Production Capacity Optimization with Rough Cut Capacity Planning (RCCP)

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Abstract. One of the factors supporting the company’s success in achieving its goals is the ability to meet demand and provide satisfaction to customers. A musical instrument industry makes products with a make to order system, so that it requires the accuracy and smoothness of the production process to meet the demand in accordance with the specified time. Based on data on average total daily production of Spray and Sanding Balikan Factory 2, it is known that there is still often an imbalance between the actual production of the planned production at regular work time. This study aims to analyse and evaluate the capacity of production resources and facilities. The Rough Cut Capacity Planning (RCCP) method is a method that can show a comparison between the actual capacity available and the capacity needed. Based on the research results, workload rearrangement must be carried out to distribute labor and increase work hours 90 minutes and 120 minutes so that demand can be fulfilled.

1. Introduction

One of the factors supporting the success of a company in achieving its objectives is the ability to meet demand and provide satisfaction to customers. Successful planning and manufacturing control requires effective capacity planning to be able to meet the established production schedule [1]. The industry that is the object of research is a musical instrument industry that produces Upright Piano (UP) and Grand Piano (GP) pianos that apply make to order production systems, so that it requires the accuracy and smoothness of the production process to meet demand in accordance with the specified time.

In general, it can be described that the piano production process is wood working which is responsible for processing the abrasive material into cabinet - painting, which has the duty to provide coloring to the cabinet, and assembly, which is to assemble the cabinet into a piano music instrument. Not achieving the production target in the painting department will have a major effect on the delay in sending the piano to the customer. One of the work stations under the painting department is the Spray and Sanding Balikan Factory 2. Based on the average total daily production for the last 6 months, it is known that there is still an imbalance between the actual production and the production plan at regular work time. The imbalance between the actual production and the production plan causes the Spray and Sanding Balikan Factory 2 work stations to increase daily work hours (over time) and accept process delegation for some cabinets from other work processes, causing overload.

Production capacity planning needs to be balanced with available production capabilities [2], both human resource capacity [3] [4] [5] [6] and the machinery capacity used [7] [8]. In dealing with these problems, integration between the production plan and the capacity plan needs to be done [9].
Therefore, it is necessary to conduct an analysis and evaluation of the capacity of production resources and facilities available in the Spray and Sanding Balikan Factory 2 production line so that they are suitable and can support the planned master production schedule. To analyze these problems the Rough Cut Capacity Planning (RCCP) method is applied. RCCP is an analysis to test the availability of production facility capacity to meet the established master production schedule [10]. RCCP is second in the priority-capacity planning hierarchy that plays a role in developing Master Production Schedule (MPS). RCCP validates the MPS that has been made.

RCCP method can show a comparison between the actual available capacity and the required capacity, so that the company is able to make the right production capacity planning to meet consumer demand. RCCP method can also be used to determine whether a production schedule requires overtime work, sub-contracts, as well as the addition of facilities or labor to meet demands on time.

This study aims to balance between the actual productions capacities available against the production targets at the Spray and Sanding Balikan Factory 2 work stations so that the spray department is able to meet the needs according to the production target.

2. Method

The research object is a music industry with the main material are wood. Focus of this research is to analyze the balance between the actual production capability of the company's production targets in the coming period in the “Spray Working Group” and “Sanding Balikan” Department of Painting Factory 2.

Primary data obtained in the field which includes direct observations and interviews, data Secondary data is obtained from company records to conduct capacity planning, including: data on total demand, work center cycle time, number of days and hours of work, number of workers, and others. Secondary data is also taken from the research literacy of various parties that have a correlation with the.

3. Result and Discussion

3.1. Production process

Research focuses on the spray and sanding section of the Painting Factory 2 department. The production process in this section is generally as follows:

- **Spray Undercoat**, serves as a base coating so that the main paint can adhere properly
- **Sanding Balikan** is the process of sanding on the remnants of paint. The sanding and reverse process is carried out on the part after going through the process of painting. The process of reversing sanding goes through three stages: sanding machine belt sander on the surface, free hand sander on the rib part, and cleaning.
- **Topcoat Spray** is the main paint for piano parts that use a type of enamel paint.
- **Waiting Room**, is the process of drying freshly painted parts that lasts for 1.5 hours.
- **Seasoning Room** is a drying process after the waiting room process with a temperature of 40\(^\circ\)C and lasts 2 hours.

![Figure 1. Step of research](image)
3.2. Work Groups & Time Working
Groups are divided based on the similarity of tasks and workload on each operator. The list of working groups and direct operators in the Spray section is presented in the following Table 1:

| No | Work Group      | Operator         |
|----|-----------------|------------------|
| 1  | Painting Booth 1| Operator 1 - 4   |
| 2  | Painting Booth 2| Operator 5       |
| 3  | Painting Booth 3| Operator 6       |
| 4  | Painting Booth 4| Operator 7 - 9   |
| 5  | Painting Booth 5| Operator 10 - 13 |
| 6  | Painting Booth 6| Operator 14      |
| 7  | Painting Booth 7| Operator 15      |

Time hours in industry is Monday to Friday with daily work schedules 07.00 - 16.00 with a total rest period of 60 minutes. The number of normal working hours is assumed to be the same as 460 minutes. The data is used as input in calculating RCCP.

3.3. Cycle Time & Allowance
Data on standard time for piano products:

| No | Work Group      | Total time (Minute) |
|----|-----------------|---------------------|
| 1  | Painting Booth 1| 120,39              |
| 2  | Painting Booth 2| 117,35              |
| 3  | Painting Booth 3| 21,95               |
| 4  | Painting Booth 4| 673,14              |
| 5  | Painting Booth 5| 1240,78             |
| 6  | Painting Booth 6| 4,90                |
| 7  | Painting Booth 7| 1623,93             |

The standard time data in table 2 are the accumulation of standard time for working the piano cabinets which are the responsibility of each working group.

| No | Work Group      | Work Margin (%) |
|----|-----------------|-----------------|
| 1  | Painting Booth 1| 15%             |
| 2  | Painting Booth 2| 28%             |
| 3  | Painting Booth 3| 20%             |
| 4  | Painting Booth 4| 37%             |
| 5  | Painting Booth 5| 17%             |
| 6  | Painting Booth 6| 30%             |
| 7  | Painting Booth 7| 30%             |
Allowances are all activities that are outside the main work activity group. The allowance level is represented in the form of a percentage ratio of the work sampling observations.

3.4. Capacity

Data taken is the demand data for piano products in the "period 195" which began in April 2018 until March 2019, which is 2939 consisting of various types of cabinets. Data on demand for piano products in the 195 period will then be used as input to predict the daily production of pianos in the coming period that is "period 196".

Data processing is done forecasting to predict demand for piano products in the period 196 (April 2019-March 2020) with product demand data in the period 195 (April 2018-March 2019) as initial input. Based on the results of the calculation of the three methods (time series analysis is Moving Average, Single Exponential Smoothing, and Linear Regression) forecasting used is known that forecasting with the dominant linear regression method produces the smallest forecasting error value. Based on these results, the forecasting method chosen is forecasting using linear regression method. By using demand data for selected forecasting products for the period 196 (April 2019-March 2020), the required capacity is calculated for each working group.

Capacity available for spray working groups in the Spray and Sanding Balikan Factory 2 section, capacity requirement and count of comparison between both for each work group are presented in the following table 4:

| No | Work Group       | Capacity Available (Hour/Day) | Capacity Requirement (Hour/Day) | ± Capacity (Hour/Day) |
|----|------------------|-------------------------------|---------------------------------|-----------------------|
| 1  | Painting Booth 1 | 26,07                         | 40,21                           | -14,14                |
| 2  | Painting Booth 2 | 5,52                          | 1,92                            | +3,60                 |
| 3  | Painting Booth 3 | 6,13                          | 7,48                            | -1,35                 |
| 4  | Painting Booth 4 | 14,49                         | 5,43                            | +9,06                 |
| 5  | Painting Booth 5 | 25,45                         | 20,72                           | +4,73                 |
| 6  | Painting Booth 6 | 5,37                          | 3,91                            | +1,46                 |
| 7  | Painting Booth 7 | 5,37                          | 3,40                            | +1,97                 |

Based on data in table 4, can be seen that there is an imbalance in capacity. The capacity needed, the working group Painting Booth 1 experienced a shortage of 14.14 hours per day, and Painting Booth 3 at 1.35 hours per day.

Operator workload is presented in Figure 2. Based on workload calculations, it can be seen that the operator workload is uneven, seen in operators 1–4 (Painting Booth 1) having the highest workload. To make this workload evenly needed distribution of workload to other operators who have a category and similarity of work processes. The working group that has similar expertise and work process is operator 5 (Painting Booth 2). Time requirements for operators 7-9 (Painting Booth 4).
1 operator on painting booth 4 will be moved to painting booth 2 to help work on painting booth 2. With this scenario the division of workload on each operator in the Spray Booth 1 working group will experience changes as shown in the following table 5.

### Table 5. Data of after addition overtime

| No | Work Group          | Man | Capacity Available (Hour/Day) | Capacity Requirement (Hour/Day) | ± Capacity (Hour/Day) |
|----|---------------------|-----|-------------------------------|-------------------------------|-----------------------|
| 1  | Painting Booth 1    | 4   | 26,07                         | 30,33                         | -4,27                 |
| 2  | Painting Booth 2    | 2   | 11,04                         | 10,99                         | +0,05                 |
| 3  | Painting Booth 3    | 1   | 6,13                          | 7,48                          | -1,35                 |
| 4  | Painting Booth 4    | 2   | 9,66                          | 3,69                          | +3,69                 |
| 5  | Painting Booth 5    | 4   | 25,45                         | 20,72                         | +4,73                 |
| 6  | Painting Booth 6    | 1   | 5,37                          | 3,91                          | +1,46                 |
| 7  | Painting Booth 7    | 1   | 5,37                          | 3,40                          | +1,97                 |

By distributing workloads, the results obtained there are still capacity shortages in the Painting Booth 1 and Painting Booth 3 work groups as much as 4.27 hours / day and 1.35 hours / day. Workload distribution in Painting Booth 1 and Painting Booth 3 can no longer be done, so the other strategy is by increasing are work hours. The data with the scenario of adding work hours is shown in the following table 6.

### Table 6. Overtime

| No | Work Group          | Man | Capacity Available (Hour/Day) | Capacity Requirement (Hour/Day) | ± Capacity (Hour/Day) |
|----|---------------------|-----|-------------------------------|-------------------------------|-----------------------|
| 1  | Painting Booth 1    | 4   | 1,5                           | -4,27                         | +0,83                 |
| 2  | Painting Booth 2    | 1   | 2,0                           | -1,35                         | +0,25                 |
Based on the data in table 6 the capacities in PB 1 and PB 3 have been fulfilled, so the comparison between the available capacity and the required capacity after all the proposed improvements is as follows on table 7.

**Table 7.** Data after addition overtime

| No | Work Group       | Man | Capacity Available (Hour/Day) | Capacity Requirement (Hour/Day) | ± Capacity (Hour/Day) |
|----|-------------------|-----|-------------------------------|---------------------------------|-----------------------|
| 1  | Painting Booth 1  | 4   | 31,17                         | 30,33                           | +0,83                 |
| 2  | Painting Booth 2  | 2   | 11,50                         | 10,99                           | +0,51                 |
| 3  | Painting Booth 3  | 1   | 7,73                          | 7,48                            | +0,25                 |
| 4  | Painting Booth 4  | 2   | 9,66                          | 5,97                            | +3,69                 |
| 5  | Painting Booth 5  | 4   | 25,45                         | 20,72                           | +4,73                 |
| 6  | Painting Booth 6  | 1   | 5,37                          | 3,91                            | +1,46                 |
| 7  | Painting Booth 7  | 1   | 5,37                          | 3,40                            | +1,97                 |

By redistributing excess workloads, moving operators from one group to another, and adding overtime hours of 90 minutes and 120 minutes each day, all of the existing capacity deficiencies, booth in Painting Booth 1 and Painting Booth 3 can be overcome.

![Figure 3. Capacity comparison after repair.](image)

4. **Conclusion**

Comparative analysis of available production capacity against the capacity needed for the level of demand in the period 196 (April 2019-March 2020) there is still an imbalance in capacity. Based on the results of the analysis, it is necessary to optimize the capacity planning in each working group by managing and increasing the available capacity.

In order to balance between the actual production capacity and the planned production target in the period 196 (April 2019-March 2020) redistributing loads and overtime are redistributed.
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