

Stock Replenishment Analysis and Optimization for Dynamic Fluid Control

By

**Franko Botes
28097166**

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Executive Summary:

Dynamic Fluid Control has identified the need of a Dynamic Safety Stock mechanism and optimal Economic Order Quantities. The current Static Safety Stock Policy used by the organization results in costs that can be avoided and customer dissatisfaction because of fluctuations in demand during the year. The objective of this project is to supply Dynamic Fluid Control with dynamic safety stock level recommendations as well as optimal order quantities through a Dynamic Safety Stock model. The objective will be satisfied after a comprehensive investigation and analysis of the current Static Safety Stock policy, in order to propose a Dynamic Safety Stock model to Dynamic Fluid Control.

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Section 1:

1. Introduction

1.1. Background Information:

Dynamic Fluid Control Pty Ltd. (DFC) was established in the year 2001. Their service and products are well established locally and internationally. Their international market contains seven of the most renowned and recognized valve brands.

Since 1958 the entire company carries a tradition of fine production, individual brands that permeates a good level of service as well as technical support even though the company changed in name. Management identified the two prime markets, namely mining and water, and with the natural synergies amongst the variety brands the company was divided as follows: DFC Water and DFC Mining & Industrial. These two companies are responsible for the marketing, service and research and development of Dynamic Fluid Control (Pty) Ltd. Dynamic Fluid Control strive to satisfy customer's expectations with professional solutions and products, which requires a dynamic and dedicated management team.

Dynamic Fluid Control exports the majority of their products, but also enjoys a fair share of the local market.

Dynamic Fluid Control's main office is situated in Benoni. Dynamic Fluid Control has two manufacturing plants, one of them located at the main office, while Sebenza is located in Edenvale. Dynamic Fluid Control also has two assembly plants, one located in America while another is based in Finland. [www.dfc.co.za]



Figure 1: Manufacturing plant in the 1950's.

2. Problem Statement

The inventory policy adopted by the organization is designed to keep safety stock of high flowing items and only place an order per customer order for low flowing items (or make to order). In other words safety stock is rarely kept for low flowing items. The following short term benefits are obtained from keeping minimum inventory levels:

- Increase cash availability.
- Reduce the risk of material and components wastage, not being used.
- Reduce storage requirements
- Manufacturing is systematic

Furthermore, the safety stock kept by the organization is in static format, it does not adapt according to demand changes experienced during the year. The main difficulty encountered when an organization relies on static safety stock is that at any point in time, the safety stock rarely truly satisfies the demand.

This difficulty can further be subdivided into two categories: the first is that of too much stock and the second is a shortage of safety stock, according to the demand.

Although overly high safety stock levels supplies an organization with the security of ever meeting demand, it sports numerous disadvantages:

- The organization will have to pay high storage costs due to the excess safety stock.
- It will have a noticeably negative impact on the organizations cash flow.
- A large amount of obsolete material due to ever changing product lines and customer requirements.

During periods where a shortage of safety stock is experienced, the disadvantages are:

- Low productivity levels due to production halts.
- Unacceptable long lead times.
- Lost customers due to unreliable service.

The addition of a Dynamic Safety Stock model to the existing Inventory Management model is required to provide the following optimum conditions:

- Optimum Safety Stock levels

3. Project Aim

The project objective is to implement a Dynamic Safety Stock model for Dynamic Fluid Control that provides dynamic safety stock levels in accordance with the organization's demand requirements. The purpose of the Dynamic Safety Stock model is to reduce storage costs and the costs associated with obsolete components and enable more efficient inventory management.

If the project schedule were to allow it Economic Batch Quantities of all raw materials and/or components will be determined and included within the scope. This aspect of the project will provide quality information on:

- Quantity to order
- Cost of order
- Cost of stockholding

4. Project Scope

Dynamic Fluid Control requires a Dynamic Safety Stock model for improved Inventory Management. The project objective is to provide Dynamic Fluid Control with suitable dynamic safety stock levels as a function of lead time. The Dynamic Safety Stock model should not only provide suitable safety stock levels but also minimise all costs associated with inventory management. Costs such as:

- Ordering cost
- Holding cost
- Setup cost
- Opportunity costs

The Dynamic Safety Stock model should be user friendly, easily updateable and maintainable, since maintenance and future development of the model will eventually become Dynamic Fluid Control's responsibility. The Dynamic Safety Stock model will focus only on the procurement of raw materials and components required for manufacturing and not on finished products that are delivered to customers.

5. Deliverables

- A comprehensive study must be conducted on the current inventory management model of Dynamic Fluid Control to accurately design the Dynamic Safety Stock model.
- The analysis of the present Replenishment policies and underlying (if any) motives thereof.
- Determine sufficient Dynamic Safety Stock levels.
- Incorporate sufficient dynamic levels of Safety Stock into a sustainable inventory management model.
- Study EOQ, Operations Research and MRP Inventory Management methods available in practice.

All above mentioned methods need to be subjected to comprehensive research and logical reasoning.

- Candidate solutions:
 - Create a Dynamic Safety Stock model in MS Excel using a query from Syspro (Dynamic Fluid Control's Information System), supplying Dynamic Fluid Control with live data throughout inventory management activities.
 - The MRP in current use modified by manner of providing an additional module stipulating the required daily inventory levels.
- Implement preferred solution and provide training required to operate the model.
- A mechanism to ensure continual customer satisfaction and footprint expansion.

Section 2:

1. Literature Study

1.1. Inventory Management

Inventory Management is currently presented with a wide variety of competent material planning methods that control the material flow within a supply chain segments. Examples of these methods are the Material Requirements Plan (MRP), Run-out time, Re-order Point, Kanban and Fixed order interval. These methods demonstrate numerous similarities but mostly differ in the type of inventory they control.

The performance for material planning depends greatly on employing the correct method and applying it properly. In order to ascertain acceptable performance levels, parameters need to be determined mathematically and not based on experience or so-called gut feel based on experience. A longitudinal study conducted by Jonsson and Mattson (2006) concluded that companies between 1993 and 2005 used general judgement to determine parameters for order quantities and safety stocks. There are very sophisticated systems in use and companies have paid billions for these systems. Companies not using these expensive sophisticated systems but uses more in-house developed systems, will often not apply the correct methods to determine mathematically calculated parameters.

The two fundamental questions asked in material planning are the Time related question “When to order/deliver?” and the Quantity related question “How much should be ordered?”. These questions are answered by a wide range of material planning methods that are further categorised into dependant and independent demand categories. MRP is the best method for organizations that conduct material planning experiencing dependant demand regarding their materials. The other mentioned material planning methods are applied to situations were independent demands are expected. Rabinovich and Evers (2002) showed that MRP is the method most frequently used for controlling the flow of raw materials, work in progress and finished goods.

The determination of order quantities is basically a matter of balancing inventory carrying costs and ordering costs. Manufacturing companies tend to use MRP models for their inventories where distribution companies are more likely to use the Re-order Point method for their inventory management purposes. (Jonsson & Mattsson 2008)

When a basic Economic Ordering Quantity (EOQ) model is studied, the following assumptions are made:

- Demand is deterministic and occurs at a constant rate.
- A set up cost “K” is incurred per order.
- Lead time for each placed order is zero.
- No shortages are allowed.
- The inventory cost “h” is per unit per time period.

In practice the assumptions mentioned above cannot be made as demand will not be constant and there will almost certainly be a lead time when ordering raw materials or products from a supplier.

Ordering costs are once-off costs that are associated with placing an order but do not depend on the quantity that is ordered. Inventory carrying cost can be explained as the cost associated with holding one unit of inventory per time period, including costs such as taxes on inventory, storage cost and insurance costs. Lead time is the total time from the instant an order has been placed up until the order arrives at its destination.

When working with a nonzero lead time the amount of stock that is left in inventory must be calculated in order to place the next order. This will ensure that the inventory level is at zero when the ordered inventory arrives. The point in time where the new inventory is ordered is called the Reorder Point. This Reorder Point may fluctuate with the demand. (Winston n.d.)

1.1.1. Material Requirements Planning (MRP)

As can be deduced from section 1.1. of this paper, it is evident that numerous inventory management methods are available. For the purpose of this paper, only Material Requirements Planning will be examined in more depth, as it is the inventory management model practised by Dynamic Fluid Control.

Production due dates in the manufacturing environment poses a constant problem. Since most of the total capacity of a manufacturing plant is normally fairly inflexible the following two points cause problems when variations in demand are experienced over time:

- Quantity of products demanded
- Product mix

This can partially be curtailed to some extent by changing the manufacturing capacity to the short term varying demand but it is usually very costly.

Increasing finished products in the inventory and by increasing the work in progress is an approach to alleviate the production scheduling problem. It is obviously very costly to make increases in finished products and work in progress. This results to unsatisfied customers and inefficient utilization of production facilities due to production scheduling problems.

By including materials requirements in the statement of the schedule is an essential part in creating a realistic production schedule. The manufactured components and raw materials needs to be available when operations are scheduled to take place at particular work groups without any unnecessary delays.

The following is an integrated approach to the materials requirements plan (MRP):

- By loading the production operations of the required jobs (Products, Inventory, manufacturing processes), a feasible production schedule is obtained from the list of required finished goods by quantity and date (master production schedule).
- A start time and finish time is then allocated to a job through the capacity constraint schedule.
- For each operation a list of material requirements is given by the time phased material requirements plan included in the schedule. Since the time phased material requirements plan is based on a feasible production schedule, it is assumed to be realistic.
- The bill of materials is combined with the production scheduling routine as a data processing task.
- The production scheduling computer links each operation to its materials requirements information for the same time slot. These requirements are then showed as output, showing the exact times and quantities.

- Each material's requirements are then procured taking into account the on-hand inventory as well as on-order quantities.

(Hastings, Marshall & Willis 1982)

1.2. Safety Stock

Supply Chain Managers are faced with an arduous task when managing inventory levels and especially so for safety stock. Any decisions related to inventories have a major impact on the lead times, response time, service time and total cost of the supply chain. The function of safety stock is to protect Supply Chains from demand variability. For this reason correct levels are critical. (Sitompul et al. 2008)

Sitompul et al. (2006) said most companies usually keep safety stock at the final stage of the supply chain where the retailers deal with the customer's demand. This means, the final stage of a supply chain, addresses the variation effect of demand. Reality shows that the variability of demand cannot be fully addressed at the retailer stage. The upstream stages of the supply chain gets breached by the effect of variability in demand, this effect goes through to the production stages up to the supply of raw materials. (Sitompul et al. 2006)

Given the variety of factors influencing inventory levels, it makes sense to hold safety stock at some critical stage of the supply chain. The safety stock inventory may consist of the following; raw materials, finished goods and semi-finished goods (Sitompul et al. 2008). The key is to determine the right amount of stock at the correct location at the lowest cost (Sitompul et al. 2006). With the variability in lead time demand, a safety stock level is required to compromise the variability in order to maintain a given service level (Sitompul et al. 2008). Strategies to procure efficient safety stock levels can be deployed after all of the above mentioned relationships have been determined (Sitompul et al. 2006).

Safety stock is affected by three levers in a fixed-cycle service level – uncertainty of the demand, replenishment lead time and the uncertainty of the lead time. These relationships have been estimated through normal approximation. (Chopra, Reinhardt & Dada 2004)

Based on the argument of central limit theorem the approximation is often justified, according to Eppen and Martin (1988). In reality Eppen and Martin (1988) say, “the normality assumption is unwarranted in general and this procedure can produce a probability of stocking out that is egregiously in error”.

Reducing the lead time variability for cycle service levels above 50 % will decrease the reorder point and the safety stock levels. Reducing the lead time variability for cycle levels above 50% is more effective than reducing the actual lead times due to such decrease in safety stock. Managers tend to focus on service quality measures such as the “fill rate” (Aiginger, 1987; Lee & Billington, 1992; Byrne & Markham, 1991), instead of the cycle service level. The proportion of the demand that is met from inventory is measured by the fill rate, whereas, the proportion of replenishment cycles where a stock out does not occur is measured by the cycle service level. (Chopra, Reinhardt & Dada 2004)

1.2.1. Fixed Safety Stock Policy (Static)

In the fixed safety stock policy the inventory level is brought back to a safety stock level if the current inventory position minus the lead time demand is less than the safety stock level. In this policy, the order quantity to level and the reordering point are the same. Analytical calculations are used to determine fixed safety stock levels. This means the fixed safety stock levels remains constant until it is manually changed. (Rawat & Altiok 2008)

1.2.2. Dynamic Safety Stock Policy

In terms of ordering and parameters used for controlling inventory, the dynamic safety stock policy is identical to the fixed safety stock policy. The constant change in the safety stock levels with respect to the demand is the major difference between the two policies. This entails that lower safety stock levels will be stocked if the demand is of low intensity and higher safety stock levels will be stocked during peak demands. This means that the safety stock levels keep changing dynamically on a daily (fixed time) basis. “Safety time” is known as the period (days, weeks, etc.) for which the safety stock level can cover the deviation in demand. The fill rate of a dynamic safety stock policy tends to be the same as other inventory control policies, but with less on-hand inventory. (Rawat & Altiok 2008)

1.3. Moving Averages:

Taking the averages of several sequential values of a time series, collates a moving average which is also classified as a time series. It is a type of mathematical evolution. Weighted averages are also often used. Rolling averages or running means are further measures used when addressing moving averages. The process of taking one time series and transforming it into a different time series is called “filtering”. The term “moving average” is used to explain the process since each average is calculated by eliminating the oldest observation and including the latest next one.

The most popular “Mean Average” methods being used are:

- Two-sided (weighted) moving average
- One-sided (weighted) moving average

Smoothing of a time series for the estimation or emphasizing the underlying trend are done by the two-sided (weighted) moving average, whereas the one-sided (weighted) moving average is used for simple forecasting methods for the time series. Forecasting, decomposition and time series smoothing are all complicated methods that use the very simple application of “moving averages” as building blocks. Observations which are close by in time are also possibly close in value is the main concept in use for smoothing moving averages. A reasonable estimation of the trend is obtained at a certain observation by taking the average of the points at the same observation. This means that a smoother trend is obtained by eliminating some of the randomness in the data. (Hyndman 2009)

Section 3:

1. Supplementary Methods

The three solutions considered were:

1. Modifying the current Static Safety Stock model within the MRP that will result in provision of Dynamic Safety Stock levels to Dynamic Fluid Control. The Dynamic Safety Stock levels will be the actual safety stock levels for each time period and updated automatically on the MRP as demand fluctuates. It will eliminate the requirement of physical input by a user.
2. Creating a Dynamic Safety Stock model in MS Excel using a query from Syspro (Information System used by Dynamic Fluid Control), supplying Dynamic Fluid Control with consistent live data each time when refreshing the model. The following two options are based on this query:
 - 2.1. The model will provide Dynamic Fluid Control with suggested dynamic safety stock levels and the query should be executed in such a manner that the suggested dynamic safety stock levels get written back into the MRP when the query is refreshed. This means that the suggested dynamic safety stock levels in the query will become the actual safety stock levels in the MRP. Therefore a user is only required for the refreshing of the model.
 - 2.2. The model will only provide dynamic safety stock level recommendations and won't necessarily become the actual safety stock levels. Therefore it is the prerogative of Dynamic Fluid Control to adapt the safety stock levels within the MRP to the level of suggested dynamic safety stock computed by the MS Excel model. This option requires a more frequent interaction from the user with the model.

Although option 1. and 2.1. would be more efficient in solving the problem option 2.2. was selected as the solution to be implemented due to time constraints and limited knowledge. The concept of the model is similar to that of the other options but differs in the sense that it will require recurrent inputs from a user to update the safety stock levels on the MRP.

2. Data Analysis

2.1. Raw Data

Raw data was obtained from Dynamic Fluid Control (Appendix A). Raw data includes \pm 35000 raw materials and/or components. Due to the size of the raw data only a few raw materials will be used as examples in the document. After analysis of the data it became evident that the Static Safety Stock is certainly not ideal (Figure 1).

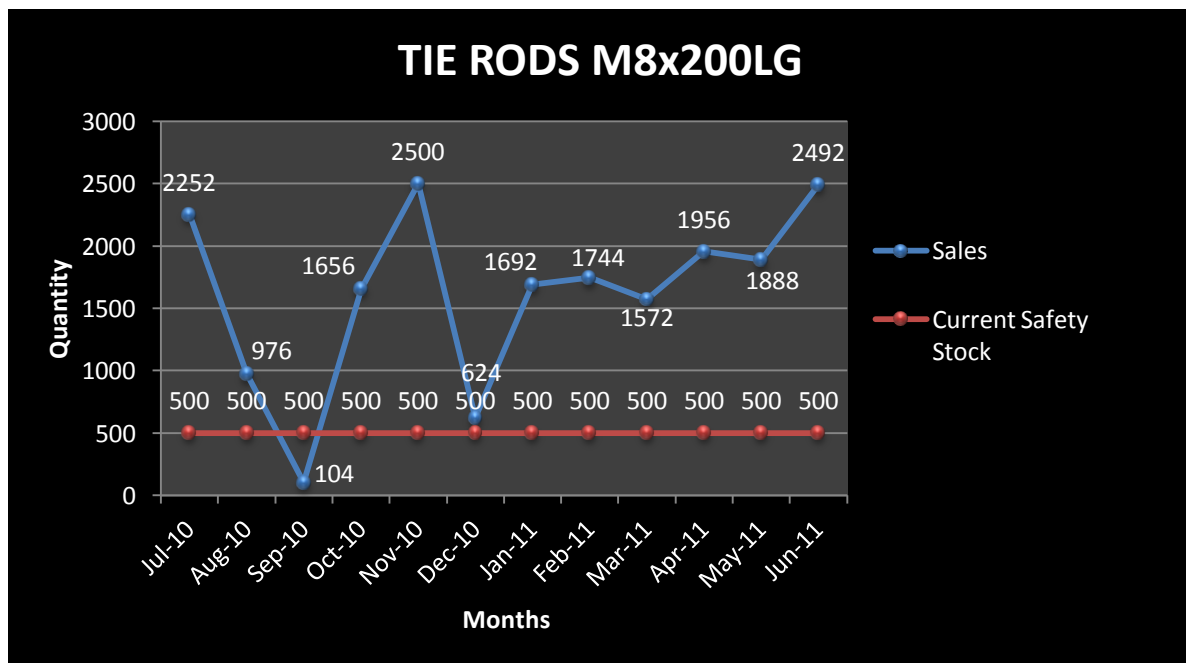


Figure 1: Demand of 12 months with current safety stock level.

The lead time for the component (Tie Rods M8x200LG) is 10 days (Figure 1). With the current safety stock level on 500 units, Dynamic Fluid Control paid an unnecessary excess in inventory costs during Sept 2010 & Dec 2010 due to the low demand and excessively high safety stock levels. Since Jan 2011 – Mar 2011 the average consumption rate of the component was 56 units/day. With the current consumption rate the current safety stock will be exhausted within nine days if a problem should arise. This will lead to an increased lead time of the customer of one day. Since the increase in demand from Apr 2011 – Jun 2011 the average consumption rate increased from 56 units/day to 70 units/day. This indicates that the current safety stock will be exhausted within seven days if a problem should transpire, which shows that the customer's lead time will increase with three days.

The lead time endured by a customer is an important component of Customer Satisfaction and must be kept to a minimum. The increases in customer lead time might seem insignificant but is unacceptable considering Dynamic Fluid Control competes in a fierce global league where extended lead time could be an inconvenience to a customer that makes him seek the product elsewhere. Because Static Safety Stock does not fluctuate harmoniously with demand, it is responsible for the abovementioned problems. More examples of these graphs are available in Appendix B.

2.2. Playing with Data

In Figure 2 it becomes apparent that the demand fluctuates continuously over a period of 12 months. This redoubles the difficulty to determine Dynamic Safety Stock levels as safety stock cannot fluctuate adequately with demand (Figure 2).

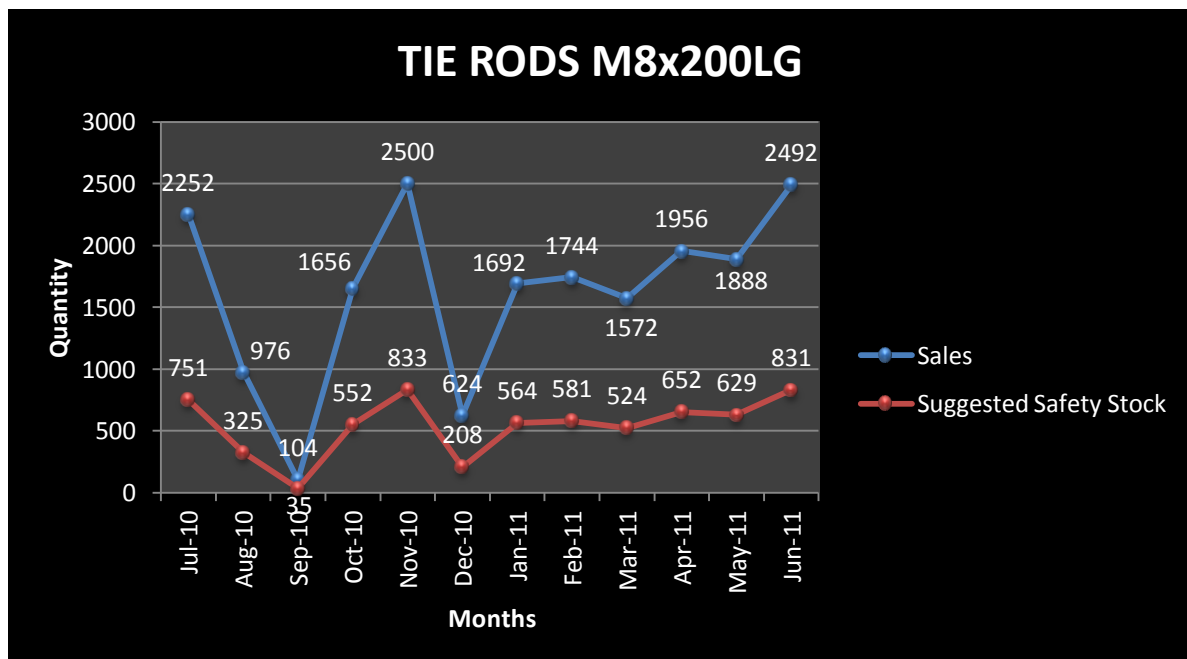


Figure 2: Demand of the last 12 months with suggested safety Stock.

The Suggested Safety Stock was calculated by the data obtained (Figure 2):

- Consumption rate per day = Demand / 30 days
- Suggested Safety Stock = Consumption rate per day * Lead time

Since safety stock levels cannot fluctuate adequately (Figure 2) a method was searched for to resolve the problem. The best way found to resolve the problem was to acquire a smoother demand trend. This was done by using moving averages of three month intervals (average demand per month of a quarter). The big jumps and/or drops in demand are due to unnatural causes, therefore when taking the average demand over a period of three months a more realistic demand is acquired that also supplies a much smoother trend (Figure 3).

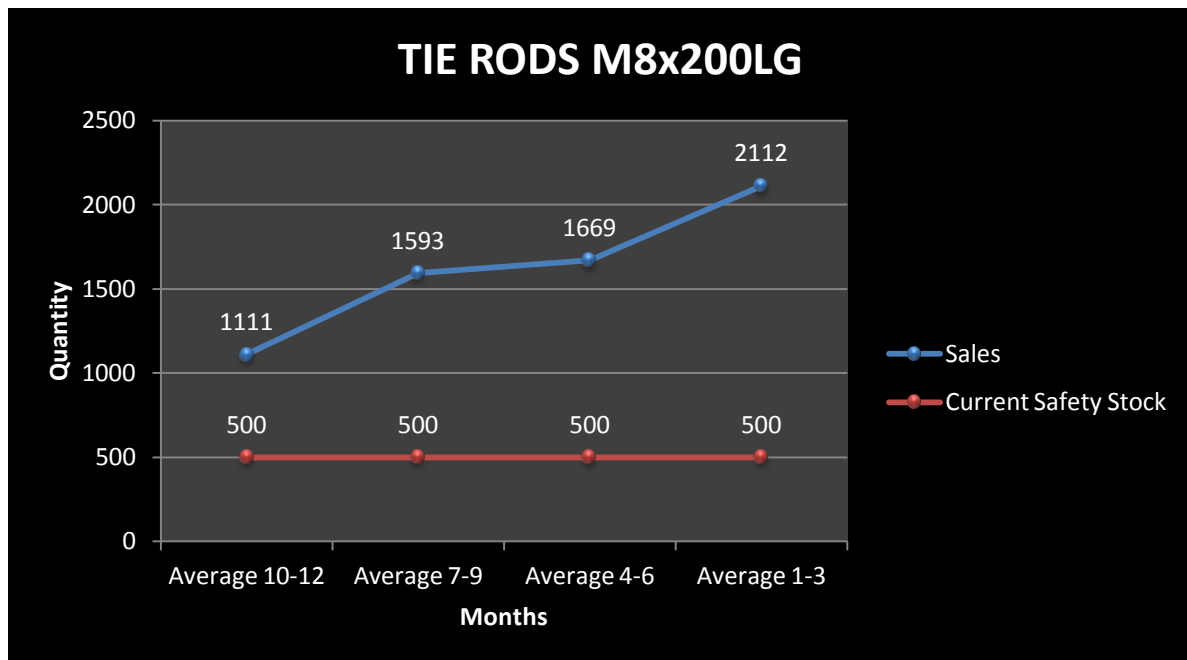


Figure 3: Demand with moving averages and current safety stock.

This allows determination of dynamic safety stock sans many fluctuations. The final model with the suggested safety stock levels can be seen at the problem solving stage.

3. Development of Conceptual Design

Note that the following points apply to all of the $\pm 35\ 000$ raw materials and/or components stocked by Dynamic Fluid Control:

- Moving averages of three month intervals are used for demand to present a smoother trend.
- Average consumption rate per day is determined.
- A “Calculated Safety Stock” column with the following conditions:
 - If the Lead Time is greater than zero.
 - If the new “Calculated Safety Stock” column is within 6% (round about) of the current safety stock.
 - If the new calculated safety stock is within 6% of the current safety stock implemented it takes on the value of the current safety stock.
 - If the new calculated safety stock is outside this 6% it takes on the value of the new calculated safety stock.
 - Captures a value depending what condition is satisfied.
- A “Suggested Safety Stock” column with the following conditions:
 - Compares the “Calculated Safety Stock” of the new period with the implemented safety stock of the previous period and determines if the two values are within 6% of each other.
 - Captures a value to recommend a new safety stock level for the new period.

The conceptual design can be seen in Appendix C.

4. Final Design

The Final Design is an elaboration on the conceptual design therefore all the concepts of the conceptual design as well as more concepts are build into the Final Design. The elaboration on the conceptual design includes the following concepts:

- The Suggested Safety Stock Column is the new recommended safety stock and should be looked at when comparing it with the current safety stock level.

- A mechanism will be used to show the current safety stock status (red, orange or green) of the raw material and/or component. This is done through conditional formatting to easy identify problems around safety stock.
- A column is included to show whether it is necessary to update the safety stock or not.

This includes all the features of the Dynamic Safety Stock model regarding the safety stock levels.

The Final Design of the Dynamic Safety Stock model also includes columns regarding the calculations around EBQ's such as:

- The Setup Cost which was obtained from Dynamic Fluid Control.
- The Holding Cost which is 12% of the unit price.
- The total cost per order for the current EBQ's.
 - The total cost is calculated with the following formula:

$$\blacksquare \text{TC}(Q) = p \times D + \frac{Q \times h}{2} + \frac{D \times K}{Q}$$

p = Unit price

h = Holding cost/ unit/ time period

D = Demand/ time period

Q = Current Order quantity

K = Set-Up Cost

- Columns for new calculated EBQ's.
 - The EBQ's are calculated with the following formula:

$$\blacksquare Q^* = \sqrt{\frac{2 \times K \times D}{h}} \quad (Q^* \text{ is the optimal order quantity})$$

- A "New Suggested EBQ with safety Stock" column, which are the recommended EBQ's for the order policy.
 - It is the sum of the optimal order quantity and the safety stock:
 - New Suggested EBQ = $Q^* + SS$
- The total cost per order for the new suggested EBQ's.
 - The total cost for the new suggested EBQ's are calculated on the same way as mentioned above.

- A column which compares the two total cost columns.
 - Shows the difference between the total cost of the current order policy and the new suggested order policy.
- Mechanism that shows whether savings or losses occur when the new suggested EBQ's will be used as the order policy.
- A column which indicates whether the current EBQ or the new suggested EBQ should be used.

The Final Design as well as print screens of the implementation at Dynamic Fluid Control can be seen in Appendix D.

5. Problem Solving

- The model makes provision for the fluctuation of demand, in order to calculate new suggested safety stock levels on a monthly basis.
- The model is adaptable to new data.
- If a problem occurs the model can be easily updated and/or changed.
- Mathematical calculation of safety stock levels is used, instead of fixed values.
- The model calculates new EBQ's for each raw material and/or component.
- The total cost of the current EBQ's and the new suggested EBQ's are compared in the model to establish any savings or losses.

The model highlights to the management of Dynamic Fluid Control exactly which raw materials and/or components are presenting problematic safety stock levels and require attention. It also assist management with decision making on which order policy to use, the current EBQ or the new suggested EBQ with the savings or losses that occur. Although the model is only a recommendation tool to bring problem areas under the attention of management it will enrich management decision making and save a significant amount of money and time.

6. Results

6.1. Conceptual Design

- The conceptual design already showed significant differences between the suggested safety stock and the current safety stock.
- The conceptual design showed monthly savings up to 8% per raw material, but it may vary with different raw materials.
- Safety Stock will be managed more efficiently.

Due to these few significant results the Dynamic Safety Stock model was further developed and implemented at Dynamic Fluid Control.

6.2. Final Design

6.2.1. Safety Stock

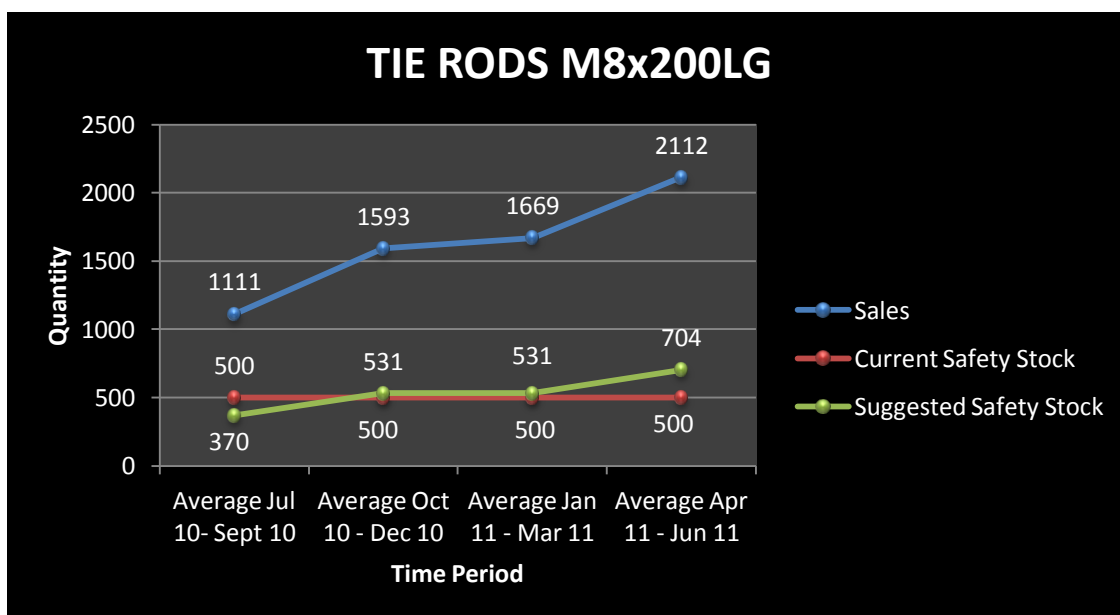


Figure 4: Demand with moving averages, current safety stock and suggested safety stock.

Figure 4 illustrates the dynamic safety stock concept of the Dynamic Safety Stock model by comparing the current safety stock level with the suggested safety stock level. Figure 4 illustrates that during Jul 2010 - September 2010 there were 130 excessive safety stock units. A total of R149.50 excessive storage cost was paid and although it is not a direct loss to Dynamic Fluid Control, it caused an unnecessary decrease in their cash flow of R 1250.60 since having the excessive safety stock in their inventory. Although this is not a

direct loss and the units can still be used in future, the risk exists of obsolete material. During the time periods Oct 2010 – Dec 2010 and Jan 2011 – Mar 2011 the current safety stock level is very close to the suggested safety stock level and Dynamic Fluid Control wouldn't experience any major problems. When looking at the time period Apr 2011 – Jun 2011 a shortage of 204 units of safety stock occurred. This will result in unnecessary long lead times, low productivity and will bring the production to a hold for three days. This indicates that if the correct safety stock level was implemented throughout this period, Dynamic Fluid Control could have saved a minimum of R 1400.10 plus the cost of the production stoppage over the period of 12 months. When looking at this saving it seems small over a period of 12 months but this includes only one of the raw materials and/ or components and when looking at $\pm 35\ 000$ raw materials and/ or components it could result in significant savings. More examples of these graphs are available in Appendix B.

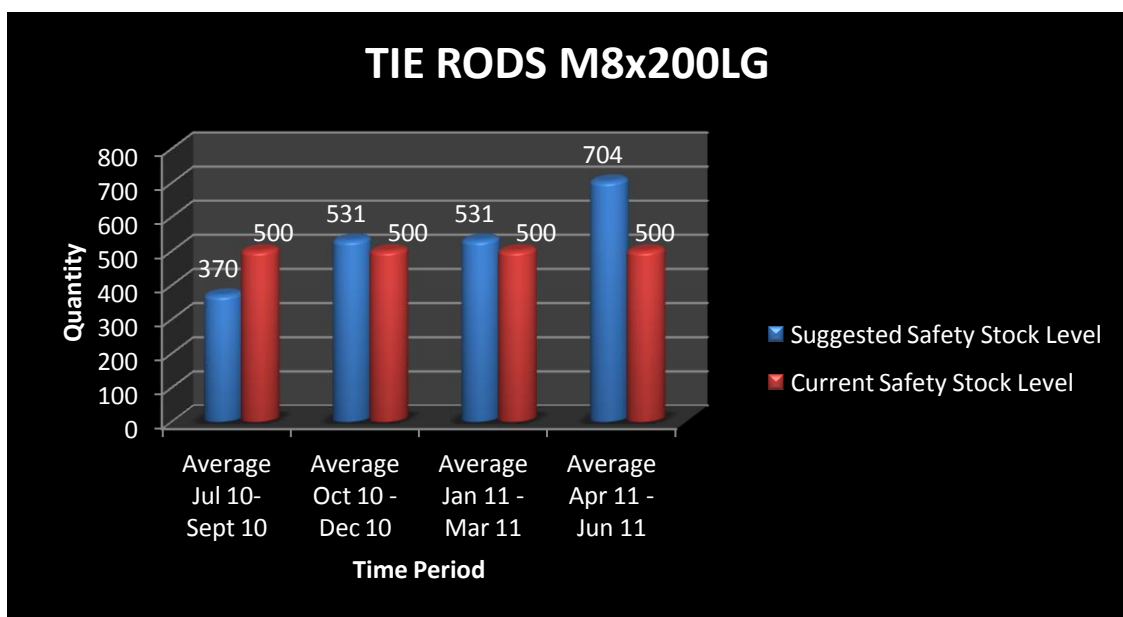


Figure 5: Comparison between current safety stock and suggested safety stock.

Figure 5 illustrates the difference between the suggested safety stock levels and the current safety stock levels during the time periods. More examples of these graphs are available in Appendix B.

6.2.2. Economic Batch Quantities (EBQ's)

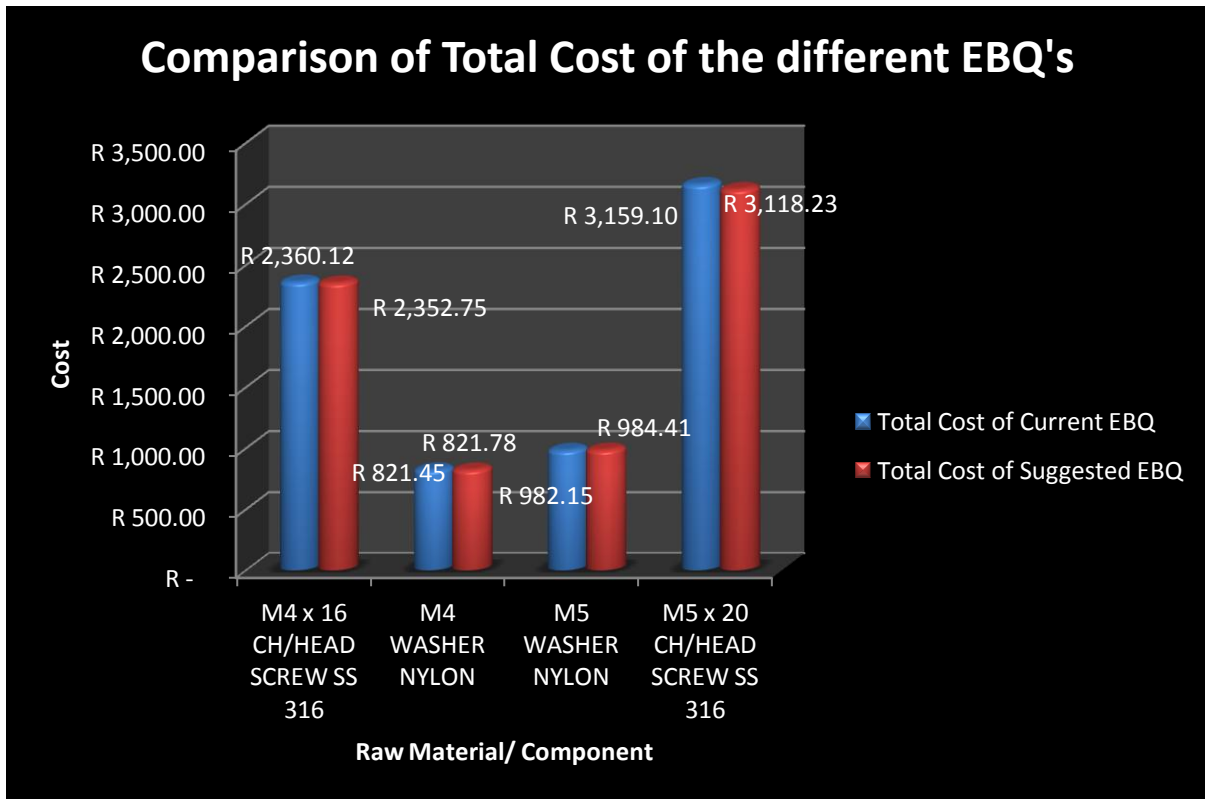


Figure 6: Comparison of Total Cost of the different EBQ's.

Figure 6 shows the comparison between the total costs when using the different order policies namely:

- Current EBQ
- New Suggested EBQ (Calculated by the Dynamic Safety Stock Model)

As can be seen from Figure 6 is not all of the New Suggested EBQ's will be more profitable than the current EBQ's when used as the order policy. For example when looking at the M4x16 CH/HEAD SCREW SS 316 raw material and/or component in Figure 6 there will be a saving of R 7.37 per order when the New Suggested EBQ will be used. But when looking at the M5 WASHER NYLON raw material and/or component a loss of R 2.27 per order will occur when using the New Suggested EBQ as the order policy. Therefore this is also only a recommendation tool to compare the different order policies to see which one of the order policies should be used as the New Suggested EBQ won't always be the most profitable one. There is a column included in the Dynamic Safety Stock model that provides which one of the order policies should be used to get the most profitable result (Appendix D).

Note that the current EBQ is equal to a month's demand so it may vary from month to month which one of the order policies will be used to get the most profitable result. The Dynamic Safety Stock Model model automatically updates the data on a request of a user, therefore the EBQ's will also be automatically updated when the Dynamic Safety Stock Model is updated. Although the savings are very small that are showing when using the New Suggested EBQ's, it can contribute in significant savings when looking at $\pm 35\ 000$ raw materials and/ or components. More examples of these graphs are available in Appendix B.

Section 4:

1. Recommendations

- Safety Stock:
 - To replace the current Static Safety Stock with the Dynamic Safety Stock method where relevant.
 - To implement the Dynamic Safety Stock model at Dynamic Fluid Control in order to monitor the changes for management with the new proposed safety stock levels.
 - To appoint someone on a permanent basis to regulate the safety stock on a daily basis.

- Economic Batch Quantities:
 - To have a look at the Dynamic Safety Stock model to see which one of the EBQ's should be used before an order is placed.

- Give relevant training to all of the staff working with the Dynamic Safety Stock model.
- The model should be updated and used on a regular basis.
- To write all of the concepts that are included in the Dynamic Safety Stock model directly into the MRP of Dynamic Fluid Control on a later stage, which will save them even more time and money.

2. Conclusion

The research and data analysis showed that Dynamic Fluid Control's current static safety stock policy is not very effective and is the root of many problems that occur. Therefore a method to resolve this is to use the Dynamic Safety Stock model as a guideline. The Dynamic Safety Stock model is a versatile and user friendly query written in MS- Excel to assist with inventory management. Along with the dynamic safety stock policy there are many conditions that must be satisfied to make it more cost and time effective than the static safety stock model as mentioned in the conceptual and final design. With all the conditions incorporated and after the implementation of the Dynamic Safety Stock model with Dynamic Fluid Control, the advantages with safety stock control and economic batch quantities will be significant. The Dynamic Safety Stock model will help save a lot of time and money for Dynamic Fluid Control with implementation.

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Section 5: Appendices

1. Appendix A: Raw Data

2. Appendix B: Graphs

3. Appendix C: Conceptual Design

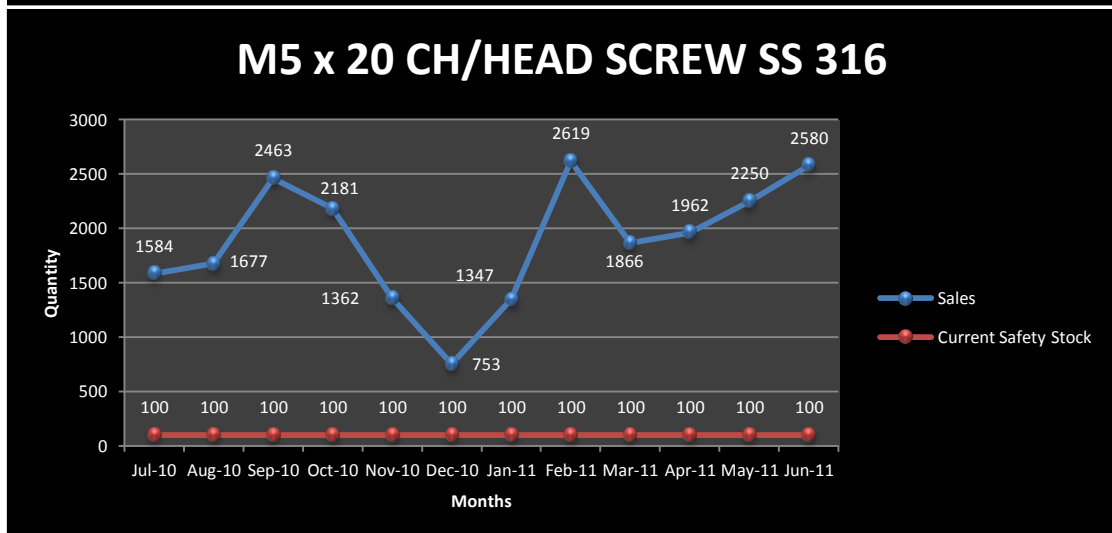
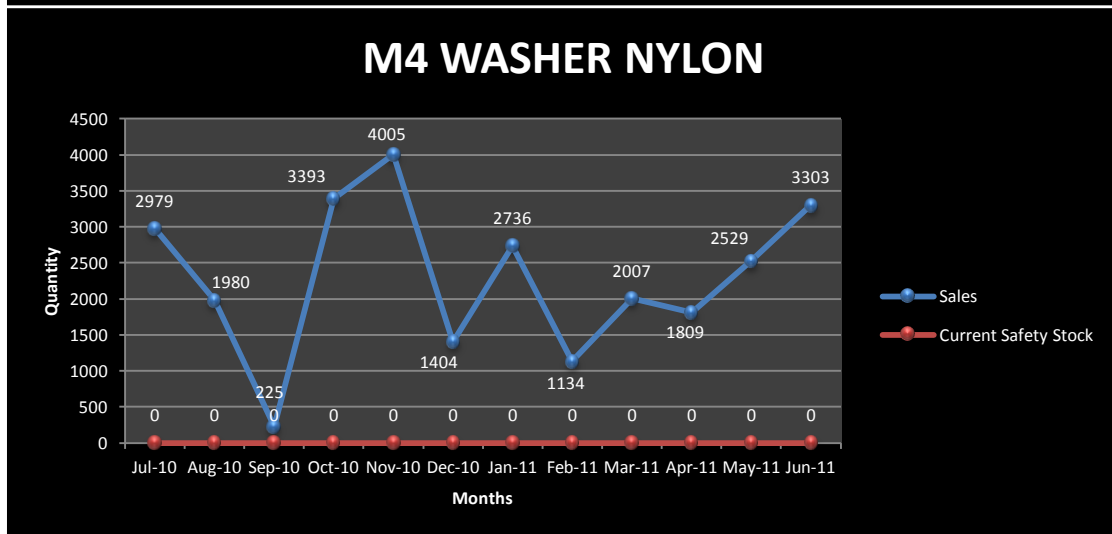
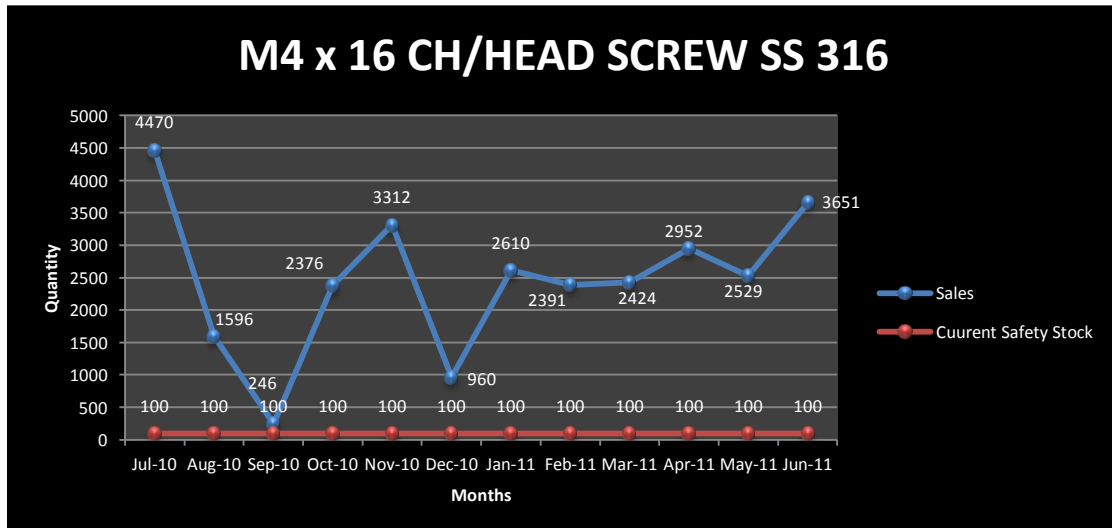
4. Appendix D: Final Design

1. Appendix A: Raw Data

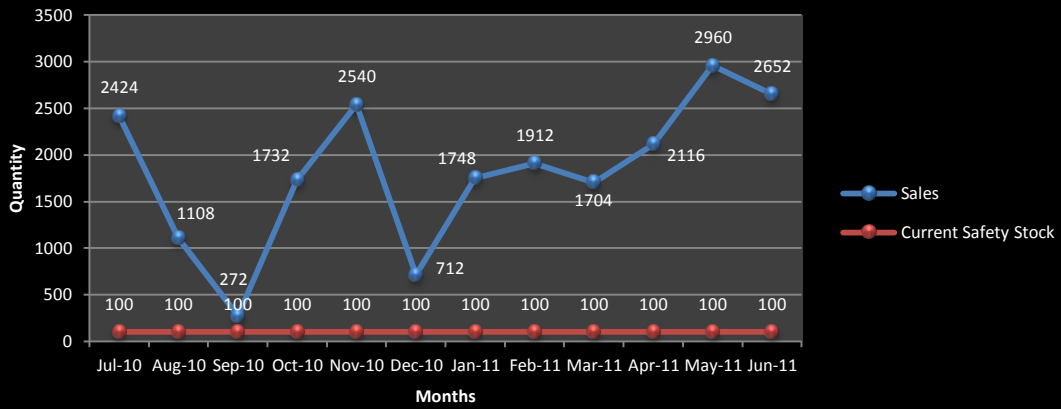
Due to the size of the raw data it cannot be included in the document and must be printed separately.

2. Appendix B: Graphs

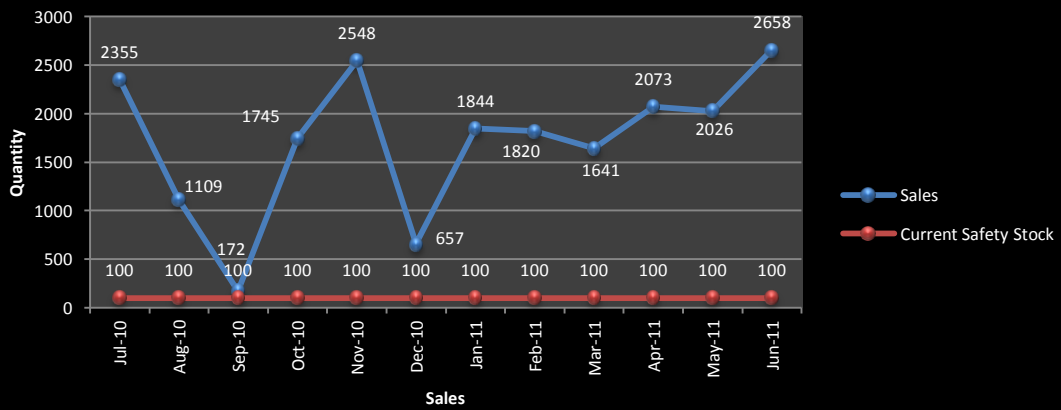
2.1. Raw data graphs



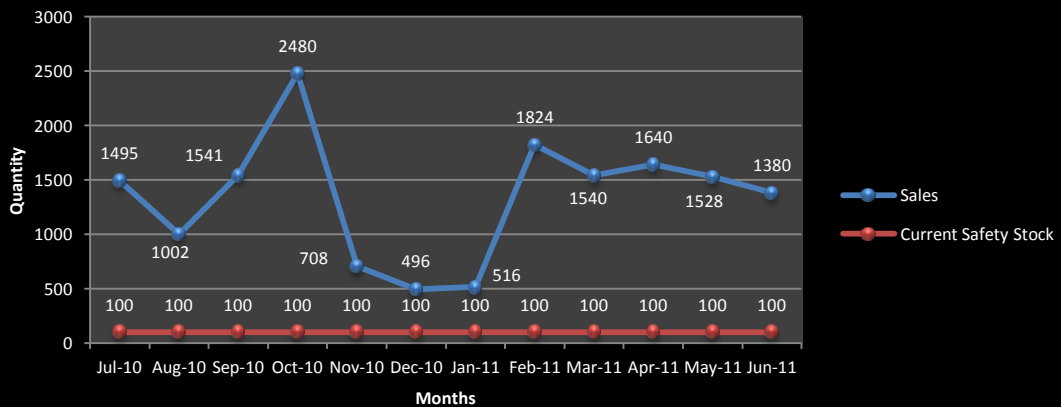
M8 WASHER SS 304



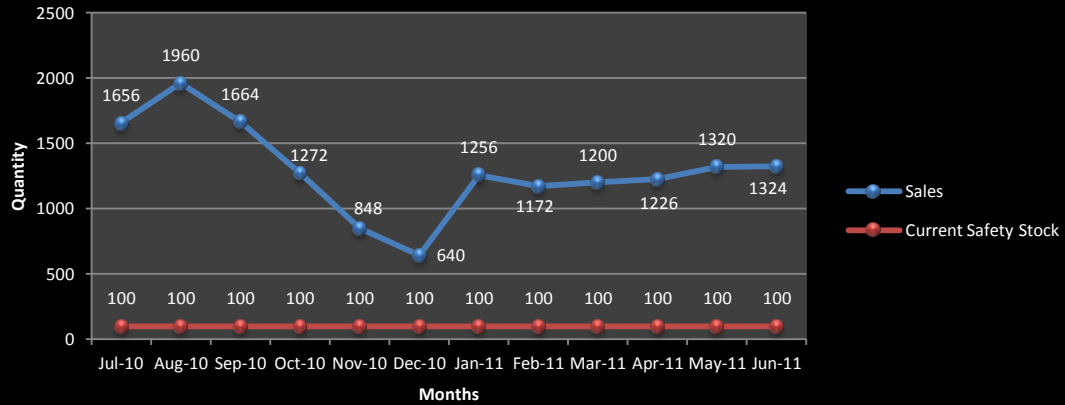
M8 NUT SS 304



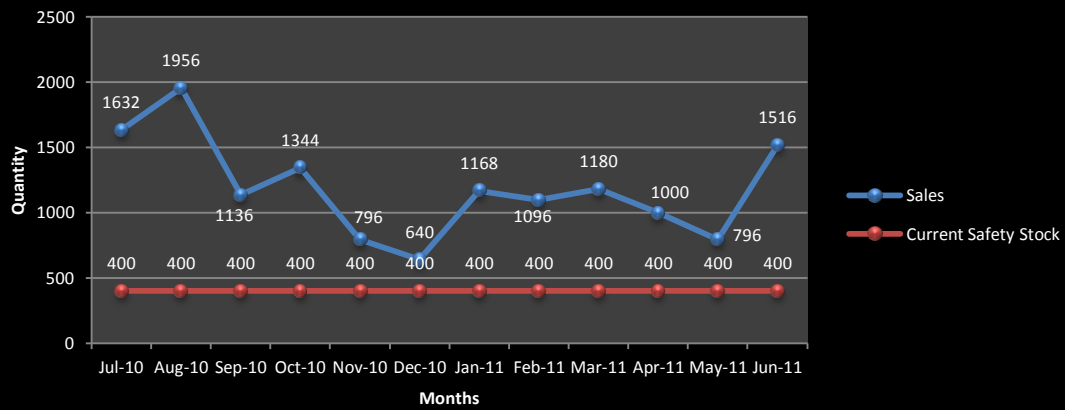
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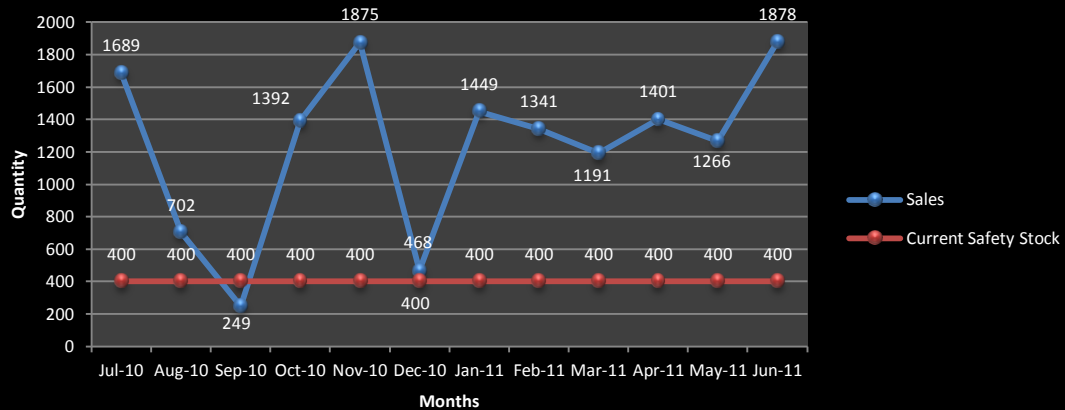
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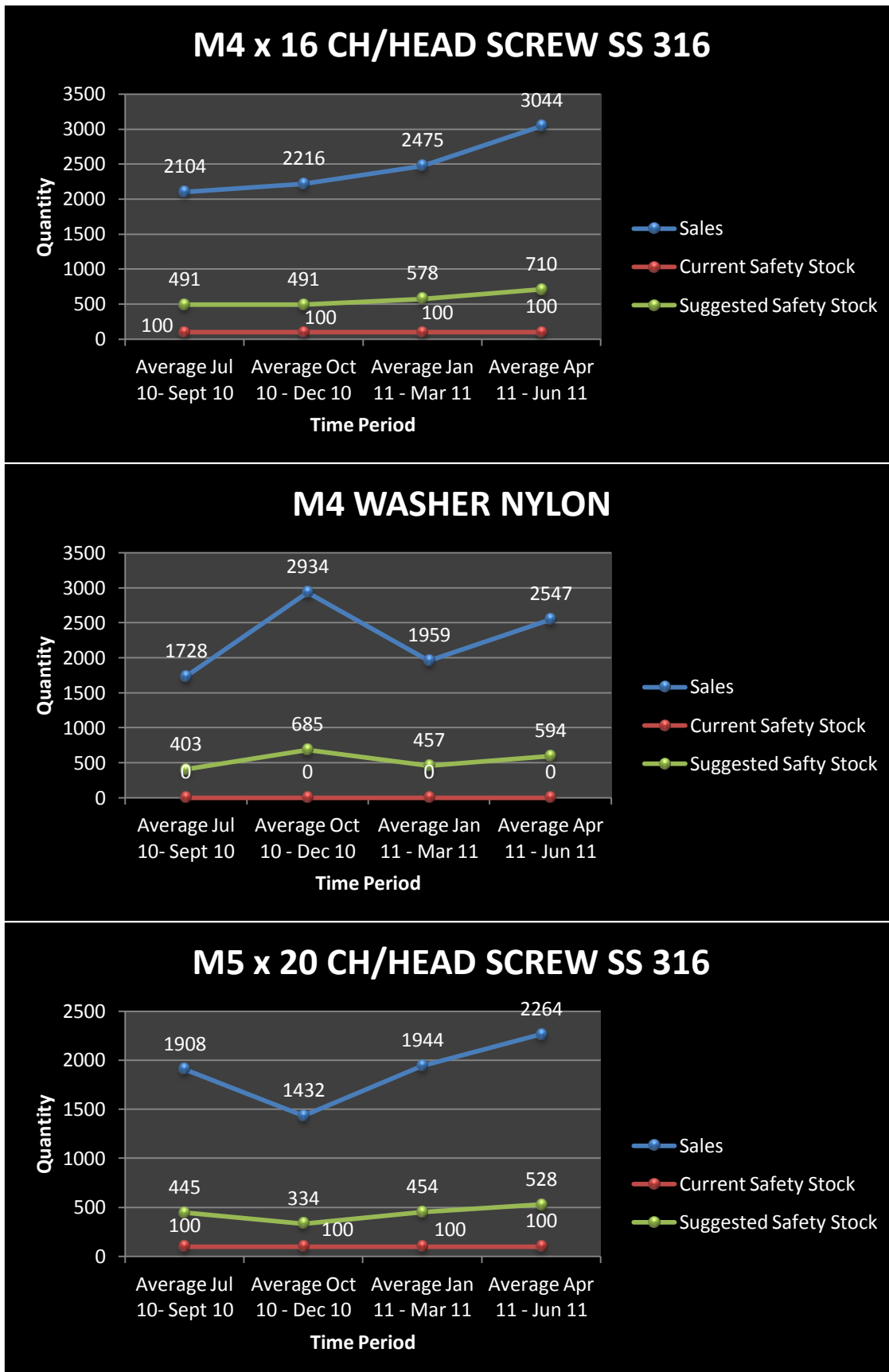
TIE RODS M12x237 LG



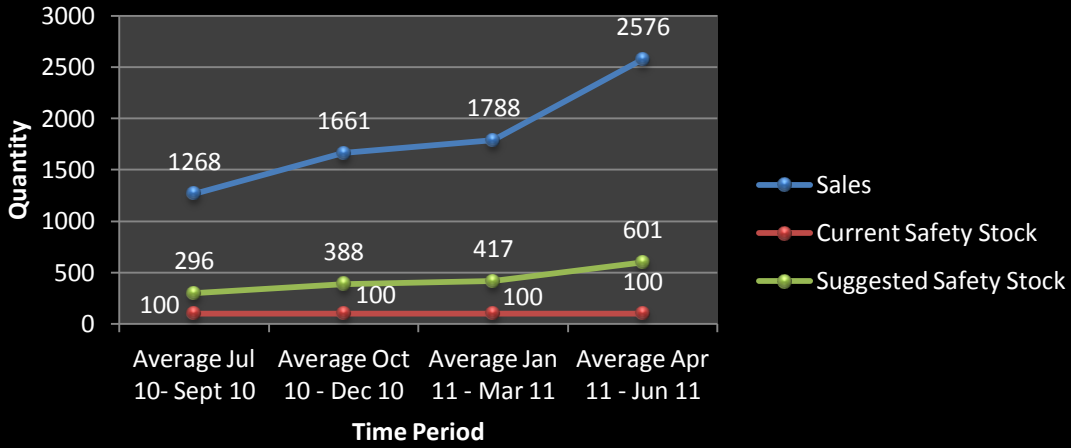
FLOAT GUIDE



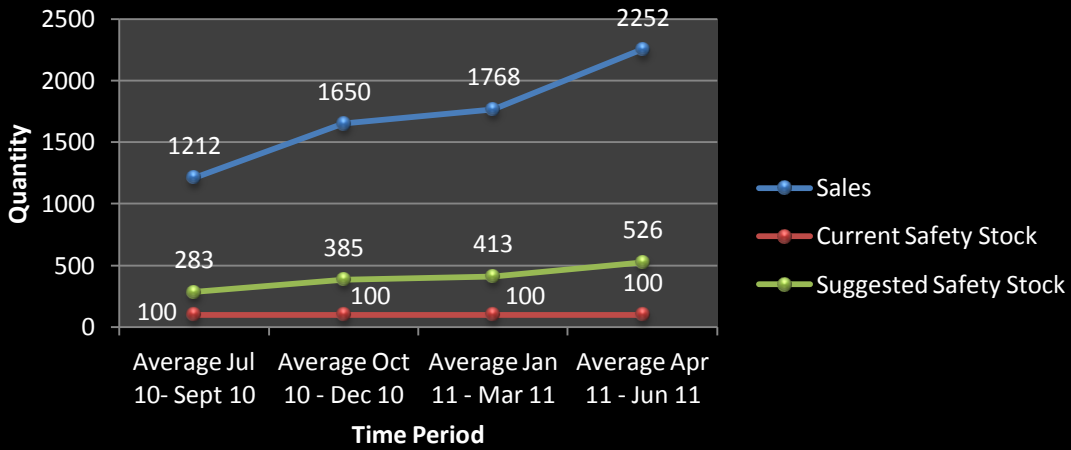
2.2. Final Design graphs



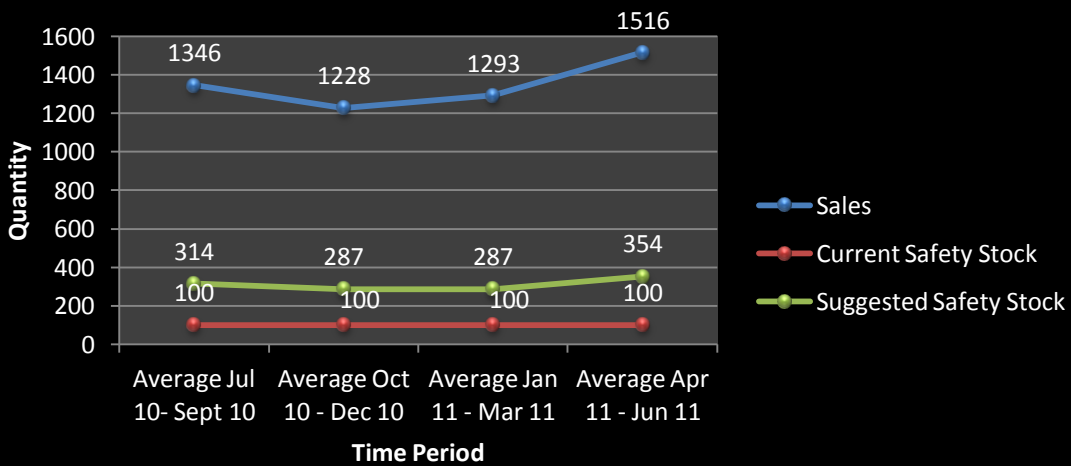
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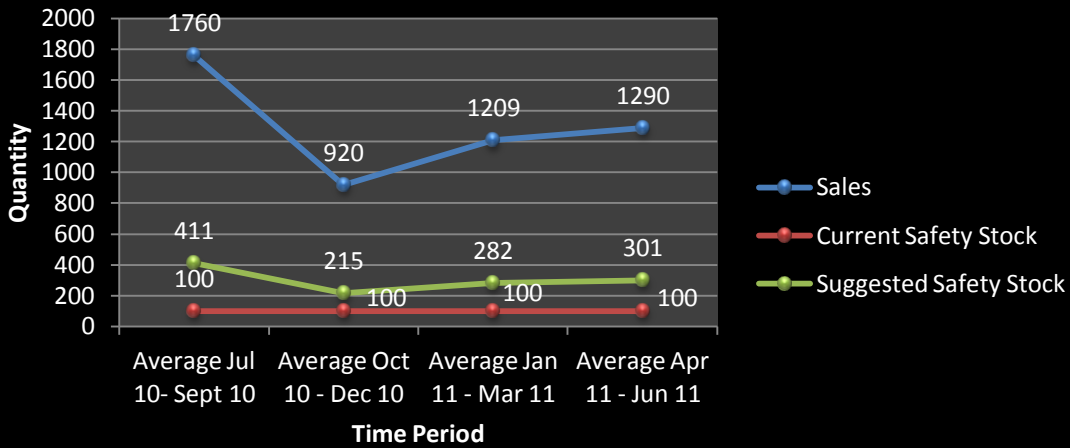
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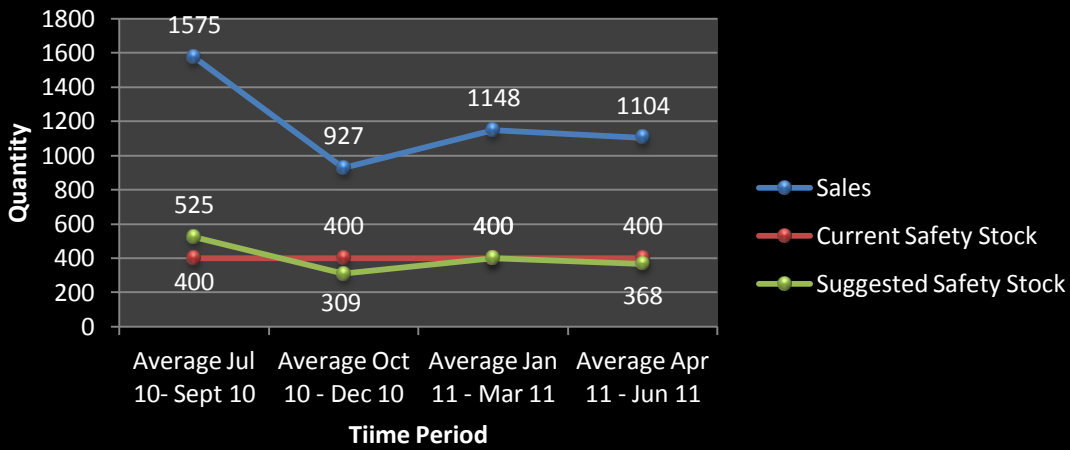
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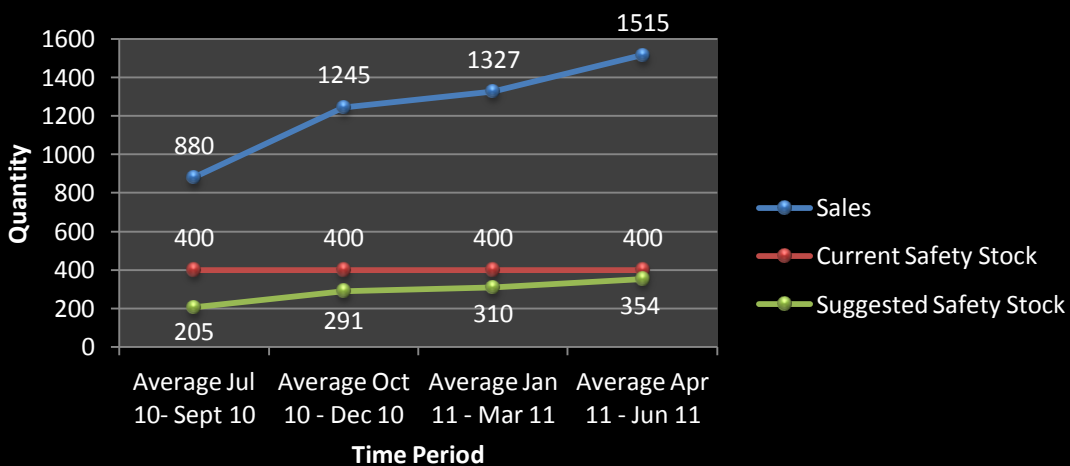
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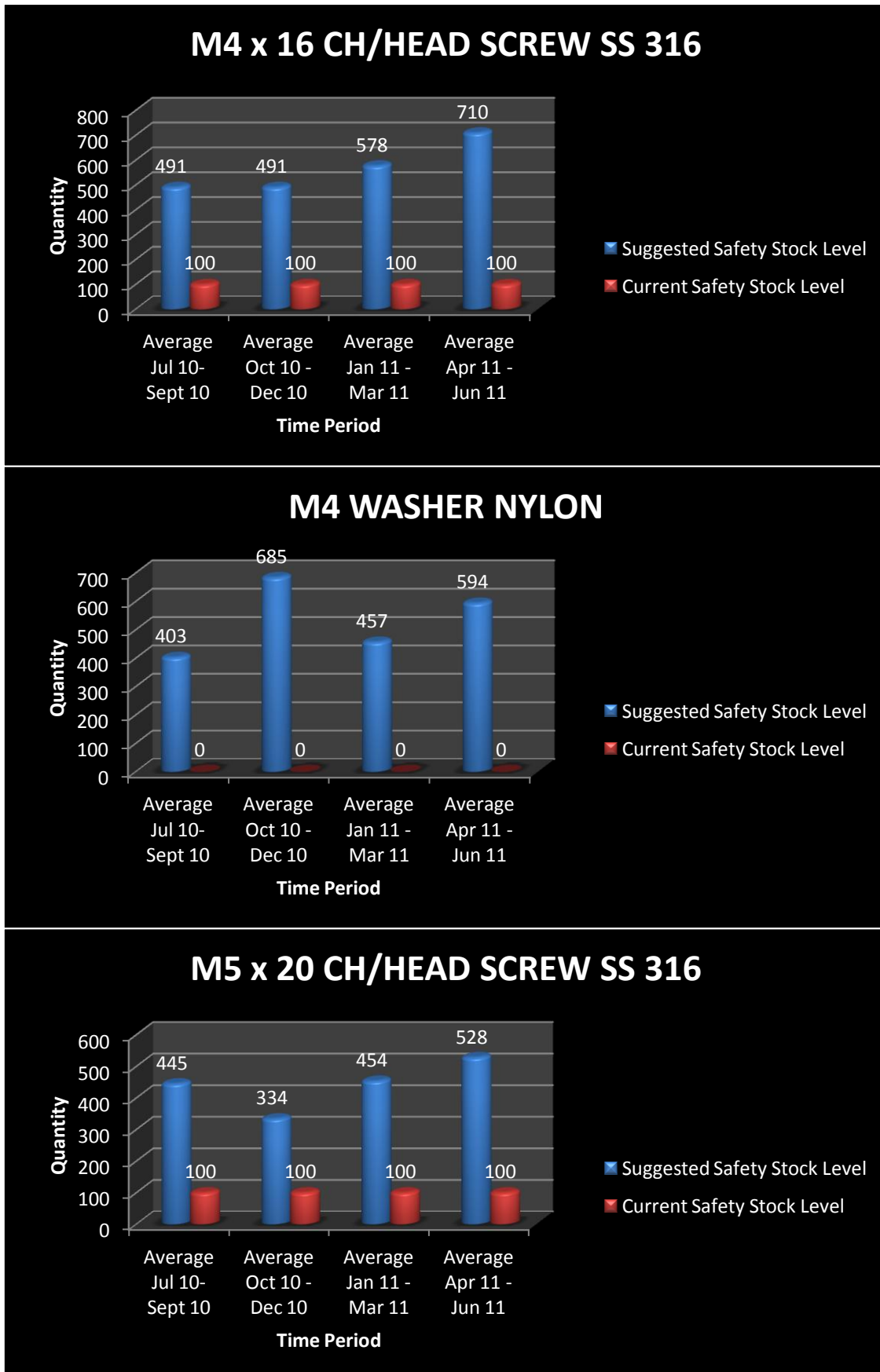
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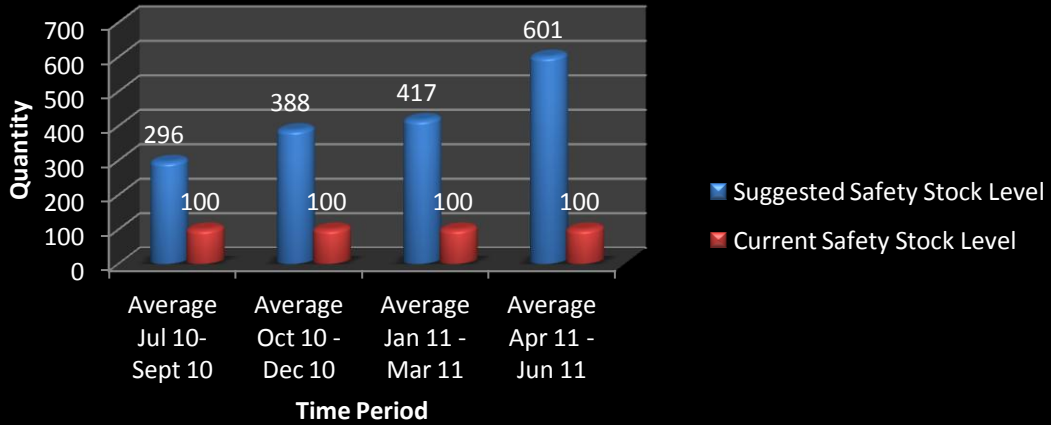
FLOAT GUIDE



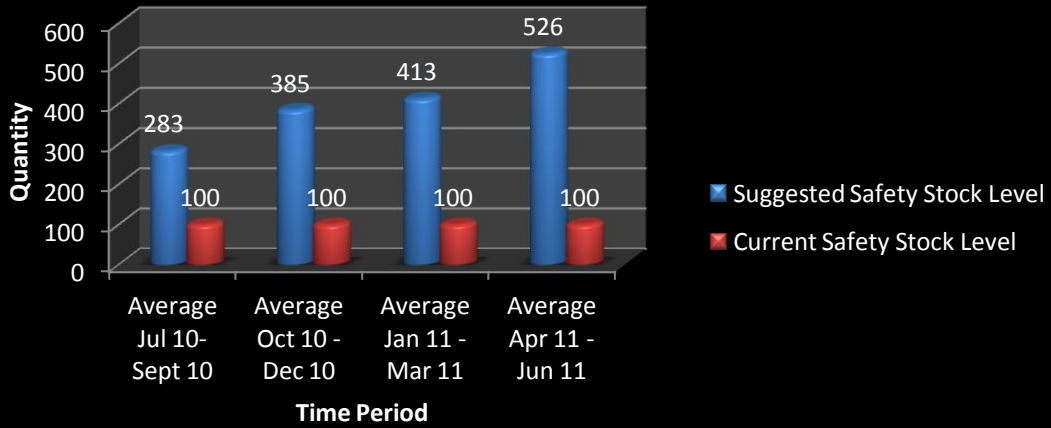
2.3. Safety Stock Comparison graphs



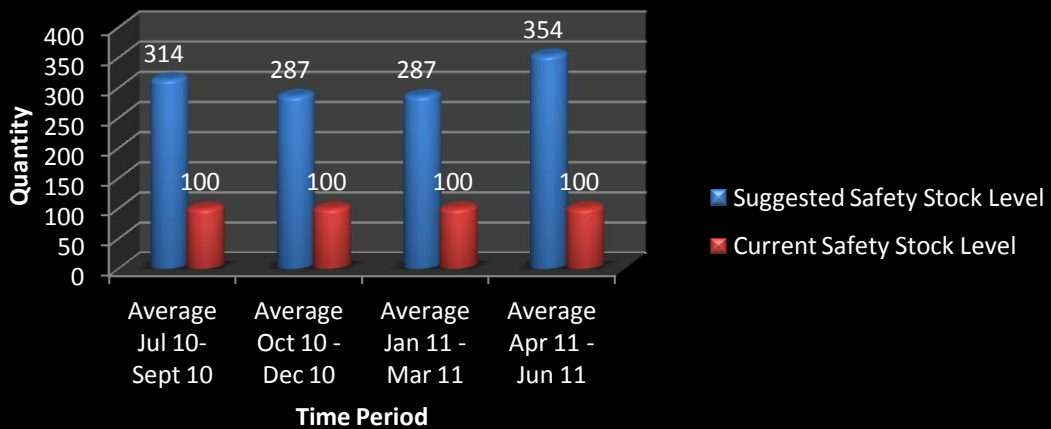
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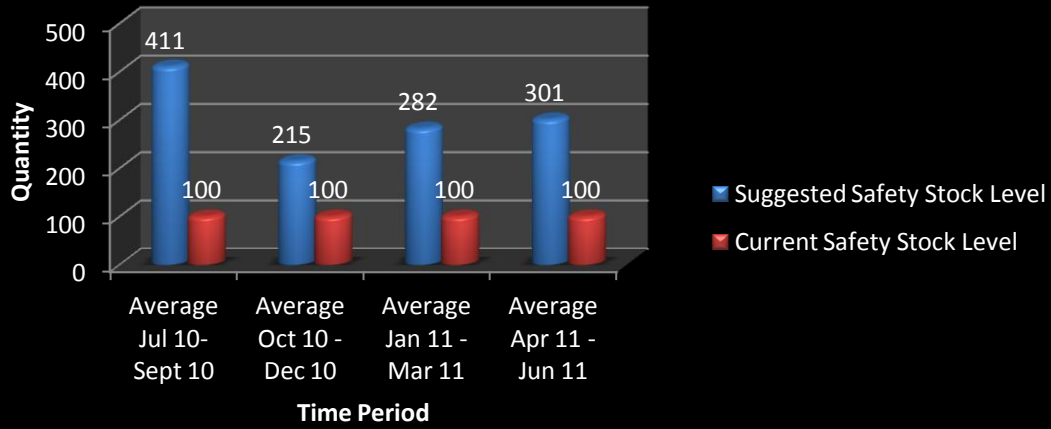
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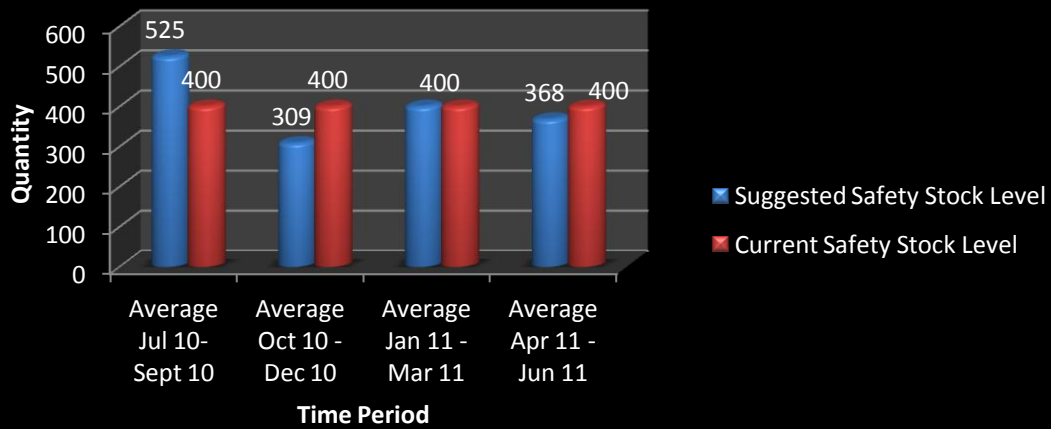
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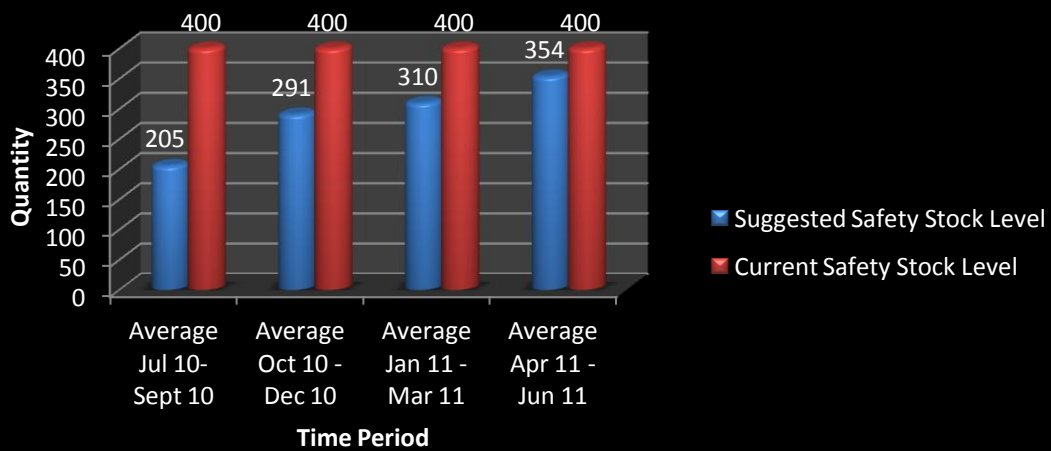
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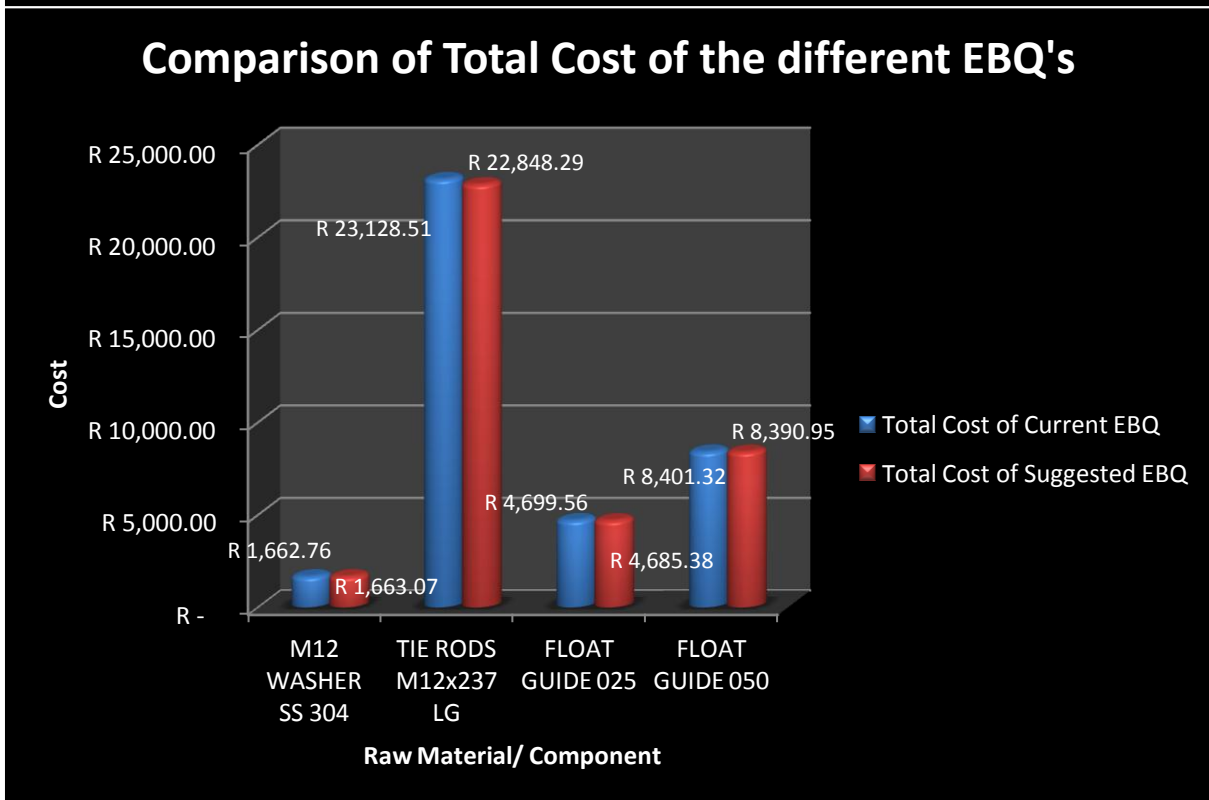
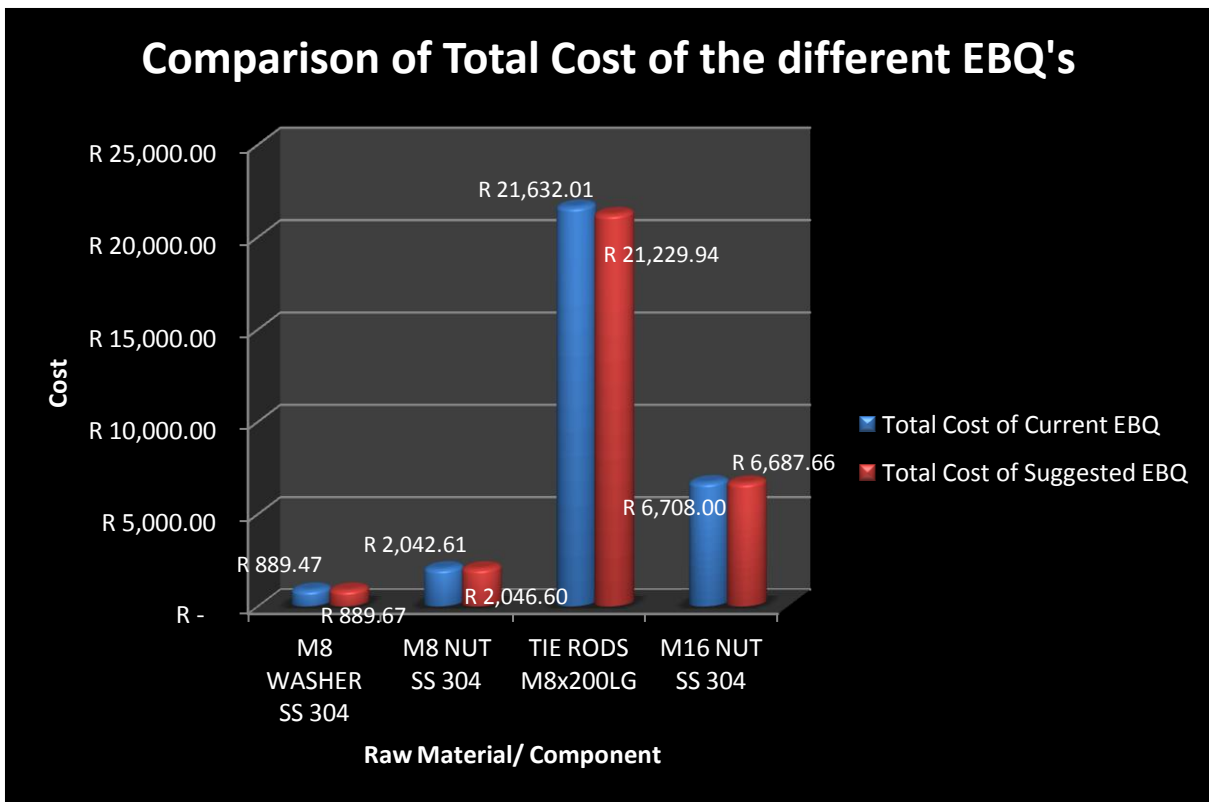
TIE RODS M12x237 LG



FLOAT GUIDE



2.4. EBQ's cost comparison graphs



3. Appendix C: Conceptual Design

Due to the size of the conceptual design it cannot be included in the document and must be printed separately.

4. Appendix D: Final Design

Due to the size of the Final design it cannot be included in the document and must be printed separately.

Microsoft Query - [Query for Dynamic Safety Stock]

File Edit View Format Table Criteria Records Window Help

INVMAS... INVWAREHOUSE

StockCode	Description	Warehouse	SalesQty12	SalesQty11	SalesQty10	SalesQty9	SalesQty8	SalesQty7	SalesQty6	SalesQty5	SalesQty4	SalesQty3	SalesQty2	SalesQty1	SafetyStockQty	LeadTime	UnitCost	QtyOnHand
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015VFP0	15MM BODY NPT. PLA	FP	0	0	20	0	0	0	0	0	0	0	0	0	10	0	0	0
015VFP0	15MM BODY BSP-FLA	FP	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0
025R00001	025R00 SERVICE KIT I	FA	0	0	0	0	0	0	1	0	0	20	5	0	0	0	0	0
025R00015D	025R00 SERVICE KIT	FA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
025R00002	025R00 BIAS MECHAN	FA	0	0	0	0	0	0	3	13	0	0	0	0	0	0	0	0
025R00002	025R00 BIAS MECHAN	FA	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
025R00003	DISH 025R00 S4	FA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
025R0001A3	TOP COVER ALUMINIL	RA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
025R0001PA	TOP COVER (K 600)	RA	38	418	477	160	435	338	411	467	371	573	244	385	100	14	3.95	1458
025R0001S4	TOP COVER	RA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
025R0001SD	TOP COVER SAF2507	RA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
025R00022S4	BARREL	RA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
025R00022S6	BARREL	RA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
025R00022S5D	BARREL	RA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
025R00024S4	BARREL	RA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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025R000264S4	BARREL	RA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
025R000264S6	BARREL 64BAR	RA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
025R0002HYB54	BARREL HYBRID	RA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
025R0002S54	DO NOT USE	RA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
025R00034C1	TOP FLANGE	RA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
025R00034C54	TOP FLANGE	RA	1	0	4	0	0	0	11	0	0	0	0	0	0	0	0	0
025R00034MS	TOP FLANGE (K)	RA	2	50	150	0	0	111	2	78	35	0	0	0	0	0	0	0
025R00034S4	TOP FLANGE	RA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
025R00034S6	TOP FLANGE	RA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
025R00034S5D	TOP FLANGE	RA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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025R000364S6	TOP FLANGE 54 BAR	RA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
025R00039MS	TOP FLANGE 100 BAR	RA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
025R00039S4	TOP FLANGE 100 BAR	RA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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025R00039W5S	FLANGE RAW	RA	6	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0

Select View Criteria to show/edit criteria limiting records shown

Microsoft Query - [Query for Dynamic Safety Stock]

File Edit View Format Table Criteria Records Window Help

INVMAS... INVWAREHOUSE

SalesQty7	SalesQty6	SalesQty5	SalesQty4	SalesQty3	SalesQty2	SalesQty1	SafetyStockQty	LeadTime	UnitCost	QtyOnHand
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0	0	0	0	0	0	0	0	75	79.09	0
0	0	0	0	0	0	0	0	30	20.8	359
0	0	10	0	0	0	10	0	30	20.8	114
1	0	0	20	5	0	0	0	60	27.64	0
0	0	0	0	0	0	0	0	60	31.712	0
0	3	13	0	0	0	0	0	51	106.32	0
0	0	0	0	0	0	0	0	51	106.32	0
0	0	0	0	0	0	0	0	30	18.7	75
0	0	0	0	0	0	0	0	0	0	0
388	411	467	371	573	244	385	100	14	3.95	1458
0	0	0	0	0	0	0	0	10	29.5	25
0	0	0	0	0	0	0	0	21	0	0
0	0	0	0	0	0	0	0	97	41.0168	0
0	0	0	0	0	0	0	0	97	70.9678	0
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0	0	0	0	0	0	0	0	97	54.516	0
0	0	0	0	0	0	0	0	97	94.311	0
0	0	0	0	0	0	0	0	97	80.476	0
0	0	0	0	0	0	0	0	0	135.221	0
0	0	0	0	0	0	0	0	0	59.1888	0
0	0	0	0	0	0	0	0	120	100.64	0
0	0	0	0	0	0	0	0	127	36.65	0
11	0	0	0	0	0	0	0	127	125.97	0
111	2	78	35	0	0	0	0	30	33.66	0
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0	0	0	0	0	0	0	0	10	245.27	0
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311	393	449	371	573	189	329	0	40	36.65	846
19	0	0	0	1	50	3	50	120	125.97	377
7	0	4	123	89	26	16	0	14	33.66	195
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6	0	0	0	0	10	0	0	14	245.27	0

Select View Criteria to show/edit criteria limiting records shown

	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF
	Average 10.12	Average usage per day	Suggested Safety Stock	Average 7.9	Average usage per day	Calculated Safety Stock	Suggested Safety Stock	Average 4.6	Average usage per day	Calculated Safety Stock	Suggested Safety Stock	Average 1.3	Average usage per day	Calculated Safety Stock	Suggested Safety Stock	SafetyStockQty	LeadTime
9	1420	47	500	1353	45	451	451	1805	60	602	602	1599	53	533	533	500	10
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12	1172	39	273	1086	36	253	253	1266	43	300	300	1219	41	264	300	400	7
13	87	3	349	131	4	523	523	221	7	884	884	170	6	681	681	400	120
14	1092	36	354	968	32	323	323	992	33	331	323	1169	39	400	400	400	10
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22	620	21	289	243	8	113	113	335	11	156	156	309	10	144	144	130	14
23	311	10	145	311	10	145	145	416	14	194	194	401	13	187	194	100	14
24	317	11	148	262	9	122	122	276	9	129	122	300	10	140	140	100	14
25	180	5	75	362	12	169	169	241	8	112	112	347	12	162	162	100	14
26	271	9	63	281	9	66	63	420	14	100	100	315	10	73	73	100	7
27	349	12	163	281	9	131	131	430	14	201	201	469	16	219	219	100	14
28	19	1	77	31	1	125	125	44	1	177	177	24	1	100	100	100	120
29	10	0	39	1	0	4	4	50	2	199	199	28	1	111	111	100	120
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31	58	2	233	10	0	40	40	43	1	173	173	30	1	120	120	100	120
32	1978	66	462	1987	66	464	462	2635	88	615	615	2390	80	558	558	100	7
33	2002	67	487	1573	52	367	367	2026	68	473	473	2164	72	505	505	100	7
34	957	32	223	767	26	179	179	798	27	186	179	888	30	207	207	100	7
35	652	23	159	556	19	130	130	466	16	109	109	547	18	128	128	100	7
36	426	14	100	390	12	62	62	597	20	137	137	703	23	164	164	100	7
37	1488	50	347	1440	46	336	347	1913	64	446	446	1703	57	397	397	100	7
38	1275	42	297	1027	34	240	240	1072	36	260	240	1161	39	271	271	100	7
39	1576	53	368	945	32	221	221	1659	52	366	366	1517	51	354	366	100	7
40	1515	50	353	1457	49	340	353	2260	75	527	527	1756	59	410	410	100	7
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46	124	4	41	104	3	35	35	212	7	71	71	319	11	106	106	80	10
47	10	0	40	14	0	57	57	41	1	164	164	30	1	120	120	80	120
48	835	28	195	31	1	7	7	113	4	25	25	32	1	7	7	75	7
49	40	1	160	3	0	13	13	23	1	91	91	24	1	95	91	70	120
50	13	0	3	80	3	19	19	135	5	32	32	177	6	41	41	65	7
51	142	5	47	129	4	43	43	165	6	55	55	55	2	18	18	60	10
52	168	6	39	167	6	39	39	266	9	60	60	209	7	49	49	60	7
53	19	1	77	26	1	104	104	23	1	92	92	22	1	89	92	60	120
54	12	0	32	22	1	60	60	0	0	0	0	33	1	89	89	60	80