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# Capacity Planning and Layout Optimization

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**Abstract:** ***In the today's dynamic automobile market the warehouse capacity system required the high level of flexibility and changeability. This study aims to improve the warehouse operations including Layout Optimization, Capacity and space calculations, infrastructure calculations and the material movement calculations. This study is carried out in the Tractor Assembling Plant (Johndeere India Pvt. Limited, Dewas Plant, Madhyapradesh). The plant is running on the capacity of 50 tractors per day. As per the forecast of India level the volume of production is comes out to be the 80 tractors per day so there is a need to re-optimize the current facility. Initially, the warehouse is designed for the 80DPR (Daily production rate) with considering two models but due to increase in the number of models and increase in number of variant the study is need to be carried out to facilitate the desired capacity and redefine the warehouse locations. The final output of the study will results improved material flow, optimized warehouse layout, improved process efficiency, efficient warehouse operation, minimum inventory.***

**Keywords:** Daily production rate (DPR), Layout Optimization, Material Flow, Process efficiency, inventory

## 1. Introduction

**Project Background**

In the today's dynamic automobile market the warehouse capacity system required the high level of flexibility and changeability. This study aims to improve the warehouse operations including Layout Optimization, Capacity and space calculations, infrastructure calculations and the material movement calculations.

Generally, warehouses are designed by considering the four factors:-

- Flow
- Accessibility
- Space Utilization
- Throughput

**1. Flow-** What we're looking for here is a logical sequence of operations within the warehouse where each activities located as close as possible to that which precedes it and also the function that follows it. We are concerned with the controlled and uninterrupted movement of materials, people and traffic , if possible, no cross flow movement. It is also concerned with the awareness of where material is located within the system, and the status and location in the storage. Our aim is to position the various warehouse activities in order to contribute to a smooth flow of operations with a minimum amount of movement.

**2. Accessibility–** The ability to retrieve goods with a minimum of effort which reduce the motion wastage and provide high efficiency and performance of worker on

shop floor. One of the most common issues with warehouses is the need for accessibility and proper layout design. Proper accessibility can help your workers handle their tasks and more easily, prevent accidents, and smooth flow of material.

**3. Space Utilization-** Companies can also reduce their costs and improve the efficiency of their warehouse by maximizing the space utilization, ensuring that it is possible to store as many items as possible in the most optimum space. This can be achieved by providing the minimum space to the offices and other utilities in order to maximize the main storage area.

**4. Throughput –** When we look at throughput, where not only looking at the categories of product parting through the warehouse but also the nature of the product and its velocity through the flow. By nature, we mean the handling characteristics, dimensions and any other factors that will impact on how it is moved through the flow such as hazard, bulk, fragility, security requirements and compatibility with other products. The velocity of the product will consider the volumes moving through the warehouse on a daily basis.

When considering your warehouse layout or design, the factors of **Flow, Accessibility and Space** must be balance to enable the demand to **Throughput** in terms of volume passing through and the time parameters to be met.

Hence, this study is focused on these four parameters in order to optimize the current capacity and planning for the upcoming demand.

The study is performed in the tractor manufacturing plant which currently worked on the 50 tractors per day. As per the forecast, there is a visibility of increase in the volume of production to 80 tractors per day. So, in order to grab the business opportunity the current warehouse is need to be optimized and planned for the 80DPR(daily production rate).

## 2. Literature Review

Storage capacity planning is a critical process, because the storage area occupies a large space in a warehouse. Tompkins, White, Bozer, & Tanchoco (2010) consider the planned number of on-hand stocks that need to be stored based on the replenishment receiving schedule and the method of product allocation to a storage area. The common receiving schedules are either that all products are received together at the same time or that each product arrives over time. There are two methods for product allocation to a storage area: fixed or assigned location storage and random or floating location storage. To calculate the required storage space, Tompkins et al. (2010) suggest to use the maximum on-hand quantities if the replenishment orders of all products arrive at the same time and/or if the fixed location is used to assign the product to a storage area. Meanwhile, if the product arrives over time and the random location storage is used, they suggest to use the average on-hand quantities, because when the inventory level of one SKU is above average, another SKU will tend to be below average.

Several fields extensively discuss about capacity planning, such as in production, manufacturing, logistics, and healthcare. We select several relevant studies that give us insights on how to model the capacity planning problem and on how to solve the model. Mathematical modeling (i.e., integer linear programming or mixed integer linear programming) is commonly used for capacity planning.

Yao, Lee, Jaruphongsa, Tan, & Hui (2010) worked on an allocation and inventory problem in multi-source facility location that incorporates multiple resources of warehouses. In this problem, multiple products are produced in several production plants, the warehouses can receive products from several plants, each customer has stochastic demand, and a certain amount of safety stock must be maintained in the warehouses in order to achieve a certain customer service level. The objective function is to minimize the expected total costs to satisfy the target customer service level. The outcomes of the model are the number and location of warehouses, allocation of customers demand, and the inventory levels of the warehouses. The authors formulated the problem as a mixed integer nonlinear programming problem and solved the problem by an iterative heuristic method. Mirhassani, Lucas, Mitra, Messina, & Poojari (2000) developed a computational solution for a capacity planning model under uncertainty. The authors formulated the problem as an integer stochastic programming model that explicitly considers randomness and solved the problem using decomposition solution methods. The major drawback of using stochastic programming for capacity planning problems is that this is computationally demanding.

These studies from healthcare sector also gives us insights on how to model the capacity planning problem. Assume that the operating room is similar to a distribution warehouse and the hospital bed is similar to the required pallets needed. Cardoen, Demeulemeester, & Beliën (2010) reviewed recent operations research on operating room planning and scheduling by evaluating the literature on multiple areas that are related to the problem setting (i.e., performance measures or patient classes) or the technical aspects (i.e., solution methods). Bachouch, Guinet, & Hajri-Gabouj (2012) developed a decision support tool based on an integer linear programming model for hospital bed capacity planning. They took into account several constraints, such as incompatibility between pathologists, no mixed-sex rooms, continuity of care, etc. They used 3 solver software programs: GLPK, LINGO, and CPLEX. Previously, Harris (1986) also worked on hospital bed capacity planning but using a simulation model to help management decide on the bed allocation and operating schedules. Kuo, Schroeder, Mahaffey, & Bollinger (2003) used liner programming for optimizing the allocation of operating rooms (OR). The objective functions of the model are to maximize revenue and minimize operating costs. The inputs of the model are allocated OR time, case mix, total OR time used, and the normalized professional charges. The Solver linear programming was used to determine the optimal mix of surgical OR time allocation to maximize professional receipts.

These following studies show the possibility to include the production capacity in capacity planning of distribution warehouses that might be useful for the future research.

**Research Objectives**

- Material storage, space utilization.
- Optimization of per part inventory.
- Reduction In Material Movement
- Reduce Dock Congestion
- Redefined MOQ and Safety stock.
- Reduction in DOP.
- Accommodating new volume in same facility.

## 3. Theoretical Framework

### 3.1 Capacity Planning

According to R. Anthony Inman, "Capacity planning is the process used to determine how much capacity is needed (and when) in order to manufacture greater product or begin production of a new product"

### 3.2 Capacity Planning Constraints

There are two capacity planning constraints, namely:-

- **Time** - This can be a constraint where the operator requires a part at a specific time, Planners thus "plan backward". This process can identify if there is sufficient time to meet the production demand.
- **Capacity** – If there is not sufficient time then the production capacity is a constraint. Decision must then be made to whether increase the capacity or not.

### 3.3 Capacity Planning Strategies

- **Lead strategy**- Capacity increases when an increase in demand is anticipated. Lead strategy is an aggressive strategy and has a disadvantage of resulting in excess inventory, this leads to unnecessary costs.
- **Lag strategy**- Capacity is only added when production runs at full capacity. Lag strategy is more a conservative strategy which decreases the risk of waste, but could result in a decrease in customers.
- **Match strategy**- It is a moderate strategy which adds capacity in small amounts in reaction to demand.

### 3.4 Value Stream Mapping

A value stream map gives a graphical overview of the flow of material and information in a production process. This is a good foundation for understanding how activities and operations are connected and forms a basis for analyses of the process. However, the graphical representation alone is not enough. It is important to note that the whole point of doing VSM is improvement.

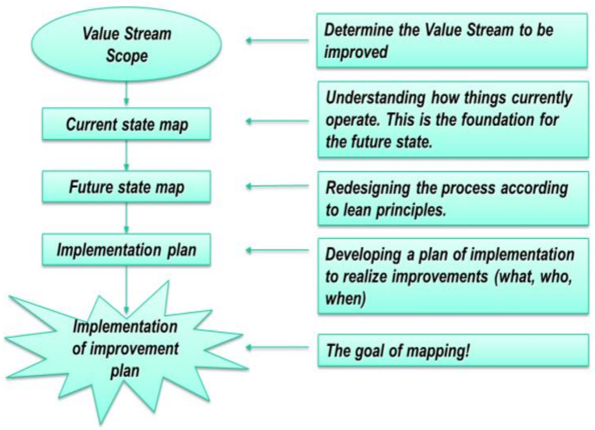


**Figure 1:** Main Steps of Value Stream Methodology

### 3.5 DPR (Daily Production rate)

It is defined as the number of end products produced per day. It depends on the forecast and capacity of the manufacturing plant. It will discuss in details in the further chapters.

### 3.6 DOP (Days of production)

Days of production are the representation of the inventory in the form of time i.e. it is the days of inventory hold in a plant in form of the production rate.

### 3.7 Takt Time

Takt time is the rate at which a finished product needs to be completed in order to meet customer demand.

### 3.8 fishbone Diagram

The fishbone diagram (also called the Ishikawa diagram) is a tool for identifying the root causes of quality problems. It was named after Kaoru Ishikawa, a Japanese quality control statistician, the man who pioneered the use of this chart in the 1960's (Juran, 1999). The fishbone diagram is an analysis tool that provides a systematic way of looking at effects and the causes that create or contribute to those effects. Because of the function of the fishbone diagram, it may be referred to as a C and E diagram (Watson, 2004).

C and E (also known as fishbone and Ishikawa) diagrams, developed by Ishikawa in 1968, help users to think through problem causes (Ishikawa, 1986). The approach combines brainstorming and a concept map. The process has four major steps: identifying the problem; working out the major factors involved; identifying possible causes and analyzing the cause and effect diagram, which are used to resolve numerous problems including risk management in production and services (Dey, 2004). The technique has been well applied to obstetrics and gynecology and emergency department healthcare management (White et al., 2004). Fishbone (Ishikawa) diagram mainly represents a model of suggestive presentation for the correlations between an event (effect) and its multiple happening causes. The structure provided by the diagram helps team members think in a very systematic way. Some of the benefits of constructing a fishbone diagram are that it helps determine the root causes of a problem or quality characteristic using a structured approach, encourages group participation and utilizes group knowledge of the process, identifies areas where data should be collected for further study.

The diagrams are useful in:

- Analyzing actual conditions for the purpose of product or service quality improvement, more efficient use of resources and reduced costs.
- Elimination of conditions causing nonconforming product or service and customer complaints.
- Standardization of existing and proposed operation.

## 4. Data Analysis

Packaging data, Cycle time, unloading dock, material movement and storage data are taken from the shop floor of the company.

On the basis of the collected data footprint analysis is done with the help of Microsoft excel which provide the area requirement for the upcoming demand.

| Part No. | Usage | Days Of Production | Daily Consumption | Max. Qty. in Warehouse | unloading Dock | Packg. | L | W | H | Storage | No. Of Packg. | Stored Qty | Stacking | footprint | Round up | Area Required | Point Of Use |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SJ300761 | 0.06 | 15 | 4.8 | 72 | 14 | Steel Pallet | 110 | 110 | 85 | Floor | 1 | 6 | 3 | 4 | 4 | 48400 | WM1 |
| SJ300762 | 0.23 | 7 | 18.4 | 128.8 | 14 | Steel Pallet | 110 | 110 | 85 | Floor | 1 | 6 | 3 | 7.1556 | 8 | 96800 | WM1 |
| SJ300763 | 0.23 | 7 | 18.4 | 128.8 | 14 | Steel Pallet | 110 | 110 | 85 | Floor | 1 | 6 | 3 | 7.1556 | 8 | 96800 | WM1 |
| SJ300764 | 0.058 | 7 | 4.64 | 32.48 | 14 | Steel Pallet | 110 | 110 | 85 | Floor | 1 | 5 | 3 | 2.1653 | 3 | 36300 | WM1 |
| SJ300765 | 0.238 | 5 | 19.04 | 95.2 | 14 | Steel Pallet | 110 | 110 | 85 | Floor | 1 | 6 | 3 | 5.2889 | 6 | 72600 | WM1 |
| SJ300766 | 0.1 | 7 | 8 | 56 | 14 | Steel Pallet | 110 | 110 | 85 | Floor | 1 | 5 | 3 | 3.7333 | 4 | 48400 | WM1 |
| SJ300767 | 0.064 | 7 | 5.12 | 35.84 | 14 | Steel Pallet | 110 | 110 | 85 | Floor | 1 | 5 | 3 | 2.3893 | 3 | 36300 | WM1 |
| SJ300768 | 0.005 | 7 | 0.4 | 2.8 | 14 | Steel Pallet | 110 | 110 | 85 | Floor | 1 | 5 | 3 | 0.1867 | 1 | 12100 | WM1 |
| SJ300769 | 0.005 | 7 | 0.4 | 2.8 | 14 | Steel Pallet | 110 | 110 | 85 | Floor | 1 | 5 | 3 | 0.1867 | 1 | 12100 | WM1 |
| SJ300770 | 0.01 | 7 | 0.8 | 5.6 | 14 | Steel Pallet | 110 | 110 | 85 | Floor | 1 | 5 | 3 | 0.3733 | 1 | 12100 | WM1 |
| SJ300771 | 0.2 | 7 | 16 | 112 | 12 | Steel Pallet | 113 | 90 | 85 | Floor | 1 | 8 | 3 | 4.6667 | 5 | 50850 | WM3 |
| SJ300772 | 0.2 | 7 | 16 | 112 | 12 | Steel Pallet | 113 | 90 | 85 | Floor | 1 | 8 | 3 | 4.6667 | 5 | 50850 | WM3 |
| SJ300773 | 0.2 | 7 | 16 | 112 | 12 | Steel Pallet | 113 | 90 | 85 | Floor | 1 | 8 | 3 | 4.6667 | 5 | 50850 | WM3 |
| SJ300774 | 0.2 | 7 | 16 | 112 | 12 | Steel Pallet | 113 | 90 | 85 | Floor | 1 | 8 | 3 | 4.6667 | 5 | 50850 | WM3 |
| SJ300775 | 0.1 | 10 | 8 | 80 | 12 | Steel Pallet | 113 | 90 | 85 | Floor | 1 | 8 | 3 | 3.3333 | 4 | 40680 | WM3 |
| SJ300776 | 0.1 | 10 | 8 | 80 | 12 | Steel Pallet | 113 | 90 | 85 | Floor | 1 | 8 | 3 | 3.3333 | 4 | 40680 | WM3 |
| SJ300777 | 0.85 | 8 | 68 | 544 | 2 | Wooden Box | 100 | 100 | 85 | Floor | 1 | 6 | 3 | 30.222 | 31 | 310000 | WM3 |
| SJ300778 | 0.15 | 15 | 12 | 180 | 2 | Wooden Box | 100 | 100 | 85 | Floor | 1 | 6 | 3 | 10 | 10 | 100000 | WM3 |
| SJ300779 | 0.26 | 7 | 20.8 | 145.6 | 2 | Wooden Box | 100 | 100 | 85 | Floor | 1 | 12 | 3 | 4.0444 | 5 | 50000 | WM3 |
| SJ300780 | 0.3 | 15 | 24 | 360 | 2 | Wooden Box | 100 | 100 | 85 | Floor | 1 | 12 | 3 | 10 | 10 | 100000 | WM3 |
| SJ300781 | 0.3 | 15 | 24 | 360 | 2 | Wooden Box | 100 | 100 | 85 | Floor | 1 | 12 | 3 | 10 | 10 | 100000 | WM3 |
| SJ300782 | 0.14 | 7 | 11.2 | 78.4 | 2 | Wooden Box | 100 | 100 | 85 | Floor | 1 | 12 | 3 | 2.1778 | 3 | 30000 | WM3 |
| RE554961 | 0.23 | 7 | 18.4 | 128.8 | 12 | Partition Bin | 40 | 30 | 12 | HR | 41.6667 | 83.3333333 | 1 | 1.5456 | 2 | 24000 | WM2 |

**Figure 2**: Footprint Analysis Sheet

The Figure 2 shows the snap of the footprint analysis sheet which is also called the PFEP ,contain the following parameters part no, Usage, Daily consumption, Days of production, Maximum quantity in warehouse, packaging type and dimensions, storage, stacking level, footprint required, area required and point of use. These parameters are calculated by using the formulas given below.

**DOP-** This is collected from the Buyers of that particular part. This data is generally available in the Supply Chain Department or in the SAP software of the company. It also termed as DOH (Days on hand ). Days inventory on hand is usually calculated by dividing the number of days in a period by inventory turnover for the period.

$$\text{DOP} = \frac{\text{No. of days in the period}}{\text{Inventory turnover for the period}}$$

**Usage-** This term is generally calculated from the past data. It is the ratio of the total consumption of the part to the total number of assembly manufactured (Finished Goods). In our study it is calculated by the following formula:

$$\text{Usage} = \frac{\text{Total consumption}}{\text{Total no. of entities manufactured}}$$

**Daily Consumption-** It is the product of DPR (daily production rate) and the usage of the part.

**Daily Consumption= DPR × Usage**

**Daily Consumption-** It is the product of DPR (daily production rate) and the usage of the part.

**Daily Consumption=DPR × Usage**

**Maximum Quantity in warehouse-**It is calculated by the multiplication of daily consumption and the DOP.

**Maximum Qty in warehouse= Daily Consump.× DOP**

By using above formulas the footprint and area required for the each part is calculated. Now, for determining the starting area of the optimization and for root cause analysis VSM analysis and fishbone diagram analysis are need to be performed.

### 4.1 Fishbone Diagram analysis

To determine the root cause of the problem the fishbone analysis is need to be performed. In our study the most influencing parameter for the warehouse capacity planning is inventory management, hence the brainstorming is done for the inventory management, which result the following fishbone diagram is obtained.

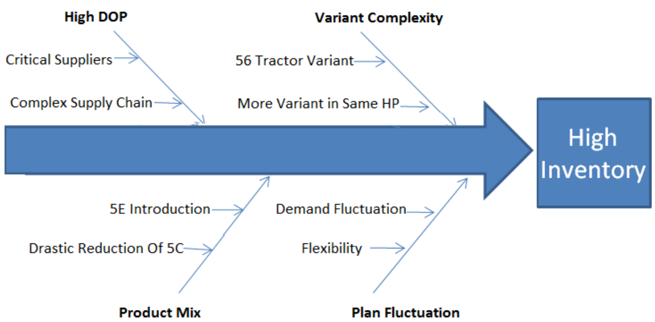


**Figure3**: Fishbone Diagram

From the figure 3, it is clear that the major critical contributor of the higher inventory is

- Product mix
- Plan fluctuation
- Higher DOP
- Variant Complexity

Out of four the main influencing contributor in capacity planning is DOP, which further leads to the higher inventory i.e. more space requirement to hold that inventory. To rectify this problem we need to optimize the DOP and storage. To optimize the DOP localization projects need to be derive for the bulky parts like casting because they are the main contributor in the space requirement and to optimize the storage we can maximize the use of upper portion i.e. increase the vertical storage.

From the above fishbone diagram following matrix can be drawn:

**Table1**: Problem Solution matrix

| Problem | Solution |
|---|---|
| Product Mix | Variant Reduction |
| Demand Fluctuation | Strong Forecast |
| Higher DOP | Localization Project |
| Variant Complexity | Part Communization |

Out of four the main influencing contributor in capacity planning DOP, which further leads to the higher inventory i.e. more space requirement to hold that inventory. To rectify this problem we need to optimize the DOP and storage. To optimize the DOP localization projects need to be derived for the bulky parts like casting because they are the main contributor in the space requirement and to optimize the storage we can maximize the use of upper portion i.e. increase the vertical storage.

### 4.2 VSM Analysis

**Table 2:** VSM Analysis

| Station | Cycle Time | FPY | OPE | Operator | Takt Time | Maximum Available Time | Utilization (%) |
|---|---|---|---|---|---|---|---|
| Station-1 | 7.5 | 100 | 100 | 1 | 9.2 | 9.2 | 81.52 |
| Station-2 | 6 | 100 | 100 | 1 | 9.2 | 9.2 | 65.22 |
| Station-3 | 7.5 | 100 | 100 | 1 | 9.2 | 9.2 | 81.52 |
| Station-4 | 7.5 | 100 | 100 | 1 | 9.2 | 9.2 | 81.52 |
| Station-5 | 5 | 100 | 100 | 1 | 9.2 | 9.2 | 54.35 |
| Station-6 | 4.25 | 100 | 100 | 1 | 9.2 | 9.2 | 46.20 |
| Station-7 | 8.2 | 100 | 100 | 1 | 9.2 | 9.2 | 89.13 |
| Station-8 | 15.2 | 100 | 100 | 2 | 9.2 | 18.4 | 82.61 |
| Station-9 | 14 | 100 | 100 | 2 | 9.2 | 18.4 | 76.09 |
| Station-10 | 7.8 | 100 | 100 | 1 | 9.2 | 9.2 | 84.78 |
| Station-11 | 8 | 100 | 100 | 1 | 9.2 | 9.2 | 86.96 |
| Station-12 | 3.6 | 100 | 100 | 1 | 9.2 | 9.2 | 39.13 |
| Station-13 | 13 | 100 | 100 | 2 | 9.2 | 18.4 | 70.65 |
| Station-14 | 4.5 | 100 | 100 | 1 | 9.2 | 9.2 | 48.91 |
| Station-15 | 6 | 100 | 100 | 1 | 9.2 | 9.2 | 65.22 |

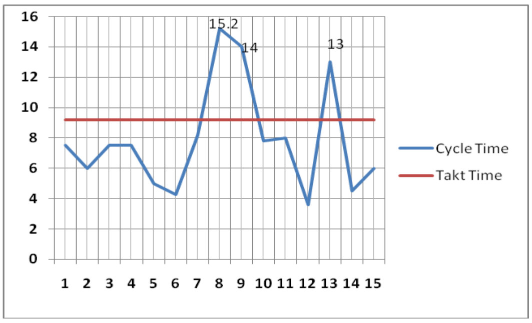


**Figure 4:** Cycle time variation on stations

From the figure 4 it is clear that the station no. 8,9,13 are the bottleneck since it has greater cycle time than takt time, hence optimization is start from these stations and horizontally deployed to other area.

## 5. Results and Discussions

### 5.1 Current Scenario

As per the current demand, running DPR is 50 tractors per day. The table given below will clearly shows the space distribution if the facility.

**Table 3:** Space distribution for 50 DPR

| Total Transmission area | 1500Sq.meters |
|---|---|
| For 50DPR (Current Scenario) | |
| Warehouse Area | 303 Sq.meters |
| Office Area | 30 Sq.meters |
| Aisle Area | 467 Sq.meters |
| Equipment Area | 210 Sq.meters |
| Main Line Area | 120 Sq.meters |
| Sub Assembly Area | 40 Sq.meters |
| Metallurgy and Quality Area | 30 Sq.meters |
| Empty | 300 Sq.meters |

### 5.2 Projected Space for 80 DPR

Now if we project the same situation for the 80 DPR following results were obtained:

**Table 4:** Projected space for 80 DPR

| Total Transmission Area | 1500 Sq.meters |
|---|---|
| projected Space (80 DPR) | |
| Warehouse Area | 686 Sq.meters |
| Office Area | 30 Sq.meters |
| Aisle Area | 467 Sq.meters |
| Equipment Area | 350 Sq.meters |
| Main Line Area | 120 Sq.meters |
| Sub Assy. Area | 40 Sq.meters |
| Metallurgy and Quality Area | 30 Sq.meters |
| Empty/Required | -223 Sq.meters |

By projecting the 50 DPR to the 80 DPR under same parameters the warehouse capacity is not sufficient to meet the upcoming demand.

Table 4 clearly shows that the warehouse capacity is short by 223 sq. meters and to fulfill the upcoming demand, either the capacity is need to be increased by at least 223 sq. meters or optimized. As per the current picture there is an opportunity to maximize the current capacity hence, we will go for the optimization for the maximization of the invested capital.To fulfill the gap between 50DPR and 80DPR following optimization methods were used-

- Casting Localization
- Reduce Demand Fluctuation
- Reduced DOP
- Kitting Improvement(To reduce lineside Storage)
- Vertical Storage
- Packaging Improvement

By using the above mentioned methods the current capacity is optimized and ready to produce 80 DPR. The optimized result will show in the next heading.

### 5.3 Optimized Space Matrix

**Table 5:** Optimized space Distribution for 80 DPR

| Total Transmission Area | 1500 Sq.meters |
|---|---|
| | |
| Optimized (80 DPR) | |
| Warehouse Area | 529 Sq.meters |
| Office Area | 30 Sq.meters |
| Aisle Area | 467 Sq.meters |
| Equipment Area | 225 Sq.meters |
| Main Line Area | 120 Sq.meters |
| Sub Assy. Area | 0 Sq.meters |
| Metallurgy and Quality Area | 30 Sq.meters |
| Empty/ Required | 99 Sq.meters |

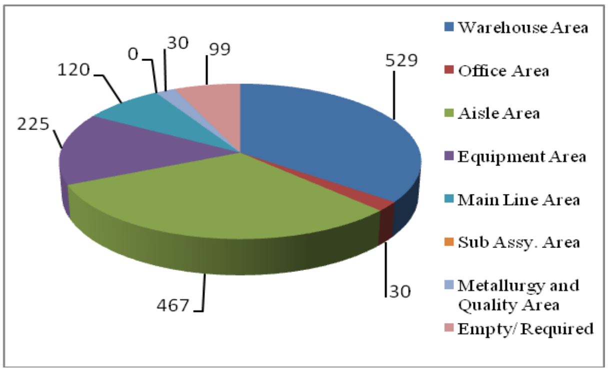


**Figure 5:** Optimized Space distribution for 80 DPR

### 5.4 Comparision

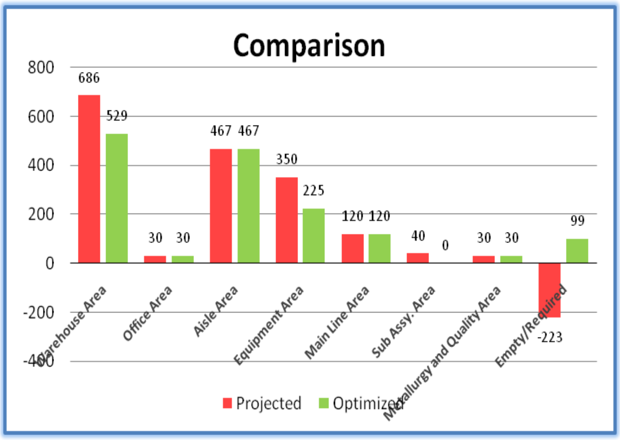


**Figure 6:** Comparison between projected and optimized space

From the figure 5.5 following results were drawn

1) The warehouse space in optimized by 157 Sq. meters by increasing the vertical storage in the current warehouse.
2) Office area remains same as there is no requirement of the additional manpower.
3) No additional walking aisle will added hence aisle area will remain same.
4) Equipment area is reduced by 125 sq. meters due to the elimination in the washing machines as in the localization, washed component will receive. Washing of the components will done on the suppliers end.
5) No additional conveyor is added hence the main line area remain same.
6) Sub. Assembly area is reduced by 40 Sq. meters as one of the sub assembly operations will shift to the main line.
7) Receiving quality and metallurgy lab area will remain same.
8) Finally, the total space is increased by 322 sq. meters. Hence in current capacity 90 sq. meter is empty which will further support the higher DPR.

## 6. Conclusion and Future Scope

### 6.1 Conclusion

- By the VSM analysis the station number 8, 9 and 13 are found to be the bottleneck station and the space optimization can be start from these stations and horizontally deployed to the other area.
- Gap analysis is done by projecting the 50DPR to 80DPR, which conclude that the warehouse space is short by 223 Sq. meters. Hence we need to optimize the current capacity.
- Warehouse space optimization is done by deriving casting Localization, reducing DOP, increasing vertical storage, packaging improvement and kitting (For lineside storage).
- Finally it is concluded that the warehouse capacity is ready to run the 80 DPR and additional 99 sq. meters will we used for the upcoming demand.

### 6.2 Future Scope

- The data collected can be used for the further capacity planning or the warehouse improvement related projects.
- Analysis can be extended for the higher DPR.

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