Study & application of Inventory Management Principles

FINAL YEAR PROJECT THESIS

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Study of Inventory Management Principles

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Declaration

I certify that this research work titled
"**Study of Inventory Management Principles**"
is our own work. The work has not been presented elsewhere for assessment. The material that we used from other sources has been properly acknowledged.

Signature of Students

Language Correctness Certificate

This thesis has been read by an English expert and is free of typing, syntax, semantic, grammatical and spelling mistakes. Thesis is also according to the format given by the university.

Signature of Students

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Copyright Statement

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Project Aim

Reduction in inventory excess through standardization in variety, “Family Grouping” of raw-material items, determination of the fast-moving products & their strategic reallocation nearest to the manufacturing area, order-point calculations for finished products

Project Abstract

Inventory or stock refers to the goods and materials that a business holds for the ultimate purpose of resale & production. Inventory for any company or firm is an all-time requirement & an asset. It is required at different locations within a facility. A company must keep its inventory safe & available all the time for the production process to be carried out according to the production schedule made by the company. While, inventory is an essential asset for a company, it also carries costs with it. Therefore it should always be kept up to a limit where it is useful to a company and not act as a waste of capital. Therefore, inventory reduction has always been a key focus for many companies and their proper sorting and storage should ensure least time wastage in locating the items and carrying them to the manufacturing area.

Starco Fans, a local fan industry in Gujarat, which we used as our case study, has its inventory stored in up to eight storerooms for different purposes. Items of different product models constitute the inventory. Bill of material for a single fan shows about 45-50 items as raw material needed to produce a finished & packed fan for sale. There are a total of 15 major ceiling fan models they produce for export. Other models constitute the miscellaneous models in a single category.

The main problems which we identified in their inventory systems were the unnecessary variety in the raw material they kept, which could be reduced easily by standardization, improper sorting & grouping of raw material items causing lots of time wastage in locating the required items for manufacturing & increasing chances to the damage and shortage of items at the required time, no declaration the top fast moving premium fan models to focus towards there availability at all times, no determination of minimum stock quantity of the premium products that should be available for delivery at all times in case of sudden order surges.

Our main aim of the project was to deal with all these mentioned problems to bring about modification in their inventory systems. This would lead to a better manufacturing system.

Different techniques were used to address these problems adequately such as standardization, family grouping, time study to determine time for transport of raw material from storerooms to their destined places of use, strategic reallocation of raw material of premium products based on this time study, ABC analysis to determine the top fast moving products & order-point calculations for these premium products.

<u>Keywords:</u> Raw material & finished goods Inventory, standardization, family grouping, strategic reallocation, ABC analysis, fast moving products, order-point calculations.

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Introduction

Our Project was mainly divided into 3 parts:

Part 1: First Part involved Background Research regarding the project in order to get some know- how about the basic concepts and terminologies used in the field of inventory management. It helped us to make a sound foundation on which we further built our project.
It also involved visits to the Starco Fans Gujarat, our case study, in order to get a deeper understanding of the inventory systems of the industry and how they managed it.

Part 2: Second Part involved some more visits to the factory as we identified the key problems associated with their inventory system and made efforts to generate best possible solutions to cope with those problems.

Part 3: In the third Part best solutions were finalized and theoretically implemented and the results were analyzed as we managed to accomplish our project aim.

Part One-Chapter No. 01

1.1. Background Research

1.1.1. Brief Introduction:

"Inventory" includes raw materials of the company; work in progress, supplies used in operations and finished products. Inventory can be something as simple as a bottle of glass cleaner than or something as complex as a mixture of raw materials and subassemblies used in a manufacturing process [1].

The decision on the amount of inventory that the company should stick to its location and facilities is very important to meet the requirements and expectations of customer service. But there is a potentially large costs associated with holding inventory. It is very important to achieve a balance between the costs and transport services.[2]

Inventory management is a science of determination of the shape and percentage of stocked goods. It is maintained at different locations within a facility to precede the regular and planned course of production and stock of materials.

The scope of inventory management concerns the fine lines between replenishment lead time, carrying costs of inventory, inventory forecasting, inventory valuation, future inventory price forecasting, physical inventory, available physical space for inventory, quality management, replenishment, returns and defective goods, and demand forecasting. Balancing these competing requirements leads to optimal inventory levels.

Management of the inventories or stock control refers to balance the need for product availability against the need for minimizing stock holding and handling costs. [3]

In the past, inventory management has focused on not running out of finished goods. This caused manufacturers to stockpile large amounts of raw materials, work in process, and finished goods. The extra finished goods would be to protect them from going out of stock.[4]

The need to hold stocks:

The most important reason for holding stock is to provide a buffer between supply and demand. This is because it is almost impossible to balance the precise requirements of demand with the fluctuations in supply. [5]

The **basic reasons** for keeping an inventory:

1. **Time** - The time lags between supplier and user in a facility, requires that maintenance of certain amounts of inventory to use in this lead time. Lead time itself can be addressed by ordering that many days in advance.
2. **Uncertainty** - Inventories are maintained as buffers to meet uncertainties in demand and supply.
3. **Economies of scale** - Bulk buying, movement and storing brings in economies of scale thus inventory.
4. **Appreciation in Value** - In some situations, some stock gains the required value when it is kept for some time to allow it reach the desired standard for consumption, or for production. For example; beer in the brewing industry[6]
5. **To keep down productions costs**. Often it is costly to set up machines, so production runs need to be as long as possible to achieve low unit costs. It is essential, however, to balance these costs with the costs of holding stock.
6. **To take advantage of quantity discounts.** Some products are offered at a cheaper unit cost if they are bought in bulk.
7. **To account for seasonal fluctuations**. These may be for demand reasons whereby products are popular at peak times only. To cater for this whilst maintaining an even level of production, stocks need to be built up through the rest of the year. Supply variations may also occur because goods are produced only at a certain time of the year. This often applies to primary food production where, for example, large stocks result at harvest time.
8. **To allow for price fluctuations/speculation**. The price of primary products can fluctuate for a variety of reasons, so some companies buy in large quantities to cater for this.
9. **To help the production and distribution operations run more smoothly**. Here, stock is held to 'decouple' the two different activities.
10. **To provide customers with immediate service**. It is essential in some highly competitive markets for companies to provide goods as soon as they are required (ex-stock).
11. **Work-in-progress**. This facilitates the production process by providing semi-finished stocks between different processes.[7]

Types of stock-holding/inventory:

•**Raw material, component and packaging stocks** – generally used to feed into a production or manufacturing process;

• **In-process stocks** – sometimes known as work-in-progress (WIP), these consist of part finished stock that is built up between different manufacturing processes;

• **Finished products** – stocks that are held at the end of the production line normally in a finished goods warehouse and sometimes known as finished goods inventory (FGI);

• **Consumables**: Light bulbs, computer and photocopying paper, brochures, tape, envelopes, cleaning materials, lubricants, fertilizer, paint, Dunn age (packing materials), and so on are used in many operations. These are often treated like raw materials

• **Pipeline stocks** – probably the most common type of stock-holding, these are held in the distribution chain for eventual transfer to the final customer.

• **Spare parts** – a special category because of the nature of the stock, which provides a crucial back-up to a manufacturer's machinery or plant where any breakdown might be critical

• **Working stock**. This is likely to be the major element of stock within a distribution depot's stock-holding, and it should reflect the actual demand for the product

• **Cycle stock**. This refers to the major production stock within a production warehouse, and it reflects the batch sizes or production run lengths of the manufacturing process

• **Safety stock**. This is the stock that is used to cover the unpredictable daily or weekly fluctuations in demand.

• **Speculative stock**. T is can be raw materials that are 'bought forward' for financial or supply reasons, or finished stock that is pre-planned to prepare for expected future increases in demand

• **Seasonal stock.** This is product that is stockpiled to allow for expected large increases in demand. Typically, this would include inventory built up prior to the Christmas demand peak.[8][9]

Inventory costs:

1. **Capital cost**: the cost of the physical stock. This is the current cost of capital to a company or the opportunity cost of tying up capital that might otherwise be producing a better return if invested elsewhere.

2. **Service cost**: the cost of stock management and insurance.

3. **Storage cost**: the cost of space, handling and associated warehousing costs involved with the actual storage of the product.

4. **Risk cost**: this occurs as a consequence of deterioration of stock, damage and stock obsolescence.

5. **Reorder cost:** This cost refers to the cost of actually placing an order with a company for the product in question. This cost applies regardless of the size of the order.

6. **Setup cost**: The set-up cost refers to the additional cost that may be incurred if the goods are produced specifically for the company. Here, the larger the order, the longer the production run and the lower the production unit cost of the items in question.[10]

Inventory Turnover Ratio:

The Inventory turnover is a measure of the number of times inventory is sold or used in a time period such as a year. The equation for inventory turnover equals the Cost of goods sold divided by the average inventory. Inventory turnover is also known as inventory turns, stock turn. Inventory turnover is calculated as follows:

$$\text{Inventory Turnover Ratio} = \text{Cost of Goods Sold} \div \text{Average Inventory}$$

Essentially, when a product is sold, it is subtracted from inventory and transferred to cost of goods sold. Therefore, this ratio indicates how quickly inventory is moving for accounting purposes.[11]

Obsolete Stock

Any stock keeper who has had to repeatedly move really slow moving or outright dead stock out of the way or finds herself hurting for space because obsolete product eats up square foot after square foot will want all such items to just go. Why is the dead stock still here? The three reasons most often given as to why the product can't be disposed of are:

1. It is already paid for.

2. We might use it someday.

3. We might sell it someday.

Strong arguments can be made in favor of disposing of nonproductive stock including unnecessary consumption of space, better use of labor and equipment, plus a reduction in the costs associated with having inventory sitting around. If the actual cubic space taken up by dead product is figured out, it would gain a powerful argument in favor of disposing of this inventory. To bolster the argument, one should find how much the company is paying per square foot for rent. Multiplying the square footage being consumed by dead product times the rent per square foot often results in a truly eye-opening amount. Not only does obsolete inventory take up a lot of space, it can also get in the way of workers. Repeatedly moving obsolete product out of the way hurts efficient use of both labor and machine time.

—During each week for one month, every time the dead product is moved out of the way, the amount of direct labor that goes into that effort can be measured. Remember, if two workers are working together to move the items and they work for fifteen minutes, that represents fifteen minutes times two, or thirty minutes of direct labor.

—At the end of the month, divide the total amount of labor hours by four to determine a weekly average. To determine the amount of yearly labor involved in moving dead stock, multiply the weekly average times the number of weeks in a year your company operates. Once again, the base information can be obtained and multiplying the average hourly the workers are paid, including benefits, times the annual labor number. The result will make a rather impressive argument as to how the organization can save thousands of dollars per year by disposing of its dead stock. [12]

Reduction of carrying costs (the K Factor):

The K Factor represents the number of pennies per inventory dollar per year a company is spending to house its inventory. It is generally expressed as a percent. In other words, a K Factor of 25 percent means that you are spending 25¢ per inventory dollar per year to house your inventory. A one dollar dead item that sits on your shelf for a year would cost you 25¢ that year, a total of 50¢ at the end of the second year, and so on. There are two ways of computing the K Factor. [13]

Locator systems: [14]

In considering which locator system will work best, the stock keeper should select a locator system that provides the best solution given the tradeoffs between conflicting objectives.

- Space available
- Location system
- Dimensions of product or raw materials stored
- Shape of items
- Weight of items
- Product characteristics, such as stackable, toxic, liquid, crushable
- Storage methods, such as floor stacked, racks, carousels, shelving
- Labor availability
- Equipment, including special attachments available
- Information systems support
- Some locator systems use space more effectively than do others. When choosing your locator system, you need to think carefully about how much space it will use.

Types of Locator systems:

Memory Systems:

Memory systems are solely dependent on human recall. Often they are little more than someone saying, “I think it’s over there.” The foundations of this locator system are simplicity, relative freedom from paperwork or data entry, and maximum utilization of all available space. Memory systems depend directly on people and only work if several or all of the conditions listed below exist at the same time.

• Storage locations are limited in number.

• Storage locations are limited in size.

• The variety of items stored in a location is limited.

• The size, shape, or unitization (e.g., pillarization, strapping together, banding, etc.) of items allows for easy visual identification and separation of one SKU from another.

• Only one or a very limited number of individuals work within the storage areas.

• Workers within the storage area do not have duties that require them to be away from those locations.

• The basic types of items making up the inventory do not radically change within short time periods.

• There is not a lot of stock movement.

The most complete space utilization is available through this system. Why? Because no item has a dedicated location that would prevent other SKUs from occupying that same stock location position if it were empty.

Pros—Memory Systems

- Simple to understand
- Little or no ongoing paper-based or computer-based tracking required
- Full utilization of space
- No requirement for tying a particular stocking location, identifier, bin, slot, drawer, rack, bay, spot, to a specific SKU
- Requirements of single item facilities

Cons—Memory Systems

• The organization's ability to function must strongly rely on the memory, health, availability and attitude of a single individual (or a small group of people).

• Significant and immediate decreases in accuracy result from changes in the conditions

• Once an item is lost to recall, it is lost to the system.

Fixed Location Systems

In pure fixed location systems, every item has a home and nothing else can live there. Some (not pure) fixed systems allow two or more items to be assigned to the same location, with only those items being stored there.

If quantities of any given SKU are large, then its "home" may consist of two or more storage positions. However, collectively all of these positions are the only places where this item may exist within the facility, and no other items may reside there. Basically, everything has a home and nothing else can live there.

Pros—Fixed Location Systems

- Immediate knowledge of where all items are located (This system feature dramatically reduces confusion as to where "to put it," "where to find it,"
- Training time for new hires and temporary workers reduced.
- Simplifies both receiving and stock replenishment.
- Allows for controlled routing of order fillers
- Allows product to be aligned sequentially (for example, SKU001, SKU002, SKU003).
- Allows product to be positioned close to its ultimate point-of-use
- Allows product to be placed in a location most suitable to an SKU's size, weight, toxic nature, flammability, or other similar characteristics

Cons—Fixed Location Systems

Space planning must allow for the total cubic volume of all products likely to be in a facility within a defined period of time

Basically, fixed or dedicated location systems allow for strong control over items without the need to constantly update location records. That control must be counterbalanced by the amount of physical space required by this system.

Random Location Systems

In a random system nothing has a home, but you know where everything is. This allows for multiple items to occupy a single bin/slot/position/rack. The primary characteristic of a random locator system that makes it different from a memory system is that each SKU identifier is tied to whatever location address it is in while it is there. In other words, memory systems tie nothing together, except in the mind of the stock keeper. Random systems have the flexibility of a memory system coupled with the control of a fixed system. Essentially an item can be placed anywhere so long as its location is accurately noted in a computer database or a manually maintained paper based card file system. When the item moves, it is deleted from that location. Therefore, an SKU's address is the location it is in while it is there. Because items may be placed wherever there is space for them, random locator systems provide us with the best use of space and maximum flexibility while still allowing control over where an item can be found. Planning space around a random locator system is generally based on the cubic space required for the average number of SKUs on-hand at any one time. Therefore, in planning space requirements around a random locator system, you need to discern from our inventory records what our average inventory levels are and what products are generally present within that average.

Pros—Random Location Systems

• Maximization of space.

• Control of where all items are at any given time.

Cons—Random Location Systems

• Constant updating of information is necessary to track where each item is at any given time. Updating must be accomplished through manual paper-based recording, bar code scanning, or data entry intensive updating.

• May be unnecessarily complicated if your organization has a small number of SKUs.

Combination Systems

Combination systems enable you to assign specific locations to those items requiring special consideration, while the bulk of the product mix will be randomly located. You achieve this by assigning only selected items to fixed homes—but not all items. A common application of the combination system approach is where certain items are an organization's primary product or raw materials line and must be placed as close as possible to a packing/shipping area or to a manufacturing work station. Those items are assigned a fixed position, while the remainder of the product line is randomly positioned elsewhere.

Common Item Placement Theories

Locator systems provide a broad perspective of where SKUs will be found within a facility. Physical control of inventory is enhanced by narrowing the focus of how product should be laid out within any particular location system. [15] Most approaches fall into one of three concepts: inventory stratification, family grouping, and special considerations.

Inventory Stratification

A-B-C categorization of SKUs:[16]

For efficient physical inventory control, using popularity (speed of movement into and through the facility) as the criterion, the most productive overall location for an item is a storage position closest to that item's point-of-use. SKUs are separated into A-B-C categories, with "A" representing the most popular, fastest moving items (the "vital few"), "B" representing the next most active, and "C" the slow-movers. In a manufacturing environment, a work station would become the point-of-use, with the most active, most often required raw materials positioned in near proximity to it. In order to separate an inventory into A-B-C categories, it is necessary to create a sorted matrix that presents all SKUs in descending order of importance and allows for the calculation of those items representing the greatest concentration of value.

What the Matrix Shows

• Column A is merely a sequential listing of the number of SKUs in the total population. In the example there are 300 items. If an organization had 2,300 SKUs, Column A of its matrix would end with row 2,300.

There are two components within Pareto's Law. The first component refers to the percentage of all items that a certain number of items represent, and the second component represents the percentage value that the same grouping of items has when compared to the value of all other items combined.

Column G reflects the first aspect. For example, 30 items represent 10 percent of 300. Therefore, column G, Row 30 shows 10 percent of all 300 items.

Column F reflects the second aspect. For example, the first three items (Rows 1, 2, and 3) of Column A has a combined value (usage rate) of 15.5 percent. That 15.5 percent is shown at Row 3 of Column F.

After creating the matrix, a review of Column F leads to decisions as to where the cut-off should be for each (A-B-C) category. There is no rule of thumb.

Creating the Matrix

• Column A—reflects the number of SKUs being analyzed. It is organized in ascending numeric sequence (1, 2, 3 . . .).

• Column B—SKU number/identifier.

• Column C—SKU description.

• Column D—Annual usage quantity of the SKU.

In a retail/distribution environment where the inventory is comprised of finished goods, Column D will contain the immediately preceding 12 months' usage quantities. This is based on the rule of thumb that the product lines will remain relatively unchanged during the upcoming 12-month period. The immediately preceding 12 months' usage rates will reflect any product trends.

In a manufacturing environment, determine the recipe of what pieces and parts will actually go into the items to be manufactured. The data necessary for Column D is ascertained by multiplying the appropriate items in the BOM times the quantity of items to be built. Column D is sorted in descending order, with the highest use item appearing at the top and the most inactive item at the bottom.

• E—Cumulative total of Column D.

• F—This is the second aspect of Pareto's Law. It reflects the percentage value that a grouping of items has when compared to the value of all other items.

• G—This is the first aspect of Pareto's Law. It reflects the percentage of all items compared with all other items. In other words, 3 is 1 percent of 300.

• After creating the chart, you look down Columns F and G and decide where you want to place the cutoff for categories A, B, and C. Product would then be arranged according to which category it is in.

Sr no.	Part no.	Description	Annual usage	Cumulative usage	% total usage	% total items
1	Part 1	Product A	xxx	xxx	xx	xx
.	.	.	.	.	.	.
.	.	.	.	.	.	.

Table 1 (Sample technique of an ABC analysis) [16]

Family Grouping[17]

An alternative to the A-B-C approach is the family grouping/ like product approach. This approach to item placement positions items with similar characteristics together. Theoretically, similar characteristics will lead to a natural grouping of items, which will be received/stored/picked together.

Groupings can be based on:

• Like characteristics—widgits with widgits, gidgits with gidgits, gadgits with gadgits.
• Items that are regularly sold together—parts needed to tune-up a car.
• Items that are regularly used together—strap with sports goggles.

Using Inventory Stratification and Family Grouping Together

Effective item placement can often be achieved through tying both the inventory stratification and family grouping approaches together.

Special Considerations

A product's characteristics may force us to receive/store/ pick/ship it in a particular manner. The product may be extremely heavy or light, toxic or flammable, frozen, odd in shape, and so on. The inventory stratification and family grouping concepts can and should be employed to ensure efficient inventory layout. [17]

Inventory replenishment systems [18]

The aim of an effective inventory replenishment system is to maintain a suitable balance between the cost of holding stock and the particular service requirement for customers

The disadvantages of low stock levels are that customers' orders cannot be immediately fulfilled, which may lead to the loss of both existing and future business, and that goods have to be ordered very frequently, which may lead to heavy ordering costs and heavy handling and delivery costs

High stock levels have a major disadvantage because capital is tied up that might be better invested elsewhere. Also, there is the risk of product deterioration (e.g. food and drink) and of products becoming outdated, superseded or obsolete if they are stored for long periods of time (e.g. computers, mobile phones and fashion goods). A final disadvantage, previously discussed, is the expense of providing additional storage space.

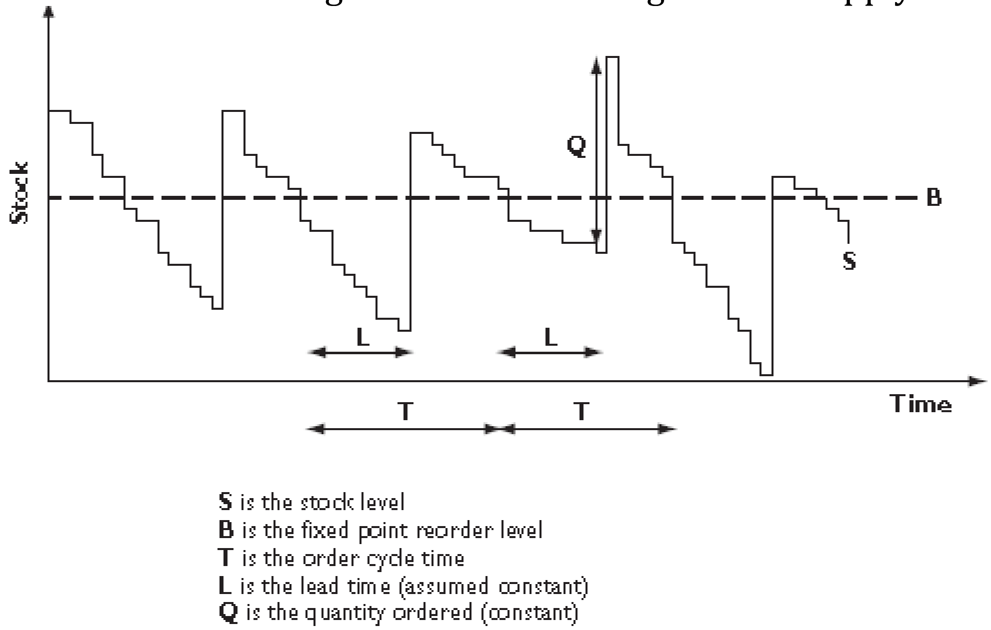
Inventory replenishment systems are designed to minimize the effects of these high/low stock level disadvantages by identifying the most appropriate amount of inventory that should be held for the different products stocked. There is a variety of systems, but the two major ones are the periodic review (or fixed interval) system and the fixed point (or continuous) reorder system

The periodic review system works on the premise that the stock level of the product is examined at regular intervals and, depending on the quantity in stock, a replenishment order is placed. The size of the order is selected to bring the stock to a predetermined level. Thus, the order size will vary each time a new order is placed

For the fixed point reorder system, a specific stock level is determined, at which point a replenishment order will be placed. The same quantity of the product is reordered when that stock level is reached. Thus, for this system it is the time when the order is placed that varies.

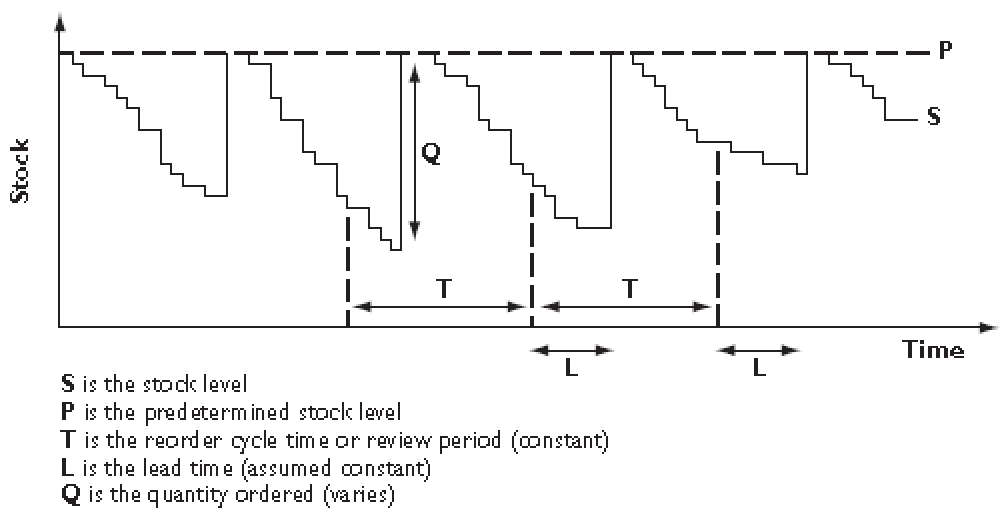
Apart from the vagaries of lead time reliability they generally work quite well. They do have one significant drawback, however, which is that they can create unnecessarily high or low stock levels, especially when demand occurs in discrete chunks.

It can be very difficult to forecast demand based only on the immediate next or lower level of demand. Accurate forecasts need to reflect the requirements at all levels, which is oft en very difficult because companies have traditionally been loath to share information with their suppliers. This is one of the reasons for the move towards more open information systems that provide a clearer vision of stock-holding and demand throughout the supply chain.



e 12.4 Fixed point reorder system

<u>Figure 1 (Fixed Point Reorder System)</u>



e 12.3 Periodic review

<u>Figure 2 (Periodic Review System)</u>

<u>The economic order quantity:[19]</u>

The next question that needs to be addressed is how much product should be reordered. The EOQ method is an attempt to estimate the best order quantity by balancing the conflicting costs of holding stock and of placing replenishment orders. The large order quantity gives a much higher average stock level than the small order quantity. The small order quantity necessitates many more orders being placed than with the large order quantity. There is a specific quantity (or range of quantities) that gives the lowest total cost and this is the economic order quantity for the product. The EOQ model is based on a number of assumptions that need to be taken into account when the method is used. It is a deterministic model: the demand for the product is known with certainty and is assumed to apply at a constant rate; each order is delivered with zero lead time; stock-outs do not occur. However, when used in association with other methods, such as the fixed point reorder system, and with safety stock provision, the EOQ is very valid and can be applied to many different products.

Formula:

$$EOQ = \sqrt{\frac{2PD}{UF}}$$

P = Cost of placing an order
D = Annual demand in units
U = Cost of a unit of inventory
F = Annual stock-holding cost as a fraction of unit cost
UF = Cost of holding stock per unit per year

This formula and its variations allow you to determine the following:

- the optimal quantity to order
- when it should be ordered
- the total cost
- the average inventory level
- how much should be ordered each time
- the maximum inventory level

The EOQ model is based on several assumptions:

- the demand rate is constant (no variations), recurring, and known.
- the carrying cost and ordering cost are independent of the quantity ordered (no discounts).
- the lead time is constant and known. Therefore, the ordering times given result in new orders arriving exactly when the inventory level reaches zero [19]

Inventory Types

In distribution you are concerned with having the right item, in the right quantity. Issues relating to having the item at the right time and place are often dealt with by simply increasing safety stock on-hand. In manufacturing, you are concerned with having the right item, in the right quantity, at the right time, in the right place. Demand for finished goods and spare parts for replacements are said to be "independent," while demand for items in the manufacturing world are said to be "dependent." Independent demand is influenced by market conditions outside the control of your organization's operations. In this environment you must have the right item in the right quantity. Dependent demand is related to another item. The demand for products built up or created from raw materials, parts, and assemblies is dependent on the demand for the final product. In this environment you must have the right items in the right quantities at the time in order to complete a finished product. A chair can be used as an example of the above. The demand for the number of chairs you need is independent from the number of tables that you need because quantity required is influenced by the demand in the market for each item. The demand for chair legs, or seats, or rails is mathematically dependent on the demand for finished chairs. Four legs and one seat are required for each chair. Dependent and independent demands demonstrate very different usage and demand patterns. Independent demand calls for a replenishment approach to inventory management. This approach assumes that market forces will exhibit a somewhat fixed pattern. Therefore, stock is replenished as it is used in order to have items on hand for customers. Dependent demand calls for a requirements approach. When an assembly or finished item is needed, then the materials needed to create it are ordered. The nature of demand, therefore, leads to different concepts, formulae, and methods of inventory management.[20]

Order-Point Formulae[21]

Order point formulae are used to determine how much of a given item needs to be ordered where there is independent demand. In these formulae a reorder point (ROP) is set for each item. The ROP is the lowest amount of an item you will have on hand and on order before you reorder.

$$(\text{Usage} \times \text{Lead Time}) + \text{Safety Stock} = \text{ROP}$$

In the above formula lead time is shown as a percentage of a month, as follows:

1 week = 0.25 = 25%	4 weeks = 1.00 = 100%
2 weeks = 0.50 = 50%	5 weeks = 1.25 = 125%
3 weeks = 0.75 = 75%	6 weeks = 1.50 = 150%

Assume:

- Usage rate of 1,200 items per month
- Lead time of 1 week

Step-by-Step Calculation:

- Calculate weekly usage. Assume a 4-week month. 1,200 items ÷ 4 weeks = 300 items per week ➜ therefore Bin 1 or working stock should contain at least 300 items
- Calculate working reserve: Given 1 week of lead time, working reserve should be 1,200 items x 0.25 = 300 items
- Calculate safety stock, use 50 percent of working reserve as a guideline (300 items x 50% = 150 items)
- Calculate ROP: (1,200 items x 0.25) + 150 items = ROP 450 items

In ROP systems there is a minimum below which you will not let your stock level fall.[21]

Demand forecasting

Different methods of demand forecasting are used to try to estimate what the future requirements for a product or SKU might be so that it is possible to meet customer demand as closely as possible. Forecasting, thus, helps the inventory holding decision process to find answers to questions about what to stock, how much to stock and what facilities are required. It is oft en said that 'all mistakes in forecasting end up as an inventory problem – whether too much or too little!'

There are several different approaches that can be used for forecasting. These are:

• Judgmental methods – subjective assessments based on the opinions of experts, such as suppliers, purchasing, sales and marketing personnel, and customers. These methods are used when historic demand data are very limited or for new products. They include brainstorming, scenario planning and Delphi studies.

• Causal methods – used where the demand for a product is dependent on a number of other factors. These factors may be under the control of the company (promotions, price), under other control (competitors' plans, legislation) or external (seasonality, weather, the state of the economy). The main method used is regression analysis, where a line of 'best fi t' is statistically derived to identify any correlation of the product demand with other key factors

• Projective methods – these forecasting techniques use historic demand data to identify any trends in demand and project these into the future. They take no direct account of future events that may affect the level of demand. There are several different projective forecasting methods available, and it is important to select the most appropriate alternative for whatever demand is to be measured. Two of the most common methods of forecasting are described. One of the most simple is the moving average, which takes an average of demand for a certain number of previous periods and uses this average as the forecast of demand for the next period. Another, more complicated, alternative is known as exponential smoothing. This gives recent weeks far more weighting in the forecast. Forecasting methods such as exponential smoothing give a much faster response to any change in demand trends than do methods such as the moving average.[22]

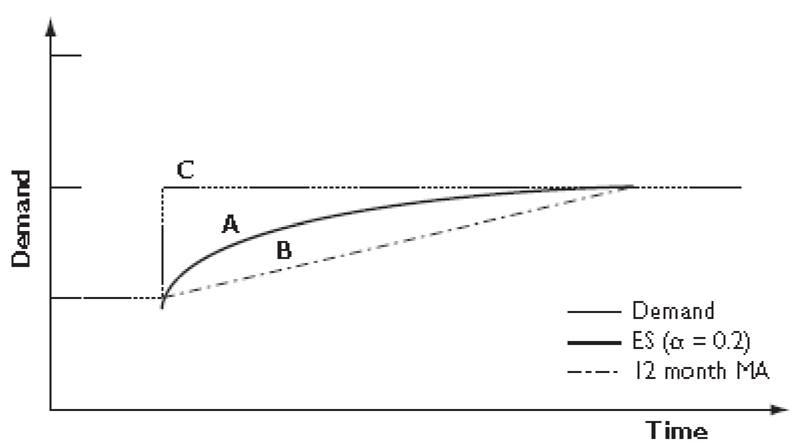
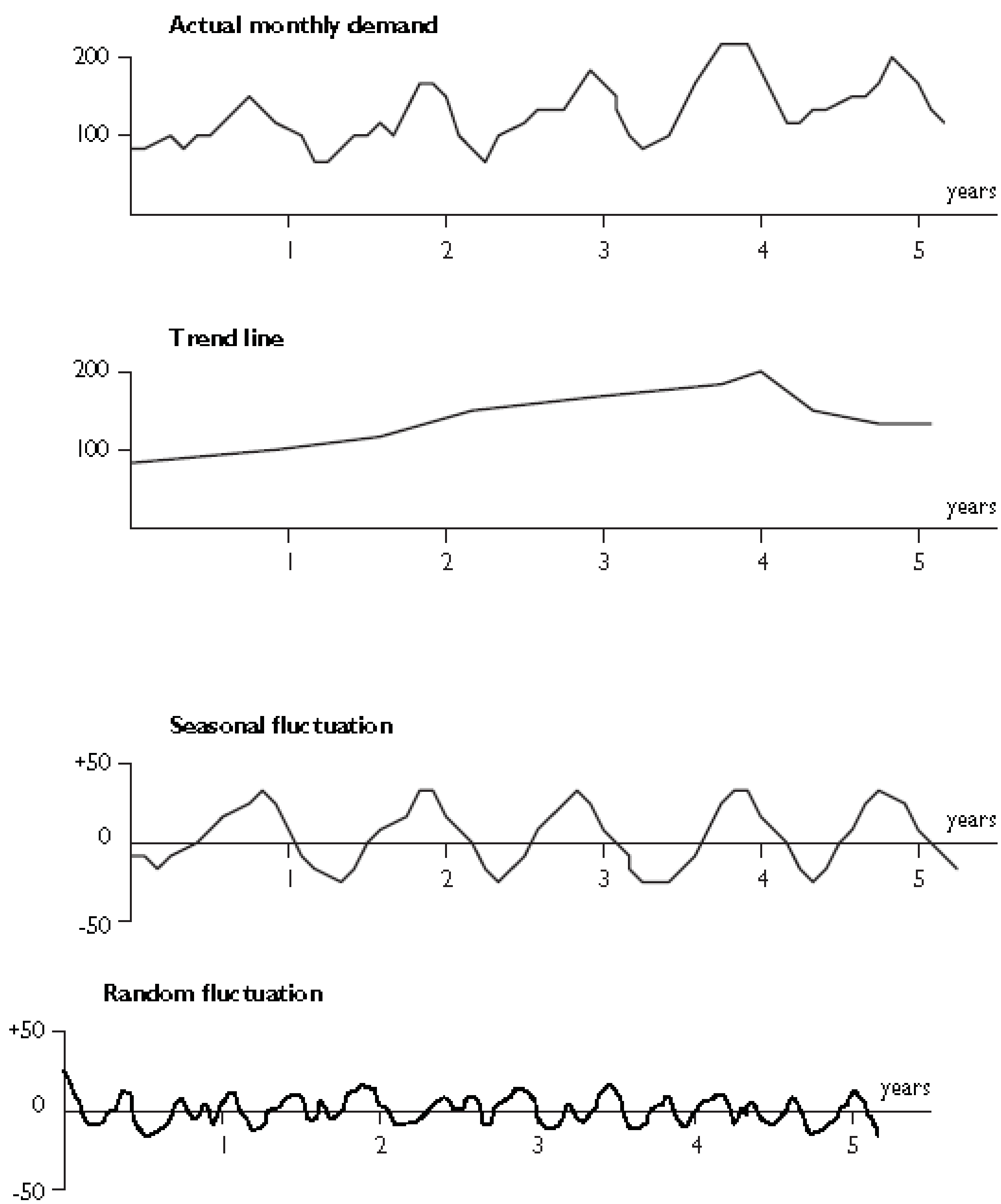


Figure 3 (Moving average & Exponential smoothing method)[22]

There are a number of ways in which the demand for a product can vary over time. These different elements of demand. It can be seen from the graphs that the overall demand pattern can be divided into the following patterns:

• A trend line over several months or years. In the graph, the trend is upward until the end of year 4, and then downward.
• A seasonal fluctuation. This is roughly the same, year in, year out. In the graph, there is high demand in mid-year and low demand in the early part of the year.
• Random fluctuations that can occur at any time.



<u>Figure 4 Elements of Demand Pattern [23]</u>

Each of these elements should be taken into account by a good stock control system:

- The trend, by a good forecasting system;
- Seasonality, by making seasonal allowances;
- Random, by providing sufficient buffer stock

It is sensible to adopt a very methodical approach to demand forecasting. To achieve this, it is recommended that a number of key steps are used. These can be summarized as follows:

1. **Plan**. Ensure from the outset that there is a clear plan for identifying and using the most appropriate factors and methods of forecasting. Understand the key characteristics of the products in question and the data that are available. Consider the different quantitative and qualitative methods that can be used and select those that are relevant. If necessary and feasible, use a combination of different methods. Identify ways of double-checking that the eventual results are meaningful – it is unsafe merely to accept the results of a mechanical analytical process. Forecasting at individual SKU level is a typical 'bottom-up' approach, so check results with suitable 'top-down' information.
2. **Check**. Take care to review the base data for accuracy and anomalies. Poor data that are analyzed will produce poor and worthless results. Where necessary, 'clean' the data and take out any abnormalities.
3. **Categorize**. A typical range of company products can and do display very different characteristics. Thus, it is usually necessary to identify key differences at the outset and group products with similar characteristics together. It is likely to be valid to use different forecasting methods for these product groups. Use techniques such as Pareto analysis to help identify some of the major differences: high versus low demand, high versus low value, established products versus new products, etc.
4. **Metrics**. Use statistical techniques to aid the understanding of output and results (standard deviation, mean absolute deviation, etc.). There may be a number of relevant issues that can impact on the interpretation of results: the size of the sample, the extent of the time periods available.
5. **Control.** Any forecasting system that is adopted needs to be carefully controlled and monitored because changes occur regularly: popular products go out of fashion and technical products become obsolete. Control should be by exception, with tracking systems incorporated to identify rogue products

that do not fi t the expected pattern of demand and to highlight any other major discrepancies and changes.[23]

Dependent Demand Inventory

Materials Requirements Planning

Independent demand inventory management is customer oriented. The objective of ROP rules and formulae is high customer service levels and low operating costs. Dependent demand systems, however, are manufacturing oriented. The objective of dependent demand inventory control is to support the master production schedule.[24]

	ORDER POINT	MRP
Demand	Independent	Dependent
Order Philosophy	Replenishment	Requirements
Forecasting	Based on past demand	Based on master schedule
Control Concept	ABC categorization	All items are equally important
Objectives	Meet customer needs	Meet manufacturing needs
Lot Sizing	EOQ	Individual item requirements
Demand Pattern	Consistent	Random but predictable
Inventory Type	Finished goods/ spare parts	Work in progress/ raw materials

Table 2 Order point vs MRP [24]

MRP Elements

Key concepts in understanding MRP are the master production schedule and the bill of materials. The master production schedule sets out what will be built, when, and in what quantities.

The bill of materials (BOM) is the recipe of raw materials, parts, subassemblies, and so on required to build or make something. There are levels to each BOM.

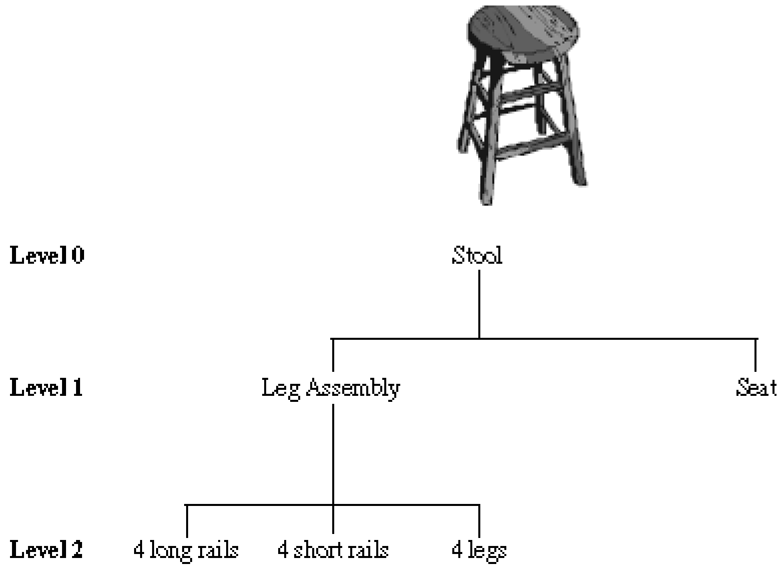


Figure 5 Example BOM for a chair[25]

MRP allows purchases to be made as and when needed to ensure that items will arrive when needed. It accomplishes this by setting up time phasing charts within the computer system.

An example of MRP would be a decision to build one bar stool in your garage on Saturday. The decision to build a single unit of something on a given day is the master schedule. You then draw-up and define what parts are required for the task. This is your bill of materials. The next step is a parts explosion where you review your on-hand inventory levels to initially determine if any POs must be prepared and released. Ultimately, all parts, equipment, and so on come together and the stool is built. A major drawback of MRP and JIT systems is that they are highly data dependent. Not only do you have to have all of the data easily available on an ongoing basis, but in addition, the information must be accurate and timely. Organizations lacking a strong software/hardware infrastructure will have difficulty in fully implementing an MRP system.[25]

Stock control

Stock control is defined as "the activity of checking a shop's stock.[26] The term "stock control system" can be used to include various aspects of controlling the amount of stock on the shelves and in the stockroom and how reordering happens. Typical features of stock control software include

- Ensuring that products are on the shelf in shops in just the right quantity.
- Recognizing when a customer has bought a product.
- Automatically signaling when more products need to be put on the shelf from the stockroom.
- Automatically reordering stock at the appropriate time from the main warehouse.
- Automatically producing management information reports that could be used both by local managers and at head office.

These might detail what has sold, how quickly and at what price, for example. Reports could be used to predict when to stock up on extra products, for example, at Christmas or to make decisions about special offers, discontinuing products and so on. [27]

Analyzing time and inventory[28]

An activity that adds value is one that provides a positive benefit to the product or service being offered. This can be assessed in terms of whether the customer is prepared to pay for this activity. An activity that does not add value is one that can be eliminated from the supply chain process and will not materially affect the finished product as far as the final customer is concerned. The aim is to identify and eliminate those activities that add cost but do not add value. The holding of inventory within a supply chain is one such activity, and many companies are now trying to eliminate unnecessary inventory from their supply chains. One method of highlighting unnecessary inventory is through the use of supply chain mapping. This technique enables a company to map the amount of inventory it is holding in terms of the length of time that the stock is held. An example of this technique is provided in Figure 9.This is an example from the US clothing industry. It shows:

- Value-adding time, which is represented along the horizontal axis. This shows the total of the manufacturing and transport time for the whole supply chain process from the initial raw material (fiber) to the supply of the finished product to the end user. It is value-adding because the product is changed either through a production process or through a movement process. It amounts to 60 days.
- Non-value-adding time, which is represented by the vertical lines that rise from the horizontal axis. This shows the various occasions when the part-prepared or finished product is held as some form of inventory. This is adding no specific value to the product. This amounts to 115 days.

• The total time or pipeline time, which is the addition of the value-adding horizontal time and the non-value-adding vertical time. This therefore includes all the time that it takes through all the different manufacturing, storing and transport processes. This is a total time (or volume) of 175 days.
Note that in some instances transport is treated as non-value-adding (movement between production processes) and in others as value-adding (movement to the final customer). The example clearly indicates the opportunities for reducing time within the supply chain by reducing unnecessary inventory. Some inventory will be required, but as illustrated by this particular example there is a lot that is not, for example there are 20 days of inventory in the finished goods warehouse and 15 in the distribution center. With better visibility in the supply chain, there is scope for eliminating some of this. It should also be noted that this type of analysis is particularly dramatic where a complete supply chain can be measured. Where a product moves from one company to another within a supply chain there is oft en evidence of large stock builds by both the supplier and buyer companies. This is due to a variety of factors, such as unreliable supply, a lack of confidence, uneven demand patterns and poor information on the real demand requirements for the finished product.[28]

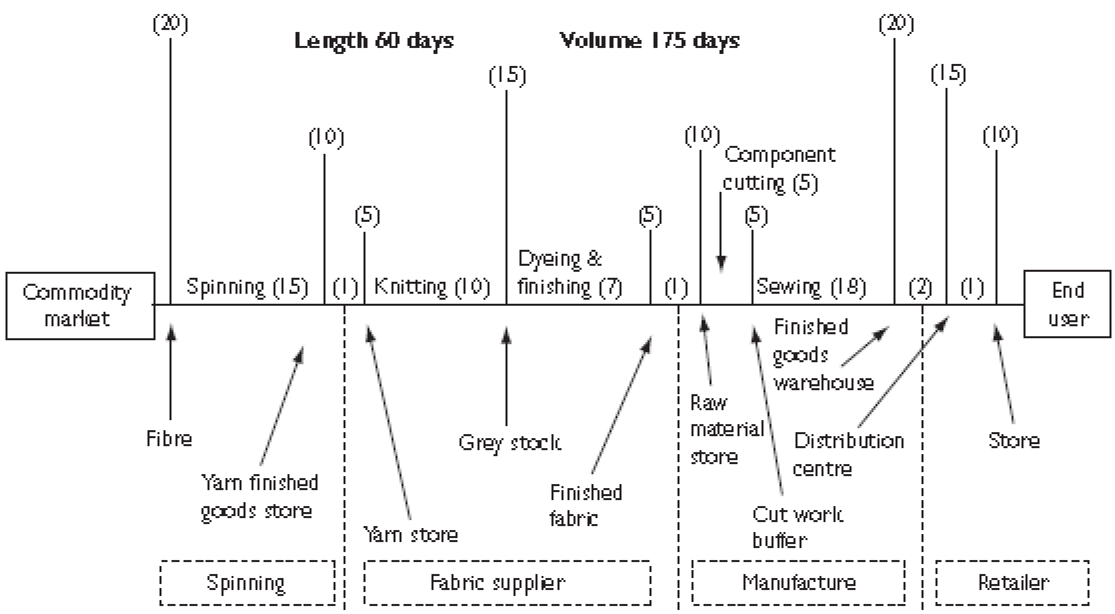


Figure 6 Supply Chain Mapping [28]

Push and pull systems

A ‘push’ system of manufacturing is one where goods are produced against the expectation of demand. In other words, goods are not produced specifically to order but are produced against a forecast demand. Demand forecasting has to be carried out where raw material suppliers’ lead times for delivery have to be considered. If there is a one-month lead time for a given raw material then it will be necessary to estimate what the level of production will be in one month’s time to satisfy forecast demand for the product. These forecasts are usually based on historical sales information. The difficulty arises when either there is a higher level of demand than expected and sales are lost, or there is a lower level of demand and finished product stocks grow too large expected and sales are lost, or there is a lower level of demand and finished product stocks. MRPII (incorporating MRP) is a ‘push’ system.
A ‘pull’ system of manufacturing is one where goods are only produced against known customer orders. This is because only actual orders from customers are being produced on the production line. None of the goods are being made to keep as finished product stocks that may be sold at a later date. Therefore firm customer orders are ‘pulling’ all the materials through the process from the material suppliers and culminating in the delivery to the final customer. Just-in-time is a ‘pull’ system.[29]

Inventory Objectives

Inventory in and of itself is not waste. Unnecessary inventory is waste. In manufacturing operations, inventory in excess of that needed to support current operations would certainly be waste. Any company should have a “zero-tolerance” inventory policy. That is, it will not accept any inventory over a stated target. But what is the target? For an organization to actually have useful inventory, it must understand its own objectives for the product it will have on-hand, on-order, or in-transit at any one time. What inventory level is required for your organization to profitably and effectively operate? All these need to be determined [30].

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Part One-Chapter No. 02

2.1. Visit to the Starco Fans Factory and Understanding of its Inventory System

2.1.1. Introduction of Starco Fans

Starco fans Gujrat is a local fan industry which we used as a case study for our project. It is a small to medium scale industry. It is working on more than 50 models of the fans which includes ceiling, pedestal and exhaust fans. But the industry focuses on the most selling models which are almost 10. We were to look at their inventory and how they manage it. Each visit we did, we looked at the different aspects of their inventory which are to be told as we proceed.

2.1.2. Components of a Ceiling Fan

Ceiling Fan is an assembly of the following components:

Component	Function
Plate	Upper part or covering of the ceiling fan.
Body	Lower part or covering of the ceiling fan.
Armature	Set of thin sheets group together to form an armature Copper or silver wire is wounded on this armature to make rotor.
Axle	Axle along with armature having copper or silver wire as a coil wounded on it forms the rotor that helps the fan to rotate.
Rotor Ring	Armature is placed in a rotor ring to make a complete rotor.
Blades	Help in Circulation of Air

Table 3 components of a ceiling fan

Storerooms:

There are a total of eight kinds of stores in the factory:

1. Storeroom no. 1
2. Storeroom no. 2
3. Storeroom 3(a)
4. Storeroom 3(b)
5. Blades section
6. Silver storing area
7. Store for paint related material

8. Thermopore storage area

Each fan model consists of at least 50 different items stores in these storerooms.

Manufacturing section:

The company produces about 500 fans every day. In addition to 5oo pieces, 100 pieces are made to compensate for defective products manufactured.
The first process is die casting of body, plate and rotor. The WIP inventory was aluminum, silver , furnace oil, the body, plates and rotors that were being casted and stacked nearby.

Sections of Ceiling Fan Workshop

Sections	**Work done**
Casting Section	Here casting of body and plate is done.
Machining Section	Machining of body and plate is done here.
Armature Section	Here sheets are cut into shape of the armature and a number of sheets are riveted here to form armature.
Blade Section	Here sheets of metal are bent and riveted to form blades.
Winding Section	Coil is wounded on armature here.
Assembly Section	Assembly of all components of fan is done here.
Testing Section	Assembled Fans are tested here.
Painting Section	Fans are painted here in this section. It is on 2nd floor of the factory.
Packaging Section	Fans are packed here in this section. It is on the 1st floor of the factory.

Table 4 sections of the ceiling fan workshop

The layout and the further processes are given:

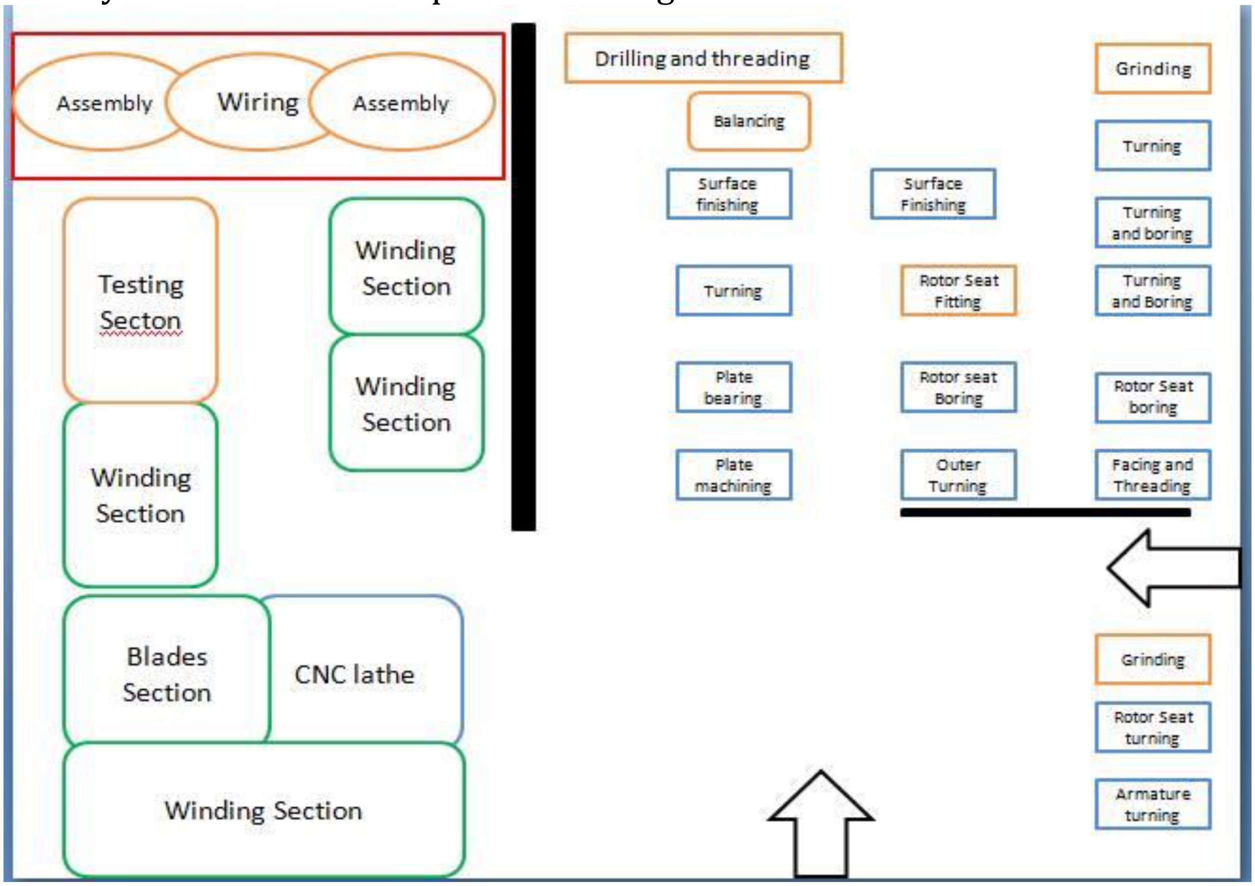

Fig.7:Layout of workshop showing manufacturing processes

The work-in-process inventory at each workstation in the layout included rotors, body, plates, armatures, winded armatures; axle fitted winded armatures, complete sets to be tested.

All WIP inventory was waiting near the workstations to be processed on.

There was no proper space for WIP and they were being just stacked near the workstation.

The WIP inventory can be shown through photos:

Figures 8,9,10,11: WIP inventory in the workshop

Red tagged WIP:

Some material that was waste or scrap and was only taking up space in the workstations was red-tagged and dispatched into a proper space in factory called as red-tagged area.

Red-tagged material consisted of winded armatures in the winding section, complete fan motors in the inspection area, Fan plates and bodies, unwounded armatures in the winding section, rotors in the machining area, repairable winded armatures in the fitting or assembly section.

Raw material:

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<u>Figure 12, 13, 14, 15: Raw material inventory in storerooms</u>

<u>Reduction of inventory through standardization:</u>

<u>Focus: variety in axle:</u>

Axel is a major component in a ceiling fan motor, as it provides an axis of rotation to the rotating armature in the motor.
Different models of fans uses different axle with different dimensions. A total of six different general kinds of axels are used in all of the fan models.
Each of these axels are being used in multiple models.

The **general kinds** are listed as:

- Chanda

- Pak
- SF/SK
- New Nabeel
- Awami Dubai
- New Galaxy

The axles are stored in container boxes shown in the figure below:

Fig.16: axle storage

These axles along with all the other models in which they were used were grouped together by the head names of each of the above axel name given above. These groups are as follows:

Group 1:

SF/SK

HD Nabeel

VIP

Group 2:

New Galaxy

Pride

Maxell

36" Fancy

Group 3

New Nabeel

Classic

Breeze Plus

Deluxe economy

Galaxy + Galaxy export

Younis deluxe

Samba

Group 4:

Awami Dubai

Group 5:

Chanda

Group 6:

PAK

Each model had different total lengths due to different subpart lengths. Our task was to standardize as much models out of these as possible.
The key was that the different subpart lengths of each model did not play a significant role in making them different with respect to performance, but only the design and hence the total height of cavity between the body and plate of models was different. Changing of the length of axles meant that the height of the cavity would change. The only purpose of the different lengths of these axels was to create a difference between sizes of the models. Some of these axles were close in length to each other, (the difference being in millimeters). Some were having a significant difference from others. The width of all axle models were exactly same. We decided to group the models close to each other in total lengths whereas leave the other models separate, which had a significant difference in their total lengths from the others. The grouping with the total lengths is as follows

Group

- Pak --- 109mm
- SF/SK --- 110.5mm
- New Nabeel --- 108.5mm
- Awami Dubai --- 105mm

The two other models were kept separate due to their significant difference in the total lengths i.e. Chanda model total length was 135mm & New Galaxy model total length was 97mm.
The most frequently used as can be seen above was model New Nabeel. Therefore we decided to standardize the lengths of the other models up to the length of this axel i.e. 109mm.
The different subpart lengths of the models are depicted in the figure below. We had to bring changes in these lengths to standardize the total lengths of the models. The engineering drawing of an axel was first made on AutoCAD shown below.

CAD Drawing of an axle

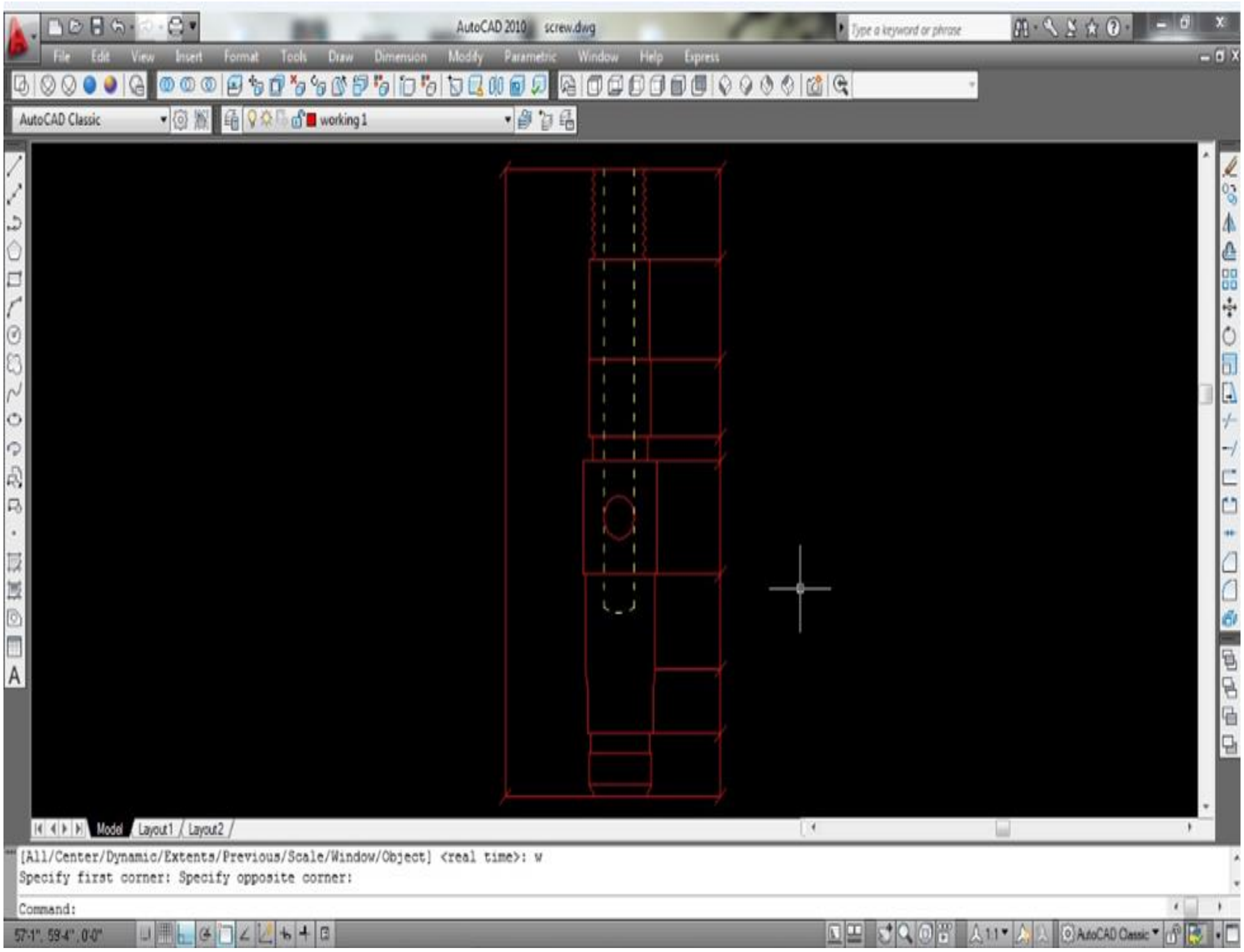

Fig.17:CAD drawing of an axle

Features labeling of an axle:

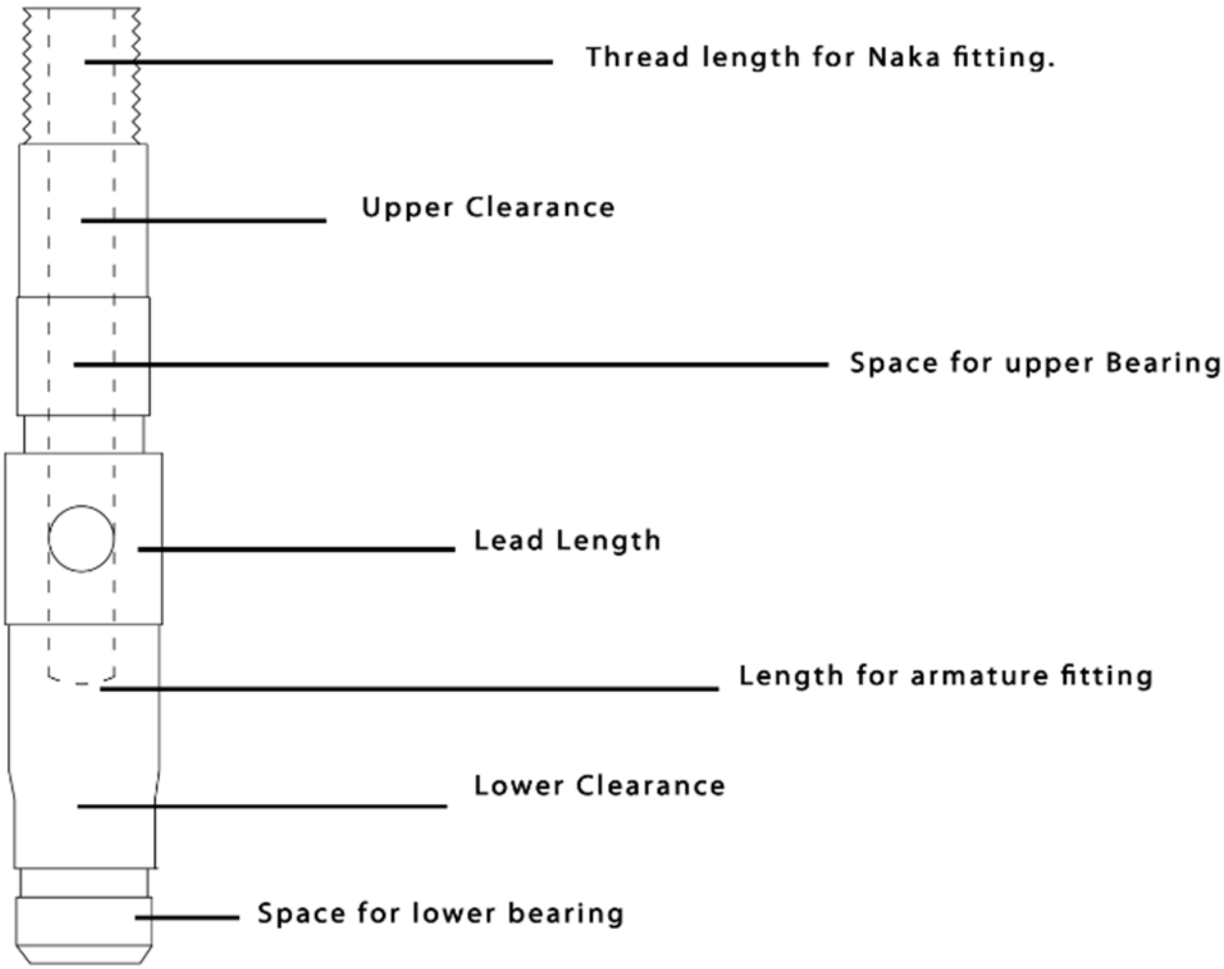

Fig.18: Features of an axle

These subpart lengths of different models are shown below:

Model Name	Thread Length + no. of threads	Upper Clearance	Space for Upper bearing	Lead length	Length for Armature fitting	Lower clearance	Space for Lower Bearing	Total Length
Chanda	16mm, 8 threads	29mm	13.5mm	28mm	20mm	15mm	9mm	131+4=135mm
PAK	18mm, 9 threads	10mm	12.5mm	14.5mm	21.5mm	17mm	10.5mm	105+4=109mm
SF/SK	18mm, 9	9.5mm	13mm	21.5mm	20mm	14mm	9.5	105.5+5=110.5 mm

	threads							
New Nabeel	17mm, 8 threads	10mm	14mm	23mm	20mm	9mm	10.5mm	103.5+5=108.5 mm
Awami Dubai	15.5mm, 8 threads	17mm	12.5mm	20.5mm	14.5mm	11mm	10mm	105+4=109mm
New galaxy	16.5mm, 8 threads	9mm	12.5mm	15.5mm	16mm	12.5mm	10.5mm	92.5+4.5=97mm

* The additional length added in total length is the small space between upper bearing and the lead length for each model

Table 5: Feature dimensions of axle models

The deciding factors:

- **Thread length & no. of threads:**
  The thread length and the number of threads on each models were different for some models but same for others as shown above. The basic purpose of threads was to provide fitting to the naka of the fan connected above. Due to different number of threads and thread lengths, different nakas were used for different models. These lengths can easily be standardized for the models having less difference in total lengths i.e. 9 threads, 18mm length.

- **Upper clearance**
  Upper clearance was not a part of the cavity between the body and the plate. This clearance was only given to provide additional safety space in case of bearing mis adjustment by the worker. This was also variable in different models and a standard and an appropriate clearance for each model was chosen i.e. 11mm
- **Upper bearing length**
  Upper bearing used in all models was 6203 having a fixed thickness of 12mm.Still the space given for its adjustment in each model was different. A length of 13mm was decided for the bearing adjustment space.
- **Lead length**
  Lead length was again variable in each model but its only function was to allow the wires from the armature winding to pass through the axel and

provide current. Keeping the hole, through which the wires were to pass, at a fixed position in each axel, the lead length of each axel could also be made the same i.e. 20mm

- **The length for armature fitting**
  The length for armature fitting in each axel was also variable. The different thicknesses of armatures used in different models were 13mm, 15.5mm, 17mm, 18mm. Therefore a length of 20mm was decided as space for armature fitting in each model which could adjust armatures of all above sizes.
- **Lower clearance**
  Lower clearance, the same as upper clearance, was only to provide additional safety space in case of bearing mis adjustment by the worker. This was also variable in different models and a standard and an appropriate clearance for each model was chosen i.e. 12mm
- **Lower bearing**
  Lower bearing used in all models was 6202 having a fixed thickness of 11mm.Still the space given for its adjustment in each model was different. A length of 11mm was decided as the bearing adjustment space.
- **Total length**
  Total length for all standardized axels accumulated to be 109mm which included an additional standard small space of 4mm between upper bearing and the lead length.

A total of six groups were compressed to three groups as a result of above considerations.

Model Sr. no	Group 1	Group 2	Group 3
1	Chanda	New Galaxy	PAK
2			SF/SK
3			New Nabeel
4			Awami Dubai

<u>Table 6: standardized groups of axles</u>

The AutoCAD drawings of each are shown below:

<u>Group 1:</u>

<u>Chanda model:</u>

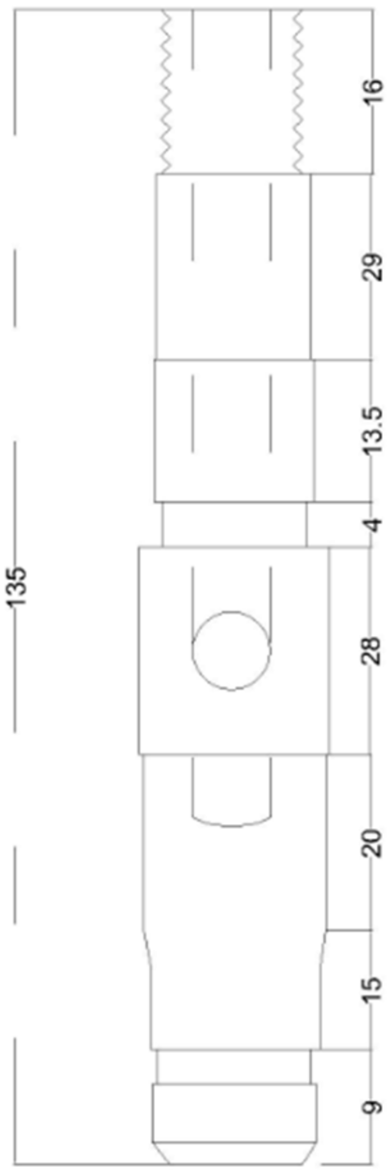

Fig.19:CAD drawing of axle Chanda

Group 2:

New Galaxy

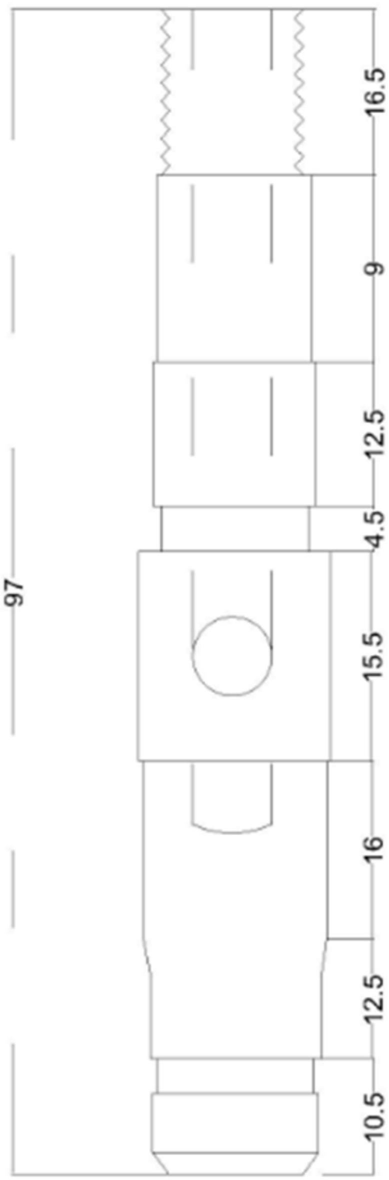

Fig.20: CAD drawing of axle New Galaxy

Group 3

- PAK
- SF/SK
- New Nabeel
- Awami Dubai

All standardized to one axel:

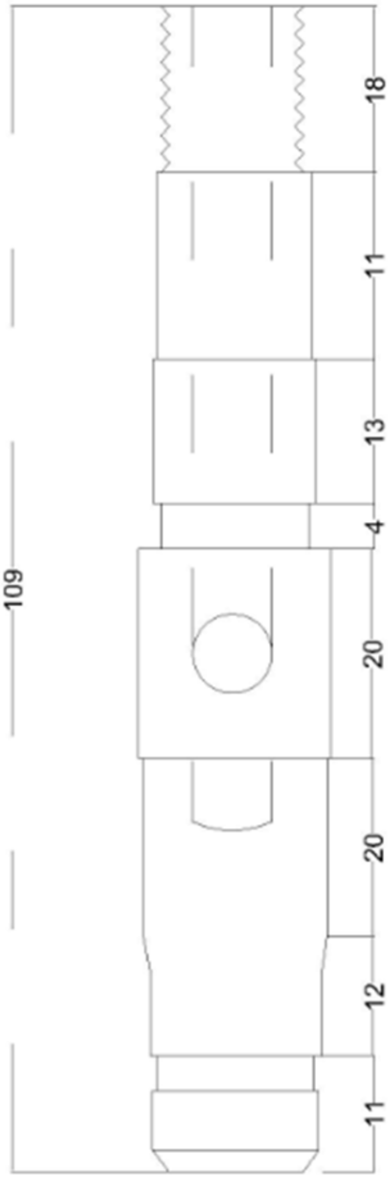

Fig.21: CAD drawing of the standardized axle

Raw Material Inventory Sorting & Placement:

Raw Material should be placed as close as possible to the manufacturing area so that it may save the maximum time possible for the workers to collect the necessary items and place them near the work stations. Starco fans have their raw material inventory stored in about six different kinds of stores for different purposes but some of the items have found to be not placed well according to the worker's ease and time saving prospects.

A single manufactured fan involves about 45-50 different purposeful items in its manufacturing. Our task was to find the small misplacements of items committed by workers and to propose such a scheme such that it would minimize the travel time for a worker to transport items to their destined work stations.

There are a total of eight kinds of stores in the factory:

1. Storeroom no. 1
2. Storeroom no. 2
3. Storeroom 3(a)
4. Storeroom 3(b)
5. Blades section
6. Silver storing area
7. Store for paint related material
8. Thermopore storage area

The material stored in each of these stores is tabulated as follows. The material proposed to be repositioned in each of these stores is also depicted in this table using a color scheme given following the table:

CAD drawing of the layout of the ground floor

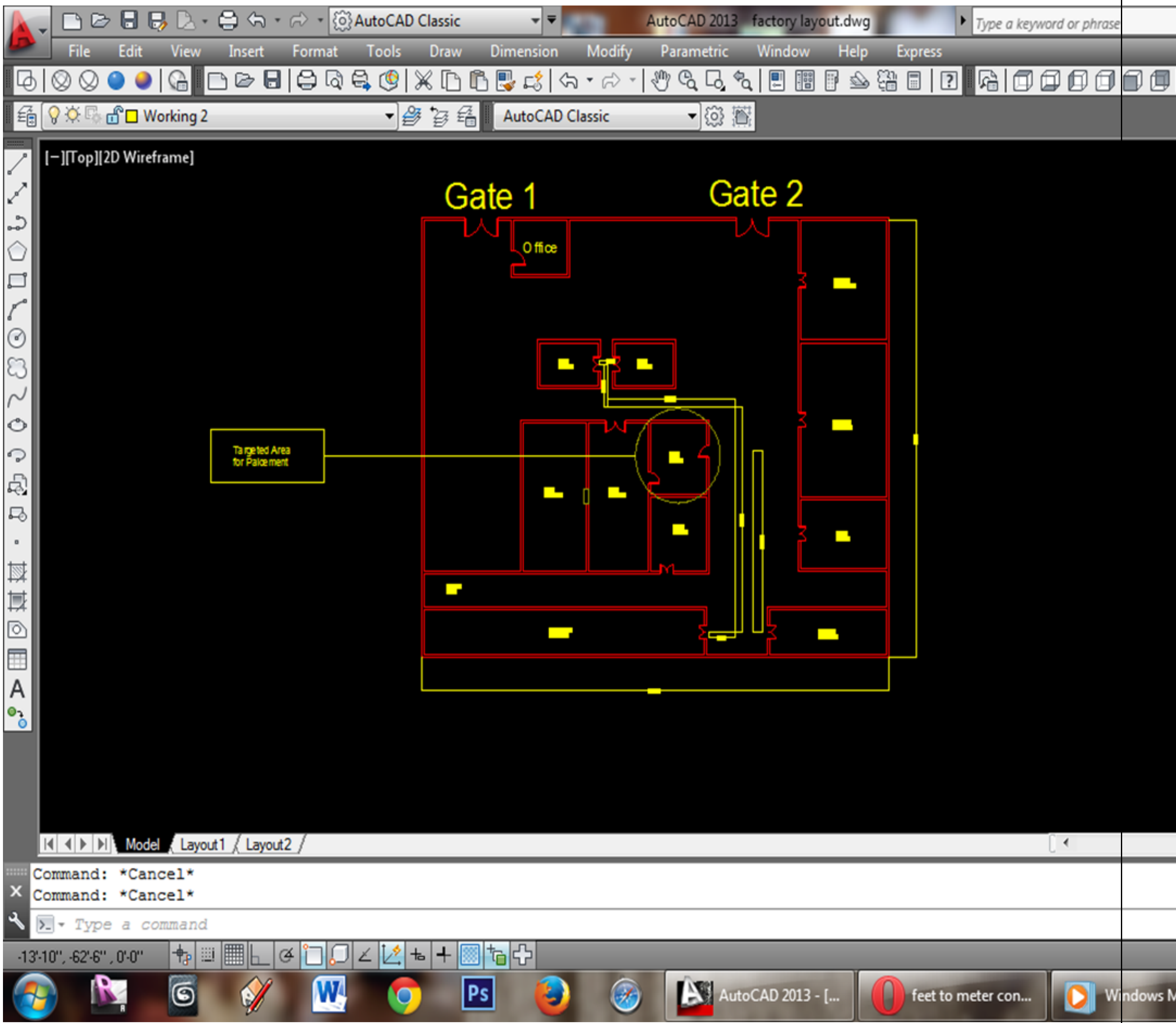

Fig.22:CAD drawing of layout of ground floor of factory

3-D picture

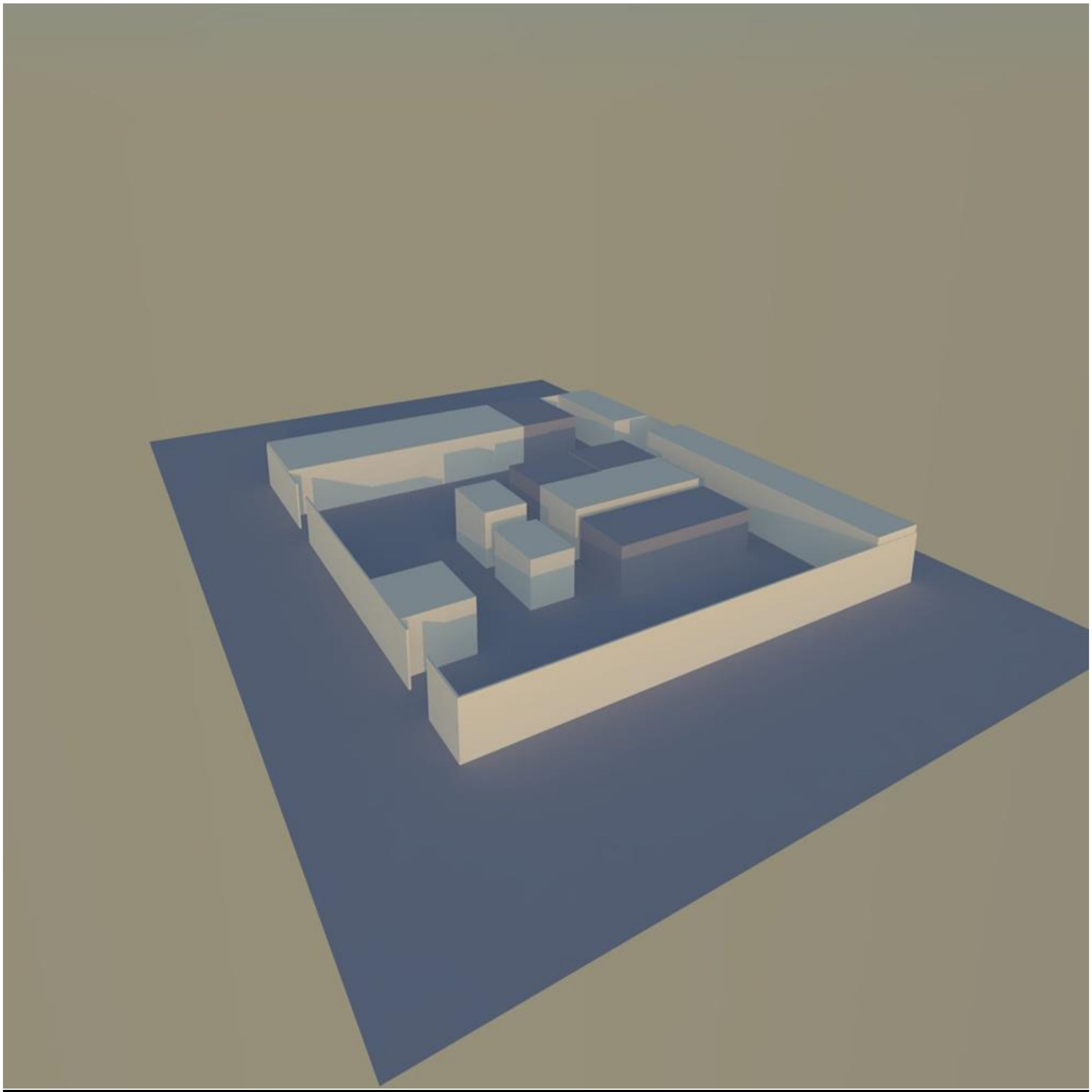

Fig.23:3-D figure of layout of factory

Original storage of items

The items originally stored in the storerooms are tabulated below.

The material proposed to be repositioned in each of these stores is also depicted in this table using a color scheme given following the table:

Place of storage	Material stored

Storeroom no. 1	Axels, body weights, lock pins, screws, nut bolts, washers,katter pins, rod hook, zinc coating powder, petrol
Storeroom no. 2	Sandpapers, sleevings, single core wires, solder wires, millinax, fibre guj, jion pari, stickers, connectors, capacitors, dimmers, cable ties, magic, bearing, chiddis, checknuts, mustard oil, varnish
Storeroom 3(a)	Nakas, ceililing rods, clamps, pari, greece cups, packing shoppers, dil pari, canopy sets, malmal & latha (clothe), packing tape.
Storeroom 3(b)	Pedestal fan material, drill bits, silver rivets
Storage room for blades	Blades of all kind
Storage room for silver	Silver (hard + soft)
Storage room for paint material	Paint, thinner, paint for insulation in armature
Thermopore storage	Theromopore

Table 7: original storage of raw material in storerooms

KEY:

Black color: items to be stored in storeroom 01

Blue color: items to be stored in storeroom 02

Dark red color: items to be stored in storeroom 03(a)

Dark green color: items to be stored in storeroom 03(b)

Bright Red color: items to be stored in a storeroom near the paint section situated upstairs on 3rd floor

The storage room for thermo pore is situated near packing area on the 2nd floor, where only thermo pore is stored for protection of the fan parts from damage. It is just the right place for thermo pore storage.

Family Grouping:

These raw material items have been sorted to be placed together according the theory of "family grouping/like product approach". According to this theory, items:

1. Those have like characteristics
2. Those are used together.

are placed together.

In our case study, following grouping was done and proposed to be placed together, according to the above theory. These are tabulated along with the group no. as follows:

MATERIAL GROUP LETTER	GROUP NAME	ITEMS STORED	PLACE OF STORAGE	AREA OF USE
A	Special considerations	Silver(hard, soft) , thermo pore	Silver storeroom, thermo pore storeroom	Casting & packing areas
B	Liquids for cleansing , insulation & services	Mustard oil, varnish, petrol, paint, thinner, zinc coating powder	Store room near paint section on 3rd floor	Paint area
C	Metallic solid small size & light weight components	Axles, body weights, drill bits, chiddis, bearings, rivets, Katter pins, screws, nuts, washers, lock pins, rod hook	Storeroom 01	Most of the material used in ceiling workshop
D	Solid material for services	Sand papers, magic, sleevings, cable ties, solder wire, millinax, single core wires, fiber guj, malmal, latha (clothe), join pari, packing tape,connectors, capacitors, dimmers	Storeroom 02	Winding section in ceiling workshop, packing area
E	Solid material heavy/greater size	Nakas, pari, ceiling rods, Greece cups, packing shoppers, blades, rings, canopy sets, dil pari,	Storeroom no 03	Packing area

Table 8: family grouping & their storages

Thermo pore & family group B were stored in their designated areas on the upper floor and cannot be shown in above schematic of the ground floor

Layout showing the item storage areas of the families

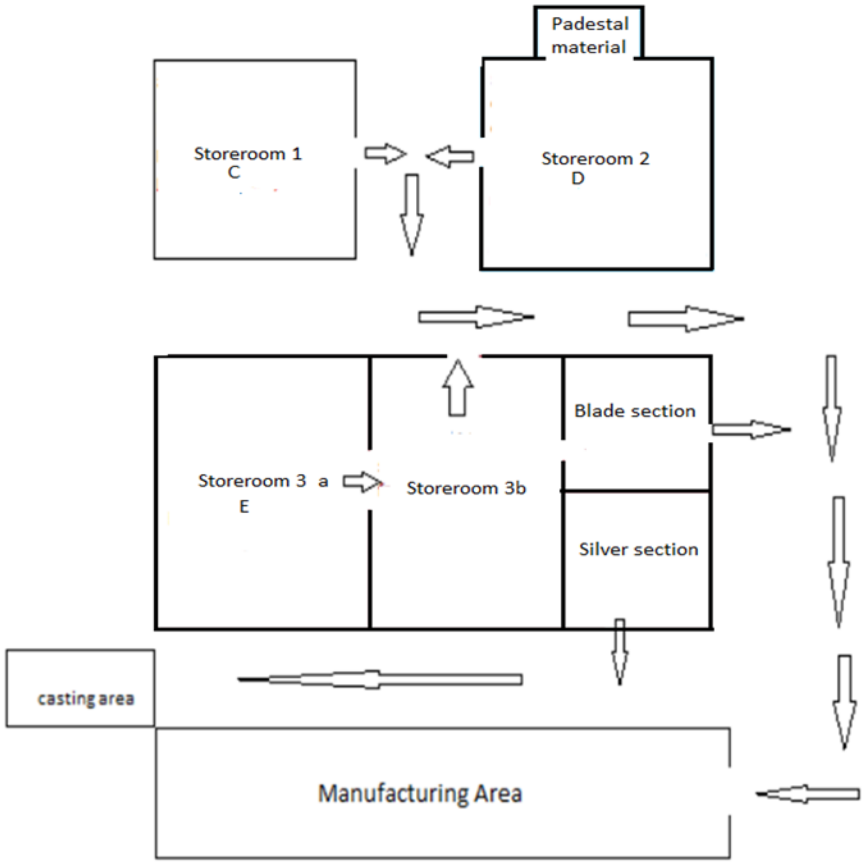

Fig.24: Layout showing the item storage areas of the families

Time study:

A time study was done to determine the time required for different items to travel from their homes in stores to their workplaces. The results are as follows:

SR NO.	DEPARTURE PLACE	ARRIVAL PLACE	AVG. TIME TAKEN
1	Storeroom 01	Manufacturing area	70 secs
2	Storeroom 02	Manufacturing area	70secs

3	Storeroom 02	Packing area	80 secs
4	Storeroom 03	Packing area	90 secs
5	Blades section	Manufacturing area	45 secs
6	Blades section	Packing area	55 secs

Table 9: time study

Based on above time measurements, the best section for fast moving products would the blades section. As shown in the above diagram, it was the area targeted because of the lesser time required to transport material from here to the manufacturing area and the packing area.

This area is shown through schematic layout of the ground floor of the factory depicting it as the targeted area:

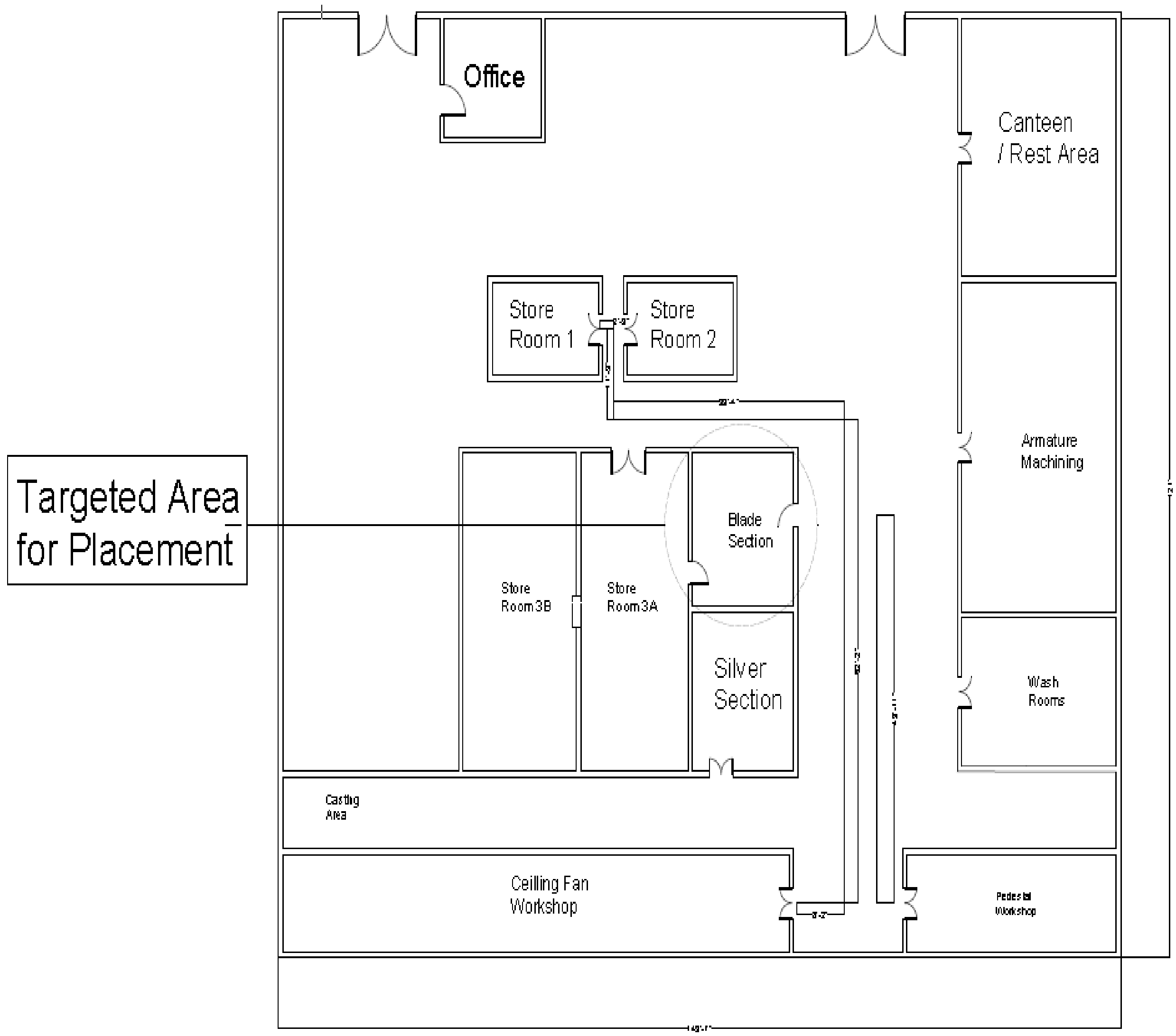

Fig 25:Targeted area for reallocation

Which items to be stored in this section ?

Parts of three of the premium models were suggested to be placed here, but only their standard parts which are to be listed later. The consideration for the three most fast moving products was based on an ABC analysis which undertook the sales for all the models from the past year. It is a rule of thumb to undertake only the previous year's usage records was an ABC analysis. The analysis done is shown below:

Production record for 2013:

Sr. no	Model	2012-13	Model wise Prod. Proportion	Average Per Month (10 Mths)
	Ceiling fan Production data of Last 12 Months (Fitting Data)			
1	Galaxy	18841	22%	1884
2	Samba Series	12000	14%	1200
3	Pak Delux	11708	14%	1171
4	Economy Models	10000	12%	1000
5	Misc	8000	9%	800
6	36" Fancy	4300	5%	430
7	General Deluxe	4216	5%	422
8	VIP Gold	2991	4%	299
9	Genral HD	2700	3%	270
10	Platinum	2565	3%	257
11	WaterProof	2100	2%	210
12	Antique	1825	2%	183
13	Breeze Plus	1443	2%	144
14	Saphire	1048	1%	105
15	Pride	904	1%	90
16	Total	84641	100%	
17				
18				

Table 10: production record of previous year (2013)

ABC Analysis:

Sr no.	Product name	Annual usage	Cumulative usage	% of total usage	% of total items
1	Galaxy	18841	18841	26	6.7
2	Pak. Deluxe	11708	30549	42	13.3
3	Classic	10000	40549	56	20
4	Miscellaneous	7171	47720	66	26.7
5	36" fancy	4300	52020	72	33.3
6	Gen. deluxe	4216	56236	77	40
7	VIP gold	2991	59227	82	46.7
8	General HD	2700	61927	85	53.3
9	Platinum	2565	64492	89	60
10	Water proof	2100	66592	92	66.7
11	Antique	1825	68417	94	73.3
12	Breeze plus	1443	69860	96	80
13	Sapphire	1048	70908	98	86.7
14	Pride	904	71812	99	93.3
15	Dubai	829	72641	100	100

16	Total	72641	72641	100	100

Table 11: ABC Analysis on factory products

After creating the matrix, a review of the column; % of total usage; leads to the decision as to where to cut-off for each A-B-C category. There is no rule of thumb for this but the decision is an intuitive one. The top three models represent around 50% of the value of all models. It is appropriate to cut-off the A category for the first three models. Row no. 9th, up till the platinum model, represents up to 90% the value of all products. Category B can be cut off at this point. The rest up till the last can be included in C category.

Category A represented by the top three models which are fast moving and their raw material items were suggested to be placed in blades section to save time for the workers. Only the standard parts of each model were suggested to be placed there. There were some common raw material items that were used in manufacturing of all the models. They were suggested to remain in their places as designated in the above schematic diagram. The standard parts of each model are listed below:

- Axles
- Nakas
- Blades
- Pari
- Greece cups
- Shoppers for blades, rods & body
- Rings
- Canopy sets

These parts for each model were to exchange places with the blades in the blades section thus, ensuring less travel time consumption in transportation of important parts of the fast moving products.

Time saving calculations

Travel time saved in transport of axels = 25s

Total travel time saved per round = 25+35 = 60s

For 16 rounds; 60 x 16 = 960 s

Total time saved per day due to reallocation = 960 + 400 = 1360 s.

On average, a batch of 550 fans is made per day.

A day of 8 working hours will give manufacture time of 28800 sec. for 550 fans

Takt time for each process 28800/550 = 52.4 sec. (approx.).

This implies maximum allowable time for each process is 52.4 sec

FOR AXEL FITTING:

The actual cycle time for one axle fitting is 12sec.

Maximum no. of axel fittings in saved time = 1360/12 = 113 units

Minimum no. of axel fittings in saved time = 1360/52.4 = 26 units

FOR PACKAGING OF ITEMS:

The actual cycle time for packaging is 48sec.

For 7 items to be packaged, cycle would be 48/7 = 7 sec. approx.

Maximum no. of items that can be packaged in saved time = 1360/7 = 194 units

Minimum no. of axel fittings in saved time = 1360/52.4 = 26 units

Improvements:

Time saved for no. of axel fittings = 113 units at max. & 26 units at minimum.

Time saved for no. of packaging of items = 194 units at max. & 26 units at minimum.

Shortages in any raw material items may cause delay in production for weeks, depending on the suppliers.

Since parts of three premium models will be separated from all other models, it will be easier to detect any shortages that may occur in their part quantities.

Too many items of different models stacked together may prompt damage to parts.

Parts of premium models, when separated and stacked orderly in a different room will lessen the chances of any damage to them.

Locator system:

- Combination system.
- Fixed home + random locator system.
- Fixed homes with SKU location addresses to be assigned to items that have specific purposes & are specific to certain fan models.
- They cannot be mixed with other items randomly.
- These include axles, bearings 6202 & 6203, screws of different kinds & purposes, blades, paris, nakas, greece cups, canopy sets etc. .
- General purpose items used commonly in all models to located randomly with no separate homes assigned.
- These include material like millinax, fiber guj, sand papers, solder wire, jion pari, packing tape, etc.

'Push' or a 'Pull' system ?

Starco fans production system is based on a 'pull' approach. They respond reactively to the actual costumer demand, & pull the required amount of products through the system. They do estimate a short-term future demand intuitively based on previous year's sales experience but do not really follow their estimates. Mainly due to lack of historical details of sales records, mathematical models cannot be used to predetermine the future demands. So, their approach is reactive rather than proactive, as in a 'push' system, where demands are forecasted and stock availability is ensured at the right time. They, however, produce 50 to 60 products more than the demand to have some safety stock, but only for local products.

Order-Point Formulae

Order point formulae are used to determine how much of a given item needs to be ordered where there is independent demand. In these formulae a reorder point (ROP) is set for each item. The ROP is the lowest amount of an item you will have on hand and on order before you reorder.

A simple formula was used for determining the reorder point for each item:

(Usage rate x Lead time) + Safety stock= ROP

In the above formula lead time is shown as a percentage of a month, as follows:

1 week = 0.25 = 25%	4 weeks = 1.00 = 100%
2 weeks = 0.50 = 50%	5 weeks = 1.25 = 125%
3 weeks = 0.75 = 75%	6 weeks = 1.50 = 150%

For our case study of starco fans industry the production lead time for each item was 4 days, which as a percentage of a month is given as :

1 week= 0.25

1 week = 6 working days

Therefore 4 days= 4/6 x 0.25= 0.17 or 17 % of a week.

The reorder point for top three model is calculated as :

Galaxy:

Annual sales of 18841 per year of 10 months imply a monthly usage of 1884 items.

A 4 week month will give working stock as 1884/4=471 items

Working reserve is calculated as 1884 x 0.17= 320 items

Safety stock is 50% of working reserve which would be 160 items

ROP= (1884 x 0.17) + 160 = **480 items**

Similarly;

PAK Model:

Annual sales=11708

Monthly sales= 11708/10= 1171

Lead time= 0.17

Working stock= 1171/4= 293

Working reserve= 1171 x 0.17= 199

Safety stock = 50% of working stock = 100

ROP= (1171 x 0.17) + 100= **299 items**

Classic model:

Annual sales=10000

Monthly sales= 10000/10= 1000

Lead time= 0.17

Working stock= 1000/4= 250

Working reserve= 1000 x 0.17= 170

Safety stock = 50% of working stock = 85

ROP= (1000 x 0.17) + 1=85= **255 items**

Feedback from the Industry

Generally, feedback on all the tasks performed was positive, given by the admin of the factory. All the tasks and their consequences were discussed in detail with the admin of the factory. The feedback on different tasks is stated below:

1. **Standardization of axles:**

Our standardization of axle was very well accepted in the factory and according to them, it was very much implementable but the main issue was how its cost benefits and losses from the original would compare with each other. For four axles to be standardized into one, the design of the body, plates and the casting die would have to be changed. For example, the size of the axle S.F/S.K would have to be reduced to 109mm from an original size of 110.5mm. Therefore the base of the cavity between its body and plate will have to be filled with aluminum up to a thickness of 1.5mm. Likewise armature sizes in some model will have to be increased, e.g. in Awami Dubai, the size would increase to 20mm from an original size of 14.5mm which means the thickness of rotor covering the armature will also have to be increased requiring extra aluminum. This addition of extra aluminum to adjust the sizes would cost them but on the other hand, they would benefit from the reduction in 4 types of axles to one. Analyzing and comparing the cost incurred in both these situations would help them conclude, whether or not it will be "kaizen" for their company.

Family grouping of RM:

- 5s rules:
- Sort
- Stabilize/ set in order
- Shine
- Standardize
- Sustain

The family grouping would sort the items into groups that have like characteristics and are used together. This would make it easier for the worker access a particular family of items that are used together. This, according to them, is exactly according to the 5S rules which they are already working on implementation in their industry. Our proposition follows the first of the 5S i.e. sort all of the items in a classified manner.

Reallocation of fast moving items:

This again was given positive remarks and they would be implementing it in accordance with the second step of the 5S i.e stabilize/ set in order of priority.

Stock keeping for finished goods:

They said that they were already keeping some safety stock of their finished goods and they consider our quantities based on the demand pattern for these fast moving items in the previous year.

CONCLUDING DISCUSSION

Inventory management is very important to all industries. The right quantity, storage & location, all should contribute to save money, time and space utilization.

Tasks Performed:

- Initial background research on inventory management which included the study of all the prerequisites to achieve effective inventory management.
- Visit to the fan industry in Gujarat to gain a keen observation of all types of their inventory, storages and the management.
- Determining the areas of improvement where we could bring about some modifications to make their inventory systems better.

Problems identified:

- Unnecessary variety in RM inventory causing unnecessary space utilization in storerooms.
- Inappropriate placement of items causing difficulty in locating any required group of items at any time in storerooms.
- Non-strategic allocation of raw material items in storerooms causing wastage of time in transport of RM from storerooms to their place of use.
- No safety stock been kept in case of sudden demand fluctuations.

Improvements through problem addressing:

- 37.5% reduction in variety through standardization.
- Grouping of items into "families" giving ease of their access to the workers for certain families of items.
- Strategic reallocation of RM items through time study of transport of material from their designated places of storage to their place of consumption in the facility.
- Time saved for no. of axel fittings = 113 units at max. & 26 units at minimum.
- Time saved for no. of packaging of items = 194 units at max. & 26 units at minimum

- Since parts of three premium models will be separated from all other models, it will be easier to detect any shortages that may occur in their part quantities
- Parts of premium models, when separated and stacked orderly in a different room will lessen the chances of any damage to them
- All-time availability of safety stock ensured against cases of sudden demand fluctuation.

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<u>THE END</u>