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AN EMPIRICAL STUDY ON CAPACITY REQUIREMENT PLANNING (CRP) IN ERW SECTION AT AN AUTOMOTIVE SECTOR, CHENNAI

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ABSTRACT - The study conducted on Capacity Resource Planning (CRP) in ERW at an automotive sector, Chennai was a great experience. The learning that happened was very precious and refreshing. The Practical experience of watching the working of each functional department gave immense exposure.This step is a stepping stone which will groom my future in the corporate world. Material is the prime requirement of any final product, so that the MaterialRequirements Planning (MRP) systems are frequently used in the industry.Productivity increase by means of a work study of a manufacturing industry is the area of interest in this project. This is an empirical study carried on, where in numerous types of tools and techniques were employed to improve the efficiency and productivity of industry.

In essence, the research deals with large-scale manufacturing industry. This research applied work study methods to improve the practices in the industry, in addition to ascertaining and rectifying problems associated with the process of production. The applied tools such techniques improved production by reducing production time and processes involved, as well as an increase in the production rate. This project highlights the advantages of adopting such an efficient process by developing the Capacity Resource Planning (CRP).

***Key words**:* MRP, CRP, CPR Types, MRP Process,

1. INTRODUCTION

Production is the process of manufacturing or fabricating or producing certain type of goods, work in process or finished, input being basic raw material or semi-finished products or sub-assemblies. Production is a measure of output only and not a measure of efficiency of the organizations. **Productivity:** biggest and most challenging task faced today by any organization is the 'productivity'. It is the measure of the combined efficiency of integrated efficiency of employees, machined and other devices and equipment, nature of raw material inputs, performance of the management, efficiency of the whole management system. Productivity can be computed and expressed as the ratio of average acceptable output per period by the total costs incurred through various resources viz., Material, Labour, consumables, power utilized, capital energy, material, personnel., consumed in that period. It is nothing but a measure of efficiency of the integrated system consisting of resources like money, men, materials, machines (4Ms of an industry) and time etc. In a manufacturing company, Material Resource Planning (MRP) and Capacity Resource Planning (CRP) are the most important criteria to be managed efficiently. MRP is essential for any business.

Optimizing material management is also an essential step in creating responsive supply chains. During the COVID-19 pandemic, demand for masks and personal protective equipment skyrocketed. Now, some areas have implemented mandates for wearing masks when working in enclosed facilities, as well as existing social distancing measures. Optimization allows for businesses to change priorities and adjust to new needs. For example, the invocation of the Defense Production Act could be a stimulus to a forced redistribution of planned activities and resources for your company. If the company lacks a transparent, easy-to-use system, optimization and pivoting to new schedules will be troublesome at best. As businesses have grown, a single material requirement planning system may not be enough to track all inventories. Multiple warehouses and manufacturing centers exist to meet demand. Yet, the need for lean manufacturing, avoiding unnecessary inventory carrying costs grew in tandem. According to Steve Banker of Forbes, the

costs of raw materials, components, and subassemblies in manufacturing is significant. Manufacturers may levy fines of $4,000 per minute for partners that fail to meet delivery obligations.The effect on the factory is clear; poor access to materials halts production. At the same time, too much raw material will lead to higher purchasing and carrying costs.

MRP synchronizes the flow of materials, components, and parts in a phased order system, considering the production schedule. It also combines and tracks hundreds of variables, including:

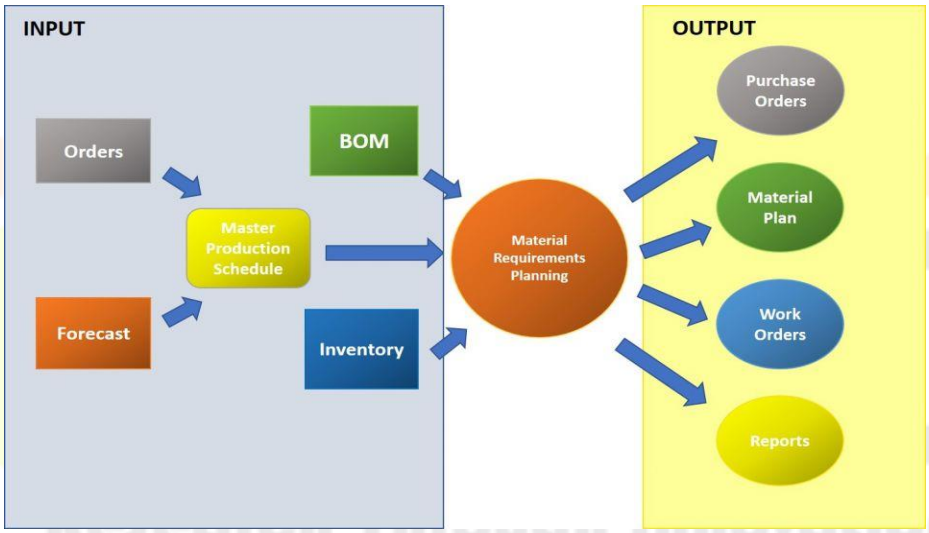
- Purchase orders
- Sales orders
- Shortage of materials
- Expedited orders
- Due dates
- Forecasts
- Marketplace demand
- Material
- Inventory
- Data
- Bill of material

These include making sure that the inventory level is at a minimum, but high enough to provide for the customer need, and that you plan all of the activities, including delivery, purchasing, and manufacturing. Terms related to MRP as a concept, and some are specific to MRP software.

Material Requirements Planning (MRP) Steps:

MRP works because it is a well-organized framework of processes and calculations. MRP system can completely transform a company's operational procedures. Business firm contributes to the MRP process, including sales, production, purchasing, receiving, stockroom, and shipping personnel.
MRP consists of three basic steps:

- **Spotting the Quantity Requests:** Determine what quantity is on hand, in an open purchase order, planned for manufacturing, already committed to existing orders, and forecasted. These requirements are specific to each company and each company location and change with the date.
- **Organization the MRP: MRP** suggestions for materials that you consider critical, expedited, and delayed.
- **Widespread the Orders:** Delineate the materials for the manufacturing orders, purchase orders, and other reporting requirements.



The MRP performs are based on the data inputs. The above diagram shows that, the data input includes:

- **Client Orders:** This refers to the specific information you receive from customers and includes one-offs and regular ordering patterns.
- **Estimate Demand:** This is anestimate from the marketplace about how much probable demand there will be for a product or service. It is based on historic accounting and current trend analysis.
- **Master Production Schedule (MPS):** Both forecast demand and customer orders feed into the master production schedule. The MPS is a plan that a company develops for production, staffing, or inventory. It is the production future plan that includes the quantities you need to produce the products in a specified time period. It also includes inventory costs, production costs, inventory information, supply, lot size, lead time, and development capacity.
- **Bill of Materials (BOM):** Also called a product structure file, this includes the details and quantities of the raw materials, assemblies, and components that make up each end product.
- **Inventory Records:** These are the raw materials and the completed products that you either have on hand or have already ordered.
- After MRP receives the input, it generates the output. There are four main outputs. These include:

- **Purchase Orders (PO):** This is the recommended purchasing schedule that includes the order you give to suppliers to send the materials. The PO includes a schedule with quantities and starts and finish dates to meet the MPS.
- **Material Plan:** This details the raw materials, assembly items, and component needs to make the end products with quantities and dates. We recommend that you use attribute settings to set the time fences and to firm orders.
- **Work Orders:** This details the work that goes into producing the end product, including which departments are responsible for what part, what materials are necessary, and what the start and end dates are.
- **Reports:** MRP generates primary and secondary reports.
- MRP is about putting mathematical controls into place using formulas that yield optimal results. MRP is an optimal control problem that calculates the initial conditions, the dynamics, the constraints, and the objective. The variables are the local inventory, the order size, the local demand, the fixed order costs, the variable order costs, and the local inventory holding costs. MRP comprises many methods and calculations. To find the order quantities, one can use any number of methods. Three of the most popular are:
- **Dynamic LotSizing:** In inventory theory, this model assumes that the demand for product fluctuates over time. This complex algorithm generalizes the economic order quantity model. It requires dynamic programming to perform, so mathematicians also developed the following models.
- **Silver-Meal Heuristic:** This is an inventory control algorithm, also called least period cost that minimizes the total relevant cost per unit of time. In other words, you use it to calculate the production quantities needed to meet the operational requirements at the lowest cost possible.
- **Least-Unit-Cost (LUC) Heuristic:** Although quite similar to Silver-Meal, LUC chooses the period in the future based on average cost per unit rather than on average cost per period.

CAPACITY PLANNING STRATEGY

Capacity planning strategy involves the process used to determine the resources manufacturers need to meet the demand for their products and services. The level of capacity directly relates to the amount of output in the form of goods and services manufacturers can produce to satisfy customer demand. Capacity planning strategies can guide manufacturers on how much raw materials, equipment, labor, and investment facilities need to be acquired over a period of time to meet the future demand. Where there is a lack of capacity planning, customers' needs are not served promptly and these customers may be lost to competition. A good capacity planning strategy helps adequately plan manufacturing resources. Excess capacity means the manufacturer's money is being spent inefficiently, and this could have been invested elsewhere for a profit instead. On the other hand, low capacity indicates the inability of the manufacturer to produce as per what the customer wants at a particular period of time.

Capacity Planning for ManufacturingProcess involved: A good process plan can help manufacturers optimally configure the system to ensure SLAs are met while only investing the necessary resources needed to get the work completed. This helps manufacturers enhance the production process and make them prepared for the future.

1.Understanding the service level requirements

- The first step is to break down the manufacturing job or production order into various categories.
- This can help create a structured flow to quantify the exact user expectations. It includes establishing workloads, determining the unit of work, and setting service levels.
- Manufacturers can then decide how each work task will be organized based on labor availability, or the complexity of work involved.
- Finally, a "service level agreement" lays out the acceptable parameters between the manufacturer and the consumer.

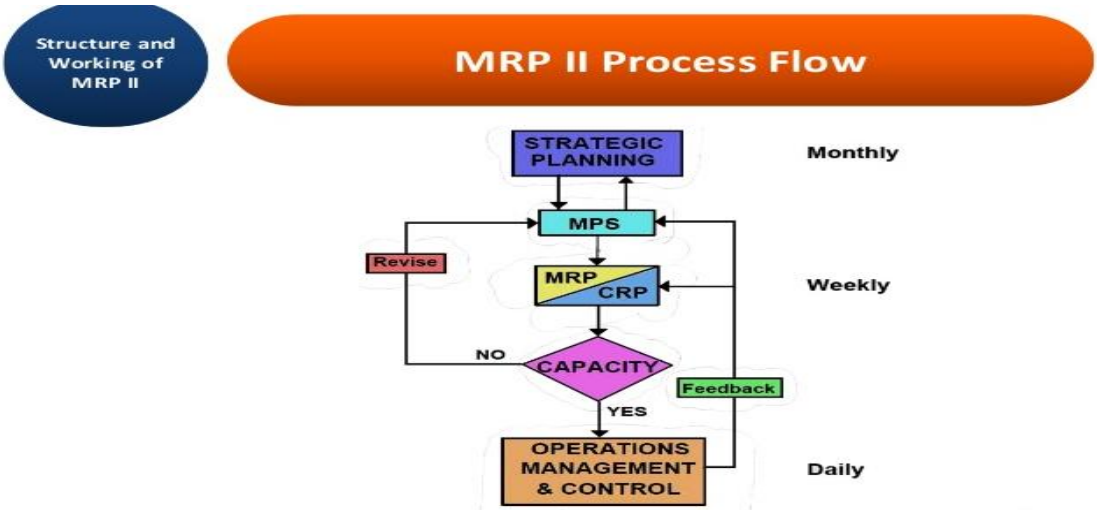
2. Estimating and analyzing the current capacity

The next step is for manufacturers to take a profounder estimate of the existing production schedule to evaluate the final capacity. Manufacturers usually analyze separate workloads and follow these steps:

- Compare the measurements of specific workloads mentioned in the SLA with the overall job objectives.
- Evaluate the actual usage of multiple resources across the system
- Checked the resource use for each workload and then decide which of these consume more manpower.
- Finally calculate the most time-consuming aspects of each workload to arrive at the response time taken for each job.

3. Planning for future requirements and demand

- Once the current capacity is analyzed, manufacturers can then plan for future demand.
- Accurately forecasting the processing requirements, a system or process overload on the manufacturing set up can be avoided.
- Manufacturers would need a clear estimation of the actual incoming work that is expected in the coming few months.
- Lastly, they can configure the most optimal system needed to satisfy these requirements over the forecasted period of time.



2. NEED OF THE STUDY

- To study and analyse the material requirement planning in partnership with capacity requirement planning to increase the productivity.
- To satisfy the future hike demands by adding the capacity and altering the productivity function, without any shortages.
- To find the optimal capacity of the facility so that cost of under capacity and over-capacity is minimum.
- To maintain the initial investment low and achieve lower break-even volume.
- To analyse the impact of constraints and bottlenecks on a process and consider the theory of Constraints.

3. OBJECTIVES OF THE STUDY

- To study in detail about the Capacity Requirement Planning (CRP) in the Electric Resistance Welding (ERW) section at Tube Products of India
- To study the material requirements as per the collection plansand shortage plans.
- To make a coverage plans for the Parts Blocking & unblocking in order to control the excess material & without collection plan material inward.
- To develop and maintain a capacity management plan to meet the future demands without any shortages.
- To analyse the impact of variances on capacity and to take proactive measures to improve performance.
- To formulate the strategies in capacity planning to anticipate the hike in demand by increasing the productivity.

4. REVIEW OF LITERATURE

YF Hung, CC Huang, YYeh - Computers & Industrial Engineering, 2013 – Elsevier: In a make-to-stock (MTS) manufacturing environment, material requirement planning (MRP), checking the capacity feasibility of a master production schedule (MPS) requires capacity requirement planning (CRP) that can be simply calculated. The time space of an order is the time interval from its ready date to its due date. In a make-to-order (MTO) engineering environment, the CRP method used to check whether a set of orders with different time windows can be scheduled for timely completion. This corporate-level CRP problem has long perplexed MTO contract manufacturers, such as those in the fashion industry. The study therefore develops an efficient and effective CRP approach that considers orders with variable time windows. Real-time capacity feasibility can be checked on both the corporate planning and detailed operational scheduling levels by applying the preemptive earliest due date (PEDD) rule to a single machine problem.

ML Junior, MG Filho - Production Planning & Control, 2012 - Taylor & Francis: the aim of the study is to determine whether the gaps identified by Guide on the subject with respect to the main complicating characteristics of remanufacturing have been fulfilled; to classify the literature based on an suitable structure to obtain a better understanding of the subject identifying sources of future research and to provide a useful source for scholars and practitioners.It is found that no studies deal simultaneously with all of the complicating characteristics, and that more practical research is needed. also found that the lack studies regarding forecasting and aggregate planning considering disassembly of returned products, material matching restrictions or stochastic routings, master production scheduling considering material matching restrictions or stochastic routings, ordering system and capacity planning considering material matching restrictions and inventory control and management considering stochastic routings.

O Ceryan, Y Koren - CIRP annals, 2009: When planning for a new manufacturing system to produce several products over a planning time, firms usually face an important decision regarding how to select the optimal quantity and portfolio of product-dedicated and flexible capacities. Flexible systems may alleviate the unfavorable effects of demand uncertainties however; they require higher investment costs compared to dedicated systems. This paper, helps to frame the optimal capacity selection problem and perform numerical studies to provide insights on how these decisions are affected by the investment costs, product revenues, demand forecast scenarios and volatilities over the planning period.

MG Huang, PL Chang, YC Chou - International Journal of, 2008 - Taylor & Francis: For those products that are heavily competitive in the marketplace, demand volatility and unpredictability have been growing. the study aims to develop a real option approach-based forecasting model for predicting demand through the upcoming planning horizon for products with high random volatility on demand. The actual option approach can effectively deal with the long-term trends and random variation involved in a given demand stochastic diffusion process. Moreover, this study suggests taking Monte Carlo simulation as a numerical method to solve the demand-forecasting model. Monte Carlo simulation not only can accurately approximate almost any type of stochastic processes, but also can competently handle the path-dependent relationship existing between successive demands. Then, these demand forecasts are used to determine the provisioned smoothing capacity during the upcoming planning horizon. The study also proposes several effective and practical smoothing capacity-planning approaches in accordance with the specified production strategy. Based on the example, the integrated planning approach can obtain a plausible result.

A Tenhiälä - Journal of Operations Management, 2011 – Elsevier: Although the reliability of production plans is crucial for the performance of business organization, most practitioners use considerably simpler planning methods than what is recommended in the operations management literature. This paper employs the contingency theory of organizations to explain the gap between the practice and the academic models of production planning. It is found from the research setting is used to test the contingency hypothesis against a conservative hypothesis that expects the most sophisticated planning techniques to always be most effective. Multisource data from the machine manufacturing industry support the contingency hypothesis and reject the universalistic hypothesis. The results have several managerial implications, that they elaborate how classic concepts in organization theory can bring practically relevant insights to operations management research.

C Martínez-Costa, M Mas-Machuca, EBenedito: The objectives of the study are to describe and analyze the strategic capacity planning problems; and to review the mathematical programming models proposed in the literature. A structured overview of the main strategic capacity planning mathematical programming models is given. A classification of the models is proposed and their main characteristics, solution procedures and industrial applications are identified. Based on the review of the existing studies, a framework for capacity planning is presented, consisting of three main phases: problem definition (considering context, characteristics of the manufacturing system and specific factors that could influence the decision-making process), model design and solution procedure. Some future lines of research are suggested. This will help both practitioners and academic researchers in developing useful models and processes to aid decision-making in strategic capacity planning.

5. RESEARCH METHODOLOGY

RESEARCH DESIGN:
Research design is the framework of research methods and techniques chosen by a researcher.

Analytical research method has been followed to conduct the research study.Analytical research is a specific type of research that involves critical thoughtful skills and the evaluation of facts and information relative to the research being conducted.

The research carried on Capacity Resource Planning (CRP) is an Analytical Research which is of the Quantitative type. This type of research method requires quantifiable data involving numerical and statistical explanations. Quantitative Research is used to quantify the problem by way of generating numerical data or data that can be transformed into usable statistics. Research is used to quantify attitudes, opinions, behaviors, and other defined variablesand generalize results from a larger sample population. Quantitative Study uses measurable data to formulate facts and uncover patterns in research. One of the most important purposes of this research is to evaluate and develop the specific manufacturing system in the company. A real time study is the fundamental of this report, following by analysis of the particular problems. This report is focused on a specific production process of a real factory manufacturing system, aims to evaluate and develop the production system by analyzing the current problems; consequently, this thesis report consists of both scientific methods and research methods as in the following sections.

DATA COLLECTION METHODS:
There are basically two main sources by which the researcher can collect data; the primary and secondary source. Primary data source is collects information either through observations, interviews, questionnaires, and then uses this data for analysis. Secondary data on the other hand is when the research uses data that was previously available in the form of websites, Journal, reports etc.,

Sources of data:
- ✓ ERP (Oracle)
- ✓ Manual book of company production
- ✓ Company records
- ✓ Annual operations data reports
- ✓ Production planning techniques

TOOLS AND TECHNIQUES USED FOR DATA ANALYSIS

The data collected from the various sources are digitalized to a basic spreadsheet, Microsoft Excel. This was later imported into the followingstatistical techniques (Traditional Methods).

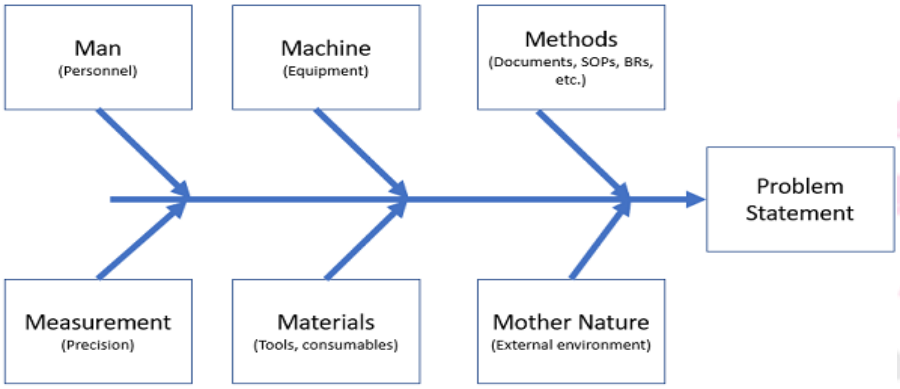
TYPES OF QUALITY TOOLS

- ✓ Cause and effect diagram
- ✓ Scatter diagram
- ✓ Pareto chart
- ✓ Check sheet
- ✓ Histogram
- ✓ Control chart
- ✓ Flow chart

Of these seven quality tools, Cause and Effect diagram and Scatter diagram have been used to interpret the results.

CAUSE AND EFFECT DIAGRAM:

Fishbone diagrams also called as herringbone diagrams, cause-and-effect diagrams, or Fishi-kawa are causal diagrams created by Kaoru Ishikawa that show the potential causes of a specific event. The uses of the Ishikawa diagram are product design and quality defect prevention to identify potential factors causing an overall effect. Causes are usually grouped into major categories to identify and classify these sources of variation.



Defect are shown as the fish's head, facing to the right, with the cause extending to the left as fishbones; the ribs branch off the backbone for major causes, with sub-branches for root-causes, to as many levels as required. Ishikawa diagrams were popularized in the 1960s by Kaoru Ishikawa, who pioneered quality management processes in the Kawasaki shipyards, and in the process became one of the founding fathers of modern management.Fishbone diagram because of its shape, similar to the side view of a fish skeleton.Mazda Motors famously used an Ishikawa diagram in the development of the Miata (MX5) sports car.

The 5 M's (used in manufacturing

Originating with lean manufacturing and the Toyota Production System, the 5M's is one of the most common frameworks for root-cause analysis

- ✓ Man / mind power (physical or knowledge work, includes: kaizens,suggestions)
- ✓ Machine (equipment, technology)
- ✓ Material (consist of raw material, consumables etc.,)
- ✓ Method (process)
- ✓ Measurement / medium (inspection, environment

These have been expanded by some to include an additional three, and are referred to as the 8 M's:

- ✓ Mission / mother nature (purpose, environment)
- ✓ Management / money power (leadership)
- ✓ Maintenance

PROCEDURE:

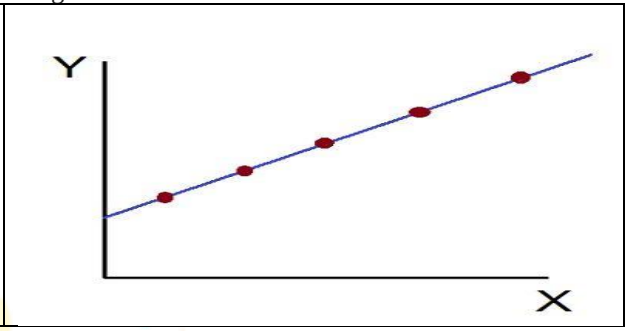
- ✓ Agree on a problem statement (effect). Write it at the center right of the flipchart or whiteboard. Draw a box around it and draw a horizontal arrow running to it.
- ✓ Brainstorm the major categories of causes of the problem.
- ✓ Write the categories of causes as branches from the main arrow.
- ✓ Brainstorm all the possible causes of the problem. Ask "Why does this happen?" the facilitator writes it as a branch from the appropriate category. Causes can be written in several places if they relate to several categories.
- ✓ Write sub-causes branching off the causes. Remain to ask "Why?" and to create deeper levels of causes. Layers of branches indicate causal relationships.
- ✓ When the group runs out of ideas, focus attention to places on the chart where ideas are few.

SCATTER DIAGRAM:

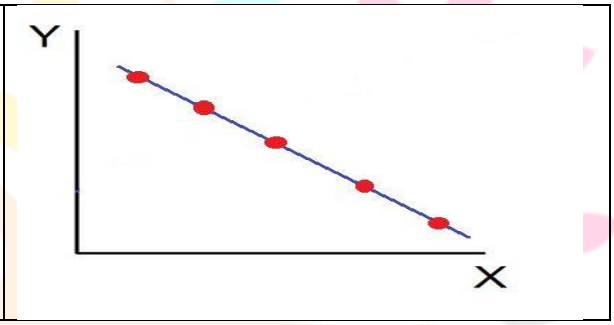
To study the correlation between two variables The Scatter Diagram Method is the method is used, wherein the values the pair of a variable is plotted on a graph in the form of dots thereby obtaining as many points as the number of observations. Then by looking at the scatter of numerous points, the degree of correlation is ascertained.The degree to which the variables are related to each other depends on the way in which the points are scattered over the chart. The more the points plotted are scattered over the chart, the lesser is the degree of correlation between the variables. The more the points plotted are closer to the line indicates that, the higher is the degree of correlation. The degree of correlation is denoted by **"r".**

The following types of scatter diagrams representsthe degree of correlation between variable X and variable Y.

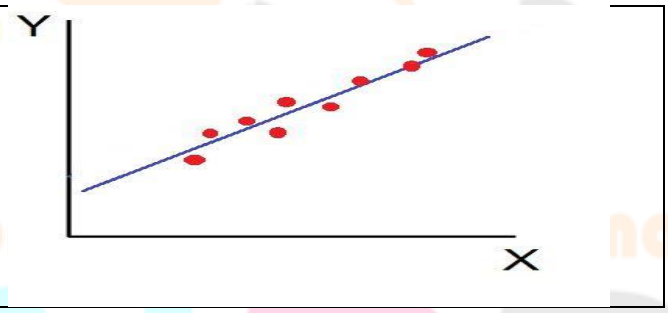
1.Correclation: All the points lie on the straight line rising from the lower left-hand corner to the upper right-hand corner.



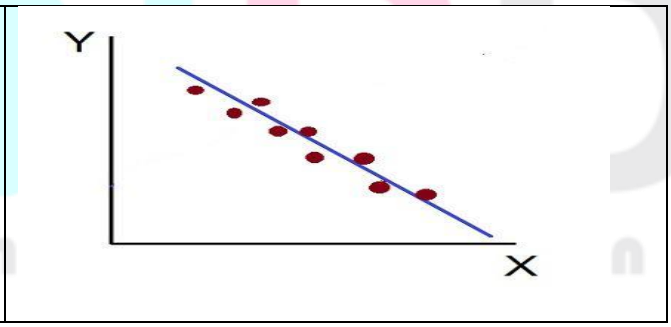
2. Negative Correlation (r = -1): When all the points lie on a straight line falling from the upper left-hand corner to the lower right-hand corner, the variables are said to be negatively correlated.



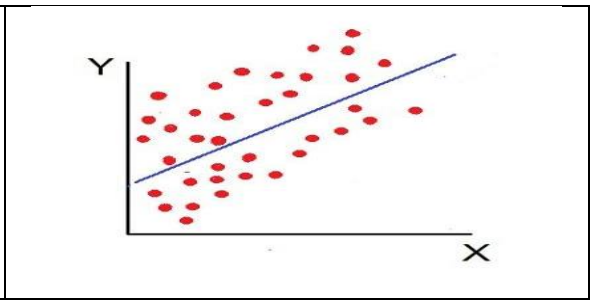
3.High Degree of +Ve Correlation (r= + High): The degree of correlation is high when the points plotted fall under the narrow band and is said to be positive when these show the rising tendency from the lower left-hand corner to the upper right-hand corner.

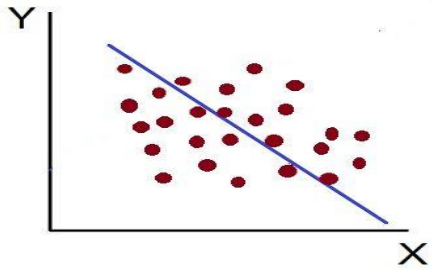


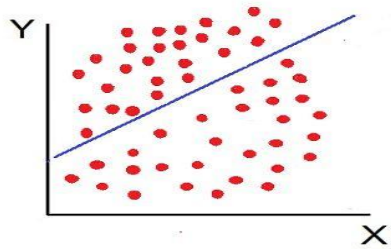
4.High Degree of –Ve Correlation (r= – High): The degree of negative correlation is high when the point plotted fall in the narrow band and show the declining tendency from the upper left-hand corner to the lower right-hand corner.



5.Low degree of +Ve Correlation (r= + Low): The correlation between the variables is said to be low but positive when the points are highly scattered over the graph and show a rising tendency from the lower left-hand corner to the upper right-hand corner.



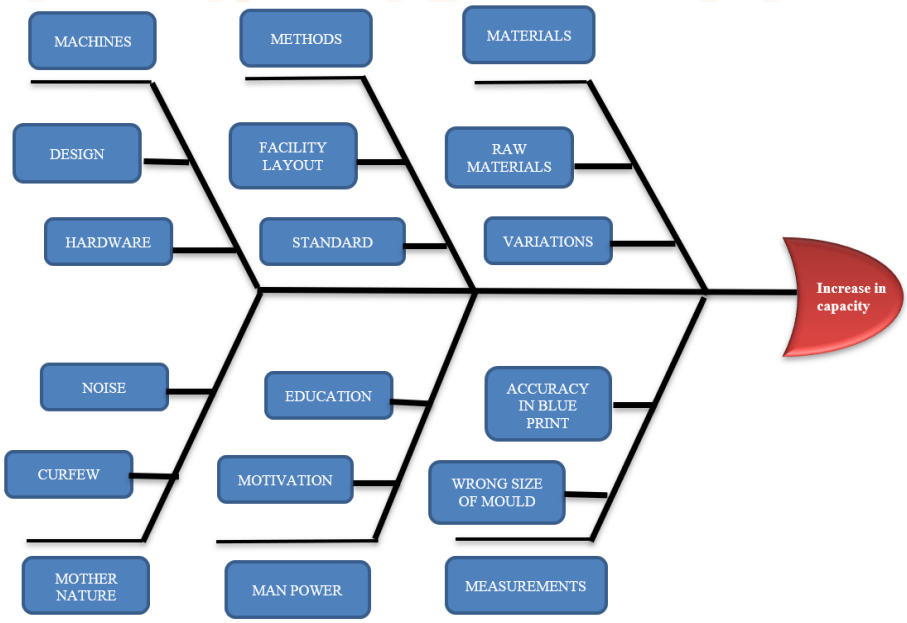
6. Low Degree of –Ve Correlation (r= + Low): The degree of correlation is low and negative when the points are scattered over the graph and the show the falling tendency from the upper left-hand corner to the lower right-hand corner.	

7. No Correlation (r= 0): The variable is said to be unrelated when the points are haphazardly scattered over the graph and do not show any specific pattern. Here the correlation is absent and hence **r = 0**.	

Thus, the scatter diagram method is the simplest device to study the degree of relationship between the variables by plotted the dots for each pair of variable values given. The chart on which the dots are plotted is called as **Dotogram**.

6. RESULTS AND DISCUSSIONS

01. CAUSE AND EFFECT DIAGRAM:



OBSERVATION:

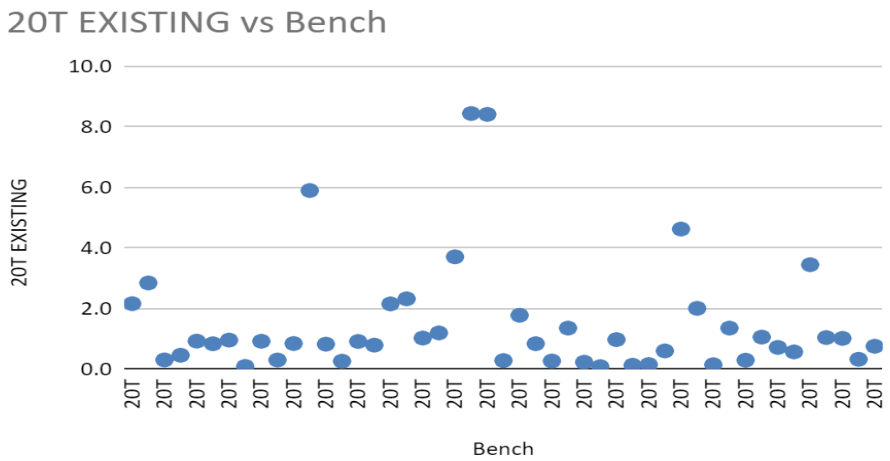
- ✓ Machinesand environment are considered to be the primary cause. To impose a new plan, design and hardware of the machines are to be considered and modified accurately according to the given norms.
- ✓ According to the methods, the facility layout should be modified to the capacity increment.
- ✓ Simultaneously, the standardization must be taken into account so that disparity must not take place in consideration with the quality of the product.

- ✓ Manpower is considered to be the important element for the manufacturing industry. When implementing the new plan, only 75% is been achieved. Rest 25% is under the union employees. The inclusive education of the plan should be given and to motivate them by increasing their wages.
- ✓ When coming to materials, complete cutting of the raw materials will be changed. Diameters should be changed accordingly with at-most accuracy because of the upcoming process which will be a long haul.
- ✓ Measurements are considered to be the one of the most important criteria to achieve the goal. When implementing the new plan,the accuracy of the blue print is taken into account. If suppose, wrong mold is inserted, there will be major defectives in the finished products.

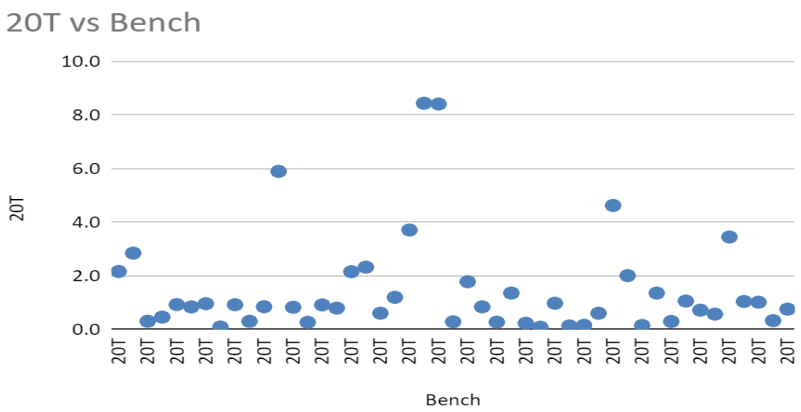
If all these 7M's are examined, the increase in capacity and the profit margin for the new plan can be achieved. Analyzingfor the new plan is performed theoretically using the Ishikawa diagram. But practically, to implement the new plan the capacity is analyzed and evaluated by deriving the formula using spreadsheets, Microsoft Excel and plotted with the help of statistical tool, The Scatter diagram.

ANALYZATION USING SCATTERS DIAGRAM:

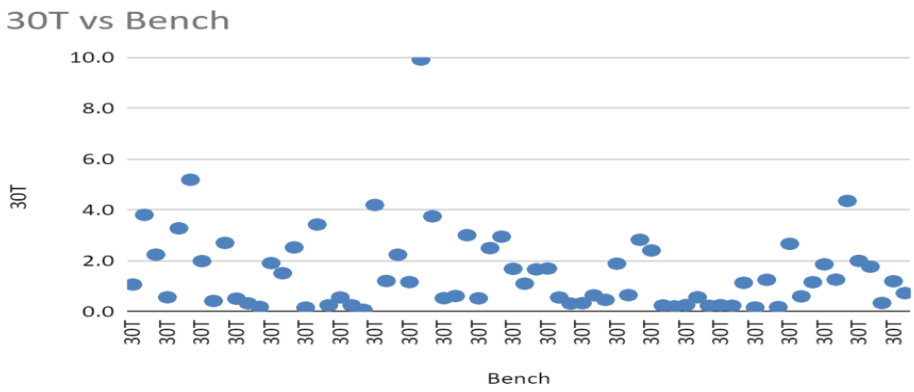
1). 20T EXSISTING SHIFTS REPRESENTATION



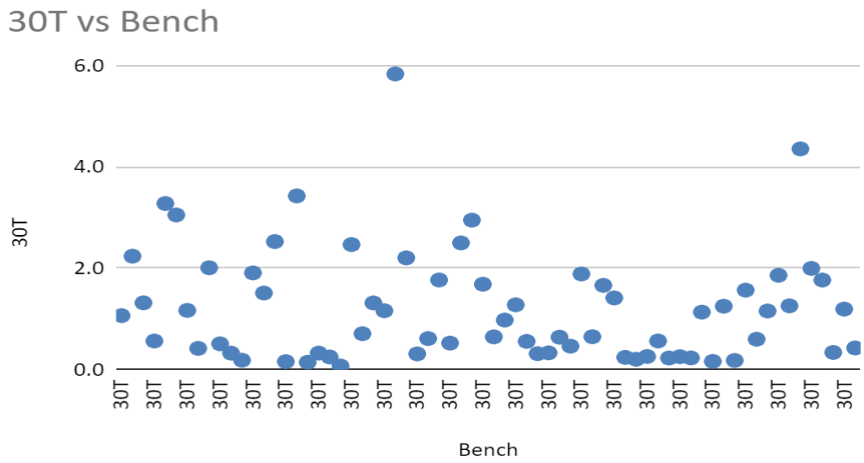
20T REVISED SHIFTS REPRESENTATION



2). 30T EXISTING SHIFTS REPRESENTATION



30T REVISED SHIFTS REPRESENTATION:



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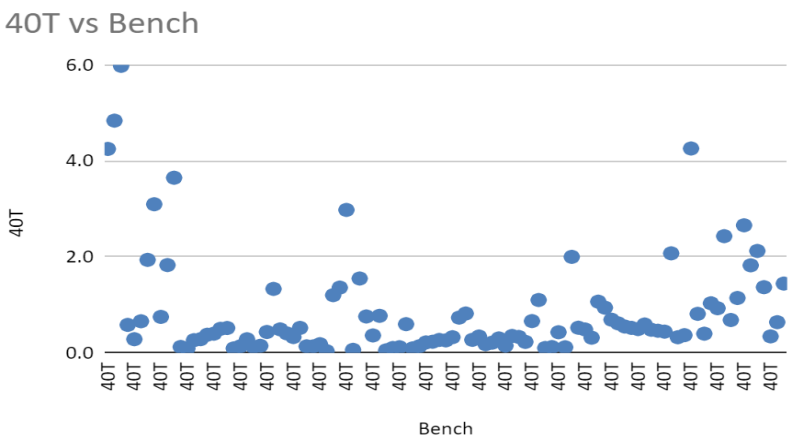
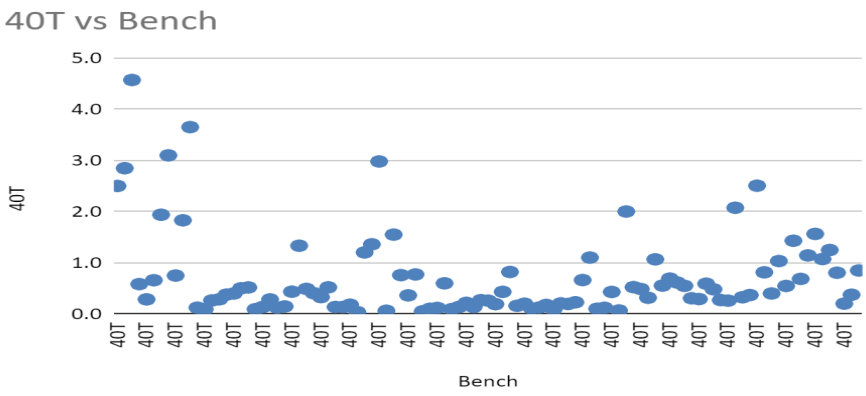
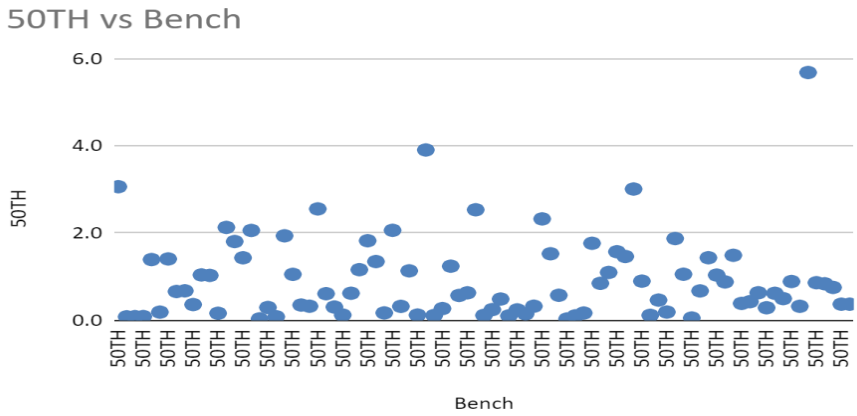


40T REVISED SHIFTS REPRESENTATION:



4). 50TH EXISTING SHIFTS REPRESENTATION:



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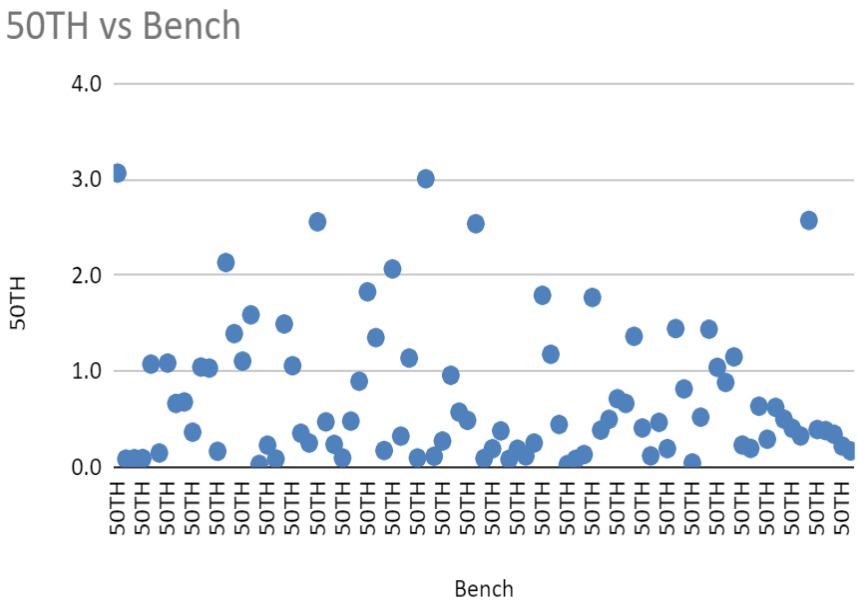

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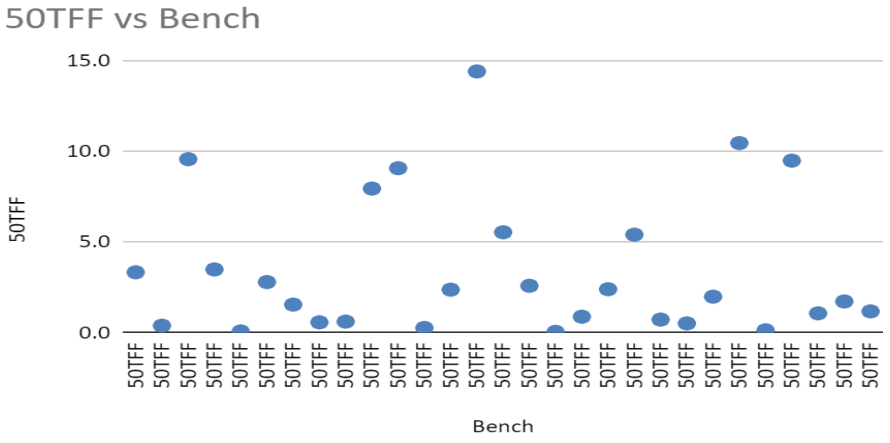

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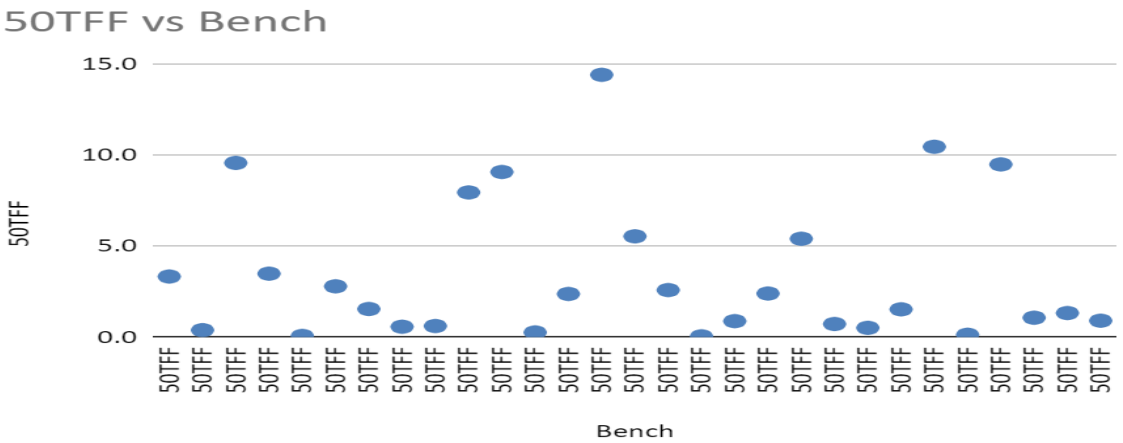
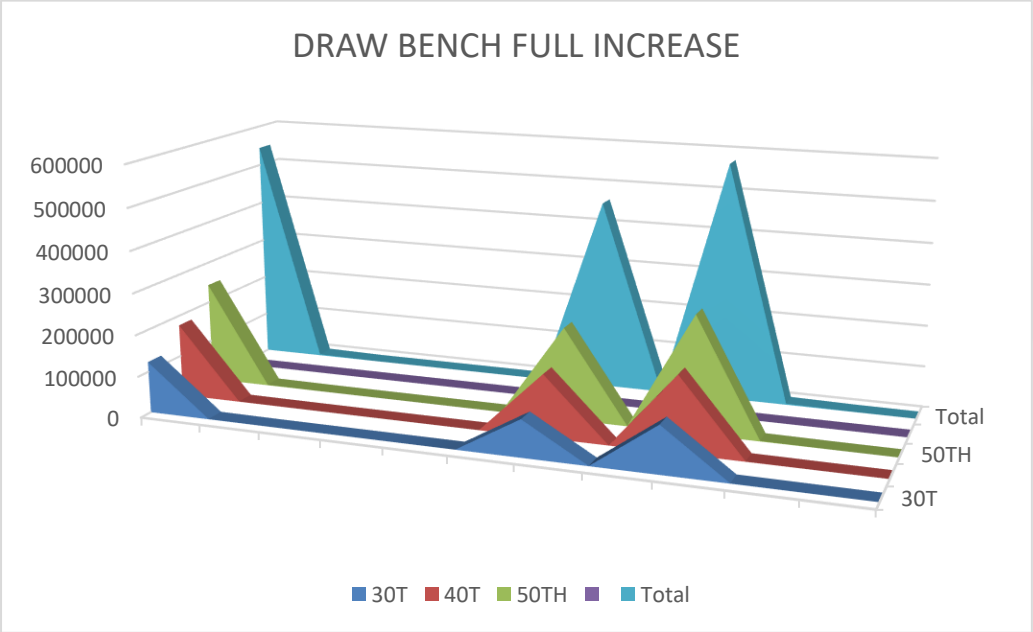
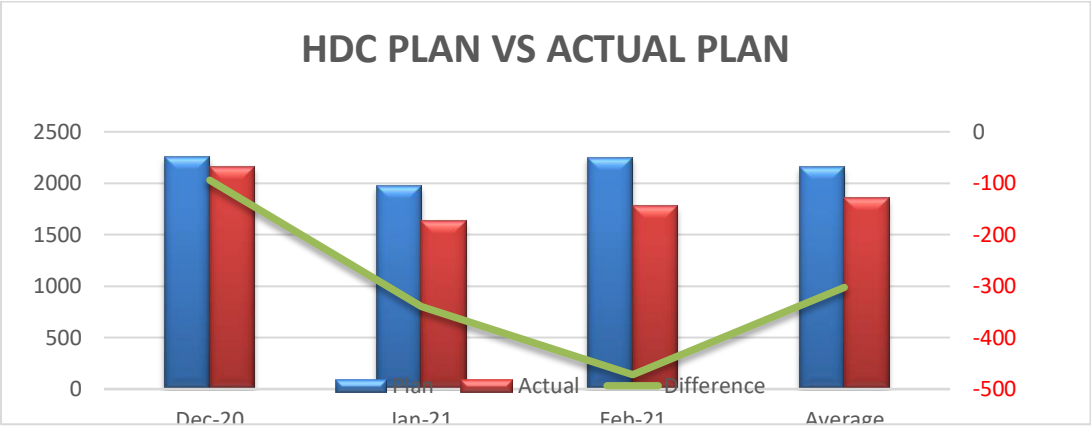


6). SUMMARY OF ANALYSIS:



HDC PLAN VS ACTUAL PLAN WITH REFERENCE TO 3 MONTH DATA:



7. SUMMARY OF FINDINGS

- ✓ From the study it is been found that the aim to improve the production by increasing the capacity is been attained to 75%.
- ✓ The observation was made from the scatter diagrams of various benches showing that the shifts required for the new plan is been matched with the existing data.
- ✓ The increase in productivity can be attained if the production planning performs accordingly to the revised norms.
- ✓ There is a possibility to increase the capacity only for 30T, 40T, 50TH benches by enabling the number of pulls to maximum 3 to all the three passes.
- ✓ Nevertheless,for 20T & 50TTH benches, the design should be changed systematically as well as manually to the revised norms.
- ✓ The finest part of the new plan is that even if we increase the capacity, the productivity can be increased with the required shifts.

8. SUGGESTIONS

From the study:

- ✓ The standard performance methods and standard cycle time involved can be established.
- ✓ Optimally, equipment and manpower usage have to be examined.
- ✓ Develop the most practical, economic, and effective Method, having due regard to all contingent circumstances.

General suggestions:

- ✓ For the manufacturing industry, man power is one of the most important criteria to attain the standardization of the industry. If the new plan is about to implement out of 100% only 75% can be achieved. Remaining 25% is under the union employees.
- ✓ The remaining percentage can be attained by encouraging the employees by increasing their wages.

9. CONCLUSION

According to the company, the Electric Resistance Welding section has high value of manufacturing the rolls which is the one of the major sections of their daily production line. The specific process to improve the capacity is been studies analyzed and then listed several improvements and suggestions are given. All operations are limited in terms of capacity. Therefore, we should be able to achieve organizational goals and objectives related to the supply chains by planning and controlling the capacity of these operations. Therefore, capacity planning and control is an issue which every operation is faced with as well as it is concerned enable that there are some kinds of balance between the demand placed on an operation and its ability to satisfy that demand. Whereas we know that there is a close affiliation between planning and control and according to many experts, the planning system without control is meaningless because managers use planning to smooth the activities path to achieve the organizational goals and control is a process that is used to determine if the organization has achieved its goals as well as they say that no system without monitoring and control can reach their full capacity. The application of new tools and techniques associatedwith work studyand method studywill reduce the machine idle time, increase the productivity. The design of new plan and fixture will reduce the losses and bending of nails which will improve the quality and reduce the production cycle time. The study also examined the problems associated with production from the point of a work study.

On an overview, it can be concluded that, in future studies, it is recommended to consider capacity control and in fact, see these two views together and consider capacity planning and control in various fields and modeling in this field as well as implement models in a large area so that the results will have high credit and can be applied in issues of the day and this will potentially ensure the company's success in the future.

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