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Supply Chain Optimization of liquid chemicals at Dorf Ketal BV

By

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Chapter 1 – Introduction

1.1 Problem Statement and Research Question

Since formally launching operations in the European Region in 2016, Dorf Ketal BV (DKBV) revenue has grown by a staggering 11 million USD. The organization's supply chain department is under a great deal of strain as a result of the growth in trade volume. In terms of missing delivery and back orders, this has a big effect on customer service standards. There are numerous factors that contribute to timely delivery of goods from manufacturing facilities in India to clients in Europe. Although there is need for improvement across a number of departments within Dorf Ketal BV (DKBV), in this study we will concentrate on inventory management. Controlling the planned quantities of inventories for different items is crucial.

It is within this framework that we attempt to calculate the optimum inventory levels, reorder points, safety stocks. There main Research Questions (RQ) remains:

"How can Dorf Ketal optimize inventory management to enable significantly high customer service levels?"

In order to answer the main research Question (RQ), we need to answer the sub-research question (SRQs)

1. What is the current structure of Dorf Ketal supply chain?
2. What does the demand pattern of different products?
3. What are the modelling techniques used?
4. What are the improvement possibilities in terms of inventory management?
5. What is the effect of improvement in new inventory management strategies?

1.2 Introduction

The study of science is a result of both a practical need and a shared interest in a group of human concerns. The field of operations research (OR) is not exception. It is the Armed Forces' offering to contemporary society. This was a sincere attempt by Prof. P.L.S. Blackett, an army officer with years of teaching experience During the Second World War in 1940, The military management of the Second World War urged scientists from all fields to support the United Kingdom in addressing a range of issues related to the military environment. The goal was to assign the uncommon assets to the various military operations in the most effective way possible. The outcome included selecting British Air Force artworks for missions, making the best use of recently developed radar, and determining the best methods for finding submarines. The successful outcomes of such initiatives led to the development of more groups in British Armed administrations, and the conception of such experimental groups represented a significant commitment on the part of western Allies. **(davidkigerinfo, 2016) (Wikipedia Contributors, 2019).**

In the immediate aftermath of the war, a large number of scientists who had been working with military organizations diverted their focus to apply similar methods to civil problems like business, space engineering, industry, agriculture, management science, economics, genetic engineering, etc. in order to investigate complex real-world systems with the aim of optimizing ideal solutions. The production system was developed as an application of operations research to a real-world issue. The stocking of goods from a smaller retailer to a larger production company or store is crucial for meeting client demand as much as feasible. Again, the stocking of commodities depends on a variety of variables, including demand, degradation, improvement, and order replenishment. The management of such issues is referred to as inventory management. **(davidkigerinfo, 2016)**

Inventory is the actual stock of goods that a business maintains in order to ensure the efficient and effective operation of its operations. It a crude material stock could be kept before the generation cycle; at a midpoint either early on in the creation cycle, like procedure stock, or later on, like completed stock of goods. The stock theory was developed in the 1920s. In the beginning, it had extremely simple models that focused on the essential parameters and only used a few of them elements. Later, these models were embellished to include more interesting aspects by adding more factors, but unpredictability and vulnerability were ignored. In the 1950s, probabilistic models were developed step-by-step to capture the consequences of unusual requests and lead times. All of these devices had the same flaw—they could only handle one product at once. The real challenge that many people faced was managing a broad range of items that were interconnected enough to provide a management challenge. As a result, the field of inventory control or inventory management, which is data processing-focused, emerged. Here, keeping track of and organizing records was the key focus. The performance of optimization has improved over time. **(Wikipedia Contributors, 2019).**

1.3 Relevance

Dorf Ketal is an Indian chemical firm that specializes in engineering, marketing, commercialization, and development for the petrochemical and refining industries. It was established in 1992 and has continuously surpassed a lot of the industry's major companies. The business makes significant investments in the research and development of new products based on consumer demand. They are able to outperform their rivals because to this. The business is a major player in the marketplaces of South East Asia, Brazil, and India, and it is expanding into other continents including Europe and North America.

The company deals with a wide range of industries in its portfolio, including isoforms and isothane products, chemical solutions for pulp and paper, petrochemicals, chemical solutions for oil and gas production, specialty catalysts, lubricants additive components, and fuel additives. The Companies Head office is in Mumbai, India. Regional offices are located in numerous places. The office located in the Netherlands' Eindhoven region is Dorf Ketal BV (DKBV) within the European Region. Sales, forecasting, ordering, procurement, inbound and outgoing travel, and legal compliance are all managed from one point. In this thesis, we concentrate on chemical goods imported from India and offered for sale in European markets.

Starting with production in India, Dorf Ketals' supply chain is global. From ports in India, the item is subsequently transported to the port of Antwerp and Ravenna Italy. Either products are shipped directly to clients or they are kept in warehouses. For Antwerp products have a large lead time of 3 months, and serves mostly all customers in Spot market and contractual customers. Due to the long lead times from India to Europe, inventory at the warehouse is utilized to shorten lead times for customers on outgoing shipments. Products are packaged in a range of containers, including drums, intermediate bulk container (IBC), and ISO chemical (International Organization for Standardisation) tanks, and then assembled in a shipping container. Delivery takes roughly three months from the time the products are fully prepared at the warehouse following customs clearance to Antwerp. This covers roughly 4 weeks for manufacture, 6 weeks for sailing, 1 week for transportation from the port to the warehouse in Antwerp, and 1 week for customs clearance. Due to the dynamic nature of maritime transportation, where numerous factors including weather, port closures, etc., it is unpredictable how long it will take to go from India to Antwerp. Therefore, it is a challenge for the logistic department to arrange inventory levels at the warehouse. There is a lack of control on the sea transportation by the European Logistic team as, sea transportation is controlled by Indian logistic team. Documentation for the shipment invoices, Dangerous goods certificate, packing list, Bill of ladings sent across by the Indian Logistic team to the European team.

1.4 Scope:

The Supply chain of Dorf Ketal BV has many uncertain elements. For example, variations in the demands from the customers, procurement of raw materials for production, delays in the shipping from India to Europe, Custom Clearance, Transport from Port to Warehouse, Booking of Trucks for outbound delivery to customers.

The biggest issue that is being encountered in the present scenario is the service level agreement between the customers and Dorf Ketal BV is 15 days, however the lead times from India Production factories is 3 Months. In the present scenarios the demand is met by placing order to Production planning team in India upon receiving order from customers. There is a limitation on increasing service level agreements with the customers as the market competition is strong and customers will choose other suppliers if there is a large delay between ordering and delivery.

There is a scope for improvement is many sectors Dorf Ketal Supply chain, however in this thesis we will focus on a very basic element, which is Inventory management. This is an element which can very efficiently close the difference between short Service level agreements and large lead times.

The products imported from India directly goes to the warehouse Mexico Natie located in Belgium. The warehouse stores products for Dorf Ketal BV in various packaging such as Drums, Intermediate Bulk Container (IBC) and International Intermodal Container (ISO) Tanks. The warehouse charges Dork Ketal on the basis of per Kilo Gram Product per day (Kg / Day) in the ware house. The warehouse based in Belgium also provides services like transport, blending of products, Loading and Discharging of Products, custom clearance of goods etc. For each of the services provided additional fee is charged by the warehouse.

1.4.1 Decision Making

Key decision making plays a major role in the optimization process of the Dorf Ketal supply chain. These decisions can be divided into 3 different categories (Strategic, Tactical and Operational). Long term decisions are Strategics decisions usually ranging between 3-18 months, Medium to Long term decisions are called Tactical and Short-term decisions are known as Operational Decisions to cope up with regular or variations in situations.

1.4.2 Strategic Level

Within the Dorf Ketal BV ecosystem, most strategic decisions deal with placement of critical infrastructure placement, like point of entry of goods in Europe, placement of ware house, contract with transport partners. Utilization of storage capacity at warehouse house can also be seen as Strategic decision. Based on forecast provided by the sales team, procurement team keeps a track of the storage space availability and cost calculations.

1.4.3 Tactical Level:

Within Dorf Ketal BV a majority are decisions are made at this level between mid – long term. A good example will be contracts with customers. Agreements are made with customers in terms of service contracts, prices, delivery terms, quantities and other clauses. The other tactical level decision are the inventory replenishments policies, namely as Continuous Review System or Period Review System.

The Process starts with forecasting of demand by multiple sales teams. Then the SCM planner complies the forecast together. Upon determining the demand, the SCM planner checks the warehouse stocks and calculates the quantities that are needed to be ordered. Allocation of present inventory is done to the orders.

1.4.4 Operational Level:

The Operational Decisions are the decisions until 3 months. The mostly include the decisions related to the transportation of goods to the customers in the outbound processes. The Lead time for customers for delivery of products to the customers is within 15 Days from placing order. So, the outbound activity starts on a very short Notice.

In the Monthly Demand Meeting, forecast and change in demand are discussed between the European Sales team, The European Supply Chain Planner and Indian Production team. Here immediate orders placed by the customers are discussed, these are known as Rush Orders. If the demand can be met by the available inventory, then it is done so, else it is determined if an urgent shipment can be sent from India to deliver to customer in time. If the shortage cannot be met then customer is informed that about the non-availability of the product.

Chapter 2 - Literature Review

2.1.0 Literature Review

The organization's drivers, sales and marketing, are only effective when they turn possible deals and bids into actual sales by placing orders. However, the effectiveness of the supply chain and management depends on the ability to deliver the right goods at the right time to the target market or client. The other essential activity for sales is inventory. Effective inventory management consists of maintaining a balanced inventory, working as effectively as possible, and maintaining control over inventory carrying costs. Any increase in operational effectiveness or inventory control has an immediate positive impact on the bottom line. Product management and the sales function both heavily rely on supply chain, which has to do with moving inventory between plants and markets, keeping inventory in transit at multiple locations, and managing complete inventory logistics. **(Juneja, 2022)**

The marketing managers who have been in charge of their departments in the businesses have advanced and made strides in the marketing of their products employing cutting-edge supply chain distribution tactics, and have therefore been able to significantly affect the bottom lines. Direct marketing, E marketing, and network marketing are all novel concepts for sales, but if you want to include them in your marketing strategy, you must first be able to comprehend and establish the supply chain and inventory management plan that will support these delivery channels. Even while an inventory strategy can be created on paper, it cannot be implemented without realistic exposure to and familiarity with field operations and a firm grasp of how things operate in the real world. Operations and inventory management involve numerous organizations and service suppliers, as well as numerous systems that need to be interfaced. The supply chain processes must be connected to the sales process, and this will ultimately drive the inventory operations process. For products to be delivered across markets on time, each of these several components must be operating in unison and continuously. **(Juneja, 2022)**

In this thesis the we calculate the optimal inventory parameter for limited products of the business of Dorf Ketal BV in order to effectively manage demand for its European consumers, in a cost-efficient manner. The volume of goods handled by the supply chain department has greatly expanded as the company's sales have doubled over the past two years. As there are more instances of late deliveries and back orders, the current system is under strain trying to keep up with this excessive rise in demand. Supply Chain Planning: Forecasting, capacity management, netting against available inventory, and procurement from suppliers with lengthy lead periods are all included in supply chain planning. Contrarily, managing material flows across the supply chain in response to actual demand or chain inventory replenishments is known as supply chain execution. **(Baladhandayutham, Shanthi, 2013).** The company is currently through a significant re-structuring process. New procedures are being created, and new regulations are in the planning stages. Inbound procedures, outbound processes, order management, OTIF analysis, and synchronization between supply chain and finance departments are all areas that could use improvement. The business is through a big re-structuring process right now. New processes are being developed, and new laws are being planned. There are many areas that might be improved, including order management, OTIF analysis, inbound and outbound processes, and supply chain and finance department coordination.

Models:

Based on the nature of Demand, we have determined that there are 2 types of items. The nature of the contracts with the clients is what determines the variation in demand. There are some goods whose demand is erratic and which primarily trade on the spot market. We used the Newsboy model to determine an inventory parament for these products. Customers who have a contract with Dorf Ketal BV place predetermined orders for goods on a regular basis. We used the Economic Order Quantity Model to determine the ideal inventory parameters.

2.1.1 Newsboy Model: This model is used fundamentally for stochastic demand of products. **(Daduna, 2022)** describes the conventional newsvendor model for scenarios involving one period and many periods. The cost function takes into account the ordering cost, overstocking cost and understocking expenses, and the unmet demand at the conclusion of one period is either lost or backlogged. The ratio of the unit underage cost to the total of the unit underage and overage charges is the crucial ratio, which represents the best chance of not stock out situation. **(Arrow, Harris and Marschak, 1951)** gave a function of the demand distribution, the cost of placing an order, and the overstocking and understocking costs, provide the first derivation of the ideal inventory level and reorder point. An (s, S) policy is the best option for a single period model. **(Veinott, 1965)** demonstrates that the base stock strategy, which replenishes the stock to a specific level if possible, is still the best option.

2.1.2 Economic Order Quantity (EOQ)

An inventory management method Economic Order Quantity (EOQ) provides the quantity of items that can be ordered of a product to lower the overall cost of order processing and inventory handling Cost and Ordering cost.) Ford W. Harris and R. created the EOQ type in 1913. Wilson, H.K. Andler are given credit for their in-depth examination and use of the EOQ model **(Aro-Gordon, 2015)**. The EOQ model determines the quantity to be included in an order for a particular item from a business perspective, taking into account a reduction in the annual inventory handling and order processing cost. These two particular types of expenses are the key ones used to calculate the EOQ in this situation. For the initial comprehension, the model has been supplied with a few presumptions; however, from that point on, its applications have been widely employed in enterprises, particularly in inventory management.

Basic Economic Order Quantity (EOQ) Model Assumptions

- Every product individually will have its own specific EOQ.
- The exact annual requirement (Demand) for the product is known.
- The cost of ordering is steady throughout the year.
- The cost of handling inventory is predictable and consistent throughout the year. Notably, the unit price of the item stays the same throughout the year if the handling cost of the item is expressed as a percentage of the price of the item.
- Discounts for quantity or currency are not permitted.
- The product is supplied all at once in one batch in the specified quantity.
- Immediate and timely replacement of the quantity ordered (No delay and stock shortage).
- Only constant lead times are permissible.

At the time of writing this research paper the organization is no particular inventory management model is being used. Orders are place by the planner based on the forecast provided. The organization has more than 300 products in its inventory. However, in this research we have focused on 2 varieties of products and for a time period of first half of year 2022. First category of products are the products with uncertain demand and second are the ones with a certain demand. The lead times from Manufacturing factories in India to the Warehouse in Belgium is 3 Months. However, the service level agreement with the customer is within 15 days from placing order. The complete process of ordering and receiving goods in warehouse has multiple stages, which due to practical reasons can have delays. In order to meet the customers' demands, Inventory Management in terms finding Optimal inventory levels, reordering points, Safety stocks become of prime importance. In this paper based on actual data provided by the organization we had calculated the Inventory parameters, for the products with uncertain demand we have used News Boys model, for products with a certain demand EOQ (Economic order quantity) model.

Overall, we have come to a conclusion that Inventory management will significantly improve the customer service levels. Inventory management is completely a internal process and can be easily managed to meet variations in demands and the uncertainty in the logical between shipping Chemical liquids between India and Europe.

2.1.3 Inventory Management System

Simply said, inventory is a collection of tangible items with some sort of worth. As long as it is not utilized, it is an idle resource. It could be used to refer to items that are kept in storage and utilized in the regular operations of an organization. Inventories were often thought to be indicators of a nation's power and prosperity. Or a specific person. It was also used as a gauge of business failures in the recent past. As a result, businesspeople have begun to emphasize liquidation more for quick turnover. Because of the rapid growth of technology, inventories are now seen more as a risk than as a measure of value. In this way, innovative management techniques, often referred as "Inventory Control," are necessary for the management of stocks. It is a system for maintaining stock levels of things. Thus, inventory management system is a method for ensuring that materials are of the required quality and according to efficiency in shortfall costs, set up costs, manufacture expenses, buy prices, and market capital, quantity is provided as needed. Generally speaking, inventory management assumes responsibility for the appropriate quantity at the ideal timing and cost.

i. It aids in efficient functioning of operations.
ii. Provides immediate service to customers, especially when Lead times are large.
iii. Acts as a hedge against price changes of products.
iv. Used a safety stock when there is a delay due to supply chain interruptions.
v. Reduces per unit cost of products due to batching.
vi. Can avoid expenditures on high inventory levels.

Term stock can be differentiated into two categories:

Direct Inventories:

These inventories include items that play a crucial role in the manufacturing process and are transformed into vital components of finished goods. Consider the stocks of raw materials, finished goods, and work-in-progress.

Indirect Inventories:

These inventories include a variety of materials like oil, grease, and lubricants that are necessary for producing the component of completed goods. To economically adjust for seasonal demand fluctuations, inventories are employed.

To accommodate demand throughout the year, specialist products like crackers are produced well before Diwali, fans and coolers before the summer season begins, and fruits and vegetables are harvested in a few months each year. Consequently, inventory control is the process to keep the supply within the required limitations. Additionally, it centralizes and standardizes data on stock levels. It maintains accurate inventory of each item. Inventory models, which are used in inventory management systems, comprise several decision variables including stock and quantity ordering. Then, three fundamental inquiries such as

i. What are the quantities of Products that are required to be ordered?
ii. What is the correct duration (time interval) for placing orders?
iii. How can maintain the end stage of items in the inventory.
iv. It is, nevertheless, very challenging to choose an acceptable procurement policy in the world of business. The following questions are resolved by an inventory management problem, which is a decision-making problem. On

> the other side, an inventory model's goal is to produce the best possible order request while minimizing overall inventory costs. In other words, an inventory challenge involves making choices that maximize overall profit while still satisfying client demand.

Chemical Companies across are paying more importance to customer satisfaction as a result of increased competition. For customer satisfaction, service level is essential. To avoid stock outs, businesses must carefully adjust their delivery times to consumer needs and be equipped to handle unforeseen changes in supply and demand. Making safety stocks is a popular way to address unanticipated demand and supply fluctuation in the context of the make-to-stock manufacturing strategy. This strategy is frequently employed in practice and frequently uses a traditional calculation that incorporates the means and standard deviations of the supply and demand lead times. The Inventory of Dorf Ketal BV is very large and constitute of approximately more than 300 Products. The demands of the products are based on the nature of contracts between the Customers and Dorf Ketal BV. Customer with long-term contract, have a stable demand and Customers on spot market have higher variation in the demand. In this research we have used actual data from Dorf Ketal BV. Data from Jan (2022) to Jun (2022) is used and to determine the demand of products. 2 Categories of products are selected, based on nature of demand.

In conclusion of this research, we have observed in simulation that Variation in Demand plays a major role in the in determining the Minimum inventory levels of the product which acts as safety stock. In the scenario of Dorf Ketal BV, the Lead time is fixed 3 months, the variation is 0. In the simulation we have observed that there is a correlation of .94 between the minimum levels of Inventory levels and the variation in demand. The second observation we noted that is the holding cost of inventory is .013 Eur Per/Kgs/Day and the Ordering cost is 2000 Eur/Order. The difference in Ordering cost and Holding Cost is quite large. Based on the simulation we have observed a marginal increase in Holding cost of the inventory can exponentially secure Dorf Ketal BV against losing out missed orders. Also, in actual practice the ordering is done for almost all products based on individual orders, in our simulation model the results show to stock up and reduce the ordering frequency to twice in the duration between Jan22 - Jun22.

Chapter 3 – Supply Chain Ecosystem in Dorf Ketal

3.1 Production:

The research is based on products sold by of Dorf Ketal BV in the European markets. The Research and development of these chemicals is done by scientist and engineers located in India. 10% of annual revenue is invested in Research and development. Dorf Ketal's research and development teams produce cutting-edge process chemicals with uses in petrochemical, polymer, and refinery production, as well as special chemistries for fuel treatment, lubricant additives, organometallic catalysts, and crosslinkers. Manufactured is also done locally in factories are located in the town of Mundra, Taloja, Dadar in India. Dorf Ketal BV deals in 2 varieties of product namely Processed Chemicals and Fuels and Additives. Small portion of raw materials are procured, and are blended at the warehouse. In this research we will focus specially on 10 products which are part of Fuels and Additives and Processed chemicals. Upon placing order, it takes 4 weeks for factory to products the ordered product. Once production is completed the batch is allotted a lot number, which is used in order management for inventory management.

3.2 Products:

Some the products that are sold in European markets are

Table 1: List Of Product

• Ammonia based products.	• Corrosion inhibitors.	• Emulsion Breakers
• Water Clarifiers.	• Scale Inhibitors, Antifoams.	• Paraffin & Asphaltene inhibitors.
• Catalysts.	• Oilfield hydraulic fracturing crosslinkers.	• Petrochemical catalysts for
• Polyolefins.	• Coatings.	• Adhesives.
• Sealants elastomers	• Antioxidants.	• Dispersants.
• Antifoam	• Anti-wear additive components.	• Isotane and Isoforms.
• Paper and Pulp related Products.	• Catalysts And Adsorbents.	• Arsine Removal Catalyst.
• Copper Chromite & Supported Copper Catalysts.	• Ammonia Cracking Catalyst & Endo Gas Generators.	• C3 class coatings.
• Meta Cresol.	• CO2 Reforming Catalysts.	• Other Noble Metal Catalysts.

3.3 Customers:

Dorf Ketal BV provides service to a sizable customer base with a diverse range of product needs. The majority of Dorf Ketal's clients are on long-term contracts, and the company also takes orders on the spot market. Depending on the length of the contract, the customer's reputation, and potential future business opportunities in terms of sales goals, the price of the product varies from customer to customer. Contractual commitments are made by clients under contractual agreements and are simple to include in a product's forecast. Dorf Ketal BV is required under the contract to provide goods to consumers within 15 days of their orders. In the case of a spot market, Dorf Ketal is not required to deliver a certain quantity of product within a predetermined timeframe; instead, the lead time is given to the customer based on stock availability. However, the company places Rush orders in an effort to meet as much of the Spot Market demand as possible. This helps the sales staff find new clients and gives Dorf Ketal BV a favorable reputation in the marketplace. Additionally, it raises the organization's turnover's sales volume.

3.4 Product Flow

All products adhere to a specific product flow before being sold in Europe. The products are manufactured in India, after which they are transshipped to Europe using sea transportation. The majority of goods are kept at warehouse in Custom Clear status and afterwards delivered to the client's location. Some goods are transshipped directly from Antwerp Port to the client's location.

3.5 Maritime Transport

Ships are used for the transportation of goods from the storage hubs in Manufacturing factories in India to Europe. An extremely big vessel has a carrying capacity of 20,000 to 45,000 tons for liquid chemicals. Liquid chemical-specific vessels include numerous compartments that can be utilized to transport a variety of different products. Every vessel has unique properties that can be used to determine if it can transship a liquid with specific transit criteria. Therefore, it is possible to determine in advance whether a ship is appropriate for transloading a certain set of liquid products. Travel times for vessels is fairly constant and for planning purposes taken as 6 weeks.

A transport plan is made if the product quantities that are available for Europe are known. A transport plan is a schedule that includes all anticipated dates for the delivery of specific product quantities at their destination. Transport plan is sent to Dork Ketal BV in Eindhoven from Dorf Ketal India. Dorf Ketal does have a contract with ship owners, to arrange transport of goods from Indian ports to Antwerp port. Prices for transportation remain fairly constant. Dorf Ketal India staff in books vessels based on availability and placements to guarantee an efficient use of vessels. Dorf Ketal BV must submit a plan outlining their requirements for volume and goods instead of being able to select their own vessel. Then, Dorf Ketal India employees will identify the best vessel that is currently available and add it to the import order. Following acceptance of the designated vessel, the ship will begin loading the goods into one or more loading ports. The products will thereafter be delivered to the specified location after the ship has sailed to the unloading port(s). It takes approximately 6 weeks for sea transport.

3.6 Warehouses:

A warehouse is a structure that, coupled with storage racks, handling tools, staff, and management resources, enables us to regulate the disparities between the flows of items coming in (from suppliers, production facilities, etc.) and leaving out (from those same places, goods being sent to production, sales, etc.). The lack of coordination between these fluxes is one of the reasons why storage facilities are crucial. **(Mecalux, 2022)** Dorf Ketal has contract with warehouse named as Mexico Natie, located in Antwerp Belgium. The warehouse has been strategically located to be in well connected to the port of Antwerp. Ware house is equipped with storing stocks in a variety of packaging, Loading and Unloading Docks, Office for Custom clearances, Dispatch goods, Truck handling spaces, Repackaging of products. Mexico Natie provides Dorf Ketal BV will addition services like blending of chemicals and transportation facilities.

3.7 Material Requirement Planning (MRP):

MRP is a tool for collecting data and converting a timetable for ordering parts, subassemblies, and raw materials from an estimate interest for a manufactured item. From a logistical standpoint, the goal of MRP is to keep these items out of inventory as much as feasible. In order to facilitate the creation phases and maintain the production of unusual inter stage slack, the MRP approach emphasizes a suitable expert generation plan (MPS). Because of the unequal parcel estimation of the coordinated arrangement of parts, it maintains the generation of unneeded interstage slack. As a result, the MPS level only includes equities that are allowed under such a methodology. Timing (when to request) and quantity are the two elements that MRP decides to go along with it (how much to order). Requests are made as late as is reasonable under the circumstances with regard to timing, but never order earlier than is necessary and never let supplies run out. Thus, MRP effectively lowers the cost of generation by reducing stock levels.

3.8 Forecasting

Supply chain planning is commonly acknowledged as being driven by demand planning. For businesses trying to integrate strategy across organizational and national barriers, this serves as the foundation.

Interfirm Demand Integration: The Role of Marketing in Bridging the Gap Between Demand and Supply Chain Management **(McCarthy, 2003)**

Currently, Dorf Ketal maintains close relationships with its clients, particularly when it comes to forecasting. Due to Dorf Ketals lengthy lead time and the need for an accurate prediction to guarantee a high quality of service, this close relationship is essential. Although there is strong cooperation when it comes to predicting, only the forecasts are shared in terms of data. The customer care person must get in touch with (a number of) clients to see if they can work together to address the problem in the event that a replenishment hub experiences a shortfall or surplus. The agent frequently has to ask the same customer whether they can accept a change in delivery because not all customers are willing to cooperate.

In order to achieve the most accurate estimate, businesses are increasingly attempting to reduce the amount of noise in their projections by seeking out the genuine origin of demand, the final consumer. Demand forecasting is important as it lowers variance at every supply-chain level. Each department used to frequently create its own forecasts in the past. The issue is that each location then stockpiled safety stock, which was expensive, to serve as a hedge against the demands of the surrounding areas. Companies are currently restructuring their organizational structures to make sure that all functional areas interact with one another. Small increases in forecast accuracy can result in significant inventory cost reductions.

Chapter 4 – Methodology

4.1.1 Ordering cost and Replenishment Cost.

The cost associated with ordering supplies for a request or purchasing, assembling, or setting up different pieces of equipment prior to the start of production is sometimes referred to as the requesting, setup, or renewal cost. Independent of the amount requested, there are costs associated with placing the purchase, following up to acquire the products, doing quality check, etc. It might in some situations rely on the number of items purchased with price or quantity discounts, or on the cost of transportation, etc.

4.1.2 Holding Cost:

The cost of maintaining the stock is known as holding expenditure. The quantity of the inventory and the timing of when an item is stocked both play a role. The symbol for it is h per unit of time. This cost comprises the price of storage, personnel salaries (for the shop, security, etc.), interest on capital blocked on inventory acquisition, insurance, degradation, obsolescence, improvement, etc. The cost of capacity, security, and other related expenses that are based on the amount of stock kept on hand may also be included in the holding expenditure.

4.1.3 Purchase Cost:

The purchase cost is the cost per unit of an item that is acquired either from an external source or from the cost per unit of internal manufacture. It's not always the same. . In many real-world scenarios, the unit purchase price is based on the amount purchased. For instance, when acquiring large lots in a competitive market, prices are discounted, which also results in a decrease in the cost per unit of replenishment when production is done on a large scale.

4.1.4 Selling Price:

The selling price of an item is its unit cost when it is sold to a consumer on demand. Selling the good generates income for it. It is not always continuous and occasionally relies on the person making the decision.

4.1.5 Stock out or Shortage Cost

The price paid for not being able to satisfy a demand where it arises is known as the shortfall cost. The business must pay a financial penalty as well as forfeit the trust of its clients as a result. P per unit time is used to represent it. When a customer searches for the item and discovers the stock exhaust, the interest can either go unmet or be met later when the item becomes available. The first situation is referred to as a lost deal, and the most recent as a delayed acquisition.

4.1.6 Salvage Cost:

Some things partially spoil while in storage, and some lose their usefulness after the selling season. It has been noted that the management generates some income by selling these goods to a specific consumer group for less money than they paid for them. Salvage value is the name for this income.

Other significant components are also used while creating an inventory model in addition to the cost components mentioned above.

4.2 Demand:

To satisfy market demands, inventory is primarily kept on hand. The organization has no control over demands. If a demand is fixed and well-known, it is considered to be deterministic. However, this is a rare occurrence because a variety of factors outside the organization's control, such as consumer preferences, technical advancements, governmental regulations, and other elements affecting the business environment, can alter demand. Stochastic demand is the term for demand that is thought to be unpredictable. When the interest over a given period is not normally known but may be determined by a likelihood calculation, it is said to have a probabilistic interest. A probabilistic interest could be resolved or remain unaltered.

4.3 Lead Time:

Lead time refers to the period of time between filing a request and accepting goods. It might not really be a consistent thing. It is the period of time for which the best policy should be chosen in order to maximize benefit or reduce overall stock expenditure. It could either be endless or finite. Depending on how the inventory system is set up.

4.4 Replenishment:

It refers to the rate at which new stock is being added. Depending on the inventory system, the replenishment quantity may be fixed or variable. When the stock is quickly added to from an external resource point, there is an instantaneous replenishment.

4.5 Buffer or Safety Stock

It is advisable to keep some additional stock on hand to make up for any shortages that may arise during the lead period because demand is unpredictable and uncontrollable. The term "buffer stock" refers to this additional stock.

4.6 Inventory Control Methods

The typical stock situation faced by producers, distributors, and retailers in everyday commercial endeavors is such that the range of stock levels are drastically reduced over time and then renewed by the addition of a number of new units. The Economic

Ordering Quantity model, also known as the economic lot size model or simply the EOQ model, is a typical model for dealing with such a situation. The foundational EOQ model was built on the assumptions that the request rate is known and consistent over time, that flaws are not taken into account, that the lead time is zero or constant, and that the request amount is only recharged once when the stock level reaches zero. Anyhow, all things considered, these suspicions are generally not addressed in applications. Before deciding on the stock levels of parts and materials, the economic lot-size model does not consider the interest example of the deciding item. This is one of the model's shortcomings. In the nick of time, or JIT, is the other widely used concept that has been adopted by several Organizations. It has been observed that numerous firms in various parts of the world are quickly changing the way they manage their inventories.

4.7 – Newsboy Model (Q)

For the products which have uncertain demand, we have decided to find the optimum inventory level using the Newsboy Model. For the chemical products it is absolutely vital to have optimum inventory level, if there is a shortage of available inventory a loss in incurred, if the inventory level is too high then there is expiry date of the products.

Optimum Quantity is calculated using the Newsboy Model, and this quantity is ordered for a determined time period of 1 Month in this research.

Newsboy Notation:

co = cost per item of items left over after demand is met (overage cost
per item)
cs = cost per item of unmet demand (shortage cost per item)
x = demand in given period (number of items)
f(*x*) = probability density function (pdf) of demand
F(*x*) = = cumulative distribution function of demand
Q = quantity held in inventory (number of items)

Expected cost *C*(*Q*) is given by -

$$
\begin{aligned}
C(Q) &= c_0 E[\text{number of items over}] + c_s E[\text{number of items short}] \\
&= c_0 \int_0^Q (Q-x) f(x)\,dx + C_s \int_Q^\infty (x-Q) f(x)\,dx
\end{aligned}
$$

The optimal quantity Q^* to hold in inventory is given by:

$$\frac{d}{dQ}C(Q)=0$$

Q^* Is the quantity that minimizes expected cost

Applying Leibnitz's rule for differentiation under the integral sign:

$$\frac{d}{dQ}C(Q)=c_0\int_0^Q \frac{\partial}{\partial Q}\{(Q-x)f(x)\}dx+c_s\int_Q^\infty \frac{\partial}{\partial Q}\{(x-Q)f(x)\}dx$$

$$=c_0\int_0^Q f(x)dx-c_s\int_Q^\infty f(x)dx$$

$$=c_0F(Q)-c_s\{1-F(Q)\}$$

$$=(c_0+c_s)F(Q)-c_s$$

Keeping:

$$\frac{d}{dQ}C(Q)=0$$

$$F(Q^*)=\frac{c_s}{c_s+c_0}$$

c = cost per item

a = selling price per item

p = lost sales penalty per item

v = salvage value per item

$$c_s=a-c+p$$

$$c_o = c - v$$

$$F(Q^*) = \frac{a + p - c}{a + p - v}$$

(Hannsmann, 1962; Hopp and Spearman, 1996; Nahmias, 1989; Ravindran, Phillips, and Solberg, 1987).

Q^* obtained here is in pdf function.

In order to obtain the optimum value of the Inventory we apply the formula

Q^* = Norm.inv(Pb, µd, σd)

Where:

µd = Mean Demand

σd = Standard Deviation Demand

3.1 – Economic Order Quantity (EOQ) and Reorder Point (s) Model

The EOQ model is a very common method for determining how much and when to request. By request amount, it is meant to imply the sum obtained or delivered each generation cycle. The expenses associated with requesting, getting, and other activities will decrease as the amount of the request increases, whereas the costs associated with stock carrying, stacking, and other activities will increase. In this manner, there are two inverse costs throughout the time spent creation; one empowers the growth in size of request and the other demoralizes. Accordingly, an EOQ is the size of request that minimizes the total year costs associated with ordering and delivering merchandise.

Notation:

D = demand (number of items per unit time)
A = ordering cost ($ per order)
c = cost of an item ($ per item)
r = inventory carrying charge (fraction per unit time)
$H = cr$ = holding cost of an item ($ per item per unit time)

Q = order quantity (number of items per order)

σd^2= Variance of demand (items per unit time)

σL^2= Variance of Lead Time (items per unit time)

s = reorder point (number of items)

Total Cost Per unit time *C(Q)* is given by:

$$C(Q) = \text{Inventory Cost} + \text{Ordering Cost}$$
$$= \frac{HQ}{2} + \frac{AD}{Q}$$

$$\frac{d}{dQ} C(Q) = 0$$

Hence:

$$Q^* \sqrt{\frac{2AD}{H}}$$

(S, S) Policy: Estimates Of Reorder Point (s) And Order-Up-To Level (S)

A sufficient amount is ordered to increase the inventory position to the order-up-to level S whenever the inventory position (items on hand plus items on order) falls to the reorder point s or lower.

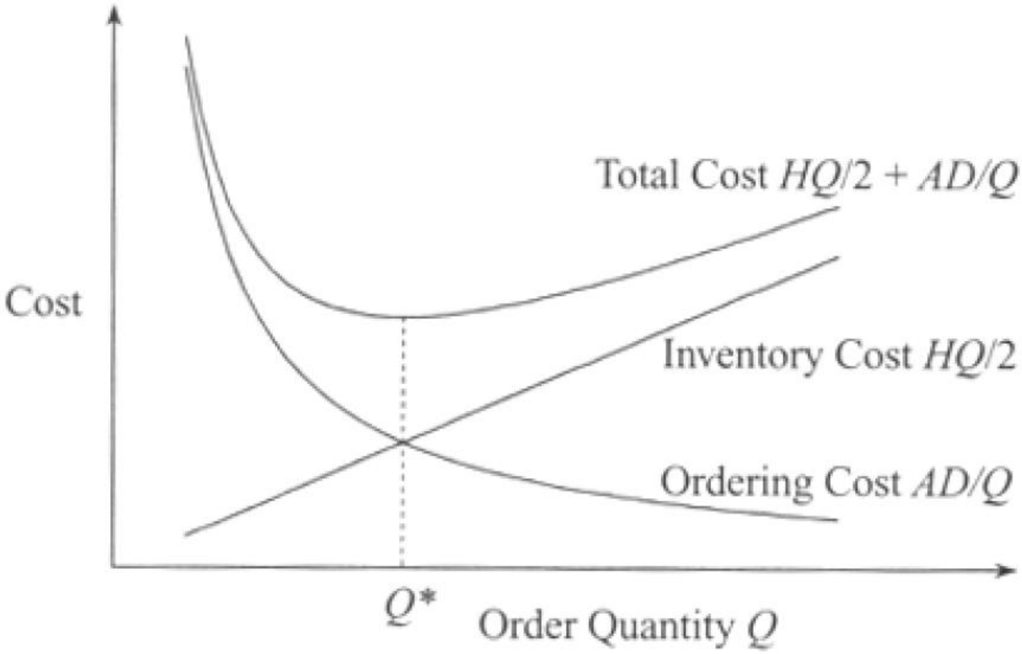
For demand in a single time unit, the demand variance D 2 is defined. The variance of demand in a fixed time of t units is equal to D 2 t because it is assumed that demands in each time unit are independent.

The (s, S) policy's approximate reorder point s and order-up-to level S are given by

$$s = DL + k\sqrt{L\sigma_D^2 + D^2\sigma_L^2}$$

$$S = s + Q$$

Figure1 - Trade-off Between Inventory and ordering Cost in EOQ Model



Source: (Blumenfeld, 2001)

Total cost per unit time C*(Q)*-

$$C(Q) = \text{Inventory Cost} + \text{Ordering Cost}$$
$$= \frac{HQ}{2} + \frac{AD}{Q}$$

With a larger lot size, the annual holding cost rises. On the other hand, as lot size increases, the annual ordering cost decreases. Because we assumed the price to be set, the material cost is independent of lot size. Thus, when the size of the lot increases, the overall annual cost first decreases and then rises.

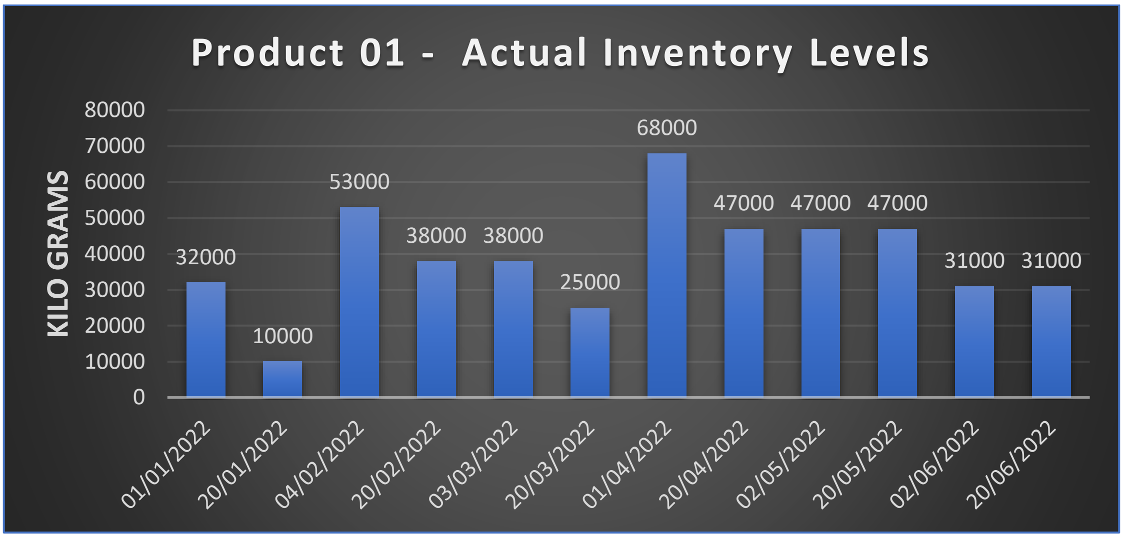
Simulation:

The simulation model used in the research is the excel based mathematical calculation of the inventory based on the paraments used in modelling. The Parameters have been applied to inventory for a same duration of time and a comparison has been made of the difference in the inventory patterns. Based on the variance of the demand and minimum inventory levels obtained by the simulation a coefficient of Determination is calculated between the two parameters.

Chapter 5 - Improvement Possibilities

5.10 - Product 1

Figure 2



Looking at the inventory levels we can observe that the inventory levels are fluctuating based on replenishment and demands. The nature of demand is stochastic in nature because Product 1 belongs to spot market. The demand is 22000 Kg s, 15000 Kg s, 13000 Kg s, 21000 Kg s, 0 Kg s and 16000 Kg s for the months between Jan/22 to June22. The Mean demand (μd) is 14500 Kgs, with a standard Deviation (σd) of 7918 Kgs, Variance (σd^2) = 62700000 Kgs. Ordering is done on assumed quantities. This does not account for variation in demand or overstocking.

Dorf Ketal BV (DKBV) starts Procurement process upon receiving order for the customer. Factories in India start production at this stage, the production planning team plans a combined quantity based on global demand of the product. After Production it is shipped to Antwerp port, custom clearance is done at Antwerp Port from where it is collected by the transport trucks arranged by warehouse (Mexico Natie). The total times for this complete process from placing order to goods finally ready for Dispatch is Lead Time (L) is 3 Months. This value is taken into account factoring for all the delays therefore variation in Lead time (σ_L^2) = 0**.**

Selling cost (a) = 8.02 Eur / Kg, Purchase Cost (C) = 3.65 Eur / Kgs, Incase of shortage and the product is stock out or shortage cost is same as the selling price (p) = 8.02 Eur / Kg, The products have a expiry date and so the Salvage Value per item (v) = 0.0 Eur / Kg.

Applying Newsboys Model :

Shortage Cost (Cs) = (a-c+p) = 8.02

Unsold Item Cost (Co) = (c-v) = 3.65

Optimum Quantity (Q) = (a + p – c) / (a + p – v) = 0.7582

= Norm.inv (Q , μ_d , σ_d)

= Norm.inv (0.7582 , 14500, 7918)

= 20048 Kg s

Applying the (s , S) Model :

Reorder point (s) = D X L + k $\sqrt{}$ (L σ_d^2 +D^2 σ_L^2)

= (14500 X 3) + $\sqrt{}$ (3 X 62700000 + 14500 X 14500 X 0)

= 57215 Kg s

Order up to level (S) = s + Q

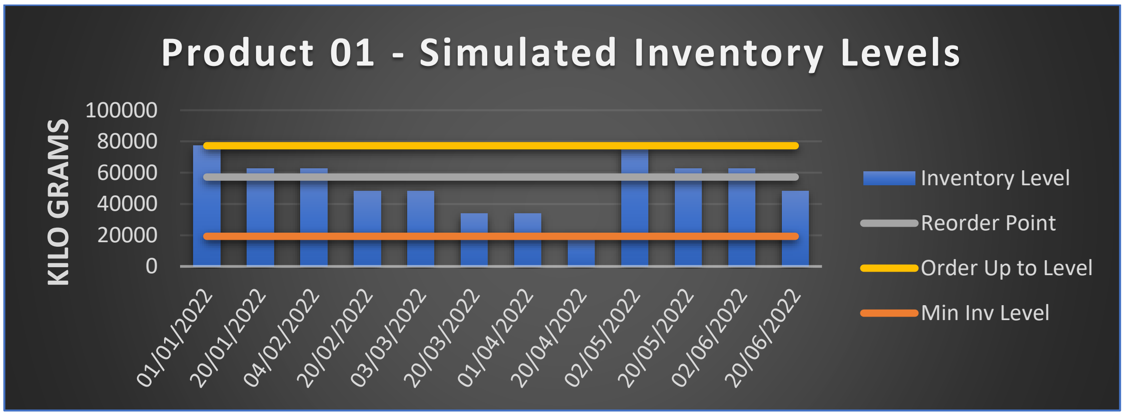
= 57215 + 20048

= 77264 Kg s

Simulation:

Based on the results of our analysis. We have applied the parameters Average Demand, order up to Level and Reorder Point. The following inventory traces are obtained.

Figure 3



Summary:

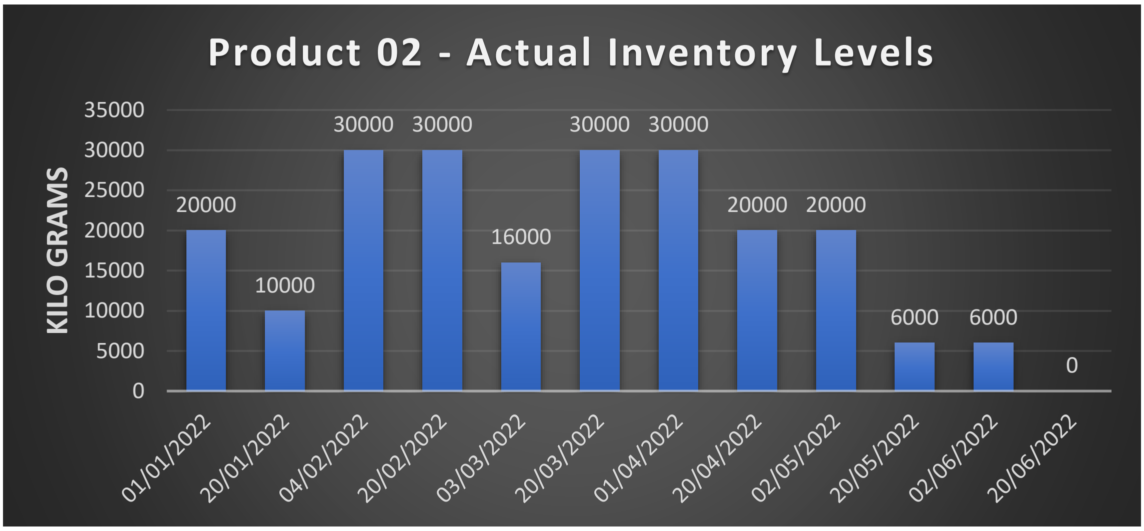
We can observe that as the inventory level falls below the Reorder Point (s) = 57214 Kg s on 20/02/2022, order was placed to bring the Inventory to the Order up to Level (S) = 77264 Kg s. Based on the simulation we can the observe that minimum inventory level at 19264 Kgs. The average inventory increases from 38917 Kg s to 53097 Kg s.

Results:

Holding Cost is 0.13 Eur / Kg s. In the present scenario the Holding cost for the complete inventory is 506 Euros for duration between Jan and June/22. After applying simulation, the Holding cost will go up to 690 Euros. This is a marginal Increase of 184 Euros. The parameters applied protect the organization the variation in demand. Based on average demand a single missed order can amount for 116290 Euros. By investing 184 Euros more the organization can protect themselves against risk of missing on orders by customers which will cost them exponentially.

5.20 – Product 2

Figure 4



Looking at the inventory levels we can observe that the inventory levels are fluctuating based on replenishment and demands. The nature of demand is stochastic in nature because Product 2 belongs to spot market. The demand is 10000 Kgs, 0 Kgs, 14000 Kgs, 10000 Kgs, 14000 Kg s and 6000 Kg s for the months between Jan/22 to June/22. The Mean demand (μd) is 9000 Kgs, with a standard Deviation (σd) of 5329 Kgs, Variance (σd^2) = 28400000 Kgs. Ordering is done on assumed quantities. This does not account for variation in demand or overstocking.

Dorf Ketal BV (DKBV) starts Procurement process upon receiving order for the customer. Factories in India start production at this stage, the production planning team plans a combined quantity based on global demand of the product. After Production it is shipped to Antwerp port, custom clearance is done at Antwerp Port from where it is collected by the transport trucks arranged by warehouse (Mexico Natie). The total times for this complete process from placing order to goods finally ready for Dispatch is Lead

Time (L) is 3 Months. This value is taken into account factoring for all the delays therefore variation in Lead time (σ_L^2) = 0**.**

Selling cost (a) = 5.80 Eur / Kg, Purchase Cost (C) = 2.50 Eur / Kgs, Incase of shortage and the product is stock out or shortage cost is same as the selling price (p) = 5.80 Eur / Kg, The products have a expiry date and so the Salvage Value per item (v) = 0.0 Eur / Kg.

Applying Newsboys Model :

Shortage Cost (Cs) = (a-c+p) = 5.5

Unsold Item Cost (Co) = (c-v) = 2.50

Optimum Quantity (Q) = (a + p – c) / (a + p – v) = 0.7844

= Norm.inv (Q , μ_d , σ_d)

= Norm.inv (0.7844 , 9000 , 5329)

= 13197 Kg s

Applying the (s , S) Model :

Reorder point (s) = D X L + k √ (L σ_d^2 +D^2 σ_L^2)

= (9000 X 3) + √ (3 X 28400000 + 9000 X 9000 X 0)

= 36230 Kg s

Order up to level (S) = s + Q

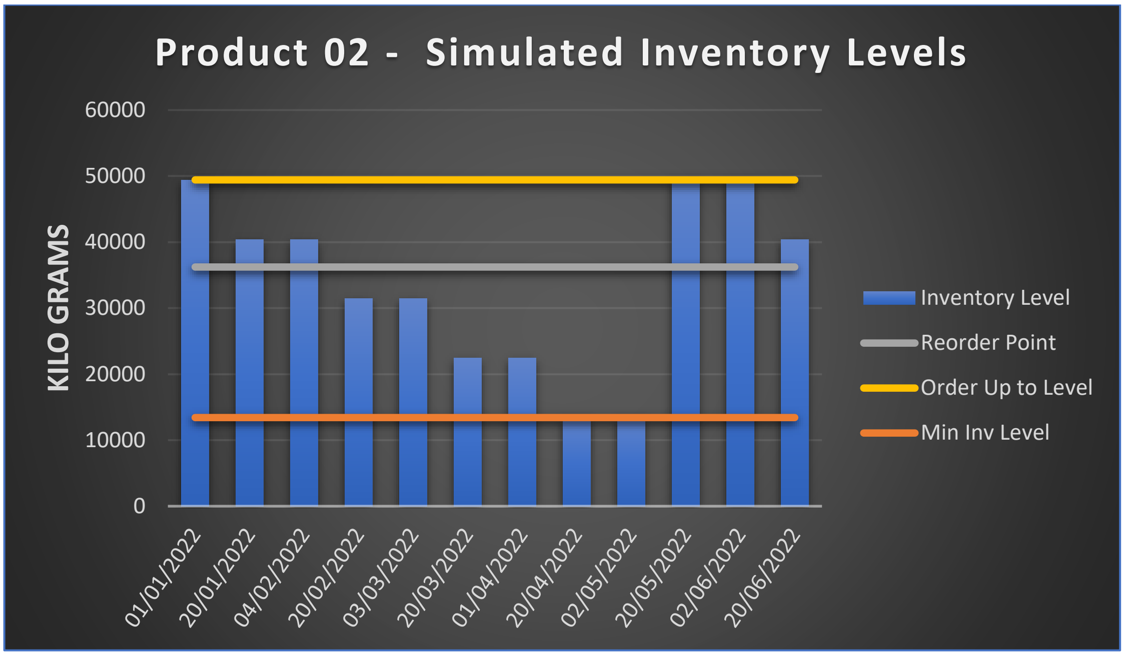
= 36230 + 13196

= 49429 Kg s

Simulation:

Based on the results of our analysis. We have applied the parameters Average Demand, order up to Level and Reorder Point. The following inventory traces are obtained.

Figure 5



Summary:

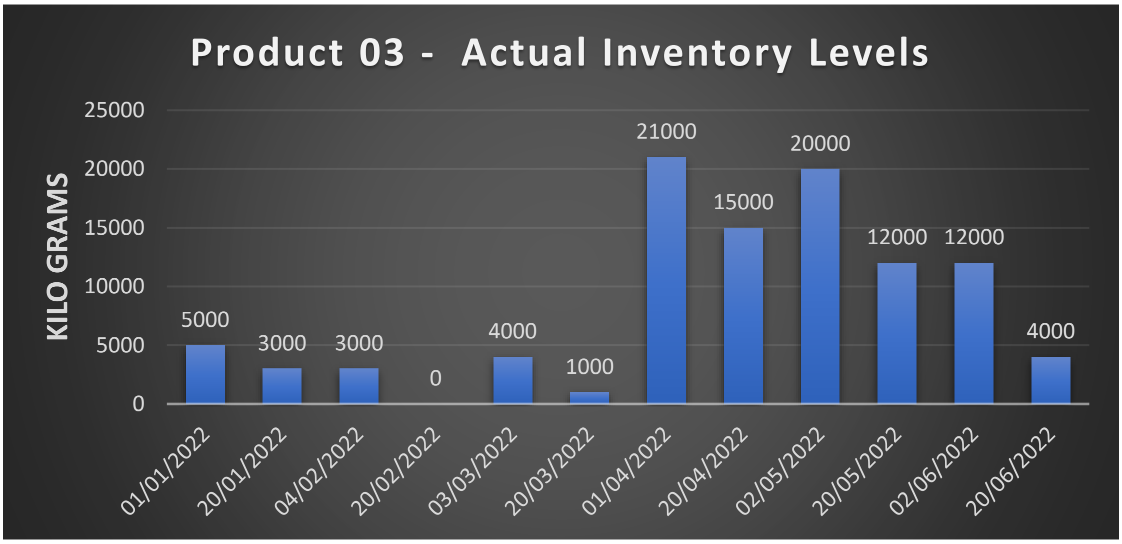
We can observe that as the inventory level falls below the Reorder Point (s) = 36230 Kg s on 20/02/2022, order was placed to bring the Inventory to the Order up to Level (S) = 49427 Kg s. Based on the simulation we can the observe that minimum inventory level at 13427 Kgs. The average inventory increases from 18167 Kg s to 33677 Kg s.

Results:

Holding Cost is 0.13 Eur / Kg s. In the present scenario the Holding cost for the complete inventory is 237 Euros for duration between Jan and June/22. After applying simulation, the Holding cost will go up to 438 Euros. This is a marginal Increase of 200 Euros. The parameters applied protect the organization the variation in demand. Based on average missed order can amount for 52200 Euros. By Just investing 200 Euros more the organization can protect themselves against risk of missing on orders by customers which will cost them exponentially.

5.3 - Product 3

Figure 6



Looking at the inventory levels we can observe that the inventory levels are fluctuating based on replenishment and demands. The nature of demand is stochastic in nature because Product 3 belongs to spot market. The demand is 2000 Kgs, 3000 Kgs, 3000 Kgs, 6000 Kgs, 8000 Kg s and 8000 Kg s for the months between Jan/22 to June/22. The Mean demand (μd) is 5000 Kgs, with a standard Deviation (σd) of 2683 Kgs, Variance (σd^2) = 7200000 Kgs. Ordering is done on assumed quantities. This does not account for variation in demand or overstocking.

Dorf Ketal BV (DKBV) starts Procurement process upon receiving order for the customer. Factories in India start production at this stage, the production planning team plans a combined quantity based on global demand of the product. After Production it is shipped to Antwerp port, custom clearance is done at Antwerp Port from where it is collected by the transport trucks arranged by warehouse (Mexico Natie). The total times for this complete process from placing order to goods finally ready for Dispatch is Lead Time (L) is 3 Months. This value is taken into account factoring for all the delays therefore variation in Lead time (σ_L^2) = 0.

Selling cost (a) = 8.60 Eur / Kg, Purchase Cost (C) = 4.29 Eur / Kgs, Incase of shortage and the product is stock out or shortage cost is same as the selling price (p) = 8.60 Eur / Kg, The products have a expiry date and so the Salvage Value per item (v) = 0.0 Eur / Kg.

Applying Newsboys Model :

Shortage Cost (Cs) = (a-c+p) = 8.6

Unsold Item Cost (Co) = (c-v) = 4.29

Optimum Quantity (Q) = (a + p – c) / (a + p – v) = 0.7505

= Norm.inv (Q , μ_d , σ_d)

= Norm.inv (0.7505 , 5000 , 2683)

= 6814 Kg s

Applying the (s , S) Model :

Reorder point (s) = D X L + k $\sqrt{(L \sigma_d^2 + D^2 \sigma_L^2)}$

= (5000 X 3) + $\sqrt{}$ (3 X 7200000 + 5000 X 5000 X 0)

= 19648 Kg s

Order up to level (S) = s + Q

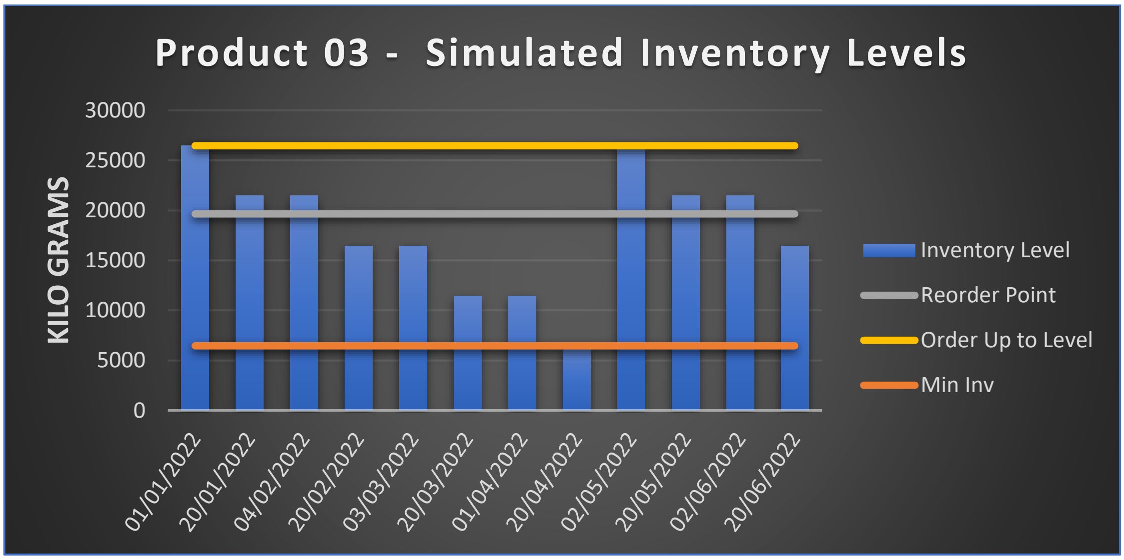
= 19648 + 6815

= 26463 Kg s

Simulation:

Based on the results of our analysis. We have applied the parameters Average Demand, order up to Level and Reorder Point. The following inventory traces are obtained.

Figure -7



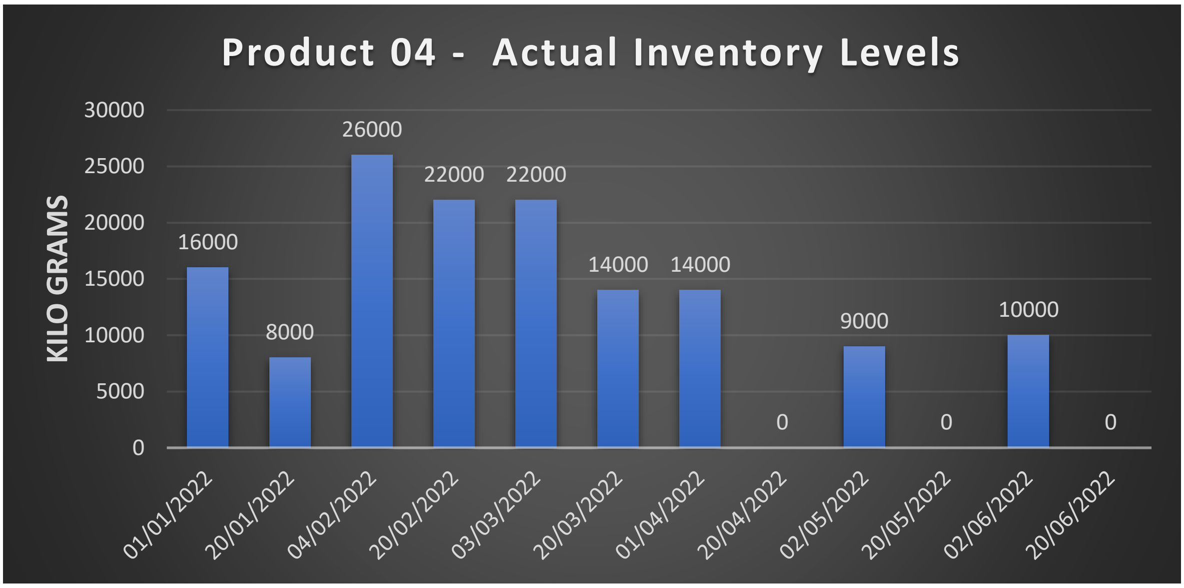
Summary:

We can observe that as the inventory level falls below the Reorder Point (s) = 19648 Kg s on 20/02/2022, order was placed to bring the Inventory to the Order up to Level (S) = 26462 Kg s. Based on the simulation we can the observe that minimum inventory level at 6462 Kgs. The average inventory increases from 8333 Kg s to 18128 Kg s.

Results:

Holding Cost is 0.13 Eur / Kg s. In the present scenario the Holding cost for the complete inventory is 108 Euros for duration between Jan and June/22. After applying simulation, the Holding cost will go up to 236 Euros. This is a marginal Increase of 127 Euros. The parameters applied protect the organization the variation in demand. Based on average demand a single missed order can amount for 43000 Euros. By Just investing 236 Euros more the organization can protect themselves against risk of missing on orders by customers which will cost them exponentially.

5.4 - Product 4 Figure -8



Looking at the inventory levels we can observe that the inventory levels are fluctuating based on replenishment and demands. The nature of demand is stochastic in nature because Product 4 belongs to spot market. The demand is 12000 Kgs, 4000 Kgs, 8000 Kg s, 14000 Kgs, 9000 Kg s and 10000 Kg s for the months between Jan/22 to June/22. The Mean demand (μ_d) is 9500 Kgs, with a standard Deviation (σ_d) of 3450 Kgs, Variance (σd^2) = 11900000 Kgs. Ordering is done on assumed quantities. This does not account for variation in demand or overstocking.

Dorf Ketal BV (DKBV) starts Procurement process upon receiving order for the customer. Factories in India start production at this stage, the production planning team plans a combined quantity based on global demand of the product. After Production it is shipped to Antwerp port, custom clearance is done at Antwerp Port from where it is collected by the transport trucks arranged by warehouse (Mexico Natie). The total times for this complete process from placing order to goods finally ready for Dispatch is Lead

Time (L) is 3 Months. This value is taken into account factoring for all the delays therefore variation in Lead time (σ_L^2) = 0.

Selling cost (a) 6.98 Eur / Kg, Purchase Cost (C) = 3.5 Eur / Kgs, Incase of shortage and the product is stock out or shortage cost is same as the selling price (p) = 6.98 Eur / Kg, The products have a expiry date and so the Salvage Value per item (v) = 0.0 Eur / Kg.

Applying Newsboys Model :

Shortage Cost (Cs) = (a-c+p) = 6.98

Unsold Item Cost (Co) = (c-v) = 3.50

Optimum Quantity (Q) = (a + p – c) / (a + p – v) = 0.7505

= Norm.inv (Q , μ_d , σ_d)

= Norm.inv (0.7492 , 9500 , 3450)

= 11819 Kg s

Applying the (s , S) Model :

Reorder point (s) $= D \times L + k \sqrt{(L \sigma_d^2 + D^2 \sigma_L^2)}$

= (9500 X 3) + √ (3 X 11900000 + 9500 X 9500 X 0)

= 34475 Kg s

Order up to level (S) = s + Q

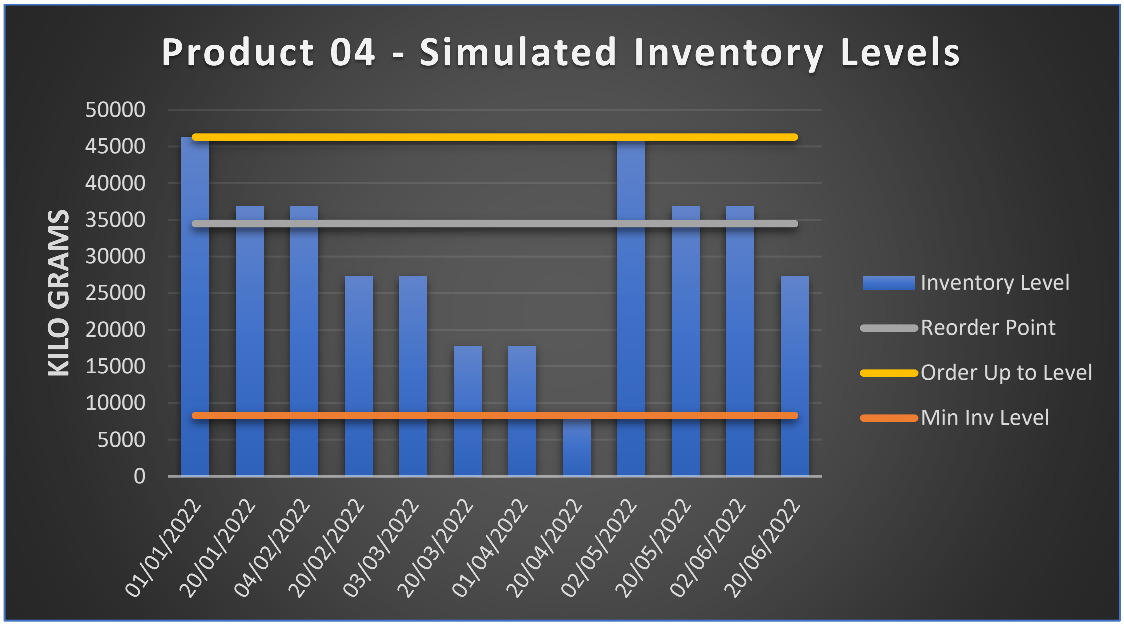
= 34475+ 11819

= 46294 Kg s

Simulation:

Based on the results of our analysis. We have applied the parameters Average Demand, order up to Level and Reorder Point. The following inventory traces are obtained.

Figure -9



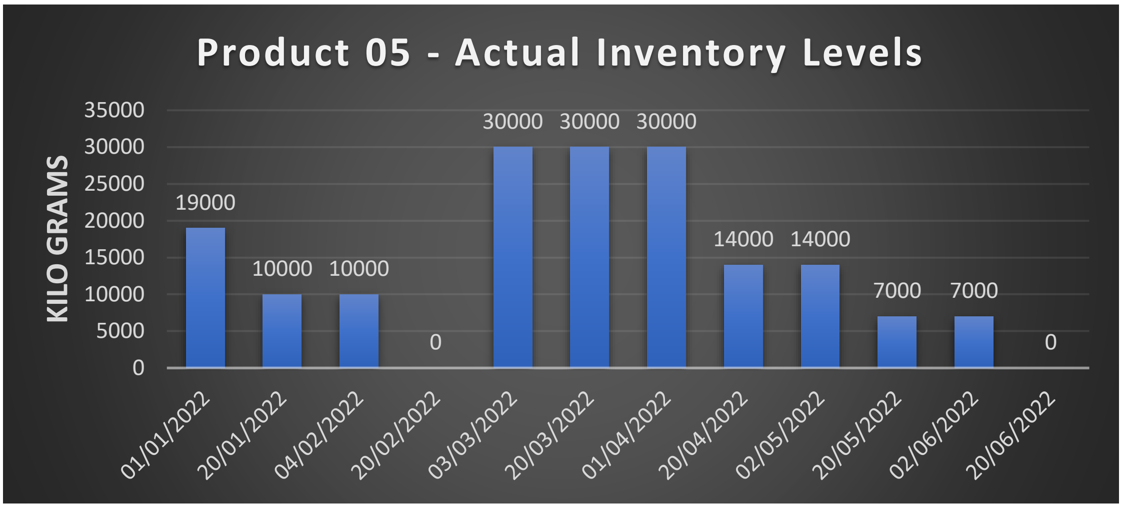
Summary:

We can observe that as the inventory level falls below the Reorder Point (s) = 34475 Kg s on 20/02/2022, order was placed to bring the Inventory to the Order up to Level (S) = 46294 Kg s. Based on the simulation we can the observe that minimum inventory level at 8294 Kgs. The average inventory increases from 11750 Kg s to 30460 Kg s.

Results:

Holding Cost is 0.13 Eur / Kg s. In the present scenario the Holding cost for the complete inventory is 152 Euros for duration between Jan and June/22. After applying simulation, the Holding cost will go up to 395 Euros. This is a marginal Increase of 243 Euros. The parameters applied protect the organization the variation in demand. Based on average demand a single missed order can amount for 66310 Euros. By Just investing 243 Euros more the organization can protect themselves against risk of missing on orders by customers which will cost them exponentially.

5.5 - Product 5 Figure -10



Looking at the inventory levels we can observe that the inventory levels are fluctuating based on replenishment and demands. The nature of demand is stochastic in nature because Product 5 belongs to spot market. The demand is 9000 Kgs, 10000 Kgs, 0 Kg s, 16000 Kgs, 7000 Kg s and 7000 Kg s for the months between Jan/22 to June/22. The Mean demand (μ_d) is 6667 Kgs, with a standard Deviation (σ_d) of 5819 Kgs, Variance (σd^2) = 33866667 Kgs. Ordering is done on assumed quantities. This does not account for variation in demand or overstocking.

Dorf Ketal BV (DKBV) starts Procurement process upon receiving order for the customer. Factories in India start production at this stage, the production planning team plans a combined quantity based on global demand of the product. After Production it is shipped to Antwerp port, custom clearance is done at Antwerp Port from where it is collected by the transport trucks arranged by warehouse (Mexico Natie). The total times for this complete process from placing order to goods finally ready for Dispatch is Lead Time (L) is 3 Months. This value is taken into account factoring for all the delays therefore variation in Lead time (σ_L^2) = 0.

Selling cost (a) 10.60 Eur / Kg, Purchase Cost (C) = 5.1 Eur / Kgs, Incase of shortage and the product is stock out or shortage cost is same as the selling price (p) = 10.60 Eur / Kg, The products have a expiry date and so the Salvage Value per item (v) = 0.0 Eur / Kg.

Applying Newsboys Model :

Shortage Cost (Cs) = (a-c+p) = 10.60

Unsold Item Cost (Co) = (c-v) = 5.10

Optimum Quantity (Q) = (a + p – c) / (a + p – v) = 0.7594

= Norm.inv (Q , μ_d , σ_d)

= Norm.inv (0.7594 , 6667 , 5819)

= 10766 Kg s

Applying the (s , S) Model :

Reorder point (s) = D X L + k √ (L σ_d^2 +D^2 σ_L^2)

= (6667 X 3) + √ (3 X 33866666 + 6667 X 6667 X 0)

= 30080 Kg s

Order up to level (S) = s + Q

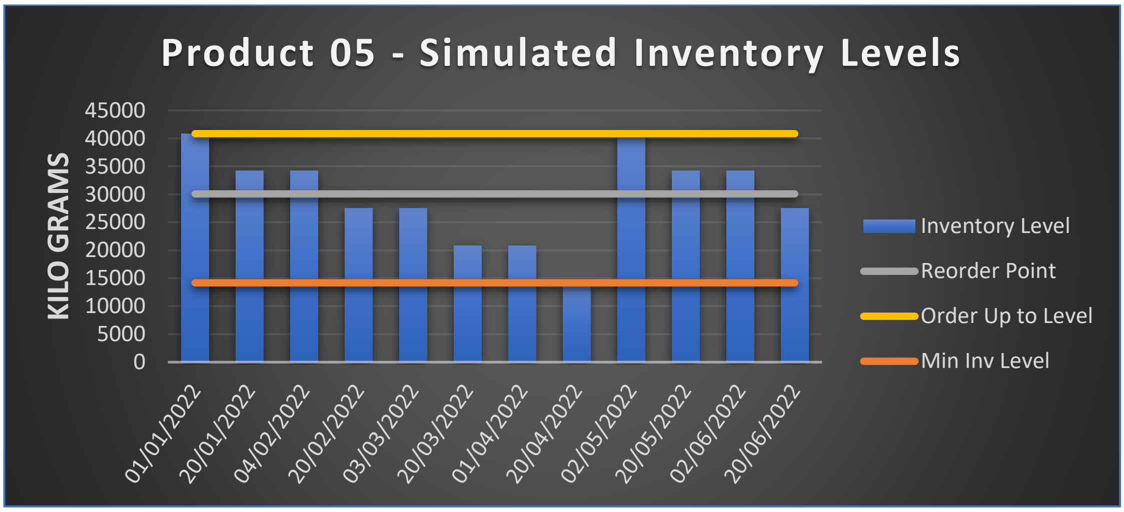
= 30080+ 10766

= 40846 Kg s

Simulation:

Based on the results of our analysis. We have applied the parameters Average Demand, order up to Level and Reorder Point. The following inventory traces are obtained.

Figure -11



Summary:

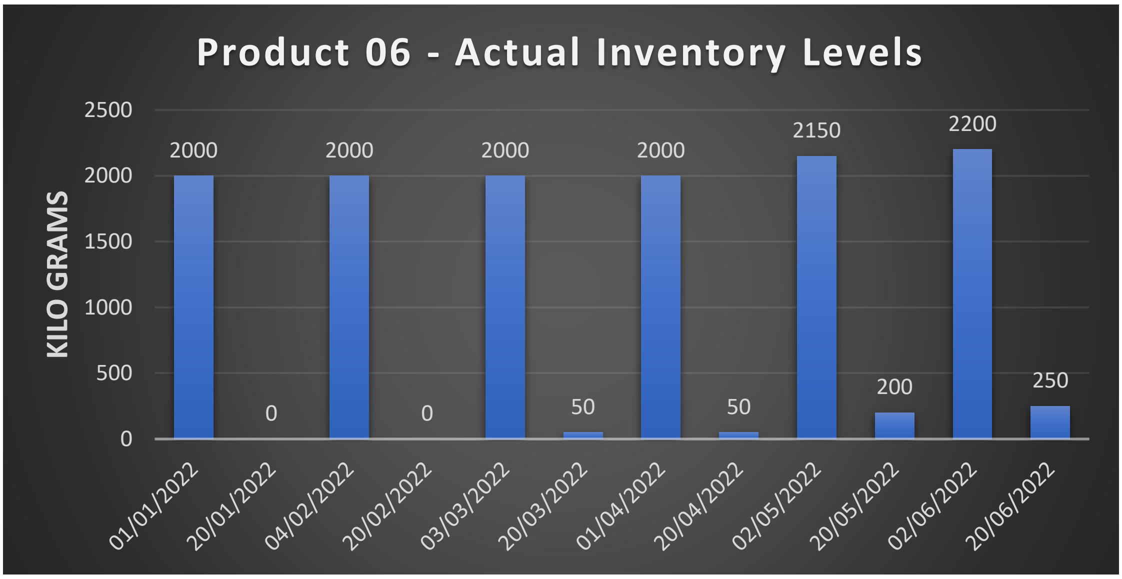
We can observe that as the inventory level falls below the Reorder Point (s) = 30080 Kg s on 20/02/2022, order was placed to bring the Inventory to the Order up to Level (S) = 40846 Kg s. Based on the simulation we can the observe that minimum inventory level at 14182 Kgs. The average inventory increases from 14268 Kg s to 29736 Kg s.

Results:

Holding Cost is 0.13 Eur / Kg s. In the present scenario the Holding cost for the complete inventory is 185 Euros for duration between Jan and June/22. After applying simulation, the Holding cost will go up to 386 Euros. This is a marginal Increase of 2401 Euros. The parameters applied protect the organization the variation in demand. Based on average demand a single missed order can amount for 70666 Euros. By Just investing 201 Euros more the organization can protect themselves against risk of missing on orders by customers which will cost them exponentially.

5.6 - Product 6

Figure -12



When we look at the inventory levels, we can see that they change in response to replenishment and demand. Because Product 6 is a part of the contractual market, demand is predictable in nature. The demand is 2000 kg s, 2000 kg s, 1950 kg s, 1950 kg s, 1950 kg s and 1950 kg s for the months of January 22 to June 22. With a standard deviation (σ_d) of 26 kilograms and a variance (σ_d^2) 667 kilograms, the mean demand (μ_d) is 1967 kilograms. Orders are placed based on ordering quantities of the individual products. Demand variation is not taken into consideration in this.

With a predictable demand, Dorf Ketal BV (DKBV) is a long-term contract with the customer. The clients have already specified to Dorf Ketal BV the products they need. The production planning team in India can plan the production well in advance and combine it with the product's global demand because the products have a predictable demand. After production, it is transported to the port of Antwerp, where customs clearance is completed before being picked up by transport vehicles scheduled by the warehouse (Mexico Natie). The entire procedure takes a total of 3 months from placing the order to the time the goods are completely prepared for dispatch, called Lead Time

(L). This value is considered when accounting for all delays, resulting in variation in Lead time (σ_L^2) = 0.

The Ordering cost per order (A) is 2000 Euros per order, and the Holding cost per order is 0.39 Eur/ Kg/ Month.

Applying EOQ Model:

$$Q = \sqrt{(2AD)/H}$$

$$= \sqrt{(2 X 2000 X 967) / (0.039)}$$

$$= 4491 \text{ Kg s}$$

$$s = D X L + k * \sqrt{(L*\sigma_d{}^{\wedge 2} + D^2 *\sigma_L{}^{\wedge 2})}$$

$$= 1967 X 3 + \sqrt{(3 X 667 + 1967 X 1967 X 0)}$$

$$= 5945 \text{ Kg s}$$

$$S = s + Q$$

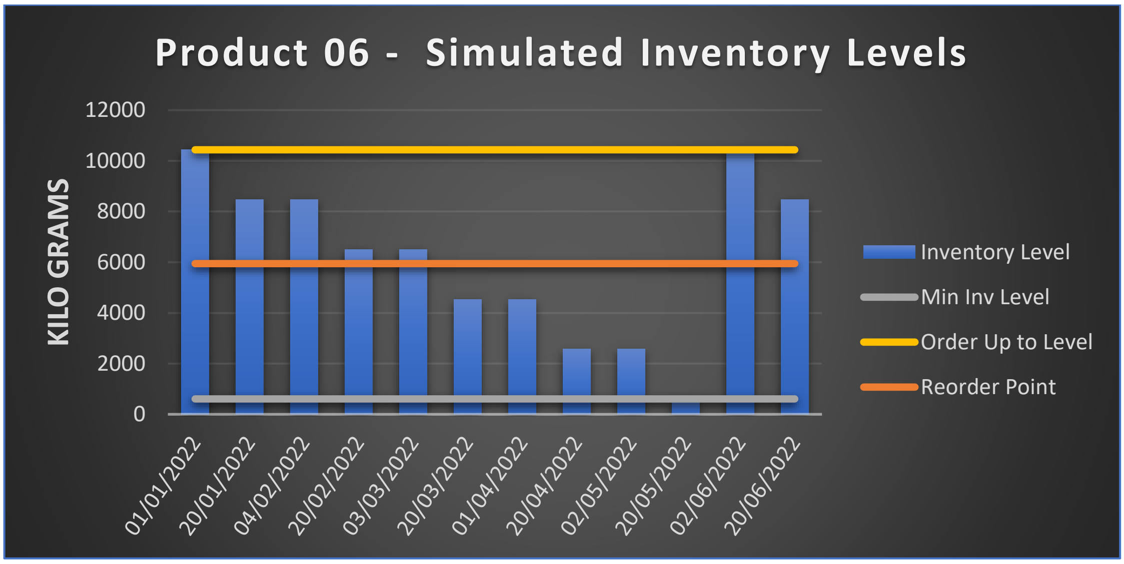
$$= 5945 + 4491$$

$$= 10436 \text{ Kg s}$$

Simulation:

According to the findings of our analysis. The variables Average Demand, order up to Level, and Reorder Point have been used. We get the following inventory traces.

Figure -13



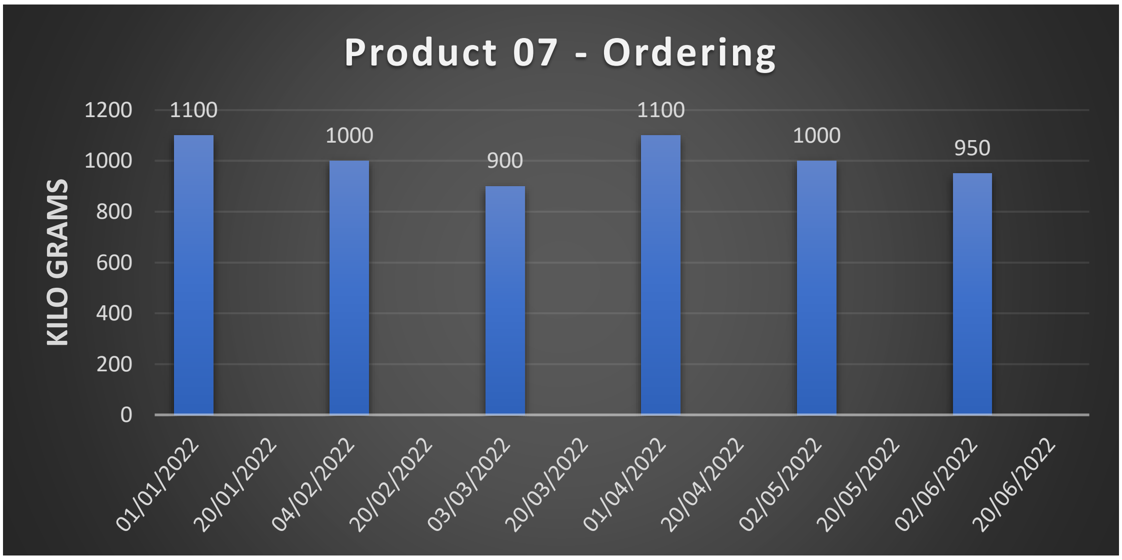
Summary:

We can see that an order was issued to bring the inventory up to Level (S) = 10436 Kg s on March 20, 2022, as the level fell below the Reorder Point (s) = 5945 Kg s. We can see that the minimal inventory level is 606 kg in actual. Based on the simulation. The average inventory rises from 1075 kilograms to 6176 kilograms.

Results:

A kg of holding costs 0.13 euros. The holding cost in the current scenario is 13.97 euros for the period from January to June/22 for the entire inventory. The Holding cost will increase to 80.29 Euros after simulation. There has just been a small increase of 66.31 Euros. The organization is protected from demand fluctuations by the criteria used. Furthermore, instead of placing orders every month, inventory is now restocked once every six months, which relieves the supply chain department's workload in terms of managing orders and the manpower required to coordinate logistics. Since cost of 1 order is 2000 Euros, in the current practice 6 order is placed in 6 months. This costs 6 X 2000, = 12000 kgs. The inventory is refilled twice every six months if the simulated model is used. Ordering costs 2 x 2000 = 4000 Euros. This equates to a saving of 8,000 euros (12000 - 4000).

5.7 - Product 7 Figure -14



When we look at the inventory levels, we can see that they change in response to replenishment and demand. Because Product 7 is a part of the contractual market, demand is predictable in nature. The demand is 1000 kg s, 1000 kg s, 900 kg s, 1000 kg s, 950 kg and 1000 kg s for the months of January 22 to June 22. With a standard deviation (σ_d) 51 kilograms and a variance (σ_d^2) 2667 kilograms, the mean demand (μ_d) is 967 kilograms. Orders are placed based on ordering quantities of the individual products. Demand variation is not taken into consideration in this.

With a predictable demand, Dorf Ketal BV (DKBV) is a long-term contract with the customer. The clients have already specified to Dorf Ketal BV the products they need. The production planning team in India can plan the production well in advance and combine it with the product's global demand because the products have a predictable demand. After production, it is transported to the port of Antwerp, where customs clearance is completed before being picked up by transport vehicles scheduled by the warehouse (Mexico Natie). The entire procedure takes a total of 3 months from placing the order to the time the goods are completely prepared for dispatch, called Lead Time (L). This value is considered when accounting for all delays, resulting in variation in Lead time (σ_L^2) = 0**.**

The Ordering cost per order (A) is 2000 Euros per order, and the Holding cost per order is 0.39 Eur/ Kg/ Month.

Applying EOQ Model:

$$Q = \sqrt{(2AD)/H}$$

$$= \sqrt{(2 X 2000 X 967) / (0.039)}$$

$$= 3149 \text{ Kg s}$$

$$s = D X L + k * \sqrt{(L*\sigma_d\wedge^2 + D^2 *\sigma_L\wedge^2)}$$

$$= 967 X 3 + \sqrt{(3 X 2667 + 967 X 967 X 0)}$$

$$= 2989 \text{ Kg s}$$

$$S = s + Q$$

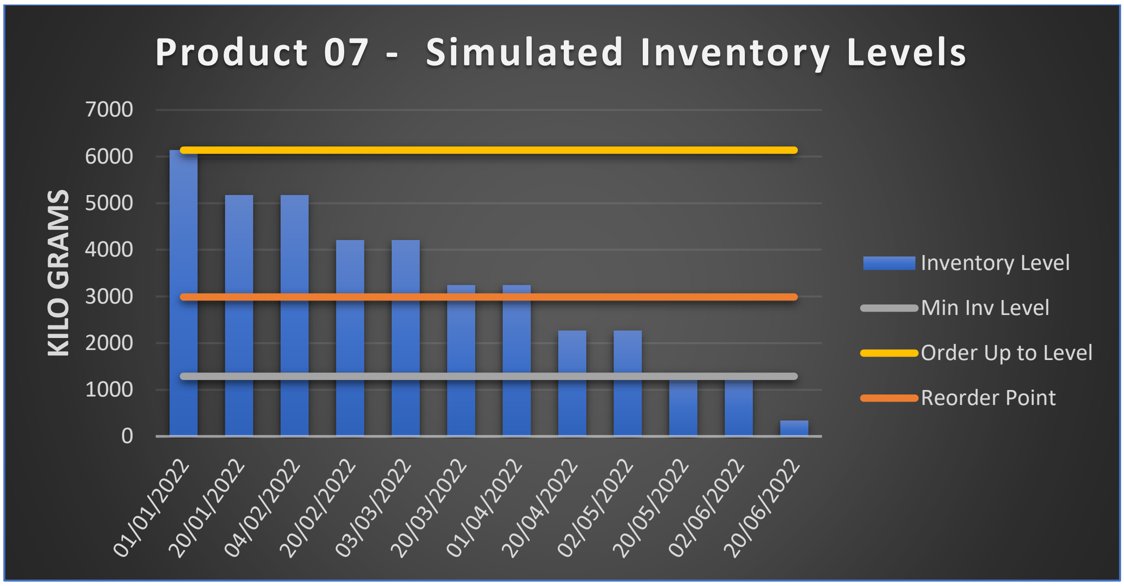
$$= 3149 + 2989$$

$$= 6138 \text{ Kg s}$$

Simulation:

According to the findings of our analysis. The variables Average Demand, order up to Level, and Reorder Point have been used. We get the following inventory traces.

Figure 15



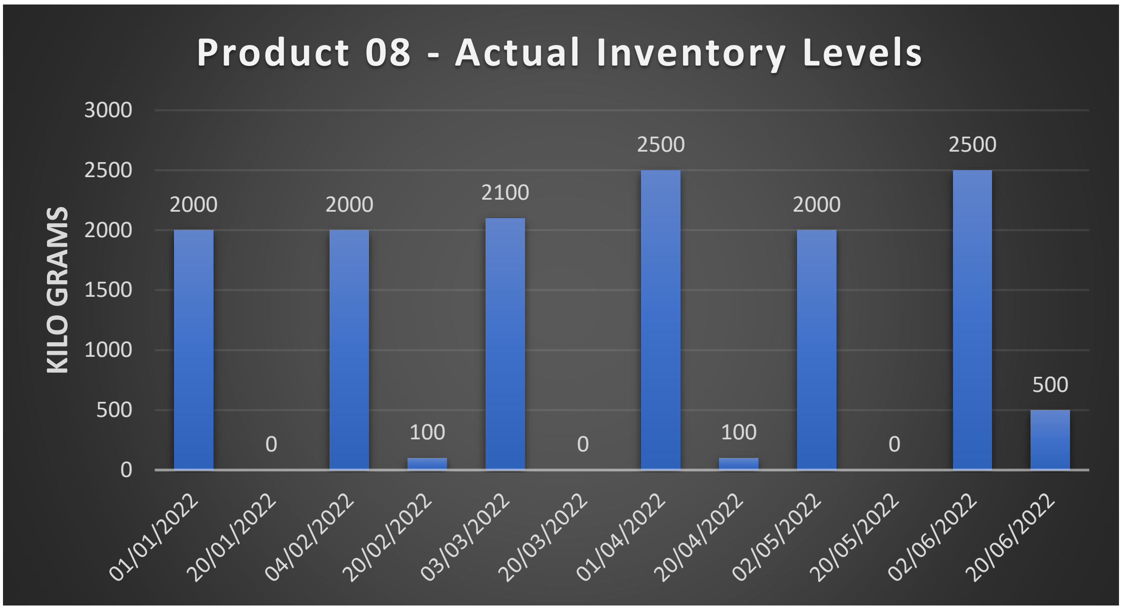
Summary:

We can see that an order was issued to bring the inventory up to Level (S) = 6138 Kg s on 20/04/2022, as the level fell below the Reorder Point (s) = 2989 Kg s. We can see that the minimal inventory level is 306 kg in actual . Based on the simulation. The average inventory rises from 545 kilograms to 3237 kilograms.

Results:

A kg of holding costs 0.13 euros/day . The holding cost in the current scenario is 7.09 euros for the period from January to June/22 for the entire inventory. The Holding cost will increase to 42.08 Euros after simulation. There has just been a small increase of 34.98 Euros. The organization is protected from demand fluctuations by the criteria used. Furthermore, instead of placing orders every month, inventory is now restocked once every six months, which relieves the supply chain department's workload in terms of managing orders and the manpower required to coordinate logistics. Since cost of 1 order is 2000 Euros, in the current practice 6 order is placed in 6 months. This costs 6 X 2000 = 12000 kgs. The inventory is refilled once every six months if the simulated model is used. Ordering costs 1 x 2000 = 2000 Euros. This equates to a saving of 10,000 euros (12000 - 2000).

5.8 - Product 8 Figure 16



When we look at the inventory levels, we can see that they change in response to replenishment and demand. Because Product 8 is a part of the contractual market, demand is predictable in nature. The demand is 2000 kg s, 1900 kg s, 2000 kg s, 2100 kg s, 2000 kg and 2000 kg s for the months of January 22 to June 22. With a standard deviation (σ_d) 63.24 kilograms and a variance (σ_d^2) 2000 kilograms, the mean demand (μ_d)is 2000 kilograms. Orders are placed based on ordering quantities of the individual products. Demand variation is not taken into consideration in this.

With a predictable demand, Dorf Ketal BV (DKBV) is a long-term contract with the customer. The clients have already specified to Dorf Ketal BV the products they need. The production planning team in India can plan the production well in advance and combine it with the product's global demand because the products have a predictable demand. After production, it is transported to the port of Antwerp, where customs clearance is completed before being picked up by transport vehicles scheduled by the warehouse (Mexico Natie). The entire procedure takes a total of 3 months from placing the order to the time the goods are completely prepared for dispatch, called Lead Time (L). This value is considered when accounting for all delays, resulting in variation in Lead time (σ_L^2) = 0**.**

The Ordering cost per order (A) is 2000 Euros per order, and the Holding cost per order is 0.39 Eur/ Kg/ Month.

Applying EOQ Model:

$$Q = \sqrt{(2AD)}/H$$

$= \sqrt{(2 X 2000 X 2000 / (0.039)}$

= 4529 Kg s

$s = D X L + k * \sqrt{(L*\sigma_d^2 + D^2 *\sigma_L^2)}$

$= 2000 X 3 + \sqrt{(3 X 4000+ 2000 X 2000 X 0)}$

= 6110 Kg s

S = s + Q

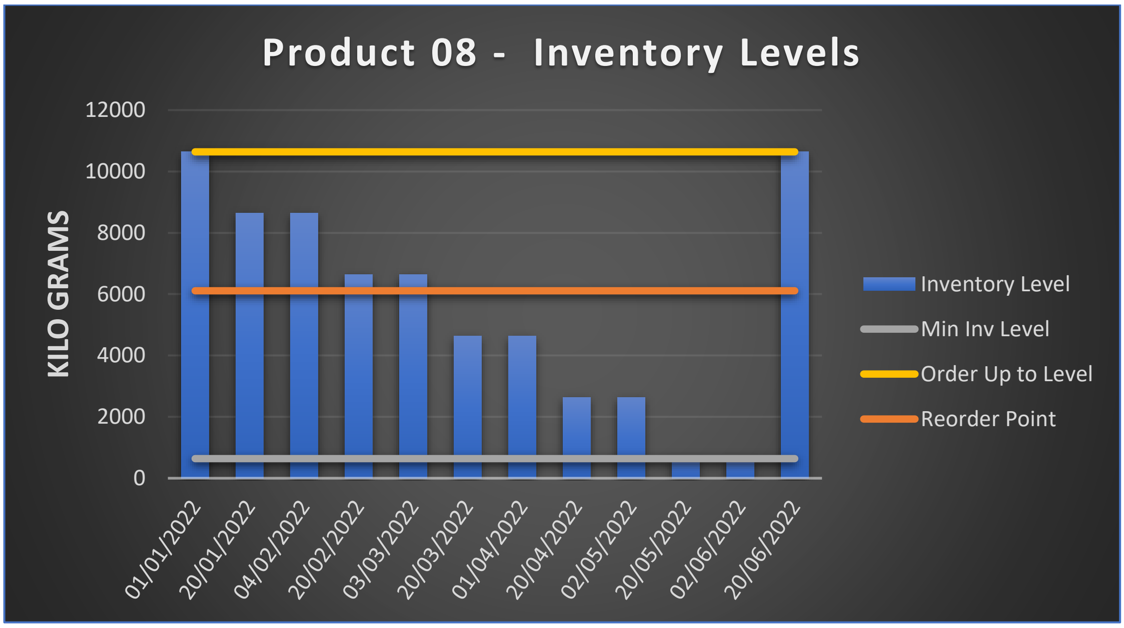
= 4529 + 6110

= 10639 Kg s

Simulation:

According to the findings of our analysis. The variables Average Demand, order up to Level, and Reorder Point have been used. We get the following inventory traces.

Figure 17



Summary:

We can see that an order was issued to bring the inventory up to Level (S) = 10639 Kg s on 20/03/2022, as the level fell below the Reorder Point (s) = 6110 Kg s. We can see that the minimal inventory level is 639 kg in actual . Based on the simulation. The average inventory rises from 1150 kilograms to 5639 kilograms.

Results:

A kg of holding costs 0.13 euros/day . The holding cost in the current scenario is 14.95 euros for the period from January to June/22 for the entire inventory. The Holding cost will increase to 73.307 Euros after simulation. There has just been a small increase of 58.35 Euros. The organization is protected from demand fluctuations by the criteria used. Furthermore, instead of placing orders every month, inventory is now restocked once every six months, which relieves the supply chain department's workload in terms of managing orders and the manpower required to coordinate logistics. Since cost of 1 order is 2000 Euros, in the current practice 6 order is placed in 6 months. This costs 6 x 2000 = 12000 kgs. The inventory is refilled once every six months if the simulated model is used. Ordering costs 2 x 2000, = 4000 Euros. This equates to a saving of 8,000 euros (12000 - 4000).

5.9 - Product 9

Figure 18

When we look at the inventory levels, we can see that they change in response to replenishment and demand. Because Product 9 is a part of the contractual market, demand is predictable in nature. The demand is 5100 kg s, 5000 kg s, 4750 kg s, 5000 kg s, 5200 kg and 5000 kg s for the months of January 22 to June 22. With a standard deviation (σ_d) 149 kilograms and a variance (σ_d^2) 22416 kilograms, the mean demand (μ_d)is 5008 kilograms. Orders are placed based on ordering quantities of the individual products. Demand variation is not taken into consideration in this.

With a predictable demand, Dorf Ketal BV (DKBV) is a long-term contract with the customer. The clients have already specified to Dorf Ketal BV the products they need. The production planning team in India can plan the production well in advance and combine it with the product's global demand because the products have a predictable demand. After production, it is transported to the port of Antwerp, where customs clearance is completed before being picked up by transport vehicles scheduled by the warehouse (Mexico Natie). The entire procedure takes a total of 3 months from placing the order to the time the goods are completely prepared for dispatch, called Lead Time (L). This value is considered when accounting for all delays, resulting in variation in Lead time (σ_L^2) = 0**.**

The Ordering cost per order (A) is 2000 Euros per order, and the Holding cost per order is 0.39 Eur/ Kg/ Month.

Applying EOQ Model:

$$Q = \sqrt{(2AD)/H}$$

$$= \sqrt{(2 X 2000 X 5008 / (0.039)}$$

$$= 8778 \text{ Kg s}$$

$$s = D X L + k * \sqrt{(L*\sigma_d{}^\wedge 2 + D^2 *\sigma_L{}^\wedge 2)}$$

$$= 2000 X 3 + \sqrt{(3 X 4000 + 2000 X 2000 X 0)}$$

$$= 15284 \text{ Kg s}$$

$$S = s + Q$$

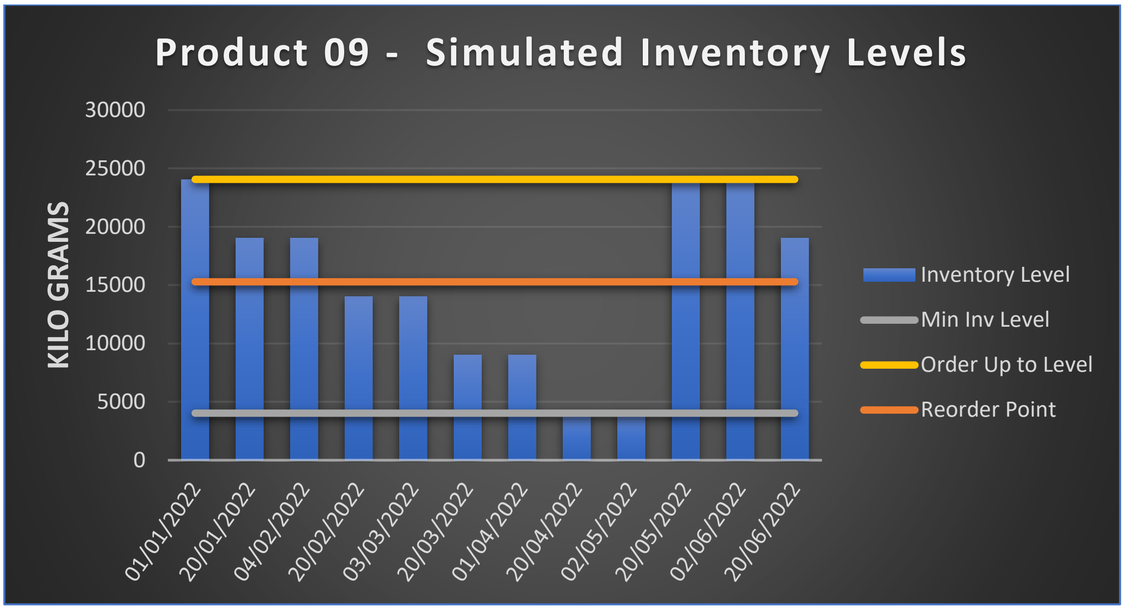
$$= 15284 + 8778$$

$$= 24062 \text{ Kg s}$$

Simulation:

According to the findings of our analysis. The variables Average Demand, order up to Level, and Reorder Point have been used. We get the following inventory traces.

Figure 19



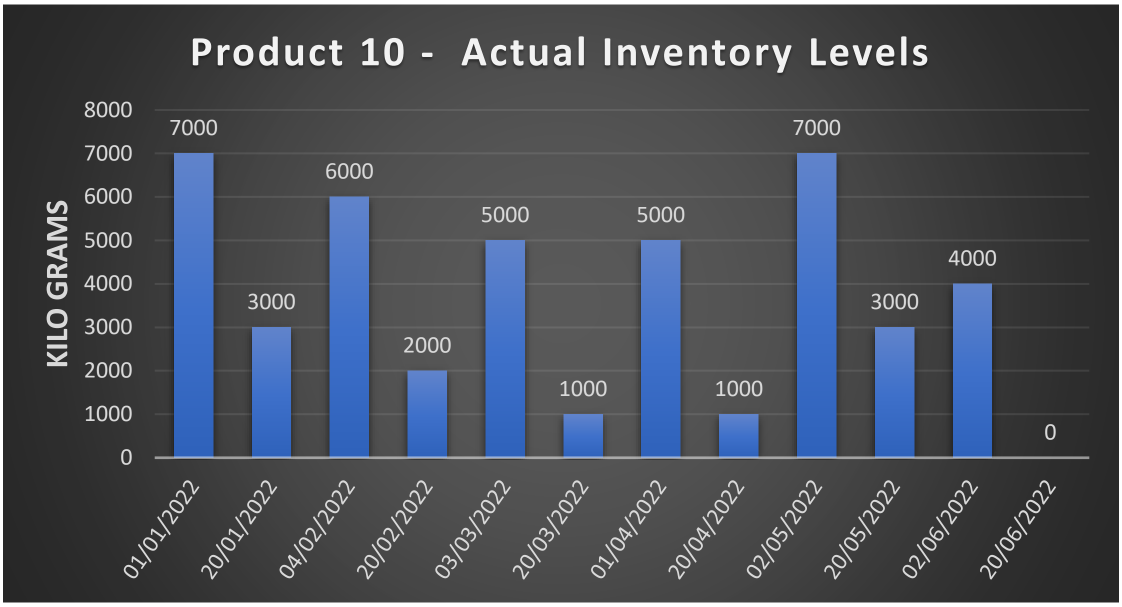
Summary:

We can see that an order was issued to bring the inventory up to Level (S) = 24062 Kg s on 20/02/2022, as the level fell below the Reorder Point (s) = 15284 Kg s. We can see that the minimal inventory level is 4030 kg in actual. Based on the simulation. The average inventory rises from 5541 kilograms to 15298 kilograms.

Results:

A kg of holding costs 0.13 euros/day . The holding cost in the current scenario is 72.0 euros for the period from January to June/22 for the entire inventory. The Holding cost will increase to 198.8 Euros after simulation. There has just been a small increase of 126.3.83 Euros. The organization is protected from demand fluctuations by the criteria used. Furthermore, instead of placing orders every month, inventory is now restocked once every six months, which relieves the supply chain department's workload in terms of managing orders and the manpower required to coordinate logistics. Since cost of 1 order is 2000 Euros, in the current practice 6 order is placed in 6 months. This costs 6 x 2000 = 12000 kgs. The inventory is refilled once every six months if the simulated model is used. Ordering costs 2 x 2000, = 4000 Euros. This equates to a saving of 8,000 euros (12000 - 4000).

5.10 - Product 10 Figure 20



When we look at the inventory levels, we can see that they change in response to replenishment and demand. Because Product 10 is a part of the contractual market, demand is predictable in nature. The demand is 4000 kg s, 4000 kg s, 4000 kg s, 4000 kg s, 4000 kg and 4000 kg s for the months of January 22 to June 22. With a standard deviation (σ_d) 0 kilograms and a variance (σ_d^2) 0 kilograms, the mean demand (μ_d)is 4000 kilograms. Orders are placed based on ordering quantities of the individual products. Demand variation is not taken into consideration in this.

With a predictable demand, Dorf Ketal BV (DKBV) is a long-term contract with the customer. The clients have already specified to Dorf Ketal BV the products they need. The production planning team in India can plan the production well in advance and combine it with the product's global demand because the products have a predictable demand. After production, it is transported to the port of Antwerp, where customs clearance is completed before being picked up by transport vehicles scheduled by the warehouse (Mexico Natie). The entire procedure takes a total of 3 months from placing the order to the time the goods are completely prepared for dispatch, called Lead Time (L). This value is considered when accounting for all delays, resulting in variation in Lead time (σ_L^2) = 0**.**

The Ordering cost per order (A) is 2000 Euros per order, and the Holding cost per order is 0.39 Eur/ Kg/ Month.

Applying EOQ Model:

$Q = \sqrt{(2AD)/H}$

$= \sqrt{(2 \times 2000 \times 4000 / (0.039)}$

= 7845 Kg s

$s = D \times L + k * \sqrt{(L*\sigma_d{}^{\wedge 2} + D^2 * \sigma_L{}^{\wedge 2})}$

$= 4000 \times 3 + \sqrt{(3 \times 0 + 2000 \times 2000 \times 0)}$

= 12000 Kg s

S = s + Q

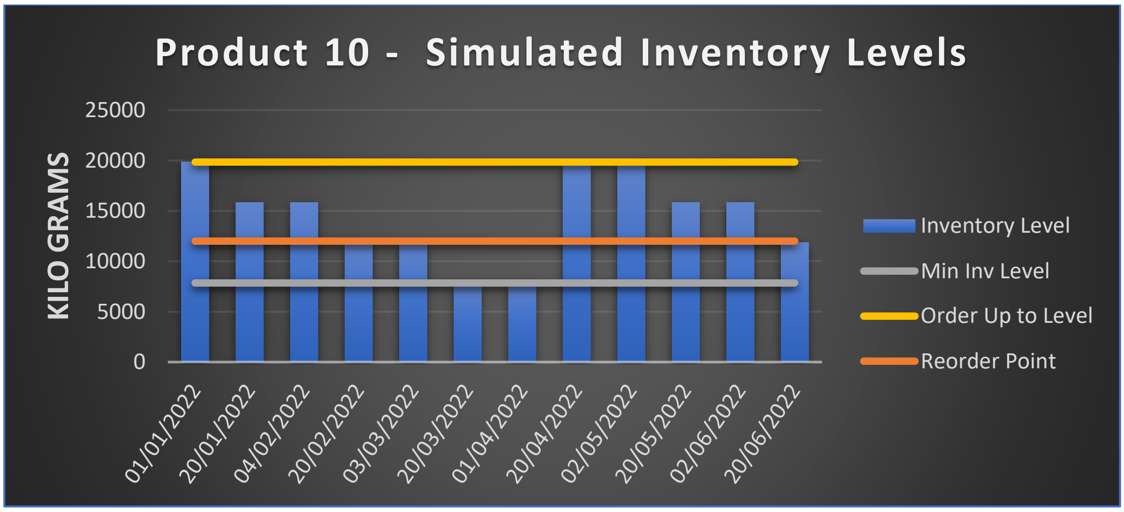
= 0 +

= 19845 Kg s

Simulation:

According to the findings of our analysis. The variables Average Demand, order up to Level, and Reorder Point have been used. We get the following inventory traces.

Figure-21



Summary:

We can see that an order was issued to bring the inventory up to Level (S) = 19845 Kg s on 20/02/2022, as the level fell below the Reorder Point (s) = 12000 Kg s. We can see that the minimal inventory level is 7845 kg in actual. Based on the simulation. The average inventory rises from 3667 kilograms to 14511 kilograms.

Results:

A kg of holding costs 0.13 euros/day. The holding cost in the current scenario is 47.0 euros for the period from January to June/22 for the entire inventory. The Holding cost will increase to 188.6 Euros after simulation. There has just been a small increase of 140.98 Euros. The organization is protected from demand fluctuations by the criteria used. Furthermore, instead of placing orders every month, inventory is now restocked once every six months, which relieves the supply chain department's workload in terms of managing orders and the manpower required to coordinate logistics. Since cost of 1 order is 2000 Euros, in the current practice 6 order is placed in 2 months. This costs 6 x 2000, or 12000 kgs. The inventory is refilled once every six months if the simulated model is used. Ordering costs 2 x 2000, = 4000 Euros. This equates to a saving of 8,000 euros (12000 - 4000).

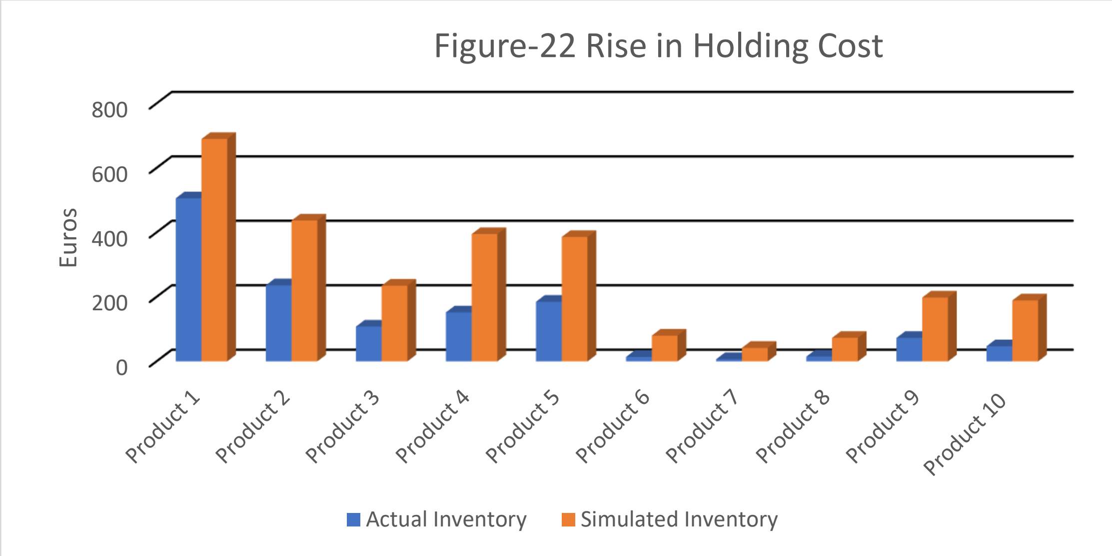
5.11 Analysis:

5.11.1 Holding Cost Analysis:

Holding Cost: 0.013 Eur/ Kg/Day

Table 2 Holding Cost Analysis (Jan/22 – Jun/22)

ITEM	Actual Average Inv. Btwn Jan22-Jun22	Actual Holding Cost in Euros (Avg Inv X 0.13)	Simulated Average Inv. Btwn Jan22-Jun22	Simulated Holding Cost in Euros (Avg Inv X 0.13)
Product 1	38916	506	53097	690
Product 2	18166	236	33677	437
Product 3	8333	108	18128	235
Product 4	11750	152	30460	395
Product 5	14250	185	29736	386
Product 6	1075	14	6176	80
Product 7	546	07	3237	42
Product 8	1150	15	5039	73
Product 9	5541	73	15298	198
Project 10	3667	47	14511	189
SUM	----------------	1343	-----------------	2725
Total Rise In Holding Price			1382 Euros	

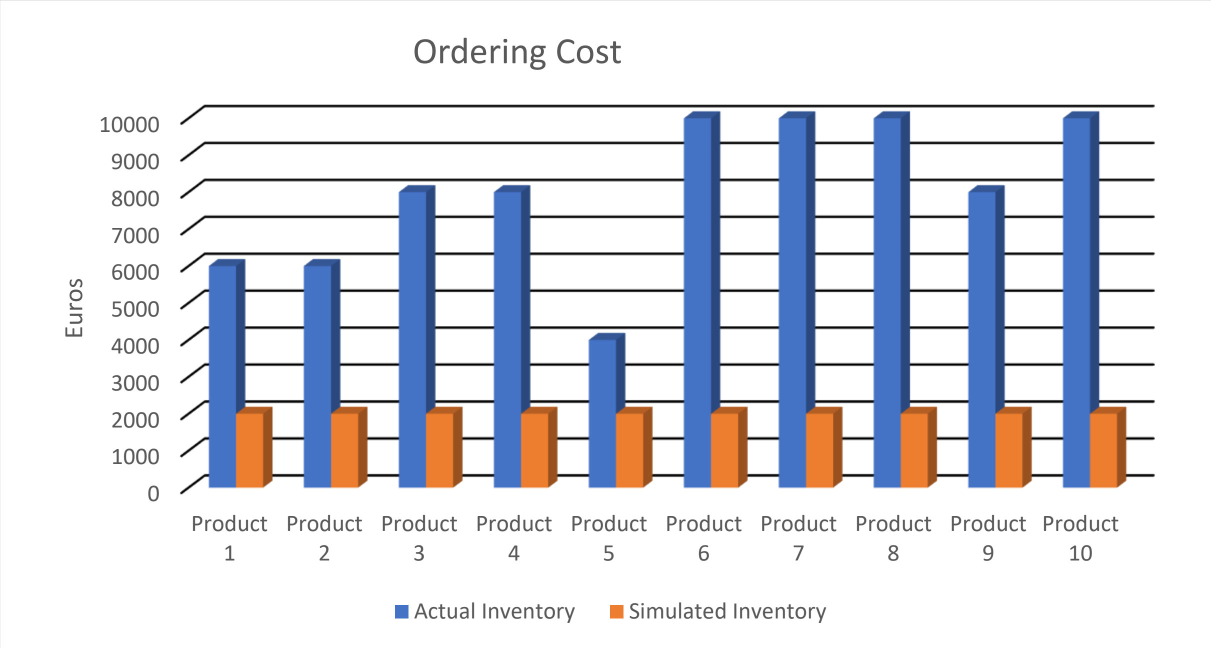


5.11.2 Ordering Cost Analysis:

Ordering Cost: 2000 Eur/ Order

Table 2: Ordering Cost Analysis (Jan/22 – Jun/22)

ITEM	Actual No. of Orders Btwn Jan22-Jun22	Actual Ordering Cost in Euros (No. of Order X 2000)	Simulated Average Inv. Btwn Jan22-Jun22	Simulated Ordering Cost in Euros (No. of Order X 2000)
Product 1	3	6000	2	4000
Product 2	3	6000	2	4000
Product 3	4	8000	2	4000
Product 4	4	8000	2	4000
Product 5	2	4000	2	4000
Product 6	5	10000	2	4000
Product 7	5	10000	2	4000
Product 8	5	10000	1	2000
Product 9	4	8000	2	4000
Project 10	5	10000	2	4000
SUM	----------------	80000	----------------	38000
Total Savings in Holding Price			42,000 Euros	



5.11.3 Lost Sales Analysis:

Table 3: Lost Sales Analysis (Jan/22 – Jun/22)

Item	Actual Total Lost sales in Kg s	Selling Price/ Kg s	Cost of lost sales in Euros
Product 1	0	8.02	0
Product 2	6000	5.80	34800
Product 3	3000	8.60	25800
Product 4	3000	6.98	20940
Product 5	3000	10.60	31800
Product 6	200	4.06	812
Product 7	100	5.83	583
Product 8	200	3.75	750
Product 9	2050	3.26	6683
Project 10	0	7.65	0
TOTAL			122168

5.11.4 Summary of Cost Analysis

Total Inventory savings = Lost Sales Value + Order Cost Saving – Holding Cost Rise

= 122168 + 42000 – 1382

= 162786 Euros

5.11.5 Analysis of Relation between Standard Deviation of Demand and Simulated Inventory levels

Table 4: Coefficient of determination Analysis

Item	Variance of Demand	Standard Deviation of Demand	Simulated Minimum Inventory level
Product 1	0	7918	19264
Product 2	36000000	5329	13427
Product 3	9000000	2683	6462
Product 4	9000000	3450	8294
Product 5	9000000	5819	14182
Product 6	40000	26	606
Product 7	10000	51	306
Product 8	40000	63	639
Product 9	4202500	149	4030
Project 10	0	0	7845
R^2 valve between Std. Dev of demand and Simulated Min Inv Levels			0.93

A very Strong Coefficient of Determination (0.93) is found between Standard Deviation of Demand & Simulated Minimum Inventory level. The simulation shows that as the Standard Deviation of Demand Increases the Minimum inventory level similar to safety stocks keep on increasing.

Chapter 6 Conclusion

What is the effect of improvement in new inventory management strategies?

This thesis sought to determine whether there is any scope of improvement in the performance of the Liquid Chemical Supply Chain in terms of timely deliveries to the customers. To accomplish this, we have used Newsboy Model and Economic Order Quantity (EOQ) Model. This final chapter makes judgments based on the conclusions drawn and their effects on the research carried out. The suggestions in subsection 6.1 are displayed. The conclusions of this study are briefly described in Section 6.2, and Section 6.3's limitations and recommendations for further study serve as the report's conclusion.

6.1 Recommendations.

Some recommendations can be made based on the research and the findings of the research questions. The following will describe these suggestions.

Get the inventory levels under control is the first piece of advice. Due to not complying with any inventory management practices, the inventory levels and ordering patterns have no control. This is very inefficient since it causes orders to be missed. Continuous flow of inbounds, increase the need for administrative manpower. This approach is also vulnerable to logistical delays brought on by outside forces. Ordering needs to be done in accordance with the models mentioned in this study. This will enable the ordering and procurement strategies that were developed. The whole cost of the product is taken into consideration when calculating optimal quantities, reordering points, and safety stocks. The process of constructing an order management schedule is assisted by time reviewing periods. Therefore, effective inventory management procedures should be followed.

The second suggestion is to analysis the sales contracts with the customers, warehouse, truck carriers, sea carriers, and customers. Lead time and service level agreement varied significantly. The delivery commitment with customers has a 15-day lead time and a three-month lead time. This problem has to be solved. The other problem is that it takes two weeks to combine the products. This is equivalent to the actual delivery time to clients. The time needed for the purchase of raw materials is another factor. Therefore, service level agreements need to be changed with the consent of all parties.

The final recommendation offered by this thesis is that Dorf Ketal and its other subsidiaries work more closely together, particularly when it comes to acquiring Rush Others. The lead time for purchases made in India is three months. This is quite significant and makes it very challenging to meet needs that are not anticipated. The other subsidiaries, such Dorf Ketal USA and Dorf Ketal Brazil, frequently have an abundance of products. It takes this location 12 to 15 days to send something. This is a significantly faster way to obtain Rush Orders. Working with other subsidiaries has the added benefit of reverse logistics. Inventory volume has grown over time, and items have been ordered but not sold. This number has increased by 20% more than the inventory. The items in the stock can meet the needs of industries in different areas and are fully certified. Subsidiaries of Dorf Ketal that are situated in different regions can aid in the reduction of non-moving inventory.

6.2 Conclusion

In Europe, Dorf Ketal offers liquid chemicals that are imported from factories in India. This guarantees them minimal production costs, but poses a problem due to the high cost of delivery and the lengthy and unpredictability in the logistics. Therefore, it is examined in this thesis whether this issue can be address using the methodological approach. Main Research question is as follows:

“How can Dorf Ketal optimize inventory management to enable significantly high customer service levels?”

Solution : Take advantage of lower Holding cost and stock up inventory levels, reduce the operational cost by placing less order.

Various parameters of the inventory were calculated on Newsboy Model and Economic Order Quantity Model based on difference in the nature of demands.

Because it was determined from the literature research that mathematical modelling was the most effective technique to investigate Dorf Ketals inventory levels, models was chosen to do so. The models have been applied based on the nature of variable demand patterns. They are an optimization of the inventory management, an optimization of the replenishment frequency, and an optimization of the Reordering points, Safety stocks, Review period, Order up to level, Optimum quantities. It is clear from this analysis that there are ways to manage the demand of products while maintaining a high level of customer service. This is the true for ten products that have been taken out of the inventory, they represent a majority of the products available in the vast inventory of projects. These findings lead to the recommendation that Dorf Ketal implements inventory management models to their current supply chain system.

6.3 Limitations:

The safety stock calculation assumes a stationary demand process, which means that demand and lead time are both assumed to have equal and independent distributions. This is an important aspect to note. Unfortunately, demand forecasting process decomposition does not always exhibit these qualities when taking empirical data into account, and as a result, this approach yields unstable findings. While the amount of historical data, or the number of periods utilized for estimating the process variability, has no bearing on the computation for a stationary demand process, this is no longer true when employing empirical data. These often-overlooked details could end up being crucial since they could affect supply chain dynamics and result in incorrect inventory and service levels.

6.4 Future Scope

A Vendor Managed Inventory model (VMI) might be an attractive solution to this problem. In a VMI model, close communication and data sharing between the client and supplier and two. The model calls for sharing the customer's inventory level with Dorf Ketal BV can use this knowledge if a capacity issue arises. The agent in charge of client service then it will be easier to decide which client orders need to be changed. By doing so, whereas the service level which might simplify the work for the customer service representative be offered either stays the same or goes up. Consequently, it would be intriguing to research whether Dorf Ketal BV will be successful in using this approach.

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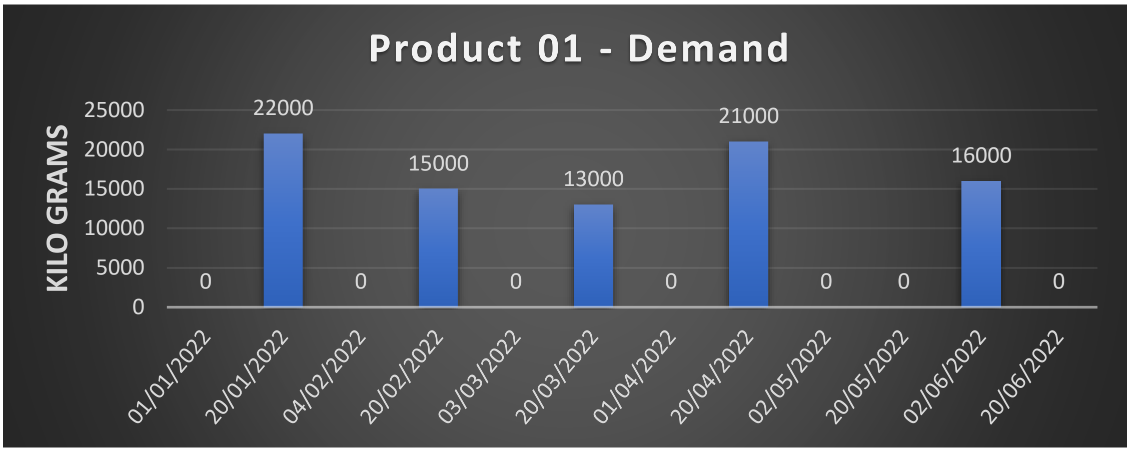
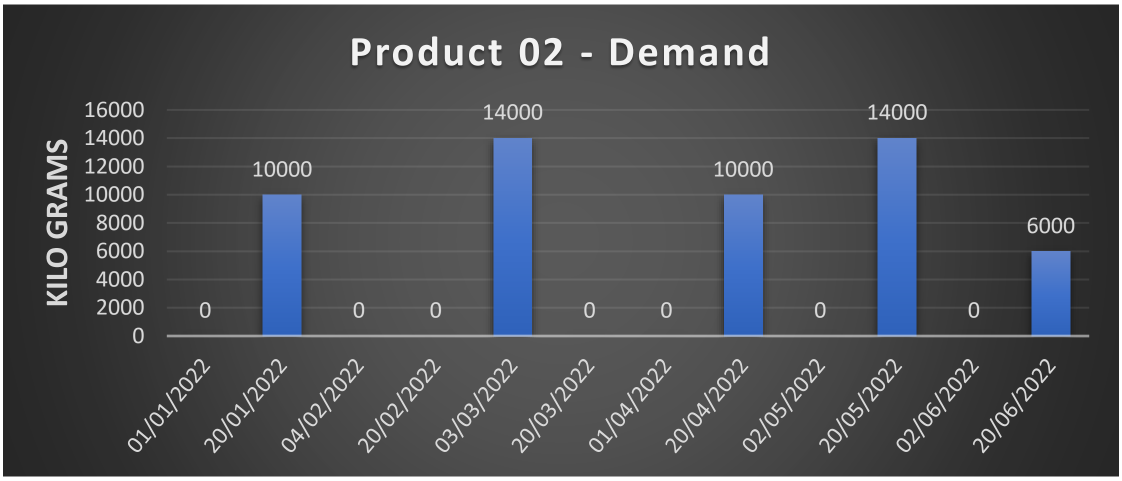
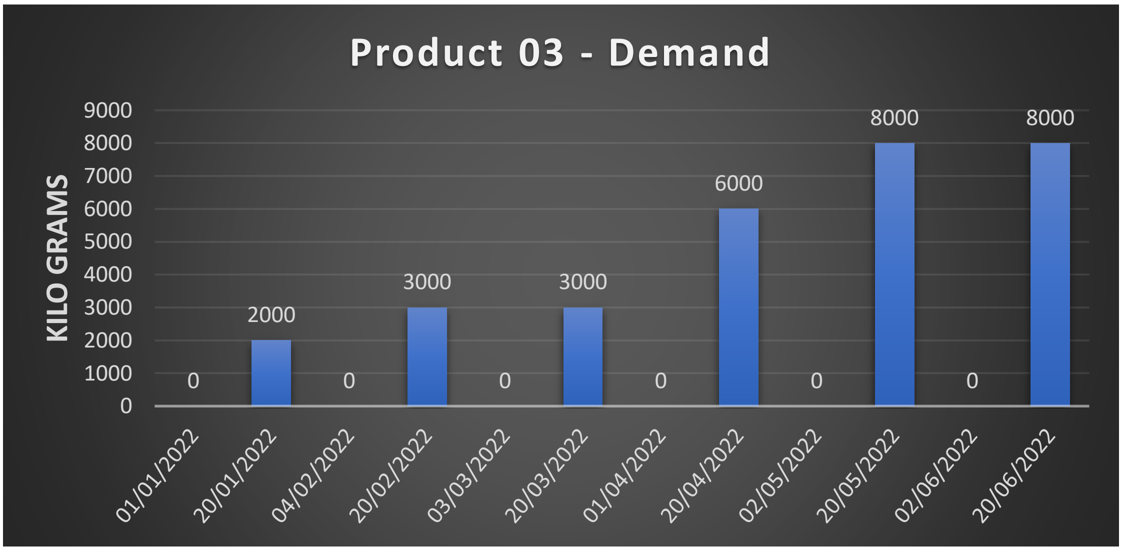
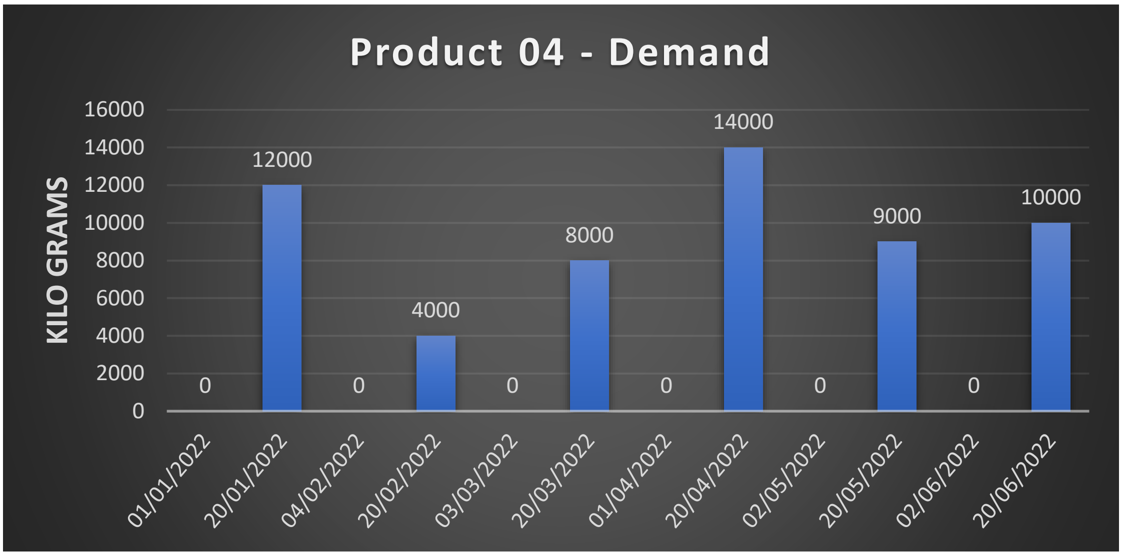
Appendices

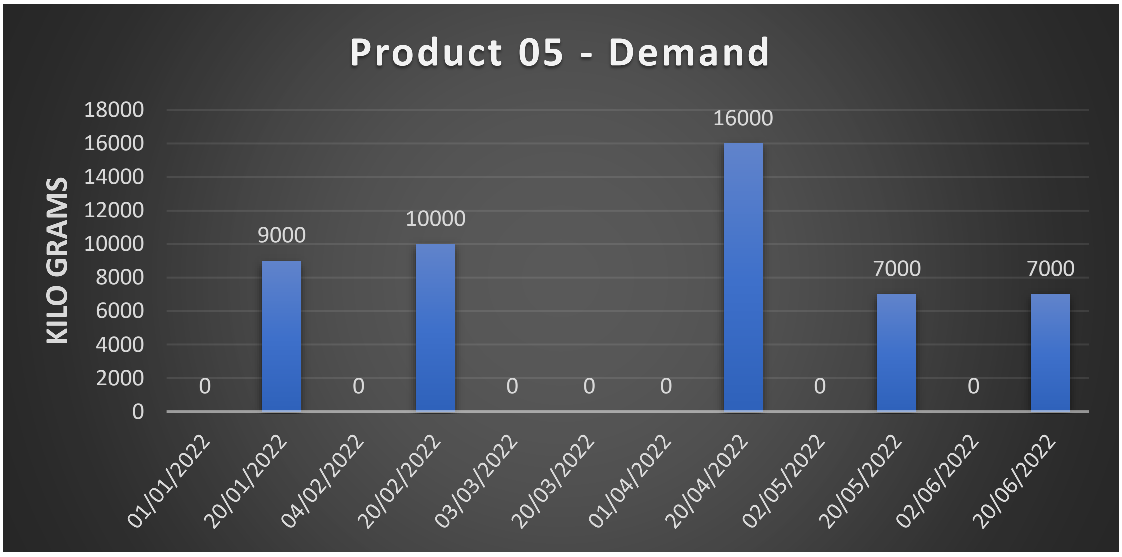
Appendix 1 – Actual Demand Pattern Of the products

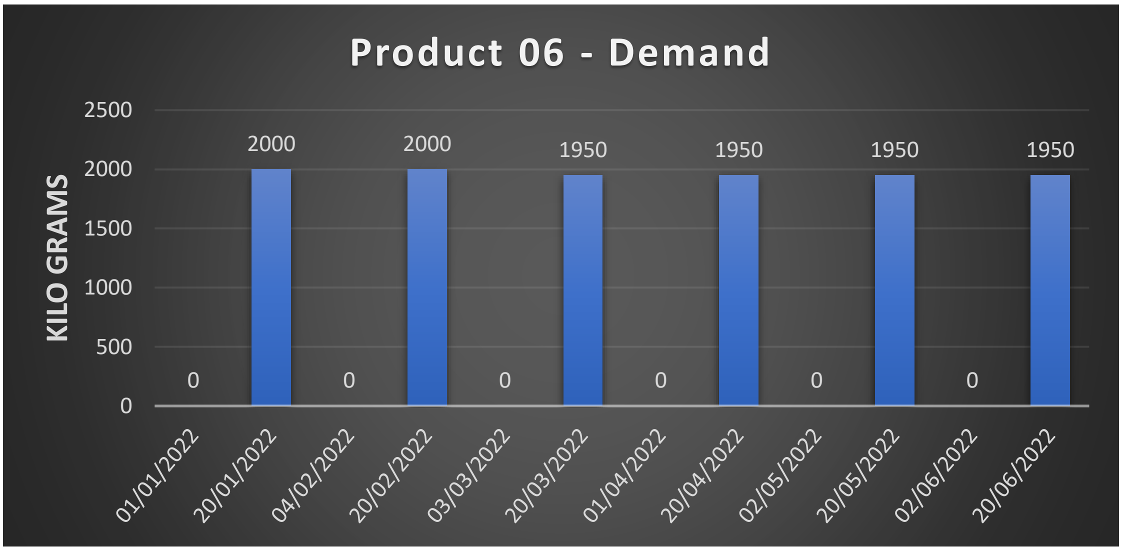


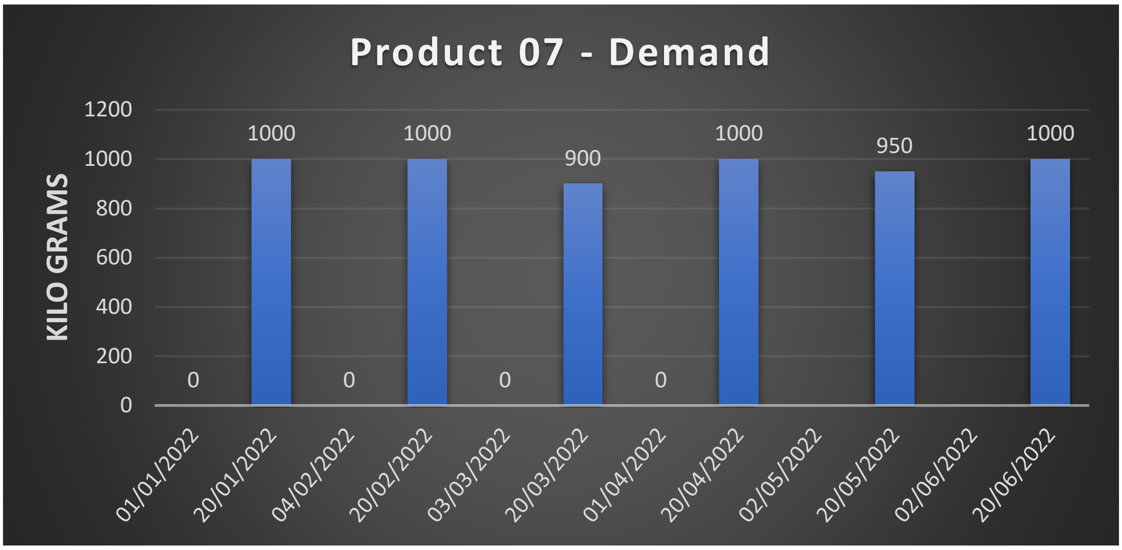


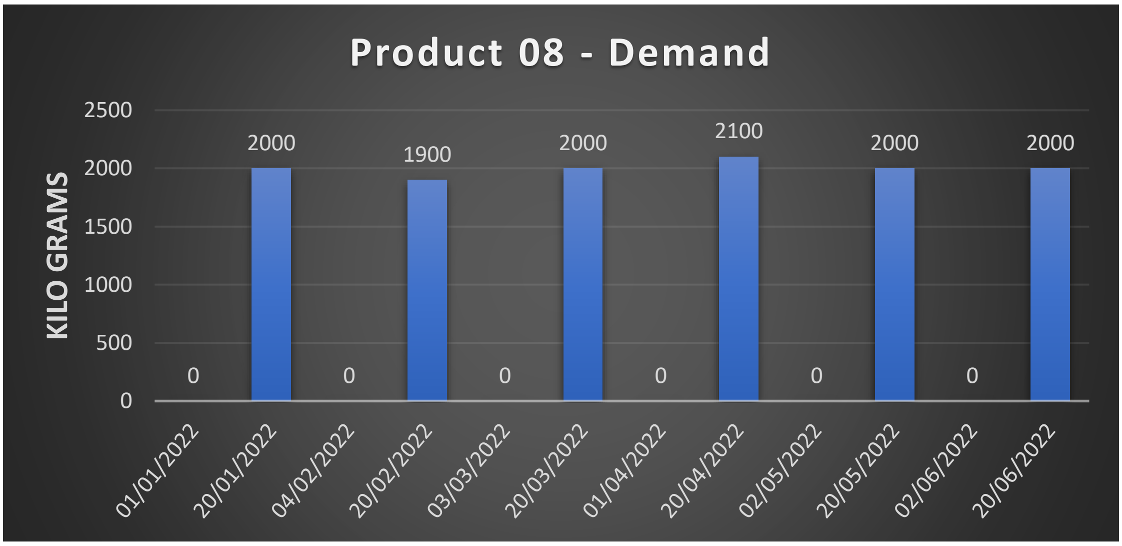


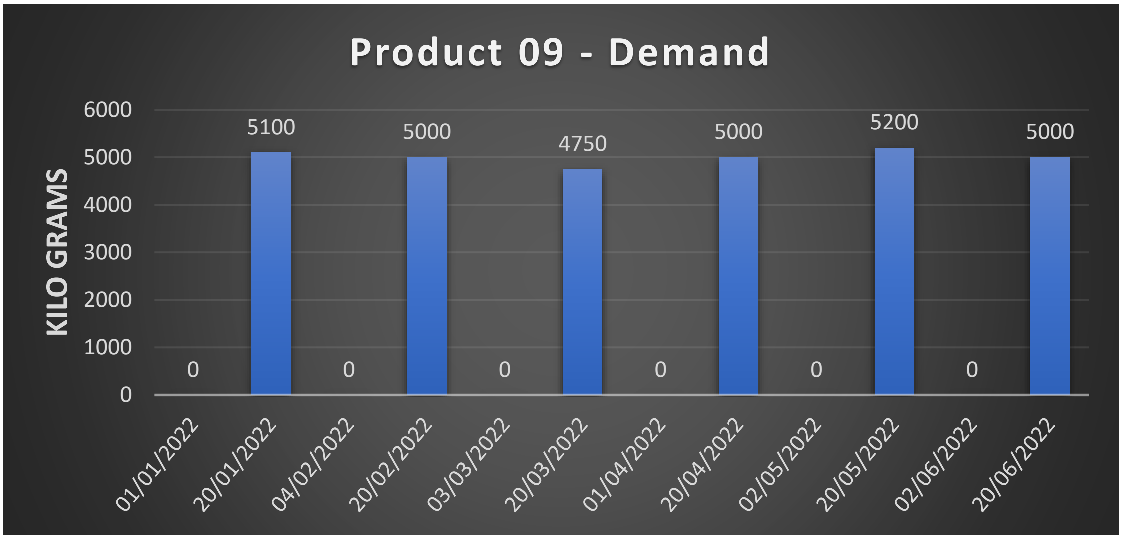

Product 04 - Demand
KILO GRAMS
16000
14000
12000
10000
8000
6000
4000
2000
0
0
12000
0
4000
0
8000
0
14000
0
9000
0
10000
01/01/2022
20/01/2022
04/02/2022
20/02/2022
03/03/2022
20/03/2022
01/04/2022
20/04/2022
02/05/2022
20/05/2022
02/06/2022
20/06/2022

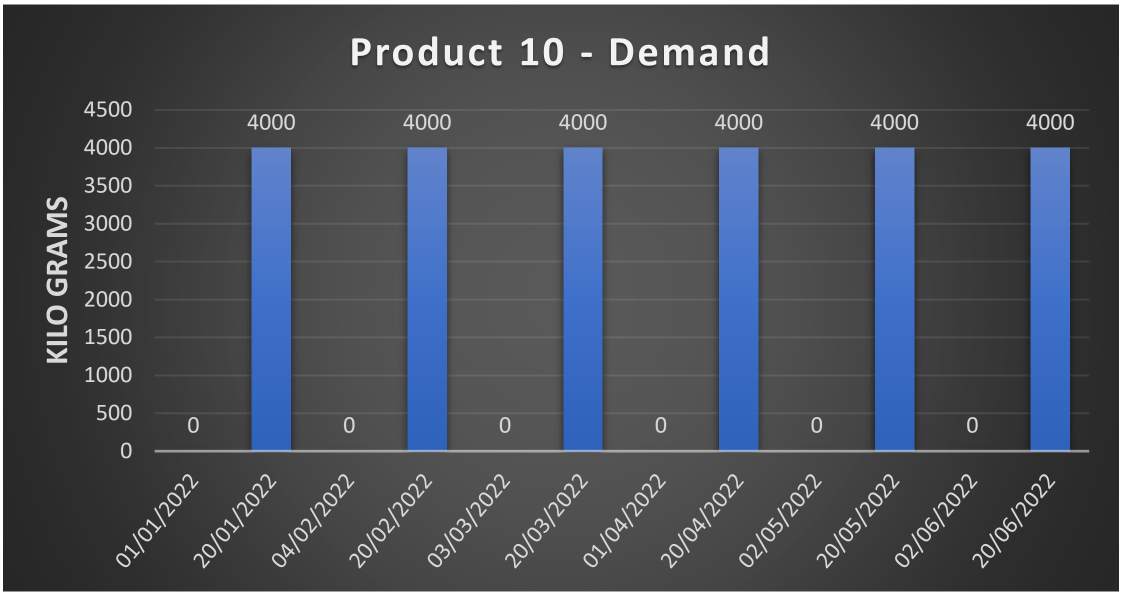

Product 05 - Demand
KILO GRAMS
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0
9000
0
10000
0
0
0
16000
0
7000
0
7000
01/01/2022
20/01/2022
04/02/2022
20/02/2022
03/03/2022
20/03/2022
01/04/2022
20/04/2022
02/05/2022
20/05/2022
02/06/2022
20/06/2022


Product 06 - Demand
KILO GRAMS
2500
2000
1500
1000
500
0
0
2000
0
2000
0
1950
0
1950
0
1950
0
1950
01/01/2022
20/01/2022
04/02/2022
20/02/2022
03/03/2022
20/03/2022
01/04/2022
20/04/2022
02/05/2022
20/05/2022
02/06/2022
20/06/2022


Product 07 - Demand
KILO GRAMS
1200
1000
800
600
400
200
0
0
1000
0
1000
0
900
0
1000
950
1000
01/01/2022
20/01/2022
04/02/2022
20/02/2022
03/03/2022
20/03/2022
01/04/2022
20/04/2022
02/05/2022
20/05/2022
02/06/2022
20/06/2022


Product 08 - Demand
KILO GRAMS
2500
2000
1500
1000
500
0
0
2000
0
1900
0
2000
0
2100
0
2000
0
2000
01/01/2022
20/01/2022
04/02/2022
20/02/2022
03/03/2022
20/03/2022
01/04/2022
20/04/2022
02/05/2022
20/05/2022
02/06/2022
20/06/2022


Product 09 - Demand
KILO GRAMS
6000
5000
4000
3000
2000
1000
0
0
5100
0
5000
0
4750
0
5000
0
5200
0
5000
01/01/2022
20/01/2022
04/02/2022
20/02/2022
03/03/2022
20/03/2022
01/04/2022
20/04/2022
02/05/2022
20/05/2022
02/06/2022
20/06/2022


Product 10 - Demand
KILO GRAMS
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
4000
0
4000
0
4000
0
4000
0
4000
0
4000
01/01/2022
20/01/2022
04/02/2022
20/02/2022
03/03/2022
20/03/2022
01/04/2022
20/04/2022
02/05/2022
20/05/2022
02/06/2022
20/06/2022
