IMPROVING OPERATIONS MANAGEMENT IN HAIDERY BOARDS

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BUSINESS PROJECT ACCEPTANCE CERTIFICATE

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AUTHOR'S DECLARATION

I Ammar Haider hereby state that my MS thesis titled Feasibility Study of Urea Formaldehyde Plant" is my own work and has not been submitted previously by me for taking any degree from National University of Sciences and Technology, Islamabad or anywhere else in the country/ world. At any time if my statement is found to be incorrect, even after graduation the university has the right to withdraw my MS degree.

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Date: 04/04/2023

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ABSTRACT

Haidery Boards is founded in 1994. It's a production and manufacturing business. It's a private company with objective of maximizing profit. It manufactures different type of Boards. Since the day it was founded, Haidery Boards is running on the same old operations and processes. No bigger change in operations has taken place.

This project aims to improve the operations management of a manufacturing plant by identifying and addressing inefficiencies in its production processes. The project is motivated by the need to reduce costs, improve productivity, and maintain high levels of quality in the manufacturing processes.

The project is divided into several stages. Firstly, a detailed analysis of the existing processes is conducted to identify areas for improvement. This includes a review of the existing production schedule and quality control processes. Secondly, various operations management techniques, such as forecasting and work measurement are applied to identify and implement improvements to the processes.

The project aims to demonstrate how an effective operations management strategy can lead to significant improvements in efficiency, productivity, and quality, and help the plant maintain a competitive edge in the market.

Overall, this project represents an important contribution to the field of operations management, and the findings will be of interest to managers, academics, and researchers who are interested in improving manufacturing operations in a variety of industries.

Chapter 1

1 Introduction

Haidery Boards is a wood processing industry. Its mission is to provide superior quality products and services to its consumers in the construction industry, dealers and suppliers, utilizing state of the art machinery, technology and processes.

Haidery Board's journey began 27years ago in 1994. Since then, it is evolving and transforming into a technologically advanced particle board manufacturing company in Pakistan. Its products are widely used in kitchens, furniture, wardrobes, building materials and much more. Haidery Boards aim to provide quality boards to the clients while simultaneously fostering good relations with government bodies, professionals, contractors and suppliers.

Haidery Boards manufactures three types of boards at one of its manufacturing units in Hattar, Pakistan:

- Chip Board
- Vin Board
- High pressure Lamination

Haidery Boards commits to cater all kind of client needs in terms of quality. It produces high quality but expensive boards, and medium quality but comparatively cheaper boards. All three products are of different quality.

Three different units are being run for each product. Chipboard is the main product which is sold in raw form and is also further processed to manufacture Lamination and Vin board.

1.1 Products

1. **Chipboard**

Chipboard, also known as particleboard, is a type of engineered wood product made from wood chips, sawmill shavings, and other wood scraps that are compressed together with a resin binder

under heat and pressure. The resulting material is a dense and strong panel that can be used in a variety of applications, such as furniture, cabinetry, flooring, and construction.

Chipboard is known for its affordability and versatility, and is often used as a more cost-effective alternative to solid wood. It comes in different grades, with higher grades being more durable and able to withstand heavier loads.

Manufacturing Process

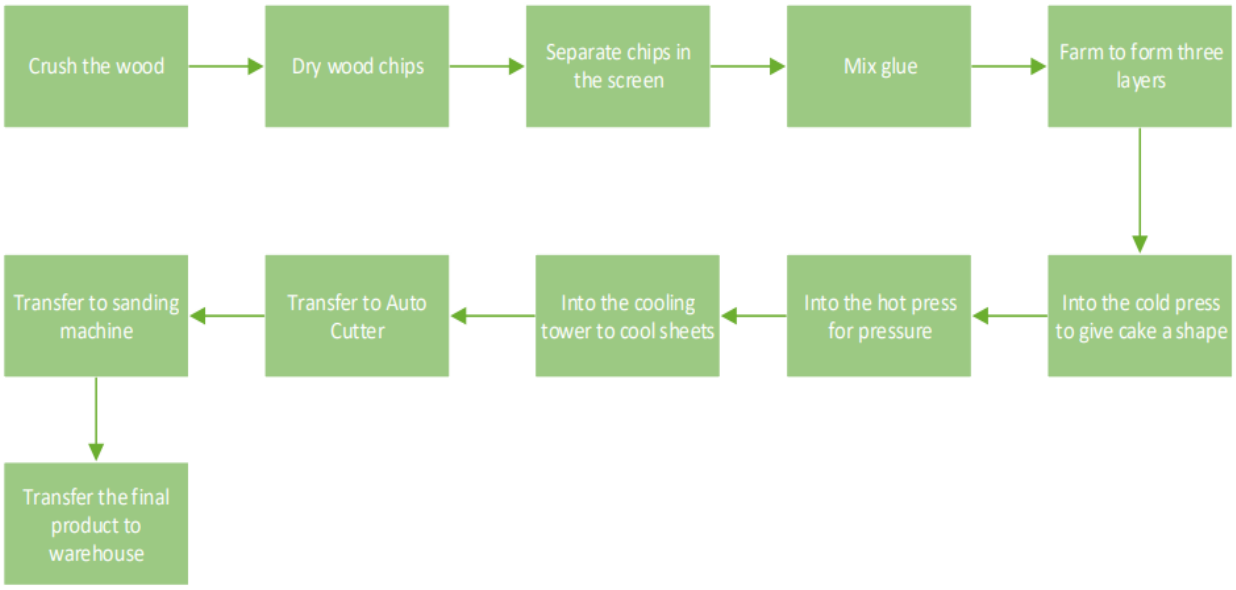

Figure 1 Summarized Chipboard process

Figure 2Chipboard

Raw materials

- Wood
- Glue

2. Lamination

Chipboard manufactured is further transferred to lamination unit for paper pressing. Hot press is used for paper pressing. Paper is imported from China so proper stock inventory is required so that paper is ordered on time.

Raw Material:

- Chipboard
- Paper

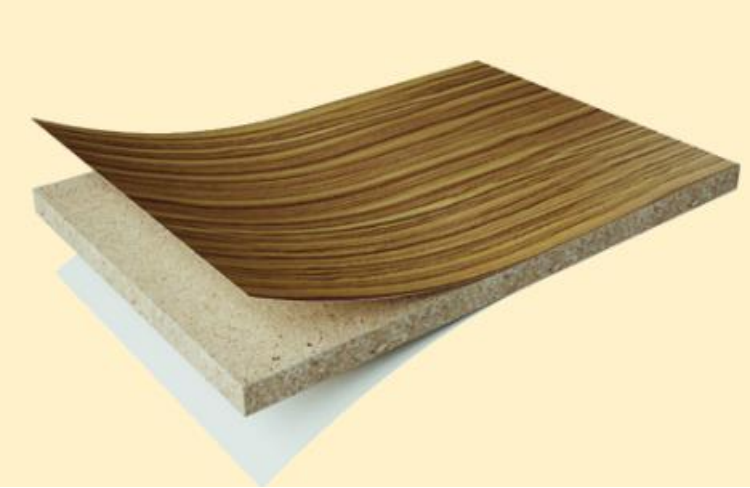

Figure 3 Lamination

3. Vin Board

Chipboard is also used in manufacturing of Vin board. A glue roller machine and hot press are used for further processing. Vineer is imported from China. Glue and Maida are purchased locally.

Raw material

- Chipboard
- Vineer
- Glue

4. Shuttering Ply

Beside Chipboard, Haidery Boards also manufacture Shuttering ply. It has a separate unit. It is mostly used for construction purposes.

Shuttering plywood, also known as formwork plywood, is a type of plywood that is specifically designed for use in concrete formwork or molds. It is made by bonding multiple layers of thin wood veneers together, with each layer oriented at a right angle to the adjacent layers, to provide excellent strength and dimensional stability.

The manufacturing process for shuttering plywood involves the following steps:

- Selection of raw materials: The raw materials used for making shuttering plywood are typically hardwoods such as birch or eucalyptus. The logs are carefully selected based on their quality and suitability for the manufacturing process.
- Peeling and drying: The logs are then peeled into thin veneers using a rotary lathe. The veneers are then dried to remove excess moisture and to ensure uniformity.
- Gluing and pressing: The dried veneers are coated with an adhesive and then stacked together with each layer oriented at a right angle to the adjacent layers. The stack is then placed in a hydraulic press and compressed under high pressure and temperature to create a strong bond between the layers.
- Finishing: After the pressing process, the plywood is trimmed to size and sanded to a smooth finish. The edges of the plywood are also coated with a waterproof sealant to prevent moisture from penetrating the wood.
- Inspection and packaging: The finished plywood is inspected for defects such as knots, cracks, or voids, and sorted into different grades based on their quality. The plywood is then packaged and shipped to customers.

Overall, the manufacturing process for shuttering plywood requires careful selection of raw materials, precise peeling and drying, strong adhesive bonding, and proper finishing to ensure high-quality and durable plywood that is suitable for concrete formwork.

Above mentioned is the overall process for manufacturing of shuttering ply. It is mostly labor oriented. So, productivity can be increased by identifying the bottle neck of the process and trying to improve it.

1.2 Current System

Chipboard Unit

For every industry sale's is very important part as it's very important to keep up with the demand of customers. If a company can't meet the demand of customers it will lead to dissatisfaction of customer which will cause the loss of customer and spread the negative image of the firm. Whereas if production is more than demand it will lead to increase in inventory levels, cost etc. In Haidery Boards currently there is no concept of forecasting on the basis of past data. Haidery Boards produce and run shifts on basis of pending orders by the end of last week of current month. If there are orders pending, two shifts will be carried on otherwise will be shifted to one shift. Therefore, it costs a lot to plan at the last moment. Management is not sure that whether next month they have to run one shift or two shifts. It is decided in the last week of month which cause hiring and firing employes at the last moment which is sometimes very difficult task. Further, arranging raw materials at last moment is too hectic for example shifting from single shift to double shift means to double the inventory level. If everything is planned properly, demand is forecasted, inventory can be planned in efficient way. So, currently there is no systematic way of planning of production planning depending on the demand.

Further, new plant has been erected 5-6 years ago and since than no major machinery change is done. Plant is designed according to demand of that time. As every year demand is increasing so several strategies are required to be considered to increase the production capacity of plant.

Moreover, on daily basis weight of board is being measured as its very important to keep up with the market standard. If weight is more than average it means that more raw material is being used which lead to extra cost. If weight is below the standard, this means that it might lead to customer dissatisfaction.

Shuttering Ply unit

Shuttering ply is a different product compared to chipboard therefore is has a separate unit. Chipboard unit is fully automated with operators just on control units to see that everything is

going well. Whereas, Shuttering ply is more labor oriented. Its manufacturing and quality are dependent upon labor. Right now, labor has set their own standard of producing ply per day. According to observation this productivity can be improved.

1.3 Objective of the project

1. Forecasting demand for the year 2023 as it will help Haidery Boards to plan their production, optimize their inventory, and manage their supply chain effectively. By forecasting the demand for their products, Haidery Boards can:
    - Plan production: Haidery Boards can plan production schedules based on the expected demand for their products. This will enable to produce the right quantity of goods at the right time, ensuring that they have enough inventory to meet customer demand without overproducing and creating excess inventory.
    - Optimize inventory: Accurate demand forecasting will enable to optimize their inventory levels. They can maintain an optimal balance between excess inventory and stockouts, reducing the risk of lost sales and minimizing inventory holding costs.
    - Manage the supply chain: Demand forecasting will allow Haidery Boards to manage their supply chain effectively. They can work closely with their suppliers to ensure that they have the necessary raw materials and components on hand to meet demand, reducing the risk of delays or disruptions.
    - Plan marketing and sales strategies: Forecasting demand will help Haidery Boards to plan their marketing and sales strategies. They can tailor their advertising and promotional activities to match the anticipated demand for their products, helping to maximize sales and profitability.
2. Proposing different options to increase the capacity for year 2024:
    - Meeting increased demand: Increasing manufacturing capacity will allows to produce more products and meet customer needs. This can lead to increased sales and revenue.
    - Reducing lead time: Increasing manufacturing capacity will also help to reduce lead times. It will able to produce products more quickly, it can get them to customers faster, which can help to increase customer satisfaction and loyalty.

- Improving efficiency: Increasing manufacturing capacity can also lead to improved efficiency in the manufacturing process. This can help to reduce costs and increase profitability, as well as make the manufacturing process more sustainable.
- Scaling up for growth: If a company is looking to grow its business, increasing manufacturing capacity is often a necessary step. By increasing capacity, the company is able to meet the demands of a larger customer base and grow its business more quickly.

3. At first, Haidery Boards is just looking at the average weight of the board. Dispersion factor from the mean is not being considered due to which everything seems perfect. R charts will be used to examine the dispersion factor.
4. Standard for production is set for the shuttering ply by the labor. Which can be improved. Critical analysis of the job and work measurement method will be used to see that whether productivity can be increased or not and how much efficiency can be gained.

Chapter 2

2 Literature Review

2.1 Forecasting

Forecasting is an important aspect of manufacturing plants as it helps in predicting future demand for products, planning production schedules, managing inventory, and optimizing resources (Heizer,2016). Here are some key steps for forecasting in a manufacturing plant:

- Collect data: Collect and analyze historical sales data, market trends, and other relevant information that can be used to predict future demand. This data can be obtained from various sources such as sales records, customer feedback, and industry reports.
- Choose a forecasting method: There are several methods of forecasting such as time series analysis, regression analysis, and causal modeling. The choice of method depends on the availability and quality of data, the complexity of the product, and the forecast horizon.
- Develop a forecast model: Once a forecasting method has been chosen, a forecast model is developed using statistical techniques or mathematical algorithms. The model should be regularly updated with new data to improve accuracy.
- Validate the model: The model is validated by comparing the forecast results with the actual sales data. This helps to identify any errors or discrepancies in the model and make necessary adjustments.
- Monitor and adjust the forecast: The forecast should be continuously monitored and adjusted as needed based on changes in the market, customer demand, and production capacity. This helps to ensure that the plant is operating at maximum efficiency while meeting customer demand.

In addition, it is important to involve key stakeholders such as sales, production, and supply chain teams in the forecasting process to ensure that the forecast aligns with overall business goals and objectives.

2.1.1 Seasonality Index

Seasonality index forecasting is a statistical technique used to forecast time series data that exhibit seasonal patterns. Seasonality refers to a regular pattern of fluctuations in a time series that repeat

over a fixed period, such as days, weeks, months, or years. Seasonality index forecasting involves identifying the seasonal pattern and estimating a seasonal index that can be used to adjust the forecast for each season (Heizer,2016).

Here are the steps for developing a seasonality index forecast:

Collect and analyze historical data: Gather historical data on the time series and analyze it to identify the seasonal pattern. This can be done by graphing the data and looking for regular patterns or using statistical methods such as autocorrelation and spectral analysis.

Calculate the seasonal index: Once the seasonal pattern is identified, calculate the seasonal index for each season. The seasonal index is a ratio that represents the relative level of the time series during a particular season compared to the overall average level of the time series.

Develop a forecasting model: Using the historical data and seasonal index, develop a forecasting model that takes into account the seasonal pattern. This can be done using a variety of methods, such as exponential smoothing, ARIMA models, or regression analysis.

Apply the seasonal index to the forecast: After the forecasting model has been developed, apply the seasonal index to the forecast for each season. This adjusts the forecast for the expected seasonal variation in the time series.

Evaluate and update the model: Monitor the performance of the forecasting model and evaluate the accuracy of the forecast. Adjust the model as needed to improve accuracy and take into account any changes in the seasonal pattern over time.

2.1.2 Regression Analysis

Regression analysis can be a useful technique for forecasting demand in manufacturing. In this context, regression analysis can be used to identify the relationship between demand and independent variables such as time, price, promotions, or other market factors. By analyzing historical data and the relationships between these variables, regression analysis can help predict future demand levels and inform decisions around production planning and resource allocation (Heizer, 2016).

Here are the steps for using regression analysis to forecast demand in manufacturing:

- Collect and clean the data: Gather historical data on demand and the relevant independent variables, ensuring that the data is accurate and complete. Any missing or inconsistent data should be corrected or removed.
- Choose the independent variables: Select the independent variables that are likely to have an impact on demand. This might include variables such as time, seasonality, price, promotions, or marketing activities.
- Perform regression analysis: Use statistical software to perform regression analysis, estimating the coefficients and identifying the strength and direction of the relationship between demand and the independent variables.
- Evaluate the model: Evaluate the goodness of fit of the regression model by analyzing the R-squared value and other statistical measures. Check for any outliers or other issues that may affect the accuracy of the model.
- Make predictions: Use the regression model to make predictions for future demand levels based on the independent variables. Consider different scenarios or assumptions when making predictions, and be sure to update the model regularly as new data becomes available.

By using regression analysis to forecast demand, manufacturing companies can better plan their production schedules and optimize their resource allocation. This can help to reduce waste, increase efficiency, and improve overall profitability. However, it's important to recognize that demand forecasting is not an exact science, and there are many external factors that can impact demand levels. As a result, it's important to use regression analysis in combination with other techniques and approaches to ensure the most accurate and effective forecasting possible.

There are several other forecasting techniques available too, but for Chipboard these two techniques are most relevant due to seasonality factor.

2.2 Capacity Planning

Manufacturing capacity increasing strategies are used to increase the production capacity of a manufacturing plant to meet increasing demand. Here are some common capacities increasing strategies:

- Adding shifts: Adding shifts is a cost-effective way to increase production capacity. The plant can add an additional shift or extend the hours of an existing shift to increase production.
- Adding equipment: Adding new equipment can help to increase production capacity. The plant can add new equipment to an existing production line, or add a new production line to the facility.
- Outsourcing: Outsourcing involves using external contractors to perform some production tasks. This can help to increase production capacity without the need for additional staff or equipment.
- Process improvement: Improving the manufacturing process can help to increase production capacity. This can involve optimizing workflows, reducing waste, and increasing efficiency.
- Automation: Automation involves using robots and other automated systems to perform production tasks. This can help to increase production capacity and reduce labor costs.
- Expanding the facility: Expanding the manufacturing facility can help to increase production capacity. This can involve building a new plant or adding to an existing plant.
- Cross-training employees: Cross-training employees can help to increase production capacity by enabling them to perform multiple tasks. This can help to reduce the need for additional staff.
- Joint ventures: A joint venture is a partnership between two or more companies to share resources and expertise. This can help to increase production capacity and reduce costs.
- Acquiring a new plant: Acquiring a new manufacturing plant can help to increase production capacity. This can be a costly option, but it can provide immediate capacity for meeting increasing demand.

These all suggestions fall under the four capacity strategies mentioned below:

2.2.1 One step Expansion Strategy

One step expansion capacity strategy is a manufacturing strategy that involves a significant increase in production capacity in a single step. This approach can be useful for manufacturers who need to rapidly increase capacity to meet growing demand or capitalize on market

opportunities. This approach is often contrasted with incremental capacity expansion, which involves adding capacity in smaller increments over time (Shafer,2015).

Here are some steps for implementing a one-step expansion capacity strategy:

- Identify the need for expansion: Identify the need for expansion, such as a significant increase in demand, or the need to meet new market opportunities.
- Determine the required capacity: Determine the amount of additional capacity required to meet the need for expansion. This can involve assessing the gap between current capacity and future demand, and identifying the specific areas where additional capacity is required.
- Develop a plan for expansion: Develop a plan for the expansion, including the purchase of new equipment, the expansion of the facility, and the hiring of additional staff. Consider the costs of the expansion and the potential impact on production efficiency.
- Implement the expansion plan: Implement the plan for the expansion, which may involve constructing a new facility, purchasing and installing new equipment, and hiring and training additional staff.
- Test the expanded capacity: Once the expansion is complete, test the new capacity to ensure that it is functioning as expected. This may involve running production tests or trial runs to ensure that the new equipment is operating correctly and that the additional staff is working effectively.
- Monitor and adjust: Monitor the results of the one step expansion capacity strategy and make adjustments as needed. This may involve making changes to the production process, adjusting staffing levels, or making changes to the equipment to optimize its performance.

By implementing a one-step expansion capacity strategy, manufacturing companies can quickly and effectively meet growing demand or capitalize on market opportunities. However, it's important to carefully evaluate the costs and benefits of the expansion, and to ensure that the new capacity is being used effectively.

2.2.2 Leads Capacity Strategy

Lead capacity strategy is a manufacturing strategy that involves adding production capacity to meet expected future demand levels. The goal of this strategy is to stay ahead of customer demand and ensure that there is enough capacity to meet it (Shafer,2015). By increasing production

capacity before demand exceeds current capacity, manufacturing companies can avoid production bottlenecks, reduce lead times, and increase customer satisfaction.

Here are some steps for implementing a lead capacity strategy:

- Identify expected future demand: Analyze historical sales data and market trends to identify expected future demand levels. This can involve forecasting future demand levels based on factors such as market growth rates, customer preferences, and economic conditions.
- Evaluate current capacity: Evaluate the current capacity of the manufacturing plant, including the production capacity of individual machines and the overall capacity of the facility.
- Determine the required capacity: Determine the additional capacity required to meet expected future demand levels. This can involve assessing the gap between current capacity and future demand and identifying the specific areas where additional capacity is required.
- Develop a plan for adding capacity: Develop a plan for adding capacity, including the purchase of new equipment, the expansion of the facility, and the hiring of additional staff. Consider the costs of adding capacity and the potential impact on production efficiency.
- Implement the plan: Implement the plan for adding capacity, including the purchase and installation of new equipment, the expansion of the facility, and the hiring and training of additional staff.
- Monitor and adjust: Monitor the results of the lead capacity strategy and make adjustments as needed. This may involve adding additional capacity if demand exceeds expectations or reducing capacity if demand falls below expectations.

By implementing a lead capacity strategy, manufacturing companies can stay ahead of customer demand, improve production efficiency, and increase customer satisfaction. However, it's important to carefully evaluate the costs and benefits of adding capacity and to ensure that the additional capacity is being used effectively.

2.2.3 Lags Capacity

Lag capacity strategy is a manufacturing strategy that involves delaying the addition of production capacity until after demand has already increased. This approach is often used when manufacturers are hesitant to make large investments in additional capacity until they are certain that there is a

sustained increase in demand. The goal of this strategy is to minimize risk and control costs by avoiding investments in capacity that may not be needed (Shafer,2015).

Here are some steps for implementing a lag capacity strategy:

- Identify increasing demand: Identify that there is a sustained increase in demand that is likely to continue for an extended period. This can involve analyzing sales data and market trends to determine if there is a long-term increase in demand.
- Evaluate current capacity: Evaluate the current capacity of the manufacturing plant, including the production capacity of individual machines and the overall capacity of the facility.
- Determine the required capacity: Determine the additional capacity required to meet the increasing demand. This can involve assessing the gap between current capacity and future demand and identifying the specific areas where additional capacity is required.
- Develop a plan for adding capacity: Develop a plan for adding capacity, which may involve the purchase of new equipment, the expansion of the facility, and the hiring of additional staff. However, the plan should be designed to minimize investment until there is sufficient data to confirm the sustained increase in demand.
- Wait for confirmation of demand: Wait for confirmation that the demand increase is sustained before implementing the plan to add capacity. This can involve waiting for several months or even up to a year to ensure that the increase in demand is not temporary.
- Implement the plan: Once there is sufficient data to confirm the sustained increase in demand, implement the plan for adding capacity, which may involve purchasing and installing new equipment, expanding the facility, and hiring and training additional staff.

By implementing a lag capacity strategy, manufacturing companies can avoid investing in additional capacity until they are certain that there is a sustained increase in demand. However, this approach can also result in production bottlenecks, longer lead times, and reduced customer satisfaction if the increase in demand is sustained and the company is slow to respond (Shafer,2015). Therefore, it's important to carefully monitor demand levels and be prepared to implement a plan to add capacity as soon as there is sufficient evidence of a sustained increase in demand.

2.2.4 Straddle demand

The straddle demand capacity strategy is a manufacturing strategy that involves adding production capacity in anticipation of future demand while minimizing the risk of investing too much capacity too early. This strategy involves adding capacity incrementally and in stages, rather than in one large step or waiting too long to add capacity (Shafer,2015). The goal of this strategy is to balance the cost of adding capacity with the need to meet customer demand.

Here are some steps for implementing a straddle demand capacity strategy:

- Identify demand trends: Identify demand trends by analyzing historical sales data and market trends to determine if there is an increasing or decreasing demand for the product.
- Evaluate current capacity: Evaluate the current capacity of the manufacturing plant, including the production capacity of individual machines and the overall capacity of the facility.
- Determine the required capacity: Determine the additional capacity required to meet the anticipated future demand. This can involve assessing the gap between current capacity and future demand, and identifying the specific areas where additional capacity is required.
- Develop a plan for adding capacity: Develop a plan for adding capacity that involves adding capacity in stages, incrementally and flexibly. The plan should take into account the expected timeline for increasing demand, and the flexibility of the production process to accommodate changes in demand.
- Implement the first stage: Implement the first stage of the capacity expansion plan, which may involve adding a smaller amount of capacity. The initial stage should be designed to meet the immediate needs of the business while minimizing the risk of over-investing in capacity.
- Monitor demand and adjust: Monitor demand closely and make adjustments to the capacity expansion plan as needed. If demand continues to increase, additional capacity can be added in subsequent stages. If demand does not increase as expected, the expansion plan can be adjusted or delayed to minimize costs.
- Evaluate results: Evaluate the results of the capacity expansion plan to determine if it was successful in meeting demand while controlling costs. Adjustments can be made to the plan for future capacity expansions as needed.

By implementing a straddle demand capacity strategy, manufacturing companies can balance the cost of adding capacity with the need to meet customer demand. This strategy can help to minimize the risk of investing too much capacity too early or waiting too long to add capacity, which can both result in inefficiencies and lost opportunities.

Haidery Boards can use one or a combination of these strategies to increase production capacity and meet increasing demand. The choice of strategy will depend on factors such as the level of investment required, the time required to implement the strategy, and the impact on the company's operations. It's important to carefully consider the costs and benefits of each strategy before making a decision.

2.3 Quality Management

Quality management is an important aspect of operations management that involves planning, controlling, and ensuring the quality of products or services. It involves a set of techniques and tools used to identify and eliminate defects, reduce variation, and improve the overall quality of the products or services delivered to customers.

Here are some of the key aspects of quality management in operations management (Krajewski,2011):

- Quality planning: Quality planning involves determining the quality standards that products or services should meet, and defining the processes needed to achieve those standards.
- Quality control: Quality control involves monitoring production processes to ensure that products or services meet the defined quality standards. This can involve inspecting products, testing materials, or measuring process performance.
- Quality improvement: Quality improvement involves using data and analysis to identify opportunities for improvement in the production processes. This can involve implementing process changes or using continuous improvement techniques to make incremental improvements over time.
- Total Quality Management (TQM): TQM is a holistic approach to quality management that involves all aspects of a company's operations. It includes the participation of all employees in the quality management process and the use of data to continuously improve the quality of products or services.

- Six Sigma: Six Sigma is a data-driven methodology that focuses on reducing defects in the production processes. It involves the use of statistical tools and techniques to identify and eliminate defects, reduce process variation, and improve the overall quality of products or services.

Effective quality management in operations management can help companies to improve customer satisfaction, reduce waste and costs, increase efficiency, and gain a competitive advantage.

2.3.1 X Charts

X-Charts are statistical process control (SPC) charts that are used to monitor the variability of a manufacturing process over time. They are commonly used in quality management to detect and address process variations that can affect product quality.

An X-Chart displays the average value of a sample of process measurements taken over time. It is used to monitor the central tendency of the process and detect any shifts in the process mean. The chart has a center line (the mean of the sample means) and control limits (the upper and lower limits based on the variability of the sample means) (Krajewski,2011).

To create an X-Chart, samples of a process are taken and their means are calculated. The mean of the sample means is then calculated and used as the center line of the chart. The upper and lower control limits are set at three standard deviations from the center line.

If the sample means fall within the control limits, the process is said to be in control, and no action is required. If a sample mean falls outside the control limits, the process is considered out of control, and investigation is needed to identify and eliminate the cause of the process variation (Krajewski,2011).

X-Charts are useful in monitoring a process to ensure it is producing consistent results over time. They are particularly useful in detecting changes in the process mean, which can have a significant impact on the quality of the product. By monitoring the process with an X-Chart, companies can take corrective action before a product with a defect is produced, resulting in higher customer satisfaction and lower costs associated with waste and rework.

2.3.2 R Charts

R-Charts are another type of statistical process control (SPC) chart used to monitor process variation over time. They are also known as range charts and are often used in conjunction with X-Charts to provide a more comprehensive view of process control.

An R-Chart displays the range of process measurements within a sample taken over time. It is used to monitor the dispersion or variability of the process. The chart has a center line (the mean range of the sample ranges) and control limits (the upper and lower limits based on the variability of the sample ranges).

To create an R-Chart, samples of a process are taken, and the range of each sample is calculated. The mean range of the sample ranges is then calculated and used as the center line of the chart. The upper and lower control limits are set based on the average range of the sample ranges (Krajewski,2011).

Like X-Charts, if the sample ranges fall within the control limits, the process is said to be in control, and no action is required. If a sample range falls outside the control limits, the process is considered out of control, and investigation is needed to identify and eliminate the cause of the process variation.

R-Charts are useful in monitoring a process to ensure that it is producing consistent results over time. They are particularly useful in detecting changes in the process variability, which can have a significant impact on the quality of the product. By monitoring the process with an R-Chart, companies can take corrective action before a product with a defect is produced, resulting in higher customer satisfaction and lower costs associated with waste and rework. When used in conjunction with X-Charts, R-Charts provide a more complete picture of process control, allowing companies to identify and eliminate sources of process variation and improve product quality over time (Krajewski,2011).

2.4 Job Designing

Job design is an important aspect of operations management that involves structuring and organizing tasks, responsibilities, and roles within a company. Effective job design can help to increase productivity, employee engagement, and job satisfaction, leading to improved overall performance.

Here are some key considerations in job design for operations management (Heizer,2016):

- Task analysis: Conducting a detailed analysis of the tasks and responsibilities involved in each job to identify the skills and knowledge required.
- Job enrichment: Providing employees with additional responsibilities, autonomy, and decision-making power to increase job satisfaction and engagement.
- Job enlargement: Expanding the range of tasks and responsibilities within a job to provide employees with a broader range of activities and opportunities.
- Job rotation: Rotating employees through different roles and tasks within a company to provide them with a broader range of experiences and skills.
- Job simplification: Simplifying tasks and responsibilities to make them more efficient and easier to perform.

Ergonomics: Designing jobs and workspaces to ensure that they are safe, comfortable, and minimize physical strain on employees.

Training and development: Providing employees with training and development opportunities to improve their skills and knowledge and increase their effectiveness on the job.

Effective job design in operations management can help to improve overall performance by increasing productivity, reducing turnover, and improving employee engagement and job satisfaction. By analyzing the tasks and responsibilities involved in each job, companies can identify opportunities to improve processes and workflows, eliminate inefficiencies, and create a more effective and efficient organization (Heizer,2016). For analyzing, method study and work measurement can be used, as shown in figure below.

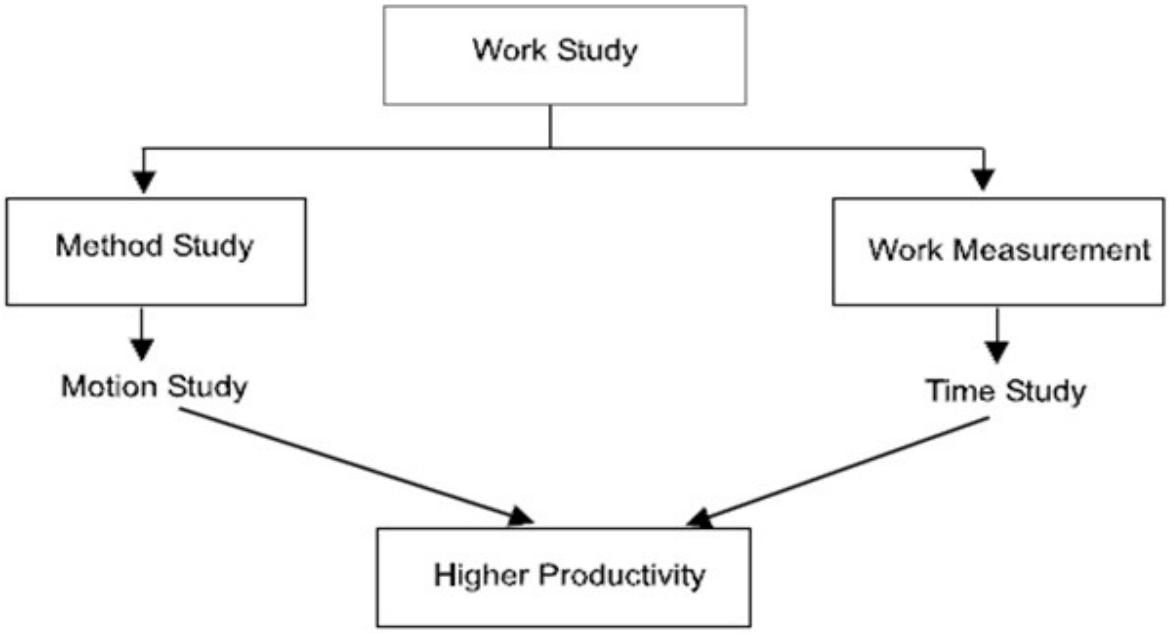

Figure 4 Work Study

2.4.1 Method Study

Method study is a key aspect of operations management that involves analyzing and improving the way work is done within a company. The goal of method study is to identify opportunities to improve processes and workflows, eliminate waste, and increase productivity and efficiency (Heizer,2016).

Here are some key steps involved in method study:

- Select the job to be studied: Identify a specific job or process to be analyzed and improved.
- Observe the job: Observe the job or process to understand how it is currently being done, including the tasks involved, the equipment and tools used, and the sequence of steps.
- Analyze the job: Analyze the job to identify opportunities to improve the process. This may involve looking for bottlenecks, inefficiencies, or waste, as well as identifying opportunities to standardize and simplify the process.
- Develop a new method: Develop a new method for performing the job that eliminates inefficiencies and waste, and improves productivity and efficiency.
- Implement the new method: Implement the new method and train employees on the new process. Monitor the process to ensure that it is working effectively and make adjustments as necessary.

- Evaluate the results: Evaluate the results of the new process to determine whether it has been successful in achieving the desired outcomes. This may involve analyzing performance metrics such as productivity, quality, and cost savings.

Method study is a powerful tool for improving processes and workflows within a company. By analyzing and improving the way work is done, companies can eliminate waste, increase productivity and efficiency, and improve overall performance. This can lead to significant cost savings, improved customer satisfaction, and a more effective and efficient organization.

2.4.2 Work Measurement

Work measurement is a key aspect of operations management that involves measuring the time it takes to complete specific tasks and activities within a company. The goal of work measurement is to establish standards for the amount of time required to perform tasks, which can be used to improve productivity, efficiency, and overall performance (Heizer,2016).

Here are some key steps involved in work measurement:

- Select the task to be measured: Identify a specific task or activity to be measured, such as assembling a product or processing a customer order.
- Break down the task into smaller elements: Break down the task into smaller elements, such as reaching for a tool, positioning a part, or tightening a screw.
- Time the elements: Time the individual elements of the task using a stopwatch or other timing device.
- Analyze the data: Analyze the timing data to identify any inefficiencies or opportunities for improvement. This may involve looking for ways to simplify the process, eliminate waste, or reduce the amount of time required for each element.
- Develop a standard time: Develop a standard time for the task, based on the time required for each element and any adjustments made to improve efficiency.
- Implement the standard: Implement the standard time as a benchmark for the task, and use it to evaluate performance and identify areas for improvement.

Work measurement can be a powerful tool for improving productivity, efficiency, and overall performance within a company. By establishing standards for the amount of time required to perform tasks, companies can identify inefficiencies and waste, and develop strategies to improve

processes and workflows. This can lead to significant cost savings, improved customer satisfaction, and a more effective and efficient organization.

2.4.3 Allowances:

In work measurement, allowances are used to account for factors that can affect the amount of time required to complete a task beyond the time required for the work itself. These factors may include rest breaks, machine downtime, fatigue, and other interruptions or delays that can affect worker productivity (Meredith,1999). The goal of allowances is to provide a more accurate estimate of the time required to complete a task, which can be used to develop more realistic performance standards and improve productivity.

Here are some of the common types of allowances used in work measurement (Heizer, 2016):

Personal allowances: These are allowances that are made for personal needs, such as rest breaks, time for personal needs like restroom breaks or drinking water, and any other non-productive time required by the worker.

Delay allowances: These are allowances that are made for factors that are outside the worker's control, such as equipment breakdowns or machine downtime. Delay allowances help to account for the time lost due to these factors and can help to ensure that performance standards are based on realistic expectations.

Contingency allowances: These are allowances that are made for factors that are difficult to predict, such as unexpected interruptions or changes in the work environment. Contingency allowances help to account for these factors and provide a buffer to ensure that performance standards are not affected by unexpected events.

By using allowances in work measurement, companies can develop more accurate performance standards and improve productivity. By accounting for the time required for personal needs, delays, and other factors that can affect worker productivity, companies can ensure that performance standards are based on realistic expectations and that workers are not penalized for factors that are outside their control. This can lead to a more effective and efficient organization, with improved productivity and higher levels of worker satisfaction.

Chapter 3

3 Application of Concepts

3.1 Forecasting

Sales is most important part for any organization or service to keep its operation running. If a company produce more than what is demanded, it increase its cost such as inventory cost. If production is less than what is demanded in market it will lead to loss of customer, their loyalty as they will switch to competitors. Therefore, keeping up with the demand of market is very important. Therefore, I decided to forecast 2023 sales for the organization I am working in, so that the production of Chipboard can be done according to demand.

Chipboard is raw material for Vin Board and Lamination. Chipboard is a product itself too. So, altogether aggregate of Chipboard forecasting is done to be on safe side. As, product wise forecasting would have been riskier one. In, this scenario, if enough chipboard is not used in Vin Board than Lamination or raw Chipboard demand might be able to cover less demand of Vin Board.

Chip board items are very season based. At the year start, there is a high demand which decreases gradually till summers and then remain almost constant till August, after it starts increasing again. So, basically its main season is winters. Therefore, plant needs to be very flexible in terms of production. Haidery Boards, works in a way that when demand is high it works 24/7 with two 12 hours shift, when demand is moderate it shifts to single shift of working 14/15 hours and when demand is low it shifts to 12 hours shift. Therefore, it's very necessary to predict the forecast sales to manufacture the boards accordingly. Therefore, it is decided to use the forecasting technique using seasonality index. A four years data is taken to have a better understanding of demand and predict 2023 demand. This will help firm to make decision before hand when to hire skilled operators to run an extra shift or when to send a prior notice to the operators of firing them.

A data of four years is taken to have a better forecast. Till November 2022, data is taken. Forecasting for December 2022 and year 2023 is done. For December demand, exponential smoothing with trend is used. Following table shows the demand for four years. There is decrease in 2020 demand due to the Covid pandemic. Figures are in terms of per unit demand of chipboard.

Table 1-1Past Sales Data

	2019(sheets)	2020(sheets)	2021(sheets)	2022(sheets)
Jan	53250	32300	56095	60687
Feb	46560	36350	47230	54614
March	42350	34620	42000	49610
April	27350	28550	32010	36499
May	29010	28010	23301	21776
June	28500	33060	36050	38435
July	33000	36873	38050	39600
August	41000	37751	40050	42205
September	40500	38426	42050	41600
October	49600	51748	46650	48630
November	58650	56847	59530	61055
December	59600	52007	60390	**?**
Total	509370	466542	523406	**?**

3.1.1 Exponential Smoothing with trend

$$F_t = \alpha(A_{t-1}) + (1-\alpha)(F_{t-1} + T_{t-1}) \qquad T_t = \beta(F_t - F_{t-1}) + (1-\beta)T_{t-1}$$

Table 1-2 Forecasted demand for december, 2022

a 0.5 0.5 b

	Actual Demand 2022 (sheets)	Smoothed Forecast (sheets)	Smoothed Trend (sheets)	Forecasting including Trend (sheets)	Deviation
Jan	60687	59000	3000	62000	1313
Feb	54614	61343.5	2671.75	64015.25	9401.25
March	49610	59314.625	321.4375	59636.0625	10026.06
April	36499	54623.03125	-2185.078125	52437.95313	15938.95
May	21776	44468.47656	-6169.816406	38298.66016	16522.66
June	38435	30037.33008	-10300.48145	19736.84863	18698.15
July	39600	29085.92432	-5625.943604	23459.98071	16140.02
August	42205	31529.99036	-1590.938782	29939.05157	12265.95
September	41600	36072.02579	1475.548325	37547.57411	4052.426
October	48630	39573.78706	2488.654797	42062.44185	6567.558
November	61055	45346.22093	4130.544333	49476.76526	11578.23
December		**55265.88263**	**7025.103019**	**62290.98565**	

MAD = 122504.3/11 = **11136.75**

Above table shows the calculation for forecasted December sale by using exponential smoothing including trend. Formulas stated above of Forecast (F_T) and Trend (T_T) were used. Initially, alpha and beta were assumed 0.5, later solver on excel was used to get the best result by adjusting the value of alpha and beta and minimizing the deviation to minimal value (shown in appendix). After changing alpha and beta value, following results were obtained.

Table 1-3 Forecasted demand for december with a,b adjusted

		a	0.921	0.608	b	
	Actual Demand 2022 (sheets)	**Smoothed Forecast**	**Smoothed Trend**	**Forecasting including Trend(sheets)**	**Deviation**
Jan	60687	59000.00	3000.00	62000.00	1313.00
Feb	54614	60790.71	2264.29	63054.99	8440.99
March	49610	55280.71	-2465.46	52815.25	3205.25
April	36499	49863.16	-4261.45	45601.71	9102.71
May	21776	37217.97	-9361.98	27855.99	6079.99
June	38435	22256.22	12768.78	35025.00	3410.00
July	39600	36148.59	3451.40	39599.99	0.01
Aug	42205	39600.00	3451.41	43051.40	846.40
Sep	41600	42271.85	2977.14	45248.99	3648.99
Oct	48630	41888.21	932.50	42820.71	5809.29
Nov	61055	48171.16	4187.62	52358.77	8696.23
Dec		60368.13	9060.37	**69428.51**	
					50552.86

MAD = 50552.86/11

MAD = 4595.7

After using the solver, MAD error is reduced to 4595.7. alpha and beta value is changed with alpha = 0.921 and beta = 0.608. Forecasted demand for December is **69428 sheets.**

Now, we have the complete data for the 4 years and Seasonality Index will be used to predict 2023 sales.

Table 1-4 Updated sales for 4 years

	2019 (sheets)	2020 (sheets)	2021 (sheets)	2022 (sheets)
Jan	53250	32300	56095	60687
Feb	46560	36350	47230	54614
March	42350	34620	42000	49610
April	27350	28550	32010	36499
May	29010	28010	23301	21776
June	28500	33060	36050	38435
July	33000	36873	38050	39600
August	41000	37751	40050	42205
September	40500	38426	42050	41600
October	49600	51748	46650	48630
November	58650	56847	59530	61055
December	59600	52007	60390	**69428**
Total	509370	466542	523406	**564139**

3.1.2 Regression Analysis

It can be seen from data that there is decrease in demand in 2020 which is random and irregular variation due to COVID which effected the business all over Pakistan. This will affect the forecasted demand for 2023. Therefore, 2020 data is ignored for the forecasting to get better results.

At first to predict 2023 total year sale as whole, regression analysis is used. (Shown in appendix)

$Y = mx + c$

$M = 16650.86$

$C = 487902.7$

$Y = 16650.86(5) + 487902.7$

Forecasted demand for 2023 is Y = 571157

Table 1-5 Predicted Sales for 2023

Year	Sales (sheets)
1	509370
3	523406
4	564139
5	**571157**

3.1.3 Seasonality Index

Forecasting with Seasonality Index is used to Predict the sales for year 2023 monthly, following table summarizes the results:

Table 1-6 Prediction for monthly 2023 sales, using seasonality index.

	2019 (Sheets)	2021 (Sheets)	2022 (Sheets)	Avg for years (Sheets)	Average Monthly (Sheets)	Seasonality Index	Forecast for 2023 (Sheets)
Jan	53250	56095	60687	56677	44358.7	1.278	**60814.11**
Feb	46560	47230	54614	49468	44358.7	1.115	**53078.581**
March	42350	42000	49610	44653	44358.7	1.007	**47912.501**
April	27350	32010	36499	31953	44358.7	0.720	**34285.192**
May	29010	23301	21776	24696	44358.7	0.557	**26498.159**
June	28500	36050	38435	34328	44358.7	0.774	**36833.897**
July	33000	38050	39600	36883	44358.7	0.831	**39575.382**
August	41000	40050	42205	41085	44358.7	0.926	**44083.721**
Sep	40500	42050	41600	41383	44358.7	0.933	**44403.829**
October	49600	46650	48630	48293	44358.7	1.089	**51818.178**
Nov	58650	59530	61055	59745	44358.7	1.347	**64105.681**
Dec	59600	60390	69428	60252	44358.7	1.423	**67747.76**
Total	509370	523406	564139	532305			

Above table gives us the forecasted sales for next year for each month. We can plan the production schedule according to it.

Shift Production Capacity

According to current capacity of plant, following table summarizes the production that can be done in the shifts.

Table 1-7 Production in shifts

Shift	Production (Units)
1 Shift	30000
15 hr. Shift	36000
2 Shifts	57000

Above table shows the average production of chipboard depending on the shift duration. Efficiency can be seen to decrease in 15hrs shift as it become hectic for operators to work for so long. Further, Efficiency decreases in second shift too, as daily approx. 1 hr. break is necessary to clean up the machines for quality product.

3.1.4 Shift prediction for 2023 as per forecasted demand

With help of forecasted demand, in advance the shift schedule for 2023 is predicted and planned.

Table 1-8 Predicted Shits and inventory for 2023.

Month	Forecasted Sales	Shift	Production	Inventory required	Stock Inventory
Jan	60814	2	57000	3814	Last year's c/f
Feb	53078	2	57000	0	3922
March	47912	2	57000	0	13010
Apr	34285	15 hr.	36000	0	14725
May	26498	1	30000	0	18227
June	36833	1	30000	6833	11394
July	39575	15 hr.	36000	3575	7819
August	44083	15 hr.	36000	8083	-264
Sept	44403	2	57000	0	12597
Oct	51818	2	57000	0	17779
Nov	64105	2	57000	7105	10674
Dec	67747	2	57000	10747	-73

Table above shows the shift time that will be required to keep the inventory up to level so that customers can be satisfied. Above table have forecasted sales column, which is predicted from

Seasonality Index. Shift column shows the required shift for production as per the forecasted demand. Production columns shows the estimated production from shift run and inventory required column shows that if demand is more than current months production, stock from inventory will be used. Further, if production is more than demand it will be moved to inventory, as shown in last column. Hence, keeping the stock up to customer demand and minimizing inventory cost. This will also help to inform the employees before time of firing them, so that they could look after another job within notice period. Similarly, before time operators can be arrange before shifting to second shift.

This technique which we are following is called following demand exactly. Key features are:

- Matches direct labor cost to production.
- Extra cost is incurred for hiring, termination, premium wages etc.
- Labor cost is treated as variable cost

3.1.5 Raw material inventory

Aggregate Forecasting for the chipboard is done in previous section which give us an idea how much production is required in each month. Using that data raw material inventory required each month can be determined and in advance that can be arranged to prevent any type of shortage.

There are two main raw materials for chip board manufacturing

- Wood (Approximately 75kg per board)
- Glue (Approximately 6 kg per board)

Table 1-9 Predicted Raw material

Month	Production (Units)	Wood Required (kg)(ton)	Glue Required (kg)(ton
Jan	57000	4275	342
Feb	57000	4275	342
March	57000	4275	342
Apr	36000	2700	216
May	30000	2250	180
June	30000	2250	180

July	36000	2700	216
August	36000	2700	216
Sept	57000	4275	342
Oct	57000	4275	342
Nov	57000	4275	342
Dec	57000	4275	342

Above table shows the required raw material for each month to keep up with the demand of customers. Planning and procurement of raw material can be done in advance to keep operations run smoothly.

3.2 Capacity Planning

Further, next year forecasted demand shows that we have reached to our maximum capacity. If we want to meet the customer demand, we will need to increase the capacity within 2023 to keep up with market demand of 2024. In literature review I discussed four different capacity strategies which can be adopted to increase capacity.

3.2.1 One Step Expansion

- Changing the hot press: Currently, 10 opening press is being used which means that every 5 minutes 10 sheets are being produced. Hot press can be replaced with 15 opening hot press. This means that with in same time 15 sheets will be produced. Estimated price of this press is 32800 USD EX works (jianzhongwoodmachine). Freight, Transportation and Insurance cost from China is an addition.
- Replacing existing Dryer: Dryer is used to dry and remove the moisture from the crushed wood chips. Existing dryer being used is according to current assembly line. It has a capacity which will not be efficient if hot press is changed too 15 opening. So, it will be needed to be replaced. Importing it from China would be very expensive. So, upon discussion with the Mechanical head and Mr. Ahmed, person who previously erected the dryer, quoted an estimated amount of 10 million PKR.

Figure 5 Hot press and Dryer.

3.2.2 Leads Capacity Strategy

- Replace Hammer mill: It is used to crush the wood chips into further smaller pieces. Heavy Hammer mill will help to give output of more raw material, hence leading to more production. It is a short-term solution which might be effective for one or at maximum two years. Estimated price for a used hammer mill would be 1.5 million PKR.
- Increasing the plates in current hot press: Current press have capacity to increase the number of plates by two. This means that production can be increase in five minutes from 10 to 12 sheets. This will cost around 0.8 million PKR.

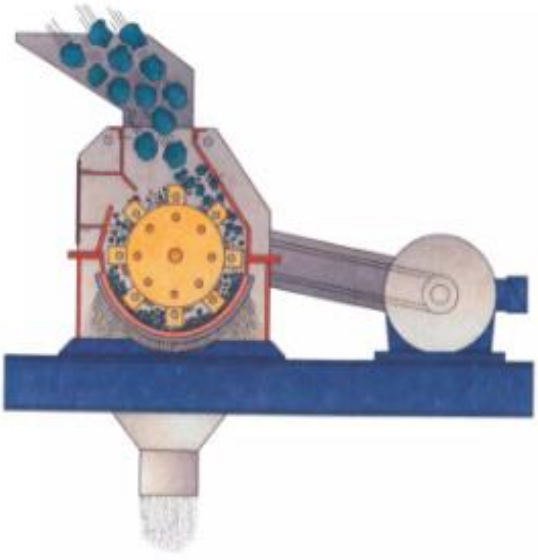

Figure 6 Hammer mill

3.3 Quality Management

It's very important to keep the Chipboard to an average weight. Reason is that if the board is overweight it means that more wood/glue (raw material) is being used than required which increases the costing of the board. If weight is less, it means that it's not up to the market defined standard which will lead to customer dissatisfaction. So, keeping up with the board weight is very important.

On daily basis to have a quality check, 5 random boards are selected at different times and are weighed. Right now, in firm, average weight for board is considered, we don't consider the dispersion factors. So, I am planning to use the X and R chart to have a better view of the quality of process.

To perform quality check, I used the past 15 weeks data to get an idea. I have daily weight averages of the board available, from which we get the weekly average, which is presented to executives on every week, Monday. Market standard weight defined is 32kg. R charts will be very helpful in this. As we are not considering the dispersion factor in current scenario.

Following data is available (All values are in **kg**):

Table 1-10Average weight of Board.

		Sample														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Day	1	32	31	32	31.5	29.5	32	32.5	31.5	34	34	33	30	32	33	33
	2	31.5	32	34	32	33	32.5	31	33	31.5	32.5	32	32	31	32	32
	3	32	32	33	33	31.5	33	33	32.5	32.5	34	32.5	31	31	30	31
	4	33	33	32.5	30	32.5	32	32	32	32	33.5	31	33	31.5	35	31
	5	32.5	32.5	32	31	32	33	33	33	32	31	33	32	33	32	32
	6	32	33	33	32.5	35	31.5	31.5	32	33	33	31.5	31.5	33.5	31.5	33
mean		32.16667	32.25	32.75	31.66667	32.25	32.33333	32.16667	32.33333	32.5	33	32.16667	31.58333	32	32.25	32
Range		1.5	2	2	2	5.5	1.5	2	1.5	2.5	1.5	2	1.5	2.5	5	2

Above table shows the data for 6 days a week for past 15 weeks. With help of excel, mean is calculated for each week and average mean for 15 weeks is 483.416/15 = **32.23 kg**. Similarly, Range is calculated with average range for 15 weeks calculated as 35/15 = **2.33 kg.**

First, X charts will be drawn to look after the mean.

3.3.1 X Charts

$UCL_x = x + A_2R$

$= 32.23 + 0.483(2.33)$

$=33.35$ kg

$LCL_X = X - A_2R$

$= 32.23 - .483(2.33)$

$= 31.1$ kg

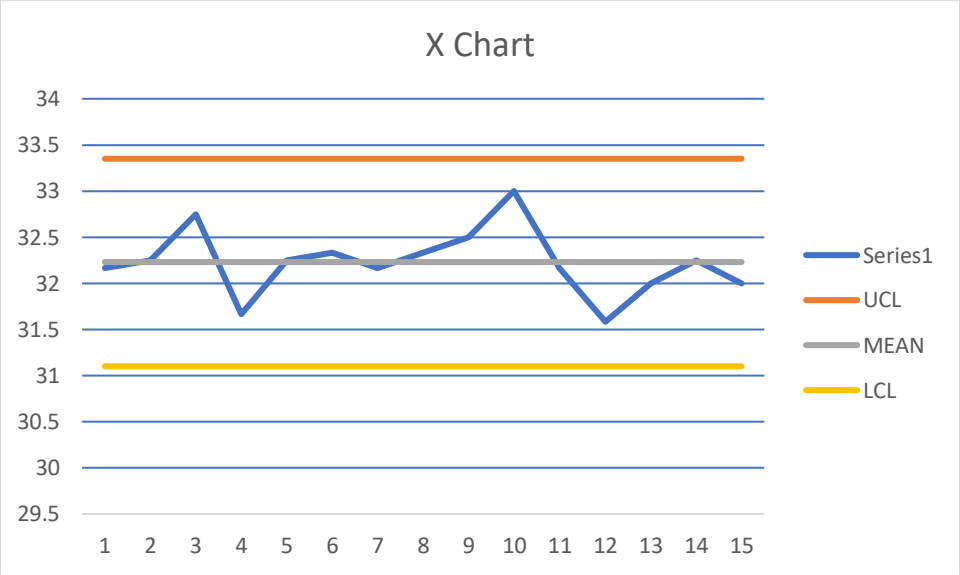

Figure 7X Chart

Above graph shows that average board weight we are getting is within the acceptable limits. There are variations but those are due to natural variations which can't be removed. One thing to ponder about is that we are more inclined towards LCL, but that is acceptable as low weight means less material being used, which leads to low cost.

3.3.2 R Charts

R charts are used to look after the variation factor. It helps to figure out and control the dispersion of the process.

$UCL_R = D_4R$

$= 2.004 * 2.33$

$= 4.676$

$LCL_R = D_3R$

$= 0 * 2.33$

$= 0$

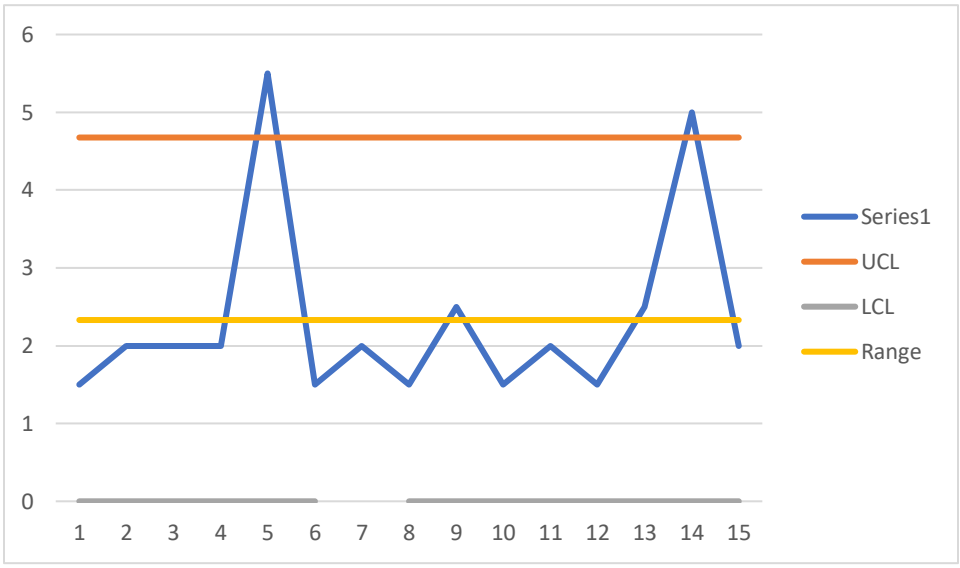

Figure 8 R Chart

At first, we just use to look after mean, variation was ignored. Due to which every thin seemed perfect. Above graph shows the result. Two points are out of the UCL, those may be due to assignable cause such as change in process etc. It is needed to be addressed to reduce this much dispersion in future. For that, bad cause for this variation is needed to be eliminated.

Upon inquiry from production department for large range gaps, following factors were listed out:

- Improper mixing of woods. As, some are light weighted and some are heavy. If proper mixing is not done than weight varies a lot.
- Wood chips over dried. This leads to more consumption of glue. Hence, increasing cost.
- Wood chips over crushed. This leads to more consumption of wood chips to attain required thickness and also increase consumption of glue.

- Operator error. He might not be able to keep an eye on weight.

So, to reduce variation these factors are needed to be addressed and this will lead to further reduction in costing.

3.4 Job Designing

Beside Chipboard, Haidery board is also manufacturing shuttering ply. Chipboard plant is fully automated, just need operators on machine whereas shuttering ply depends upon labor effectiveness as its almost manually manufactured. Right now, industry benchmark is 27.5 ply per table in 12 hours, as two workers work on one table so it makes it 55 ply/12hrs, which I think can be increased as it includes too many in efficiencies.

Flow chart below shows the manufacturing process of ply with time consumed at each step.

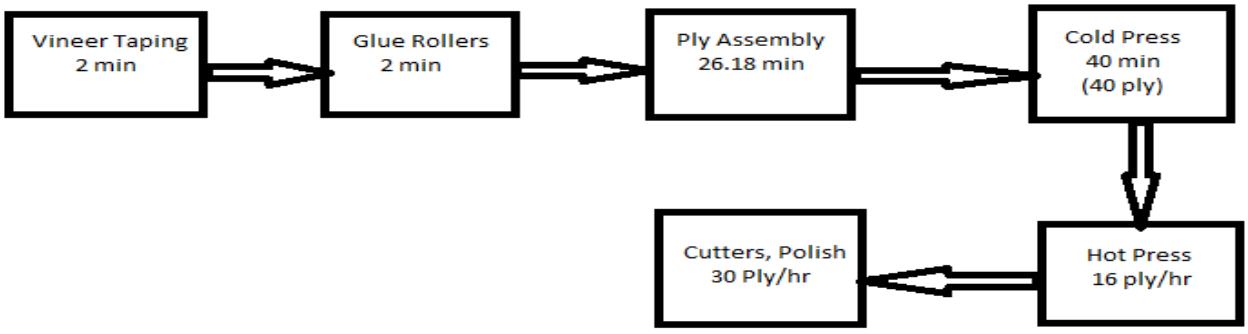

Figure 9 Process for Shuttering ply

Table 0-11Time required at each step.

Process	Throughput time (min)
Vineer Taping	2
Glue Rollers	2
Ply Assembly	26.18/5 = 5.24
Cold press	1
Hot Press	3.75
Cutter & polish	2
Total	**15.99**

Above flow chart shows the ply manufacturing process and it shows the time each step takes. As its labor intensive so time can vary little bit. From above process, ply assembly is the bottle neck of the process. Right now, 5 workers are simultaneously working on ply assembly which give an output rate of assembly as (60/5.24) 11.46 ply/hr. This process gives the throughput rate as 15.99 minutes.

Bottleneck of this process is the ply assembly, which can be improved and more productivity from labor can be taken. For this it is proposed to redesign this job by the procedure defined of calculating normal time with help of average time, performance factor etc. This will help to clear my doubt that labor is in efficient or otherwise will help to increase the production by reducing the bottle neck time.

There are two ways in which higher productivity can be achieved:

- Method Study: It is the critical way of examining the existing procedures and try finding out the ways to improve it to make it more effective and efficient. (Heizer, 2016)
- Work Measurement: It is related to time measure, time that it takes for a qualified worker to perform the job designed. (Heizer, 2016)

The process described above shows that Ply assembly is the bottle neck of the process and through this research project critical examination this time can be reduced. As this is the benchmark set by the workers, which is needed to be changed. For that work measurement is the best way to go as time will be measured by observing a qualified worker.

Qualified worker is the one who have the required knowledge, skill and other required attributes regarding the job keeping in consideration the standard of safety, quality, and quantity. This worker will help us to get the approximate time for assembling ply and resetting the benchmark for efficient operations. (Heizer, 2016)

Finding a qualified worker was a difficult task as labor knew that if they assembled the ply efficiently in less time, than the manager will ask for more production on daily basis. Therefore, it is decided to offer worker with incentive and extra bonus on number of sheets that he will assemble more than his daily routine. Worker was observed for one week.

3.4.1 Work Measurement

Table 0-12Ply assembled per day

Day	Production (12hrs) (units)	Time per ply(min)
Monday	35	20.54
Tuesday	34	21.18
Wednesday	34	21.18
Thursday	35	20.54
Friday	34	21.18
Saturday	35	20.54

This gives an average of (125.16/6) = 20.86 min per ply.

As bonus was being given on each extra sheet, so the worker was extra efficient, taking small breaks etc. Further quality was compromised little bit as more repairing compared to normal production, so rating was 1.075

Normal Time = 20.86*(1.075)

= 22.42 min

Allowance Factor = 5%

It is for the personal use such as rest room, drinking water etc.

Standard time = 22.42/ (1-.05)

= 23.6 min/ply

This gives us (60/23.6) 2.542 ply/hr. and for a full 12 hr. shift this equal to (12*2.54) 30.5 ply per day.

Benchmark set by workers was giving us 27.5 hr. ply per person for 12 hr. production. As 5 workers assembling simultaneously, so daily production according to **current system is 137 ply/12 hrs.**

Job redesigning done; time observed help us to reach a standard time which shows that each worker can assemble 30.5 ply/hr. keeping in consideration the allowance factor etc. Considering the

current scenario, 5 workers working simultaneously, our output with following time could be **increased to 152 ply/12 hrs.**

This shows that productivity can be increase by **15 sheets** on daily basis within same time and team. Hence, increasing productivity and reducing labor cost per sheet.

3.4.2 Cost Analysis

Wages of employees

Table 0-13Wages for employees

Designation	Wage (PKR)
Production Manager	80,000
Vineer taping (2 persons)	62,000
Glue roller machine (3 Persons)	88,500
Ply Assembly (5 Persons)	165,000
Pressing (3 Persons)	90,000
Fork Lifter (1 Person)	31,000
Total	**516,500**

Current Costing

Ply produced = 137 ply/day = 137*26 = 3562 ply per month

Labor cost = 516,500 PKR

Labor cost/ply = 516,500/3562 = 145 PKR

New Costing

Ply produced = 152 ply/day = 152*26 = 3952 ply per month

Labor cost = 516,500 PKR

Labor cost/ply = 516,500/3952 = 130 PKR

This shows that production has increased by 390 units per month and labor cost per unit is reduced by 15 PKR/Sheet.

Chapter 4

4 Analysis

Forecasting

First aim of the project was to forecast the sales for the chipboard, lamination and Vin board. As, chip board is the main product and others are the sub product. So, aggregate forecasting is done to be more accurate. Before 2023, forecasting was not done and production was done on month end pending orders or market condition due to which many issues were faced such as raw material shortage, employes shortage for second shift etc. By applying the forecasting, we have predicted sales for 2023, which enabled us to have the production schedule for whole year. Further, raw material required each month to keep up with the demand.

Forecasting will help to plan production schedules in advance, optimizing the use of resources, reducing the risk of delays, and ensuring timely delivery of products to customers.

Through forecasting it is now known that required raw material for this year which can be arranged beforehand so it helps to optimize inventory levels, reducing the risk of stockouts or overstocking. This, in turn, will reduce the cost of holding inventory, improves cash flow, and frees up warehouse space. Further, knowing the required raw material in advance will help to work more effectively with suppliers. Better negotiations can be done which will help to reduce the cost.

The required finished good inventory for 2023 is attained. It will help to ensure that Haidery Boards have enough stock to meet customer demand, reducing the risk of stockouts and improving customer satisfaction.

Further, forecasting shows that demand is increasing each year and plant is reaching to its capacity so necessary steps are required to increase the capacity to keep up with the customer demand.

There are four techniques to increase the capacity. Straddle demand and lags capacity techniques were ignored as those techniques can lead to customer dissatisfaction. In these techniques capacity is increased once the demand exceeds the capacity. This means back ordering or late delivery of orders which will lead to loss of customers. Considering chip board industry, in KPK and Punjab

there are already 15+ competitors so customer have other options available to switch. Therefore, its very necessary to increase the capacity in advance to keep up with the demand of customers.

Other option was one step expansion, for it two major changes are required, first is to change the hot press to 15 plates which will help to increase the production by 5 sheets with in same time. This means we can produce on average 85000 sheets per month which is a huge increase. But for it we will require the crushed wood chips in more quantity for which we will need to replace the current dryer. Therefore, it's a time consuming and expensive option. Importing press from China will take around 3-4 months considering current political and economic situation. Further, local dryer manufacturing will also take around the same time and once we have both the machines their erection will take around 1-2 months. So, it's a time-consuming process. Further, plant will be need to shut down for the time machines are being replaced. Therefore, this one step expansion strategy is not required right now but planning should be done for it and implemented within next 3-4 years.

Leads capacity strategy is the best option available. Two changes are required to meet the customer demand for next 2-3 years. Adding two hot plates means that monthly average production for 2 shifts can be increased too 68000 sheets. Which is a significant increase at least to meet demand of customers for next few years. Further, dry hammer mill is required to be replaced to keep up with the required crushed wood chips in stock. So, considering this strategy, its cheap and less time consuming. Following table summarizes the analysis.

Table 4. 1Comparison of Capacity strategies

Leads Capacity Strategy	**One Step Expansion**
Replacing Hammer mill and adding two plates in existing press	Replacing Dryer and existing hot press
2.5 million PKR	20 million PKR
Local Purchasing	Importing from China, LC's issue, taxes
Shutdown for maximum 2-3 days	Shutdown for 3-4 weeks
Enough to meet capacity demand for next 5 years	Long term solution
Capacity almost equal to demand	More capacity, less demand

Quality

At first it is required to look after the average weight of the board which shows that everything is under control. But considering the dispersion factor showed that there is a lot of variation. So possible causes for those variations were identified and solutions are identified.

Table 4. 2Cause and possible solutions for dispersion

Cause	Solution
Improper mixing of woods	Personnel need to be hired who assure proper mixing of woods
Wood chips over dried	Install Moisture meter to keep dryness constant and up to defined standard
Wood chips over crushed	Personnel hired for proper mixing of good can keep an eye on it too.
Operator error	PLC installation to record the weight of each cake passed on to hot press

Implementing these steps will help to reduce the variation and reduce the cost.

Job designing

By analyzing work processes and breaking them down into smaller, more manageable components, work measurement helps to identify inefficiencies and areas for improvement. This, in turn, lead to improved productivity and efficiency. Method study helped to analyze that current productivity of assembly of shuttering ply can be increased.

Work measurement provided a basis for standardizing work processes, reducing variation and improving quality. By identifying best practices and standardizing work methods, it's ensured that industry benchmark of ply production is required to be changed for higher efficiency.

Work measurement helps identify non-value-added activities and eliminate waste, reducing costs and improving profitability. By optimizing work processes, firm will be able to reduce labor costs,

minimize downtime, and optimize the use of equipment and materials. As, in cost analysis 15 PKR labor cost can be saved per sheet.

Through work measurement, it was ensured that productivity can be increased by 15 ply per day with in same time and labor. This means manufacturing 390 ply extra per month. Further cost analysis showed that labor cost per sheet will be reduced by 15 PKR. Hence, reducing the cost per ply and increasing the production per month.

Work measurement is an ongoing process, it will allow to track performance over time and identify areas for further improvement. By regularly monitoring and evaluating work processes, firm can identify opportunities for improvement and make incremental changes to drive ongoing improvement. So, it's a continuous process.

Although it's clear that productivity can be increased but it will be hard to convince labor to give desired output within same pay. As it's a type of labor union, so it can be a mess. Therefore, some incentives will be needed to motivate them such as:

- Pay increment
- Bonus
- Employee of month award
- Family trips

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Chapter 5

5 Conclusion

In conclusion, the analysis of the Haidery Board's operations management practices has provided valuable insights into the company's performance in key areas such as forecasting, capacity strategy, quality management, and work measurement. The following are the key findings and recommendations for each of these areas:

At first, forecasting of demand is done for 2023, this has provided us with the production, shift and raw material required for the next year in advance, so that Haidery Boards can plan accordingly. Forecasting, also helped to identify that production plant is reaching its maximum capacity so actions are required in following year to keep up with the demand of customers.

To increase capacity there were four strategies available. After analysis the best option of Lead strategy capacity is suggested. It's the cheapest and least time-consuming option available. Replacing hammer mill and addition of two plates in hot press will help to keep the demand of customers satisfied for next few years. Within this time period planning can be done for one step Expansion strategy for long term planning.

Further, Quality management aspect is covered. The company was considering its process right as were just looking at the average weight of the board and ignoring the variation. Data available showed us that there in two weeks it had high variation due to some assignable cause, which is required to be eliminated or minimized. Possible causes were identified and solutions to them are suggested. This will help to reduce the number of defective products and the associated costs, while also improving the overall quality of the products.

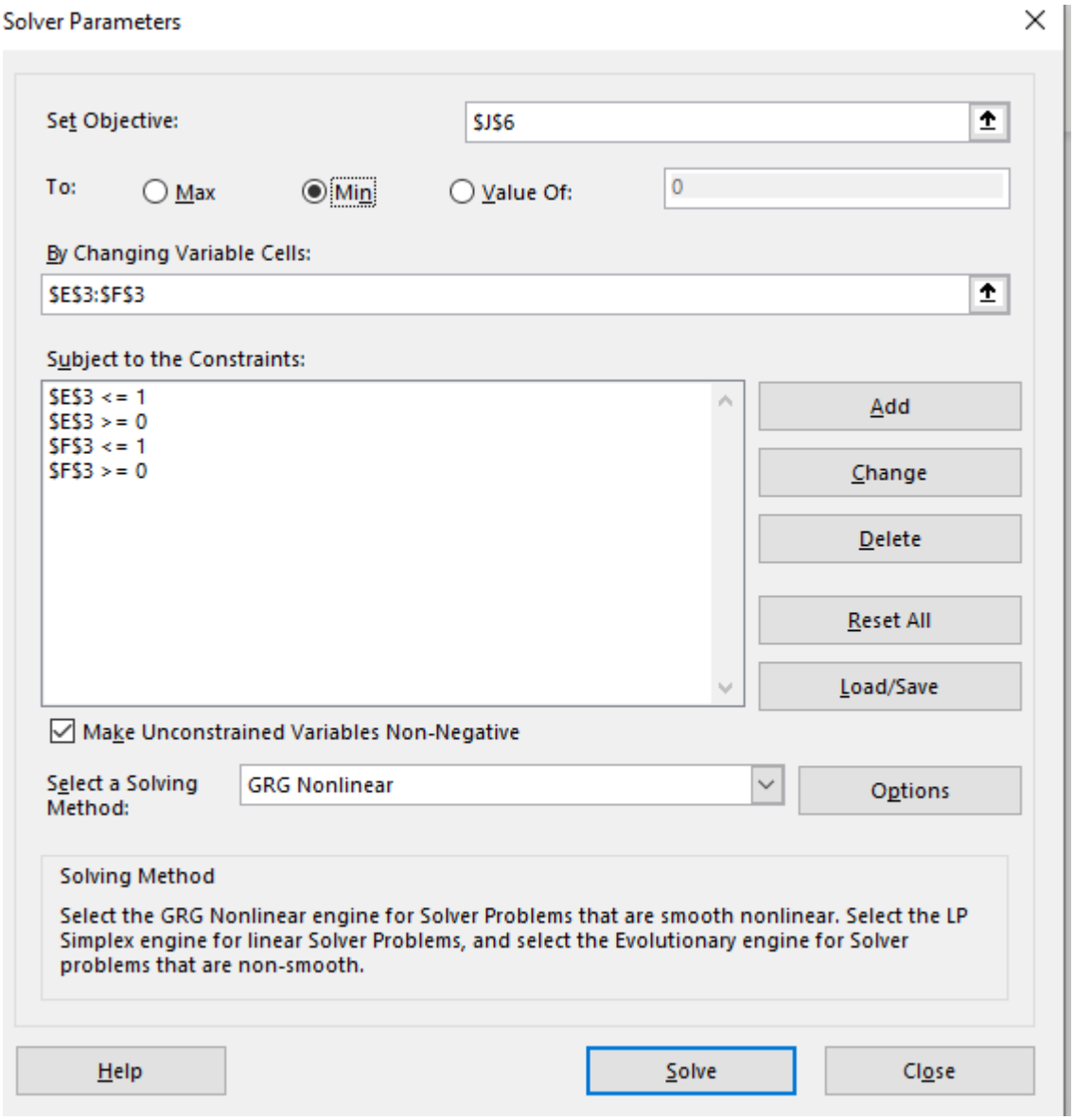
One of the key findings of this project is the need to streamline the ply production process. By eliminating bottlenecks, we can increase the throughput and reduce the time required to complete each product. This will result in a faster turnaround time for customers, which will increase satisfaction and ultimately lead to increased revenue for the firm.

After method study it was observed that ply production assembly is inefficient and its productivity can be increased. Further, work measurement was done to break down the ply production into simpler steps and new time is standardized for the assembly line. This analysis resulted in increased

ply production by 15 sheets per day. After cost analysis it was observed that 15PKR per sheet labor cost can be saved by reaching this efficiency. Hence, obtaining more productivity and efficiency with same resources (time, labor). However, it is difficult to implement due to labor union but our target is to achieve this target within two months with providing incentives to labor.

Overall, this operations management project has provided a roadmap for improving the manufacturing processes of Haidery Boards. By implementing these recommendations, the firm can increase efficiency, reduce costs, and improve customer satisfaction, which will ultimately lead to a more successful and profitable business.

6 Appendix


Solver Parameters
Set Objective:
$J$6
To:
Max
Min
Value Of:
0
By Changing Variable Cells:
$E$3:$F$3
Subject to the Constraints:
$E$3 <= 1
$E$3 >= 0
$F$3 <= 1
$F$3 >= 0
Add
Change
Delete
Reset All
Load/Save
Make Unconstrained Variables Non-Negative
Select a Solving Method:
GRG Nonlinear
Options
Solving Method
Select the GRG Nonlinear engine for Solver Problems that are smooth nonlinear. Select the LP Simplex engine for linear Solver Problems, and select the Evolutionary engine for Solver problems that are non-smooth.
Help
Solve
Close

Regression Analysis

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.89406							
R Square	0.79935							
Adjusted R	0.5987							
Standard I	18021.4							
Observati	3							
ANOVA								
	df	*SS*	*MS*	*F*	*ignificance F*			
Regressio	1	1.3E+09	1.3E+09	3.98384	0.29568			
Residual	1	3.2E+08	3.2E+08					
Total	2	1.6E+09						
	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	487903	24559.1	19.8665	0.03202	175850	799955	175850	799955
X Variable	16650.9	8342.3	1.99596	0.29568	-89348.1	122650	-89348.1	122650

7 References

- Heizer, Render, 2016, OPERATIONS MANAGEMENT: Sustainability and Supply Chain Management (12), Pearson.
- Meredith, 1999, Introducing Operations Management, Wiley.
- Krajewski, 2011, Operation Management: Processes and Supply chain, Pearson.
- Shafer, 2015, Operations and Supply chain Management for MBAs, Wiley.
- https://jianzhongwoodmachine.en.made-in-china.com/productimage/CsLnwcvEkjWi-2f1j00wKhVylrdkCzT/China-15-Opening-Hot-Press-Machine-for-Plywood-Blockbard-Particle-Board.html