Project 1 Report

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https://nestingen.github.io/DSC-680-MRO-Inventory/

Introduction

For, manufacturing companies, Maintenance, Repair, and Operations Inventory can be a large expense. This inventory group is known as MRO Inventory. These parts are used to maintain and repair the machines that are used in the manufacturing process as well as equipment needed to preform the operations. This could include motors, screws, or personal protective equipment (PPE). Inventory must be watched because there is a cost of too high or low of levels. When Inventory is too high, too much money is tied up in parts. This means the capital cannot be used elsewhere in the business. When inventory is too low, a machine repair could lead to costly down time. In this project, I investigated why inventory is changing at 30 plants across a company. By slicing the data different ways, I was able to pinpoint why inventory was increasing or decreasing at a plant. I used Qlik Sense to perform this analysis. Qlik Sense is a BI tool like Tableau. This tool is used company wide and everyone has access to this analysis. Storeroom managers can use this report to explain MRO Inventory Changes. I focused on March 2020 to December 2020 to do a deeper dive into the analysis.

Data

I used SAP data from two systems. At the end of each month, a snapshot of the MRO inventory was taken across the two systems. This data included MRO inventory for 30 facilities. Some of the columns in the data set are materials, plant, quantity, re-order point, value, unit of measure, material group, and created on date. The key I used across the database was plant and material. The MRO Inventory data was joined with transaction history also from SAP.

The transaction history shows when a part was received into inventory since 2018. This data was pulled from both SAP systems and allowed me to estimate when a new material was received into the storeroom. The data set included information like transaction date, transaction type, material, plant, quantity, and purchase order. I grouped the transaction data by material, plant, and document date and summed the quantity. I only kept the earliest document data because I only cared about when the material first came into the storeroom. Because I only had data since 2018, if the material was created before January 1st, 2018, I could not accurately estimate when the material first came into the storeroom. I did a left join between the MRO Inventory data and transaction data by plant and material.

In the load script, I added more measures and flags to make slicing the data easier. One flag I added was a capital spare. More expensive parts are labeled capital spares. There are some month end inventory evaluations that do not care to look at these parts. This toggle helped plants filter these parts in and out of their report. The capital spare flag allowed me to understand how

the inventory changes if they are capital or not. I also added a unit count flag. Inventory can increase or decrease for two reasons. The quantity changes or the unit price changes. I added a unit flag so I could analyze just the quantity of parts without looking at the outliers with very high quantities. This flag was set at 100 units. Another flag that was added was Facility type. I analyzed both plants and mills, but these facilities carry inventory very differently. Mills are larger and will carry more MRO Inventory. There is more machinery that needs to be maintained and repaired. Plants usually have newer machines and less equipment to keep up with. They should hold less inventory than a mill.

Analysis
Unit Change
My first step was looking at how the units were changing. I wanted to understand this variance with out the inconsistency of price changes. I filtered to just look at the parts that have a quantity of less than 100. When I looked at all parts, a part like a screw could swing the overall total higher or lower without much meaning. The graphs below show the value change next to unit change. The relationship is consistent. When units decrease for the month, usually the Inventory value also decreases. This is not always true and sometimes when the units change slightly, the price changes greatly or vice versa. This made me believe that price change was a bigger driver of inventory change over the last 9 months.
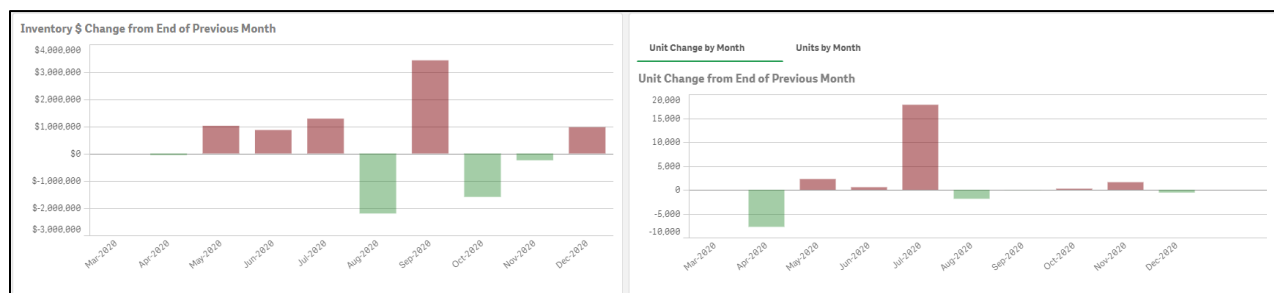
### Inventory Over and Under Safety Stock
Another aspect I evaluated was over stock and understock values by month. I wanted to see if there was trend month by month. MRO Inventory are ordered by an automatic process. When the inventory quantity goes below the safety stock, a Purchase Order (PO) is placed to the vendor in the amount up to the safety stock level. If the safety stock value was 5 and the quantity on hand is 3, a PO would be placed for 2. If the value is under stock, it usually means that the parts are on order. There are multiple reasons why a material has a quantity over safety stock. One reason might be there was a return to the storeroom. A maintenance person takes a part out of the storeroom because they think they need it for a repair. If they end up not needing it and return it to the storeroom a few days later, a new part may already be on order. The vendor may not allow for cancellations after the PO has been placed. Another reason there may be parts over safety stock is if the vendor has a minimum order quantity. Using my example above, if the safety stock

is 5 and there are 3 units on hand, ideally a PO is placed for 2. But if the minimum order quantity is 10, then the PO will be placed for 10 and when those parts come in, that material will be over safety stock. In the graph below, the value over safety stock and value under safety stock are very flat. There are some fluctuations but for the most part they are even. This leads me to believe that this is not a main driver of inventory fluctuation month to month. Although this does not cause changes in inventory month to month, it may still be a good source to decrease overall inventory. A deep dive may need to happen to understand why there is almost $40 million of MRO Inventory that is over stock. There may be a better way to make sure inventory does not go over safety stock. It would be good to implement a root cause analysis to understand this bucket of inventory. The causes could be returns, minimum order quantity, intentional over stock, obsolete part, or new decrease in safety stock level. I think there are ways that we could use the data in this app to explore the over stocked materials.
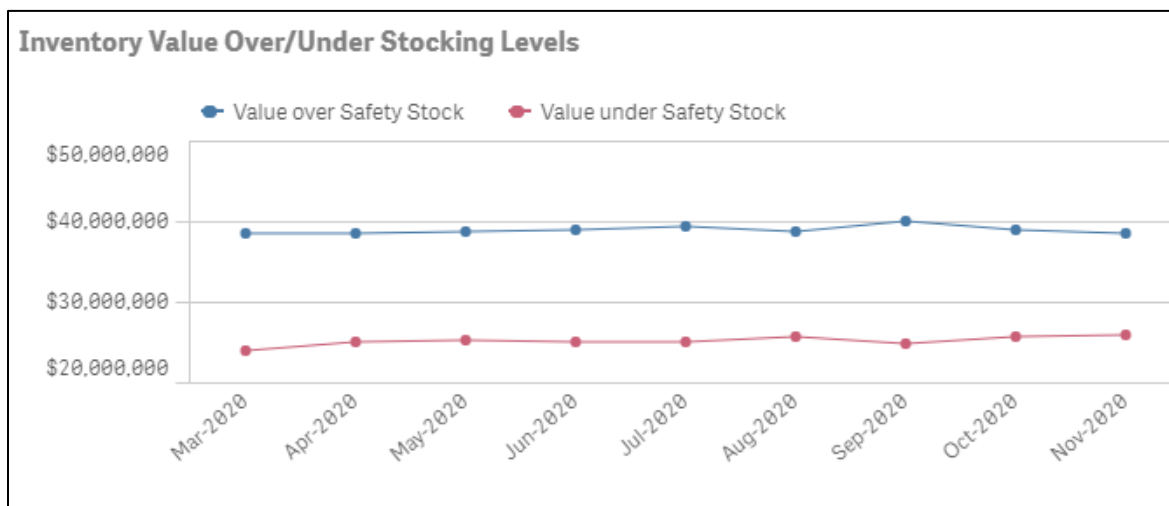
New Material
New Materials are created frequently to keep up with the needs of the plants or mills. When a material is created, it has a created date in SAP. To understand the impact of new materials on MRO Inventory, I needed to pinpoint the month it was first received. Some new materials are created one month and then received a couple of months later because of long lead times. I used the transaction table to capture the new material receipt date. The graph below shows when new materials are first received into a plant and sums their value. The colors breakdown the month by plant. Over the past 9 months, there have been $3.5 million in new materials received. This would play a part in MRO Inventory increase.

New Material Based on When it is First Received into the Storeroom
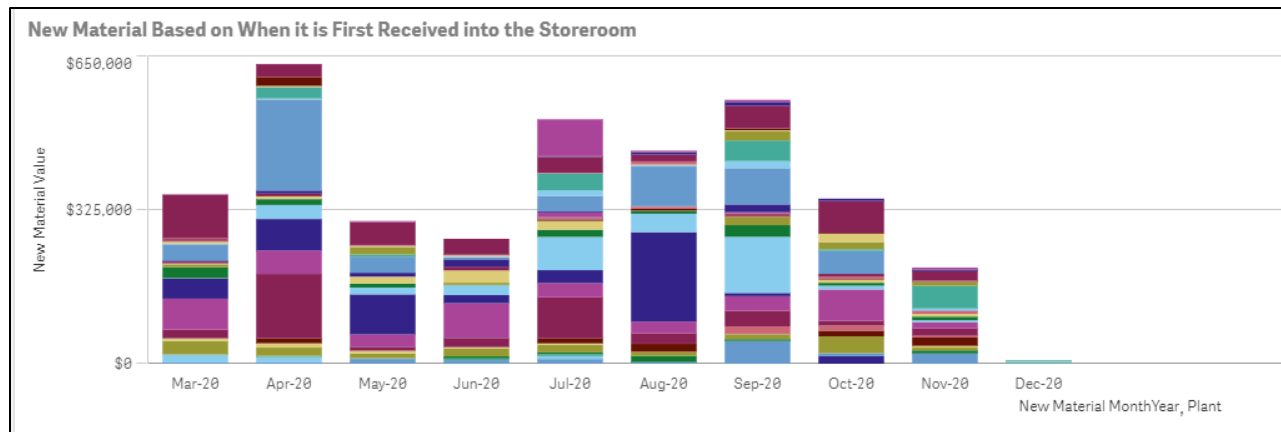
Price Change

Inflation or deflation can play a large part in overall MRO Inventory value. There are two types of price changes that I evaluated: normal inflation and inflation of adjusted prices. The inflation on adjusted prices are materials that were adjusted by accounting because of depreciation. If an expensive part is not used in multiple years, it depreciates. When a part depreciates, is used, and then bought new, the price looks like it increased greatly. In reality, the price change may not be that great, but we were holding a depreciated material. The inflation bucket accounts for prices that change for all other materials. Separating these two types of inflation help facilities determine how to tackle price increases. The price changes from normal inflation account for an increase of 41% of the price increase. The increase from Inflation from adjusted prices make up 29% of the increase. New materials round up the price increases at 31%. This gives us a better understanding on why inventory is increasing over the last 9 months. Targeted approaches can be used to decrease inventory.

Waterfall Analysis

To put it all together, I wanted to compare unit on hand, inflation, inflation on adjusted parts, and new material effect on the overall inventory change. From the end of February 2020 through the end of November 2020, inventory increased by $3.8 million dollars. Based on the waterfall graph below, inflation increased by $4.5 million, inflation on adjusted price increased by $3.3 million, on hand quantity decreased by $7.6 million, and new materials increased by $3.5 million. This past year we implemented a safety stock evaluation with the help of a third party. Based on the graph below, this was successful. The on-hand quantity decreased substantially most likely because of the efforts to safety reduce safety stock settings. The increase of prices-based inflation from adjusted prices is hard to control. This is going to happen because the parts were depreciated and now are returning to their full value. Normal inflation is a bucket that can be targeted. There are many programs to combat inflation. Bidding out parts to multiple vendors can help this. Also buying in larger quantities for many locations can help reduce the price per part. This needs to be a focus of 2021. New Materials were also a big inventory hit in 2020. There were $3.5 million worth of new material. New parts are a necessity but need to be added with

care. There needs to be an initiative to remove parts that are obsolete at the same rate that you add parts.

Shows Value change from Start Date. Starting Value is always $0.
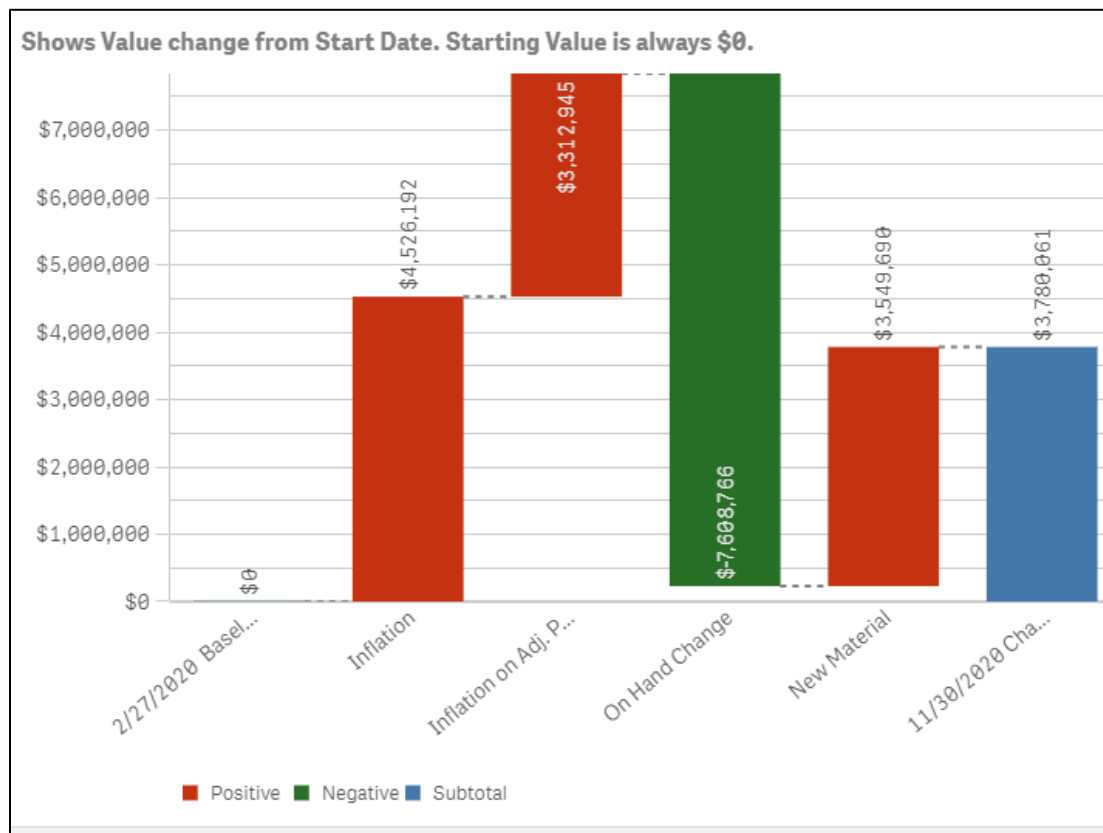
Conclusion

The Qlik Sense app that I created for MRO Inventory is a tool to help many people easily analyze MRO Inventory. It is also a tool that gave me a deeper dive into the data. Understanding why the inventory is changing gives us a path forward to decide how to make sure it does not increase and preferably decrease. To stay competitive, we must monitor our costs and decrease where we can. It is important to not slash inventory because it can be more costly to need a part that you do not have can cause downtime on a machine. The balance between too much and too little inventory is a fine line. If we can monitor and limit inflation, we can reduce inventory without reducing quantity. This is the best of both worlds but is a hard task to accomplish. Removing obsolete parts is another way to reduce inventory without reducing service. Both tactics should be used next year.

References

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Appendix

1. Units compared to Inventory value
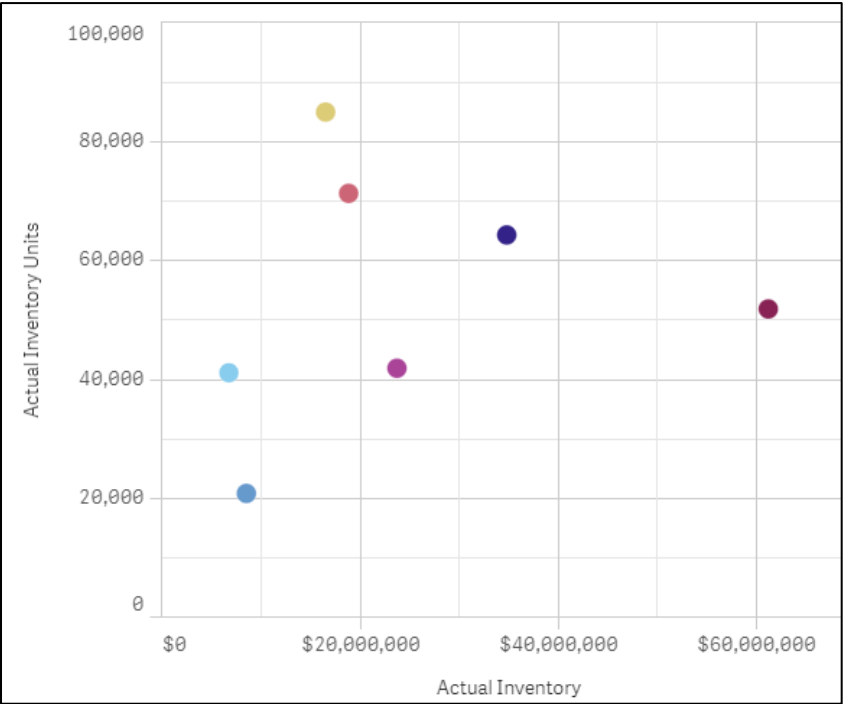
2. Unit count distribution by Month by Plant