Sales Pattern Analysis and Profit Maximation at Wind Spares Retail Shop

An End-Term report for the BDM capstone Project

Submitted by

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1 Executive Summary

Gust Wind Spares and Services, a B2B shop located in Gudimangalam, specializes in windmill spare parts and services. Established in 2011 by Mr. Prakash, this private shop supports local customers and businesses by providing essential spare parts and cost-effective repair services. Despite its reputation as a reliable supplier, the shop faces challenges with low profit margins due to stock management issues, especially during seasonal demand fluctuations.

The monsoon season, from March to August and at the end of the year, sees high demand due to increased wind activity, causing more frequent breakdowns and replacements of parts. This project aims to address these challenges by analyzing sales and purchase data to identify trends, enhance inventory planning, and optimize stock levels.

The approach includes collecting and preparing sales and purchase data, performing Exploratory Data Analysis (EDA), and analyzing customer purchasing patterns. By implementing demand forecasting through regression and machine learning models, the project will predict high-demand periods, allowing the shop to manage inventory more effectively. Python libraries such as Pandas, NumPy, and visualization tools like Power BI will be employed for data manipulation, with Scikit-learn facilitating machine learning applications.

The expected outcomes include improved inventory management by identifying top-selling products and reducing excess stock, high profit returns by pinpointing high-return items, and a better understanding of customer purchasing behavior to enhance marketing efforts. This analysis will help Gust Wind Spares and Services increase profitability and better prepare for seasonal demand variations, positioning the business for sustained success

2 Detailed Explanation of Analysis Process/Method

2.1 Method for Financial Overview

In accordance with the sales distribution throughout the year, the monthly and yearly analysis of total revenue is being conducted to check the distribution of income with highest priority months also requiring service preferences.

1. **Monthly and Seasonal Revenue**

   The total revenue is calculated by the product of Qty and Rate. To check the distribution of revenue throughout the year, the monthly revenue analysis is taken in general. The month with high revenue is given importance in the stock storage and service provided as the no. of temporary workers could be increased at the specific months. A seasonal analysis is accounted for the months of June, July, August and December. These months lie under the windy season and the demand of wind spares increases generally.

2. **ARIMA Model for Future prediction**

   The revenue of the year 2023 is used to predict the revenue distribution for 2024 with their predicted revenue and distribution in a graph. ARIMA is a time series analysis which forecasts the revenue data by handling the noise and captures the trends and seasonality. Revenue being a time-dependent attribute helps to predict the future values of months and helps the customers to be precautious in their decision making and financial clarifications.

```
seasonal_frequency = 12  # Adjust as per your dataset resolution

try:
    auto_model = auto_arima(time_series_data,
                            seasonal=True,       # Test with seasonality
                            m=seasonal_frequency,
                            trace=True,
                            error_action='ignore',
                            suppress_warnings=True,
                            stepwise=True)
except ValueError as e:
    print(f"Seasonal ARIMA failed: {e}. Falling back to non-seasonal ARIMA.")
    auto_model = auto_arima(time_series_data,
                            seasonal=False,      # Fallback to non-seasonal
                            trace=True,
                            error_action='ignore',
                            suppress_warnings=True,
                            stepwise=True)

# Print Auto ARIMA Summary
print("Auto ARIMA Summary:")
print(auto_model.summary())

# Step 6: Fit Final ARIMA Model
best_order = auto_model.order
best_seasonal_order = auto_model.seasonal_order

print(f"Best ARIMA order: {best_order}, Seasonal order: {best_seasonal_order}")

model = ARIMA(time_series_data, order=best_order, seasonal_order=best_seasonal_order)
model_fit = model.fit()
```

Fig.2.1.1 Code for ARIMA model

2.2 Method for Stock Optimization

Stock Optimization is a necessary factor in bringing the transportation cost as well as upbringing the space utilization of the shop. Particularly deals in the demand and supply of goods.

1. **Requirement of Items**

   Looking over the dataset, the no. of items are numerous and can't be classified instead depending on the Timely requirement and its frequency. The items can be classified as consistent items and seasonal items. Here the top 10 times with high frequency are listed throughout the year (consistent item) and on seasonal months individually. This could lead to better space utilization.

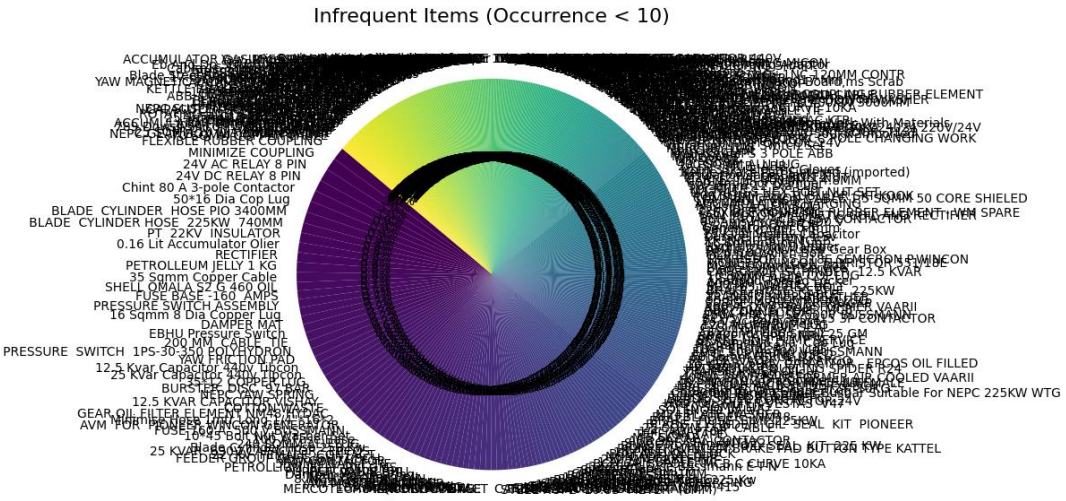

Fig.2.2.1 Frequency of items

From Fig.2.2.1, the unique items exceed over 450 difficulty in classifying.

2. **Unit and Qty Filtration**

- Space can further be optimized by filtering the quantity of items. This involves taking the unit to be Nos, Kg which requires large space in shop and other units such as the Ltr, Mtr can be avoided as the storage of these items are efficiently handled.
- Now setting up a required threshold of the quantities, the higher quantity items are listed and check manually whether these items would consume a huge amount of space because some items like Bolt may require a very little space even thought the quantity is high while items like motors are considered.
- Checking if this falls under the consistent item or seasonal item could be classified into 'Supply only if Demanded' bringing stocks under control withing the shop space.

2.3 Method for Customer Behavior Analysis

Customer behavior analysis helps in segmenting customers in groups, individual preferences boosting the business strategy.

1. **Prioritizing Customers**

   Customers are prioritized based upon the frequency of purchase and given higher preference of discounts and service at low cost. This also involves if the customer lies in a individual business or private company business. The revenue generation not only lies in the sales but also in the service. So the items brought by these customers are always kept in stock, which could attract potential buyers due to the recommendations.

2. **Customer Segmentation**

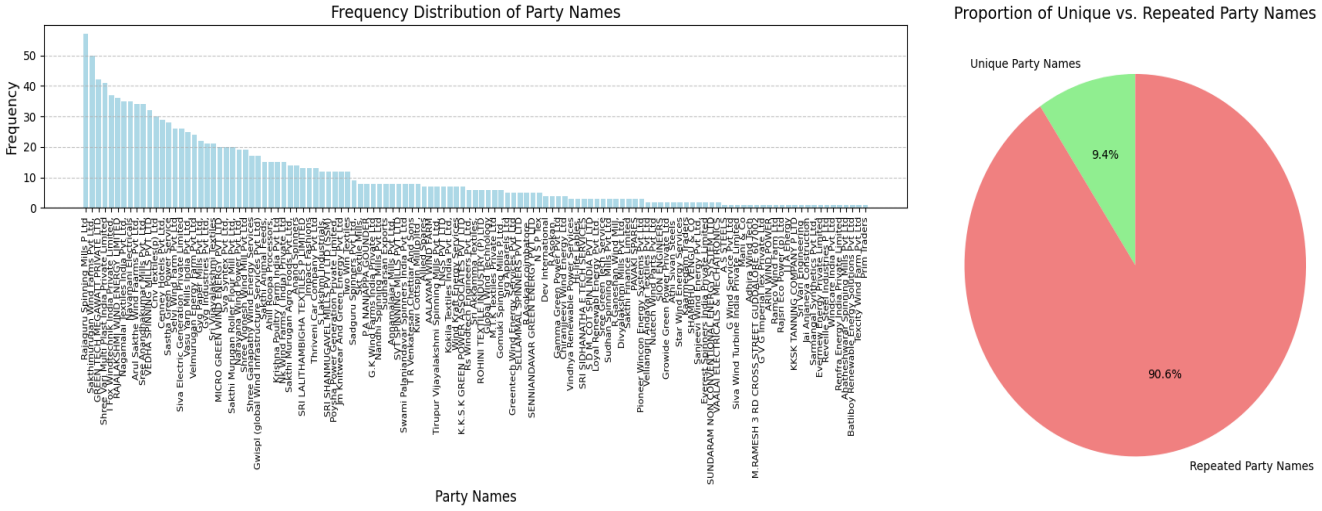

Fig.2.3.1 Frequency and Repeated Party Name

- The Frequency based on the Party Name is evaluated to know the potential customers and here the repeated party names hold 90% population.
- Setting up the customer frequency threshold, the prioritized customers are listed out and are required to classify the party into individual business or private company business as the service would be required for the individual business. The individual business customer brings a fortune and checks their occurrence on a seasonal basis.
- Unique party names are avoided as their frequency and future buy is less indicating the revenue generated from these parties are generally low.

3 Result and Findings

Financial Analysis

Total Sales Revenue with statistical description of how it varies monthly and its standard deviation.

Total Sales Revenue	₹ 1181165.0
Average monthly Sales	₹ 244531.66666666666
Median Monthly Sales	₹112852.5
Sales Range	₹ (10795.0, 1044029)
Standard Deviation	₹ 271420.4335585319

- The max range has peaked above ₹ 1044029 which explains that few items has secured to be most awarding as well as contributed to bringing the turnover of the year.

Monthly Trend Analysis of Revenue

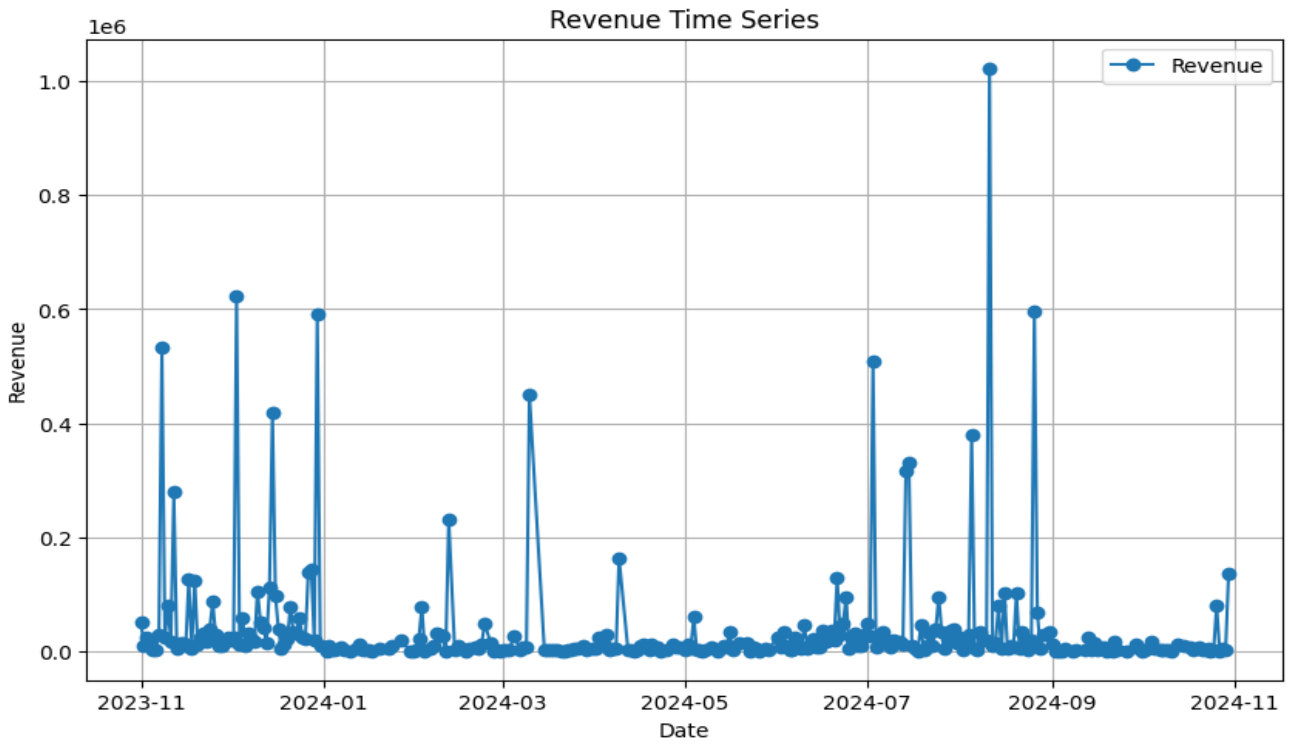

Fig.3.1 Monthly Trend (Revenue)

- The peak revenue is listed in the months of August 2024 and December 2023. In other months, the revenue distributed evenly, also some spikes can be seen due to individual items. This motivates us for a seasonal analysis as the months of August and December lie in windy season impacting the sales of wind spares on a positive note.

Seasonal Trend Analysis

- Considering the seasonal months to be from July -September.

Average Monthly Sales (June to September)	₹ 139823.0
Median Monthly Sales (June to September)	₹ 634885.0
Sales Range (June to September)	₹ (10795.0, 55789.0)
Standard Deviation	₹ 180802.05780

- More than 40% of the supply lies in the seasons making it to be productive months.
- The month of August seems to be given the most revenue generating period in the year.

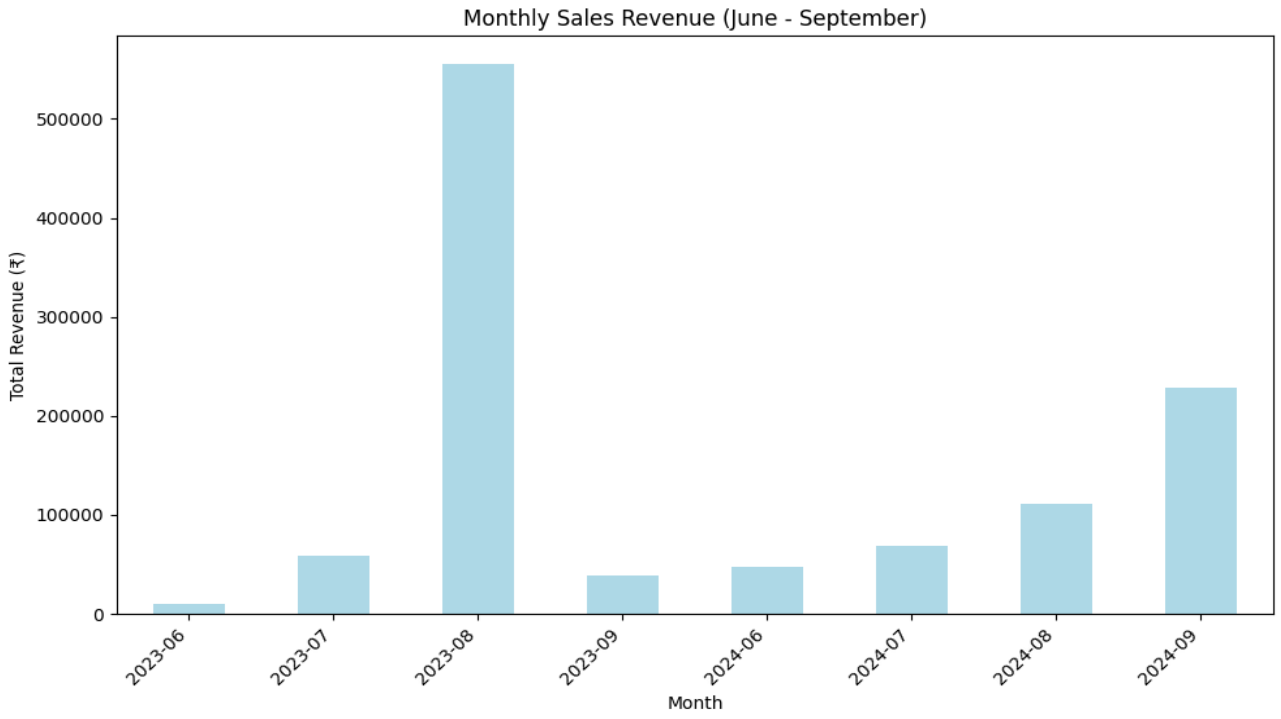

Fig.3.2 Seasonal Analysis

Forecasting using ARIMA

- ARIMA is widely used for forecasting because it can generate predictions based on historical data. It will forecast future revenue values by learning from past revenue trends and patterns.
- An ARIMA model is defined with parameters (1, 1, 1), where:
  - **p** (1): The number of lag observations included in the model (autoregressive part).
  - **d** (1): The number of times that the raw observations are differenced (integrated part).
  - **q** (1): The size of the moving average window (moving average part).

  The model is then fitted to the **Revenue** data.
- The forecast steps given as 12 indicating months for revenue distribution.

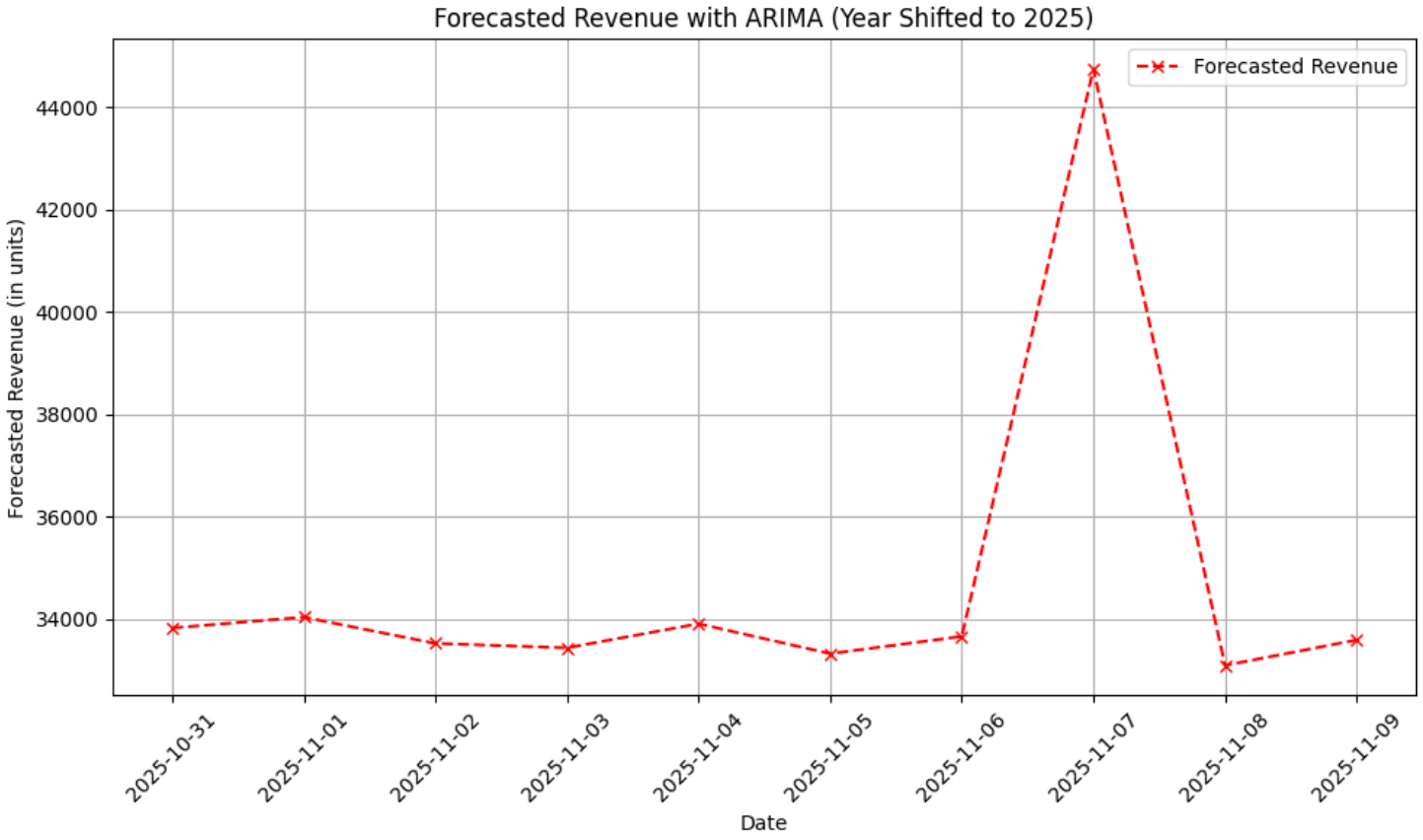

Fig 3.3 ARIMA forecast for year 2025

Date (2025)	Forecasted Revenue
2025-10-31	33825.771770
2025-11-01	34036.591180
2025-11-02	33524.088930
2025-11-03	33436.868812
2025-11-04	33907.748929
2025-11-05	33323.993914
2025-11-06	33660.007672
2025-11-07	44752.453205
2025-11-08	33094.383434
2025-11-09	33590.089562

- The forecasted revenue represents the units but not the exact value in rupees representing the differentiation in the months.

- Suggests that the month of August would bring a jackpot for the shop.

ARIMA Fit and SARIMAX Results

```
Running Auto ARIMA...
Performing stepwise search to minimize aic
 ARIMA(2,0,2)(1,0,1)[12] intercept   : AIC=8059.433, Time=0.54 sec
 ARIMA(0,0,0)(0,0,0)[12] intercept   : AIC=8053.049, Time=0.01 sec
 ARIMA(1,0,0)(1,0,0)[12] intercept   : AIC=8052.298, Time=0.09 sec
 ARIMA(0,0,1)(0,0,1)[12] intercept   : AIC=8051.462, Time=0.06 sec
 ARIMA(0,0,0)(0,0,0)[12]             : AIC=8089.276, Time=0.01 sec
 ARIMA(0,0,1)(0,0,0)[12] intercept   : AIC=8054.977, Time=0.02 sec
 ARIMA(0,0,1)(1,0,1)[12] intercept   : AIC=8053.453, Time=0.15 sec
 ARIMA(0,0,1)(0,0,2)[12] intercept   : AIC=8053.288, Time=0.18 sec
 ARIMA(0,0,1)(1,0,0)[12] intercept   : AIC=8052.398, Time=0.07 sec
 ARIMA(0,0,1)(1,0,2)[12] intercept   : AIC=8055.270, Time=0.35 sec
 ARIMA(0,0,0)(0,0,1)[12] intercept   : AIC=8049.396, Time=0.04 sec
 ARIMA(0,0,0)(1,0,1)[12] intercept   : AIC=8051.378, Time=0.08 sec
 ARIMA(0,0,0)(0,0,2)[12] intercept   : AIC=8051.238, Time=0.15 sec
 ARIMA(0,0,0)(1,0,0)[12] intercept   : AIC=8050.448, Time=0.07 sec
 ARIMA(0,0,0)(1,0,2)[12] intercept   : AIC=8053.232, Time=0.25 sec
 ARIMA(1,0,0)(0,0,1)[12] intercept   : AIC=8051.383, Time=0.06 sec
 ARIMA(1,0,1)(0,0,1)[12] intercept   : AIC=8053.452, Time=0.11 sec
 ARIMA(0,0,0)(0,0,1)[12]             : AIC=8077.248, Time=0.03 sec

Best model:  ARIMA(0,0,0)(0,0,1)[12] intercept
Total fit time: 2.300 seconds
Auto ARIMA Summary:
                               SARIMAX Results
...
Warnings:
[1] Covariance matrix calculated using the outer product of gradients (complex-step).
[2] Covariance matrix is singular or near-singular, with condition number 1.71e+32. Standard errors may be unstable.
Best ARIMA order: (0, 0, 0), Seasonal order: (0, 0, 1, 12)
```

Fig.3.4 SARIMAX Results

Stock Movement Analysis

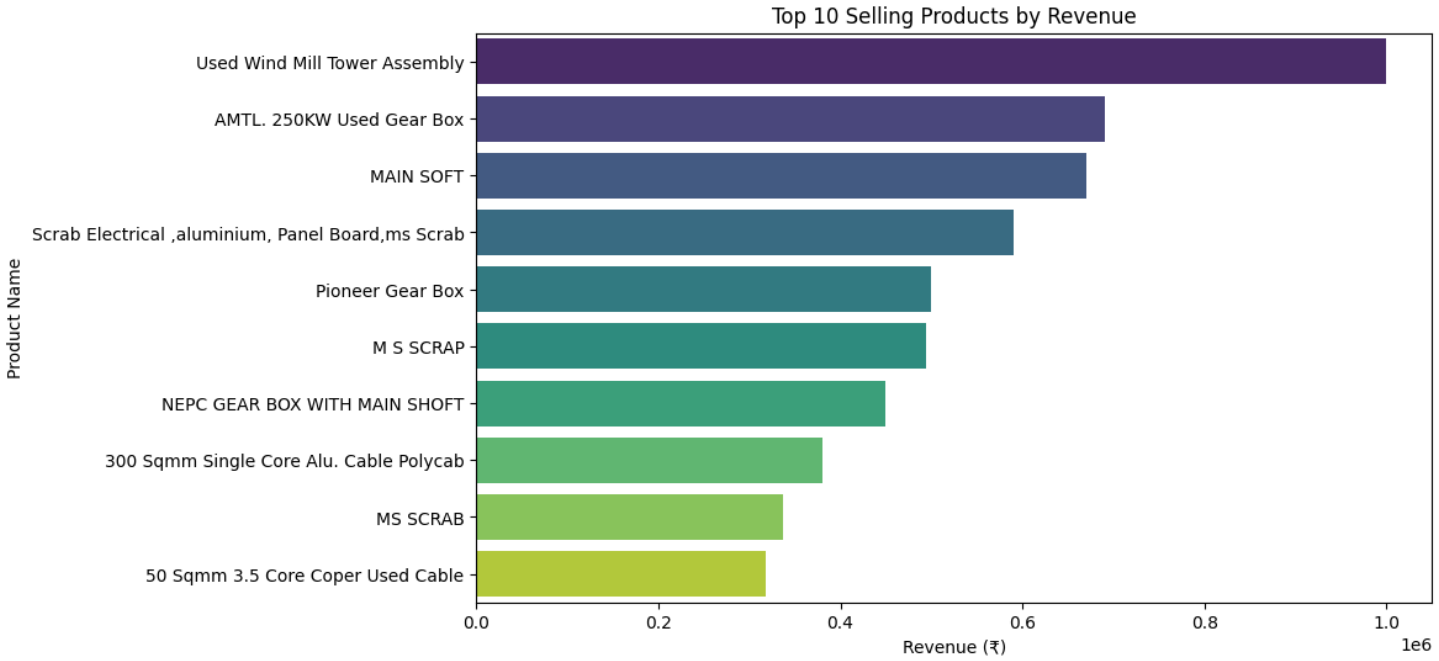

Fig.3.5 Top selling products by Revenue

- The top selling products are listed as in the working of spare parts shop the profit of an item is proportional to its cost of item indicating that these are generally highest revenue generating items.
- Windmill Tower Assembly being a toolkit is a consistent item and comes under seasonal tools too.

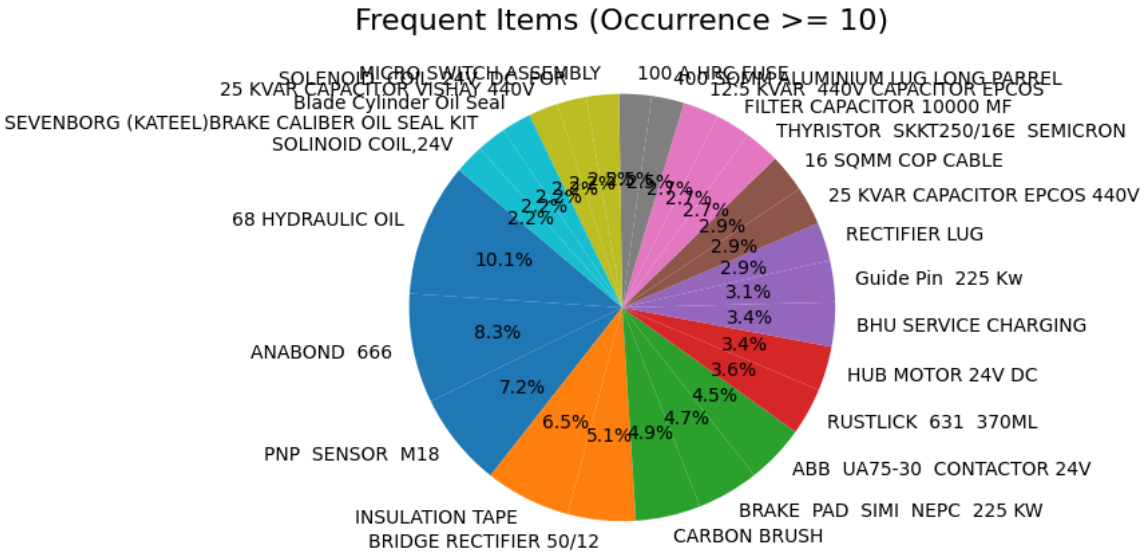

Fig.3.6 Frequency items

- These 26 items are frequently brought and are consistent items, kept throughout the year. The Hydraulic Oil, Anabond 666 and PNP Sensor M18 are primary requirements for the mills to be used for oil checks and maintenance purposes. The threshold is set at above 10.

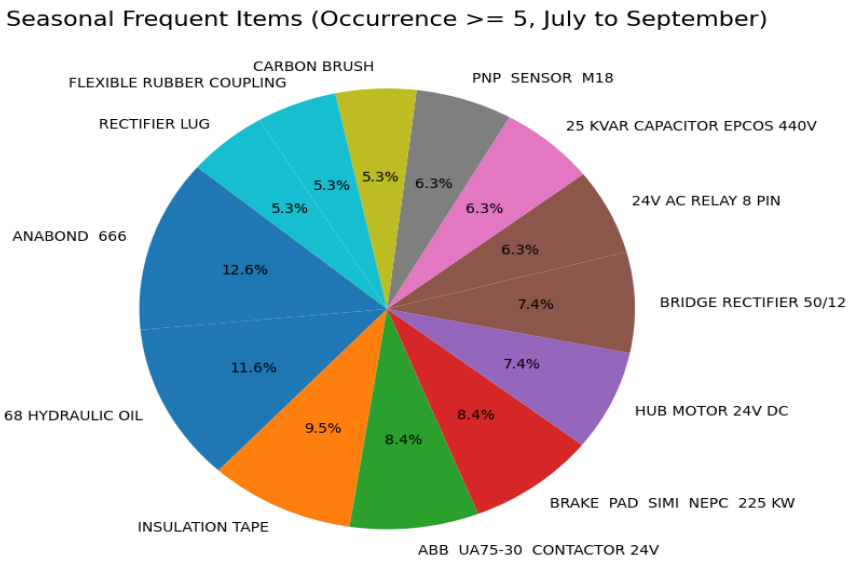

Fig.3.7 Seasonal Frequency items

- The seasonal frequency items listing of total 13 items considered to be frequently brought more than 5 times in the seasonal months of July to September by different buyers.

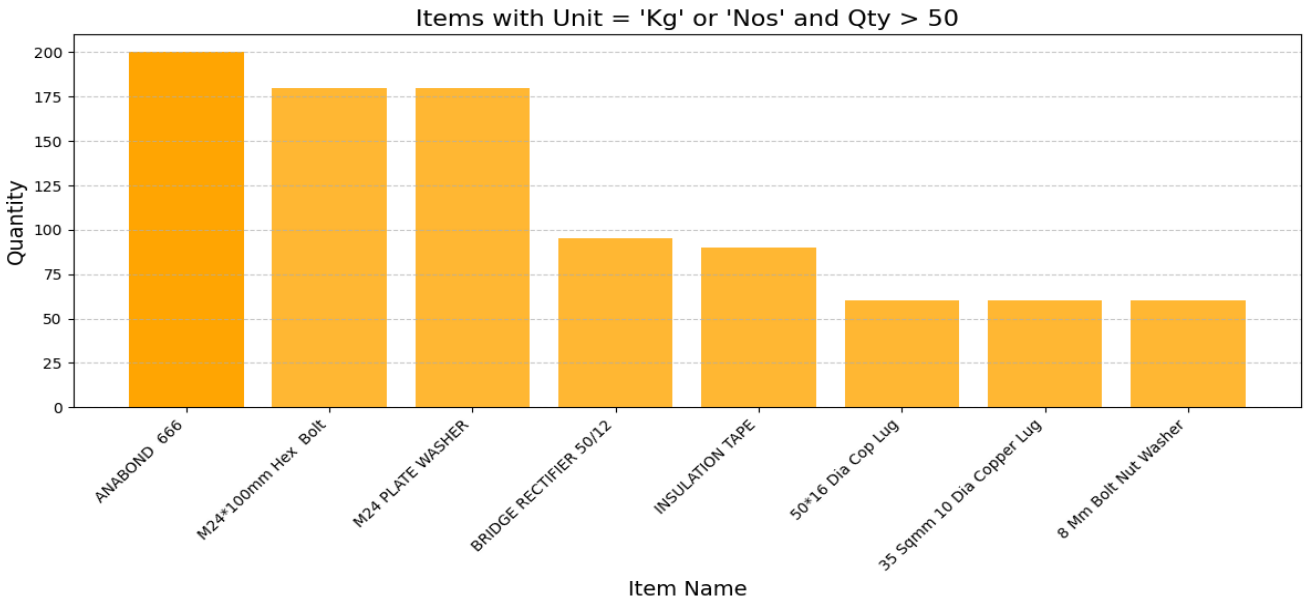

Fig.3.8 Items stored in larger qty

- The given set of items are stored in larger qty while has a distributed sales throughout the year.

- These items, even though consist of larger quantities, are generally small and need a manual evaluation check if it consumes the space. If so, the space must be optimized well if it's in the larger quantity.

- The items taken are generally of unit = Kg, No and the threshold of quantity is assigned to be 50 as the items below could be accommodated by the shop's space.

Customer Behavior Analysis

- Estimating the frequency of purchase by customer (Company) evaluated to future potential customers and the general requirements of the particular item they buy can be increased.

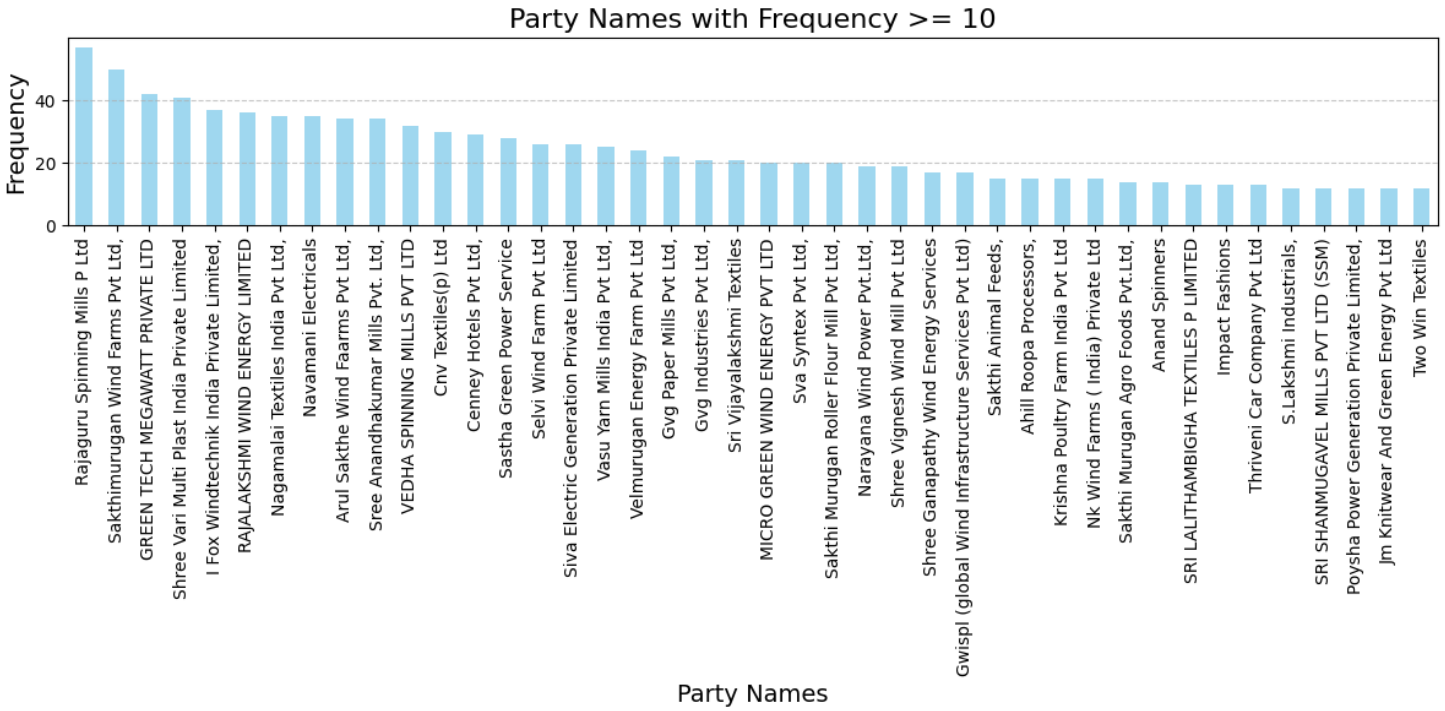

Fig.3.9 Frequent Customers

- This graph shows around 34% of total parties that has involved in the frequent purchase from the same shop indicating customer retention rate is high in the insights of a spare parts shop.

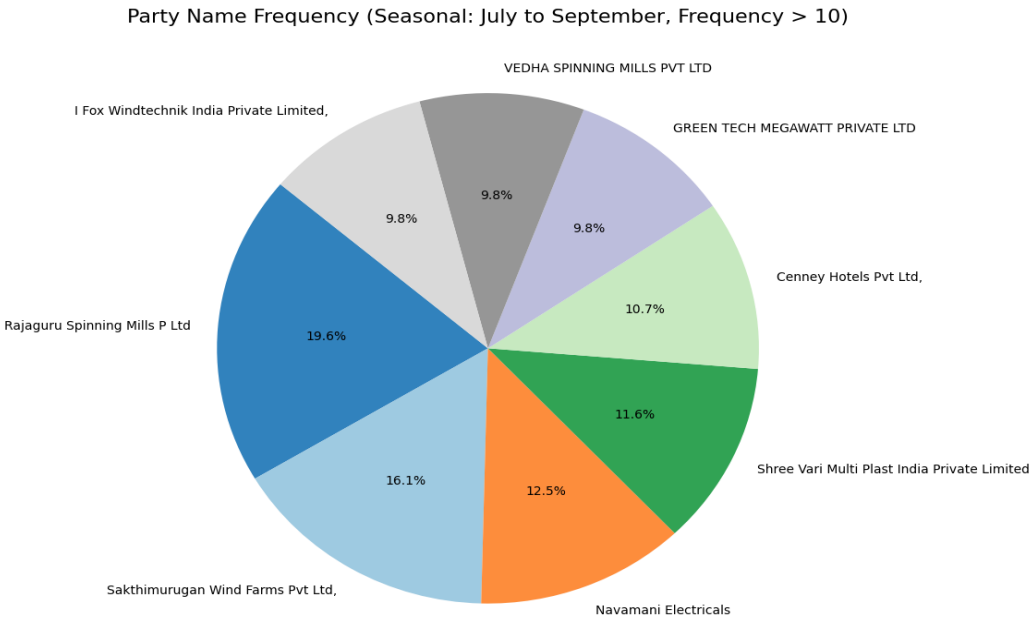

Fig.3.10 Frequent Customers (Seasonal Basis)

- The seasonal analysis shows over 8 customers who require frequent purchases, and these customers are properly segmented based on service requirement.

Customer Segmentation

- The Individual business requires service charges for the installation of the items. Over 90% of the individual businesses had required service from the shop while private company business doesn't require as they already have employees for it.
- Based on this categorizing the Frequent customers on Seasonal Basis into Service requirement. Such that the employee 's salary can be delt with these from this type of charges. It can be done manually only.

Party Name	Service Requirement
Rajaguru Spinning Mills P Ltd	Yes
Sakthimurugan Wind Farms Pvt Ltd,	Yes
Navamani Electricals	Yes
Shree Vari Multi Plast India Private Limited	No
Cenney Hotels Pvt Ltd,	Yes
GREEN TECH MEGAWATT PRIVATE LTD	No
VEDHA SPINNING MILLS PVT LTD	Yes
I Fox Windtechnik India Private Limited	No

- So over 72% require service while the frequent customers on the seasonal basis require service and pay for the service charges.
- Setting a threshold of revenue, by which potential customers are filtered, generating higher revenue for the shop.

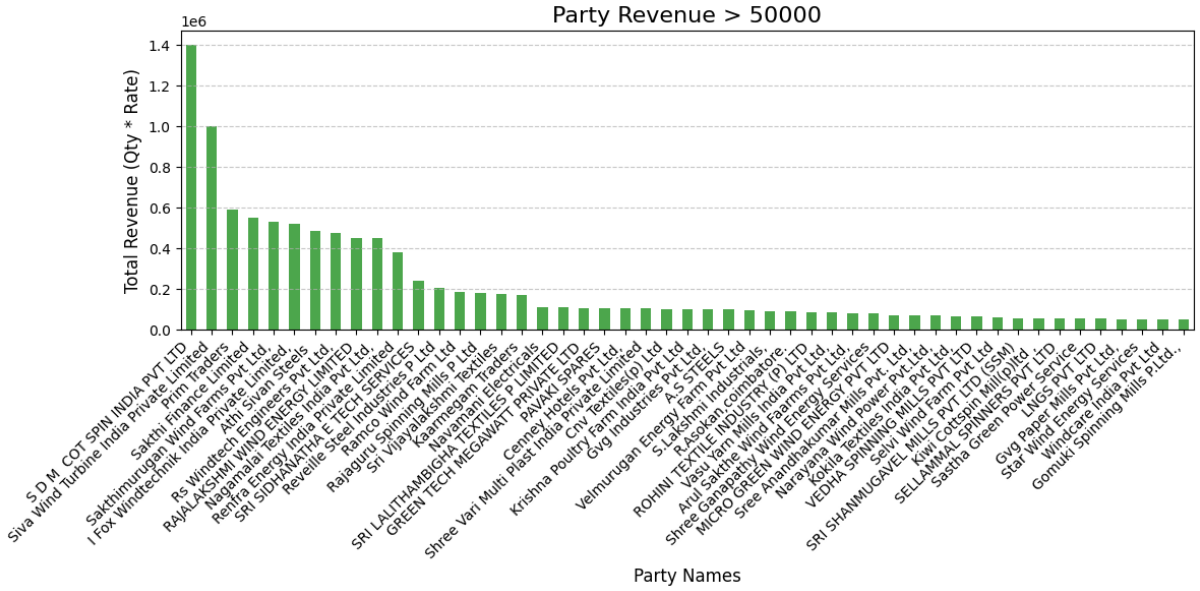

Fig.3.11 Party Name with Higher Revenue Rate

4 Interpretation of Results and Recommendation

Financial Analysis

Interpretation:

- From the seasonal analysis, more than 50% of the shop's revenue lies under the seasonal season of Julty to August and December months alone.
- ARIMA forecasting predicts that the sole income of shop will depend upon the month of August for the year 2025.
- As the complete analysis purely depends on the revenue as there is no availability of profit from the dataset, its generally assumed to be higher the item's price higher the profits based on the proportionality concept.
- The spikes in the month of December 2023 shows that there are frequent buys but not the highest revenue generating particulars.
- There is a very below average performance in the months of September to November and January to March indicating that the non-seasonal months shows a poor yield in the revenue.
- The customer company like SDM COT SPIN India Pvt Ltd has high frequent purchase and generates over 14% of the total revenue.

Recommendation

- To yield more profit in this business, it is required to clearly plan to employ only temporary employees in the service sector on the seasonal time while non-seasonal month have very poor performance requiring no service person in the frontend.
- It is necessary to maintain a very good relationship with the high revenue yielding company and inquire about any necessities of items in other non – seasonal months.
- Necessity in planning of items required to brought at the time of January – March to cope up the items in the supply at the month of August.
- High attention towards the month and employing people in service sector is clearly advantageous in revenue generation
- Expanding business by investing the profits into new shop in the wind – prone areas could be a great deal with some mutual partnerships from individual private companies.

Stock Movement Analysis

Interpretation:

- The consistent items and seasonal items are completely classified. The frequency is also noted to be an important factor in both the classes.
- In terms of revenue, the top 10 selling items are profit generating resources while items are Windmill Assembly Kit are generally necessary in all the months.
- The items like Hydraulic Oil, Anabond 666, Insulation Tape, PNP Sensors are primary products in the spare shops and utilize very less space with good profit. These items increase the retention of customers towards the shop.
- Primary products both comes under the seasonal items as well as the consistent items. While the items like Hub Motors, Rectifiers Lug fall under seasonal purchases over 12% but not in the consistent items.
- The 8 items listed in the classifying items based on quantity are done to evaluate the space consumption. The items classified does not require space and can be stored even under jar. Thus, these items are taken into consistent items.

Recommendation:

- The top selling items by revenue and consistent items are necessarily required to be in the shop while the Hydraulic Oil, Anabond 666, Insulation Type and PNP Sensors carry a high weightage in the purchases.
- To reduce the transportation cost in the seasonal period, it is required to stock up the seasonal frequent items at the period of January – March resulting in higher efficiency and availability further increases the customer satisfaction and retention rate.
- The space optimization can only be achieved if the big bearings and motors are pre-ordered, hence, to do so customer communication and relationship is highly important.
- In bringing the efficiency of stock management, transportation of stocks plays a vital role as the necessary listed items are brought at interval of travel and should be again used only for any emergency purchase by prioritized customers.
- Brack pad and Rectifier Lugs which fall under seasonal purchase requires specific size to make it available in this stock. In this type of cases, the highest probability of previous purchase of these items are taken into account and are generally ordered.

Customer Behavior Analysis

Interpretation:

- Prioritizing the customers would help in increasing customer retention rate and building long-term partnership. Customers like RajaGuru Spinning Mills and Sakthimurugan Wind Farms Pvt Ltd are the high revenue generating customers with greater frequency of purchases.

- There are over 1309 party purchases while unique party names account to just 123 or 9.4% which symbolizes that the focus should be on the retention of 90.6% of customer who are in the Repeated Party Names.

- In these Frequent Party Name, 50% of them lies in the individual business requiring service and are ready to pay the service charges while the other half are private companies which employee the service themselves and only account to revenue of item purchase.

- There are 66 customers lying in the frequent list with a threshold of more than 10 purchases throughout the year while 57 are lesser than 10 purchases.

- In the seasonal months, the frequent purchase of parties account about 88.4% which means that the Customer who purchase in the seasonal months shows 90% participation in heavy purchases.

Recommendation:

- The Individual company are given higher importance in the seasonal months as they add up to the service charges + item cost resulting in greater profit.

- Assign more temporary workers in the service front in the seasonal months.

- Parties like SDM COT SPIN India Pvt Ltd, A.S Steels boost the revenue twice so a healthy partnership and communication is appreciated.

- Contacts of Private company business would find greater collaboration and extension of the market.

- The consistent items that are frequently purchased by the prioritized customers are noted and made it available at the season items would increase retention rate.

- Employing only one permanent member of staff in service frontend can potentially reduce expenditure on the non-seasonal months.

5 Conclusion:

The analysis of Gust Wind Spares and Services shows that the shop's success depends heavily on seasonal demand and strong customer relationships. Seasonal months like July to September and December bring in over half of the yearly revenue, making it crucial to plan stock levels and hire temporary workers during these busy times. Using tools like ARIMA for forecasting and studying customer purchasing patterns can help the shop keep the right products in stock, avoid extra transportation costs, and ensure customer needs are met. Key items like Hydraulic Oil and PNP Sensors, which are frequently bought throughout the year, should always be available to improve efficiency and save storage space.

The customer analysis highlights that most of the revenue comes from repeat buyers, especially individual businesses, who also bring extra income by paying for services. Building strong relationships with top customers like Rajaguru Spinning Mills and Sakthimurugan Wind Farms will ensure steady sales and loyalty. Seasonal buyers contribute significantly during busy months, so ensuring their preferred items are available can boost satisfaction and retention. By focusing on better stock management, maintaining close communication with loyal customers, and planning for peak demand periods, the shop can solve its current challenges and grow into a stronger, more profitable business.

Additional:

Excel Spreadsheet:

https://bit.ly/4gDEDz5