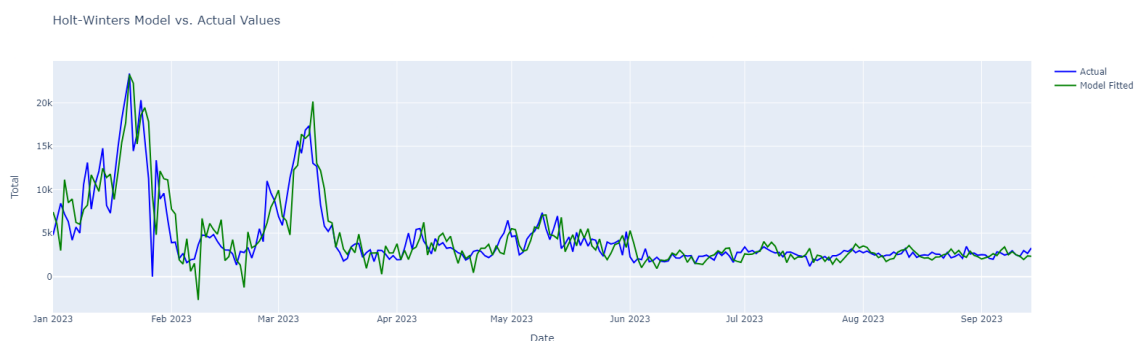
We then calculate the errors observed in this data compared to actual data. It seems that the forecast errors reduce over time hence we can confirm the model is sufficient.

Holt-Winters Forecast Errors
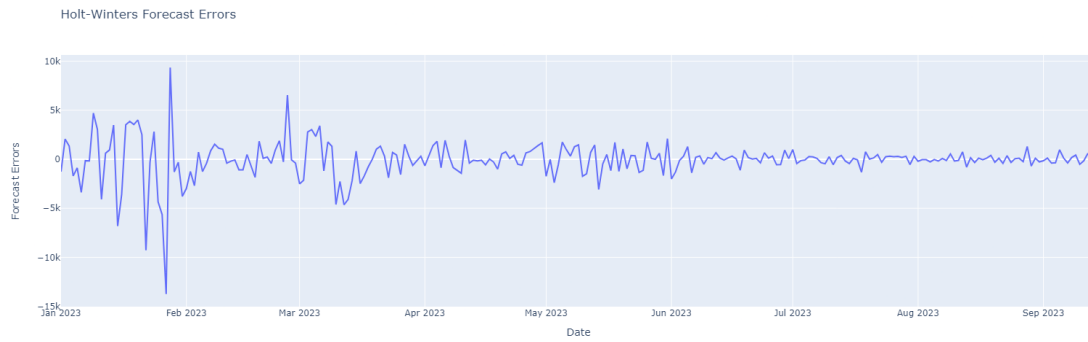
The forecasted values for the next 30 days are displayed below, as we can see the model predicts we will have a gentle rise in sale of data.

Holt-Winters Forecast for the Next 30 Days
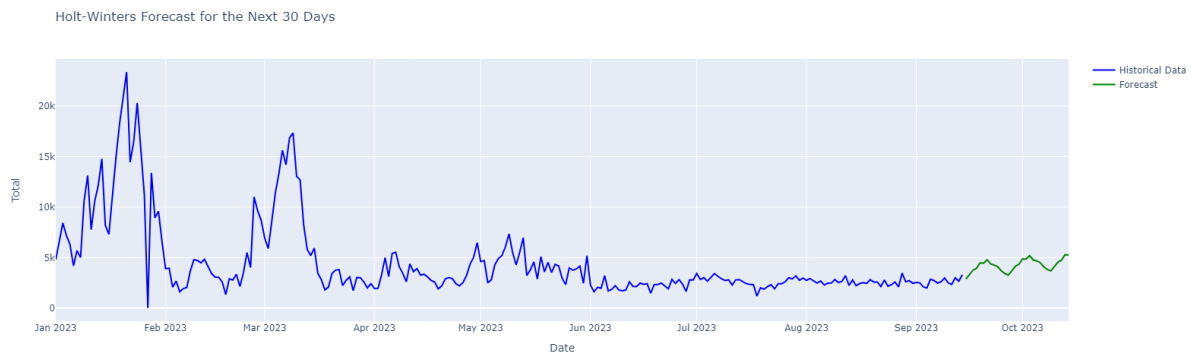
Date	Forecast
2023-09-18	3940.40
2023-09-25	3687.14
2023-10-02	4848.35
2023-10-09	3675.75

Purchase planning using Integer Optimization

Problem setting

Our company is a Nigerian country hence we must consider the situations in Nigeria to understand the need for this model. This model is derived from the salico problem in operations research by winston. (Winston, 2004)

Objective of our linear programming model

Minimise the cost of purchase while meeting demands.

Constraints of our linear programming model

1. A truck can carry a maximum of 45,000 litres and we can only order once a month.

2. There is a cost for transportation of fuel which is 2 naira for every litre.

3. All the processing from delivery to customer can be summed up as a holding cot of 5 naira per litre.

4. There is a monthly cost of maintaining the pumps for the company.

5. Having a finished inventory of 0.

The results of this will depend on constraints set based on time; however we will take a case example for our situation at the current time.

Start inventory = 10000 and end inventory = 1000

Cost of buying petrol = 160 naira, cost of selling petrol = 165 naira

Holding cost at 1 naira per litre , Transport cost at 3 naira per litre

Monthly maintenance of pumps = 40,000 naira

Hence, we must look for a way to optimise the problem considering everything above.

Purchase in week 1 = 0

Purchase in week 2 = 0

Purchase in week 3 = 4475

Purchase in week 4 = 5848

Inventory in week 1 = 4060

Inventory in week 2 = 373

Inventory in week 3 = 0

Inventory in week 4 = 1000

Optimal profit = 527468 (In naira)

Risk management

Risk management is the process of identifying, analysing and controlling possible issues that can arise in a business process.. In this report we will focus on the issues facing oil retail businesses in Nigeria which is majorly from supply chain disruption. We will take the project step by step in the following sequence.(Power, 2004)

1. Identify the risk.
2. Analyse the risk.
3. Evaluate the risk.
4. Treat the risk.
5. Monitor and control risk.

(Google, 2020)

Identify the risks

We will use a cause effect diagram (Ishikawa diagram) to locate root causes of risks. The main risk being supply chain disruption. However, using this diagram we can see the possible reasons for this and look for ways to mitigate each of them.(Liliana, 2016)
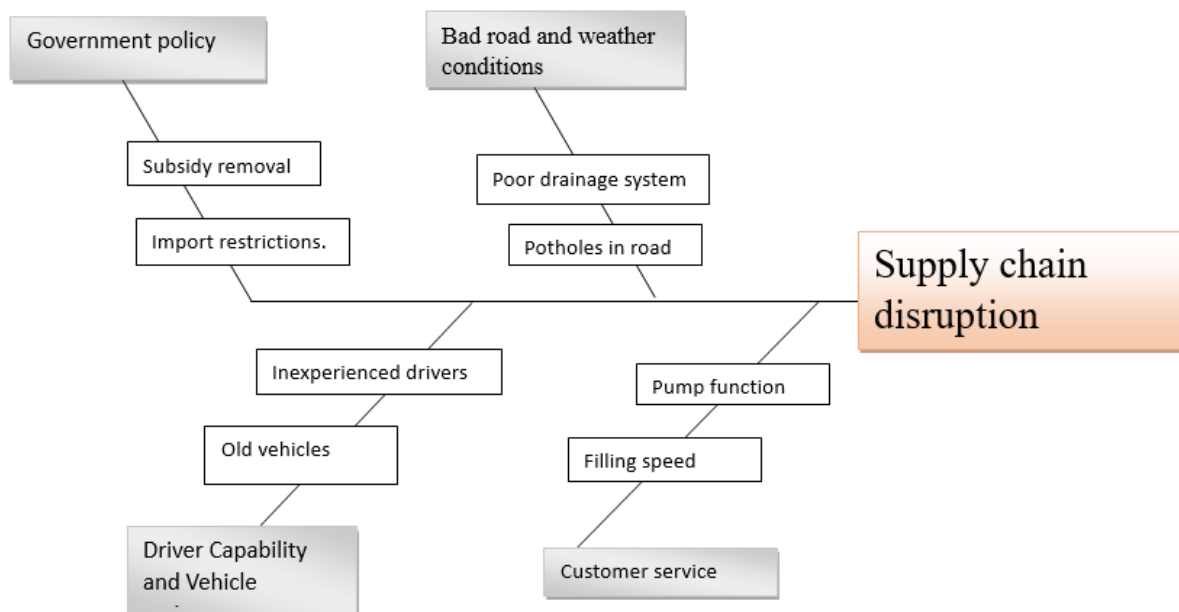
Analyse the risk

The process of analysing the possible risks and how likely they are to occur in order to prioritise each risk in a proper manner. In this section we will look a bit deeper into each risk encountered.

Probability and Impact Matrix:

Inherent Risk				
		Impact		
		Low	**Medium**	**High**
Probability	**High**		Vehicle maintenance	Government Policy
				Driver capability
	Medium		Customer service	Bad road and weather condition
	Low			

For a better look at the possible impact of government policy on prices of petrol we can observe from the chart below the volatile nature of Nigerian petrol prices. Over the last 10 years, we see the recent subsidy removal in 2023 having a big Impact on the price per litre in dollars of petrol.

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From this chart shown earlier we can also see the fluctuation of sales in each pump. It is relatively stable considering the occurrences over this period i.e., subsidy removal.
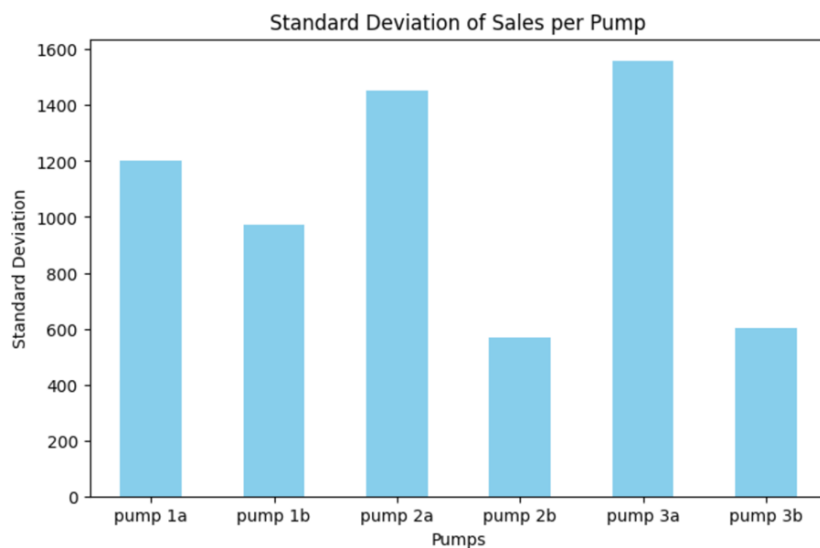
Evaluate risk

In this section we will talk briefly about each risk factor and what they entail as well as their impact on the disruption of the supply chain of petrol of this company.

1.**Bad road and weather conditions:** This is a major risk factor that is to an extent out of our control. The roads in Nigeria linking the sellers of petrol to the retail companies that sell petrol is very bad and the main cost of accidents on the road for companies. This can cause a company to lose its entire petrol purchases in one go hence this risk takes precedence above all others. The weather conditions can slowly get bad as well in the form of heavy rain combined with the bad road which causes major difficulties in transporting petrol.

2. **Driver Capability and Vehicle maintenance:** The conditions of the road or the weather condition might not be the best however the experience and ability of the driver can be pivotal in reducing the chances of a crash as such getting a good driver is important moreover the state of the vehicle is also important as without regular maintenance. the likelihood of a crash is higher.

3. **Customer service:** The speed at which cars get their orders fulfilled will influence the satisfaction of the customer, hence making sure the customers are well searched for is important to making sure customers are satisfied. And improve profit.

4.**Government Policy:** Certain policies and restrictions placed by the government can have a direct impact on the supply chain. For example the government can decide to limit the amount of companies that can bring petroleum products into the country as they did in Nigeria.

Below each risk is classified under Internal or External and Control or out of control

	Control	Out of control
Internal	1. Customer service 2. Driver capability and vehicle maintenance	
External		1. Bad road and weather condition 2. Government policies

Treat the risks

   After evaluating the risk, we see possible issues that can or cannot be controlled by us. We will focus on risks that we can control and are internal to us mostly, however we will put focus on all risks. There are several ways of treating a risk also known as risk mitigation methods.

1.   Avoid

2.   Accept

3.   Reduce/control.

4.   Transfer

We will apply one of the above to each of the possible risks to the supply chain.

·**Customer service:**   This is an internal problem which we can directly solve by the company, this is a problem that we can avoid. The company can put measures which make sure vehicles that come in are filled with petrol as fast as possible and avoid hold up. This can be done by   doing the following.

1.   Proper training of staff on using the petrol dispenser.

2.   Monthly mandatory maintenance

·**Driver capability and vehicle maintenance:** This is another risk we can avoid by taking certain measures such as the following.

1.   Ensuring we hire drivers with the utmost capability and training.

2.   Mandatory monthly vehicle maintenance.

Alternatively, we can transfer the risk to a delivery company, which is a possible choice.

·**Bad road and weather conditions:** This as a risk can only be controlled at this point, we can follow measures such as.

1. Constant monitoring of weather forecasts and cancelling deliveries if weather conditions are in doubt.

2. Use of advanced mapping technology to map out the least dangerous road paths.

·**Government Policy:** This as a problem can only be accepted, we have no power to affect or influence the policies made by the government however we can set extra inventory to help us in terms of uncertainty of policies made by the government.

Control and monitoring

After we have evaluated and treated the issues that may arise, we must now set up policies to control and ensure our measures are being followed to avoid these issues from coming up at all. The recommended method of control is to digitise the process and use of pumps to be able to check how good each is functioning. Furthermore, steps can be taken to carry out surveys on customers to see the effectiveness of business processes and lastly use of high tech gps locators for trucks to track progress while in delivery. An important aspect in being able to control risk ids the company ability to make correct decision making.
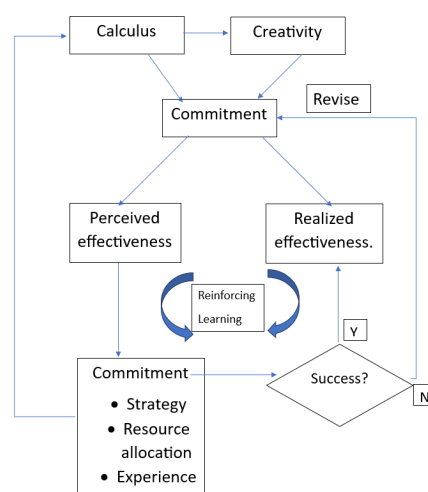
(Kim, 2023)

Above we see a decision making learning methodology which we can apply as we will want to try and control, monitor and improve on the current model we formed in this project. The process starts with calculus in this sense calculus refers to all the quantitative analysis that is needed for the decision then to creativity which involves all the flexible strategic methods we will apply to improve the system we will go back and forth between creativity and calculus until we are satisfied with our plan then we commit to it by allocating resources into it. After we commit to it from the perceived effectiveness we anticipate we will allocate resources to make sure the learning process is effective. If successful we reinforce the system and if not successful we revise the system and start again.

4.6 Results

The project has been completed so far however as the description implies this is a project that serves the purpose of equipping the company with tools to mitigate every circumstance the company may face in the future. Hence this stage of the project may be completed however the project will continue to grow and improve based on the needs of the company.

5. INTERNSHIP EXPERIENCE

5.1 Learning to Discuss what you learned from the internship

The internship has made significant changes to my career path as I have a clearer direction now. I know the tools and fundamentals to get my desired career which is a career in supply chain management.

5.2 Relation to undergraduate education

I have been able to use two skills that I got in university for this project; these include integer programming and Forecasting. I learned integer optimization from operations research courses and I learnt the basics of forecasting from an introductory course on industrial engineering. I would have liked to have learnt more complex forecast methods to help in the forecasting procedure perhaps an entire course focused on time series forecasting.

5.3 Difficulties

I did encounter some difficulties while in my internship some of the difficulties i faced and how i overcame them include

1. Communication: It has always been difficult to express myself however after being put in the work environment the need to try to communicate my ideas became more apparent hence i made presentations to help me learn to present.
2. Research: being my first time making research on my own it was not the easiest finding resources that I could use for the project but with enough time and dedication I found it easier to get necessary resources.
3. Time management: At the end of my first internship it clashed with my second internship hence looking for a way to manage both at the same time was a challenge but i discovered mapping all tasks and allocating enough time for each was the best way to manage time.

5.4 A typical day

I conducted my internship as a hybrid internship. Typically starts at 9 am , there is always a career development session that helps the interns with future career paths after this we start our individual allocated tasks for the day. Sometimes we got training on project management skills which I found very helpful.

6. CONCLUSIONS

The entire internship experience was highly beneficial. I got to learn career development skills that would put me ahead in the market as well. I was able to apply skills I had learnt in university. I believe it was indeed useful. The project itself was new ground for me as I had to meet with a company in Nigeria and propose my system to them to reduce the impact of uncertainty. I presented it to them and they saw it beneficial. Hopefully they implement it and we will see the results.

7. RECOMMENDATIONS

I would recommend future students who take this course to first try and look for a company to take your internship with early, research this company and make sure your speciality aligns with that of the company. Always sharpen your skills moving on from when you get accepted. In the internship be attentive and proactive, take as much advice from your supervisor as possible and always ask for evaluation of your performances. As for the project itself, look for a project that can make an impact on a company where you really get to apply your skills you learnt in university. I was lucky to have a very good internship with Eartech where I was able to develop properly and have a clear direction for my future.

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