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Capacity Planning of New Product in PT Perkebunan Nusantara VIII (Oolong Tea)

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ABSTRACT: In early 2021 PTPN VIII began producing a new product based on consumer demand, namely oolong tea, within an estimated contract worth IDR 6.000.000.000 of 150 tons. Thus, the firm should be prepared related to the garden and the factory to produce the oolong tea. This research uses a quantitative descriptive method by analyzing the capacity of the garden to provide the raw material for oolong tea; in the process of oolong tea production, the garden can provide 2.5 tons per day, exceeding the calculation of 1.9 tons. However, the machine used for the production process is inadequate. The machine's capacity is only available to produce 106.78 tons per year, which is below consumer demand. It requires the firm to add three rotary dryer machines. Adding three machines meant oolong tea production reached 150 tons only in 13 hours and 25 minutes. Adding these machines also requires the firm to invest as much as IDR 540,000,000; by this investment value of the machine, the payback period will return in 4,4 years with the machine durability more than 25 years.

KEYWORDS: Bottleneck, Capacity, Capacity Planning, Payback Period, Production.

INTRODUCTION

The food and beverage industry is one of the world's largest and most important industries, playing a vital role in feeding population and providing employment opportunities [1]. The industry continues to evolve and expand with a growing global population and increasing demand for convenient, high-quality food and beverage products. Especially in Indonesia, GBG Indonesia said that Indonesia's economy is largely driven by rising household consumption, and one industry that thrives on this like no other is that of food and beverages. GDP growth over 11 years from 2010 to 2021 has fluctuating growth of the food and beverage industry [2]. In 2020 to 2021, the food and beverage industry are growing from 1,58 to 2,54. The GDP shows the resilience of the sector, in this case the growth of food and beverage GDP will affect the production process. Demand for the food and beverage industry in Indonesia can be said to be good, and the potential for companies to develop products will be very good. One of them is a company that produces types of drinks, especially tea, namely companies owned by the Badan Usaha Milik Negara (BUMN), namely PT Perkebunan Nusantara VIII produces various kinds of tea ranging from black tea, white tea, and green tea.

PTPN VIII is a subsidiary of PT Perkebunan Nusantara III which is one of the State-owned plantations established based on Government Regulation. The company engaged in the agro-business and agro-industry industry has the purpose and objective of organizing business and utilizing the company's resources in order to produce goods and services of high quality and strong competitiveness. Early in 2021, PT Perkebunan Nusantara VIII planned to develop a new product "oolong tea" and decided to produce in response to a request from the client, Suntory Japan. The contract will be carried out in February 2023 throughout the process of growing oolong tea. It's done from 2022 to 2023 after the trial period. Oolong tea is produced using a different brewing technique than other types of tea, such as black tea and green tea, as well as a separate semi-fermentation procedure. The company uses the Rancabolang garden in Kabupaten Bandung and the Pangheotan facility in Purwakarta to produce oolong tea. The Rancabolang plantation was chosen to supply the raw materials with the firm RB3 clone, which has a distinct aroma of tea flavour. The Purwakarta factory, on the other hand, has a proper machine for producing oolong tea that is entirely dedicated to the production process. Currently, the company has an issue with signing a contract with a production amount of 150 tons per year; the agreement is calculated based on 1 kg of oolong tea that has been produced, IDR 40,000 / kg. Now, the company needs to calculate the capacity of the tea garden and the machines and profit in 150-ton production. According to the description, this study will aim to analyze the existing capacity of oolong tea, capacity planning and does it need additional capacity and also the payback period.

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THEORITICAL FOUNDATION

1. Manufacturing Process Flow Design

Manufacturing is the conversion of materials and information into goods that meet human needs. The growing trend of manufacturing globalization and decentralization [3]. Real-time information exchanges and seamless coordination across the many nodes in a product development life cycle, such as design, setup planning, production scheduling, machining, assembly, etc., are necessary for manufacturing [4].

Manufacturing process flow design is a method to evaluate the specific processes that raw materials, parts, and subassemblies follow as they move through the plant. The most common production management tools used in planning and designing the process flow are assembly drawings, assembly charts, route sheets, and flow process charts. Each of these charts is a useful diagnostic tool and can be used to improve operations during the steady state of the production system. Indeed, the standard first step in analysing any production system is to map the flows and operations using one or more of these techniques. These are the "organization charts" of the manufacturing system [5].

2. Capacity planning

Capacity planning is vital for any manufacturing company, and a few factors make this problem especially difficult for the semiconductor manufacturing industry [6][7][8][9][10]. While many industries measure and report their capacity in terms of outputs, those whose product mix is very uncertain often express capacity in terms of inputs. An operations and supply chain management view also emphasizes the time dimension of capacity. That is, capacity must also be stated relative to some period of time. This is evidenced in the common distinction drawn between long-range, intermediate-range, and short-range capacity planning. Capacity planning can be viewed in three-time horizon.

- **Long-range planning**: greater than one year. Where productive resources (such as buildings, equipment, or facilities) take a long time to acquire or dispose of, long-range capacity planning requires top management participation and approval.

3. Design and Effective Capacity

Design and Effective Capacity Design capacity is the maximum theoretical output of a system in a given period under ideal conditions. It is normally expressed as a rate, such as the number of tons of steel produced per week, month, or year [11]. For many companies, measuring capacity can be straightforward: it is the maximum number of units the company is capable of producing in a specific time. However, for some organizations, determining capacity can be more difficult. Other organizations use total work time available as a measure of overall capacity. Assuming that the delay-outage probability is limited, we use the link-layer effective capacity concept to find the achievable throughput of the fading channel [12]

4. Capacity Flexibility

Capacity flexibility allows a manufacturing system to vary the production volumes of different products to accommodate changes in the volume demand, while remaining profitable. It reflects the ability of the manufacturing system to contract or expand easily. It has been traditionally seen as being critical for make-to-order systems, but is also very important in mass production, especially for high-value products such as automobiles [13]. In another hand, One part is related to capacity as a decision category within a manufacturing strategy, dealing with the strategic acquisition (or reduction) of capacity relative the long-term demand [14]

5. Capacity planning in services versus Manufacturing

Service capacity is more time- and location-dependent, it is subject to more volatile demand fluctuations, and utilization directly impacts service quality [5]

- **Time** Unlike goods, services cannot be stored for later use. As such, in services, managers must consider time as one of their supplies. The capacity must be available to produce a service when it is needed. For example, a customer cannot be given a seat that went unoccupied on a previous airline flight if the current flight is full. Nor can the customer purchase a seat on a particular day's flight and take it home to be used at some later date. 6. Evaluation Technology Investment

2

According to [15] the transformative capacity of new technologies has to be combined with the adaptability of the sectoral structures, institutions, and actors when confronted with the challenges of new technological opportunities. Scale economies in farm production associated with machinery thus require both that effective machine capacity depends on acreage and that there are economies of scale in machine capacity[16].

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METHODOLOGY

Descriptive quantitative are used in this study to analyze the existing capacity in oolong tea production by using secondary collecting data methods. Secondary data are collected from the company data in the operational division, in particular cultivation and maintaining assets and infrastructure division. This data will be used to calculate the capacities of the machine to produce oolong tea and also the factory storage capacity to keep the oolong tea produced. The data used in this study are the contract with Suntory Japan, the number of machines, each machine's capacity, and COGS.

ANALYSIS

In this research, the author analyzes the existing capacity production, then calculates the ideal capacity to produce 150-tons oolong tea. The raw material of oolong tea is provided from the Rancabolang garden with RB3 clone type. After the raw materials were sent to the factory, then the raw materials are processed into the machines that capable to produce oolong tea. To meet the 150-tons production of oolong tea, this study will analyze the machine's capacity first, then calculate the garden supply needs.

1. Existing Capacity

The first capacity analysis starts with the machines due to customer requests to produce 150 tons of oolong tea. It is necessary to analyze the machine's capacity to determine what can produce raw materials. Afterwards, it continued to analyze how the capabilities of the garden to provide raw materials.

a. Machine

In the production of oolong tea, five types of machines are used: withering through, rotary panner, open top roller, tray, and rotary dryer. Each machine has a function to reduce the water content of oolong tea raw materials. As depicted in the oolong tea production flow figure 1 below:

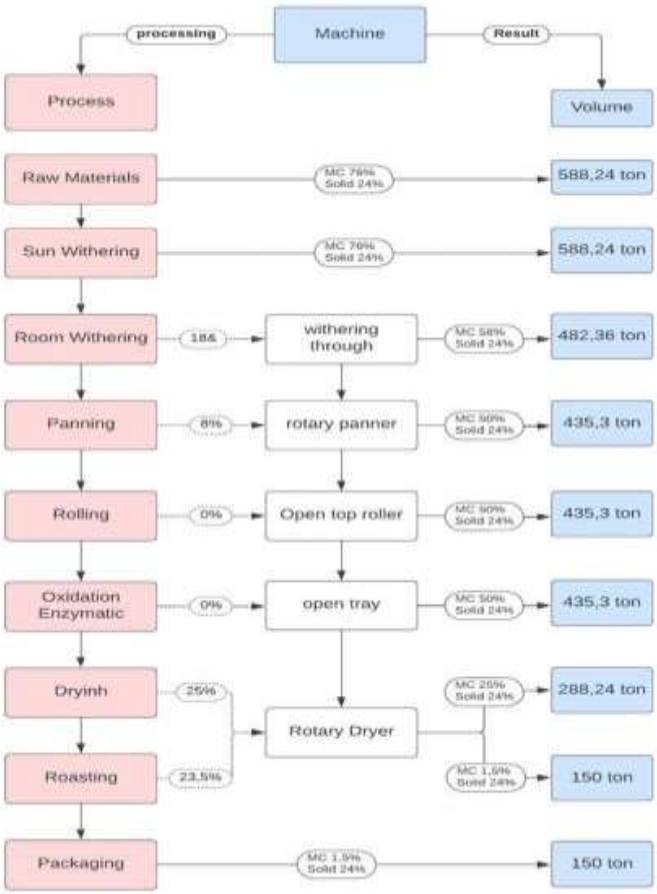

Figure 1. Oolong Tea Processing Flow Chart

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The procedure shows how 150 tons of raw tea are produced, which requires 588.24 tons of raw materials to be supplied from the Rancabolang garden. Production of oolong tea is done in phases in the flow to deliver 150 tons of Suntory's demand in a year. The raw material supply, measured daily, is 1898 kg. Machines with the capacities mentioned in table 1 below are used to process the data.

Table 1. Machine Capacity

Machine	Enable Unit	Stand by Unit	Maximum Capacity Per Unit (kg)	Maximum Capacity (kg)	Time
Withering Through	7	3	750	5250	14 hours
Rotary Panner	4	0	75	300	25 minutes
Open Top Roller	4	2	37,5	150	20 minutes
Open Tray	4	1	75	300	15 minutes
Rotary Dryer	2	1	75	150	100 minutes

According to table 1, each machine has a different capacity and a varied processing time. At the same time, each machine is characterized by the oolong tea manufacturing flow, which produces up to 150 kg of raw material. Companies refer to it as "batch," as seen in figure 2.

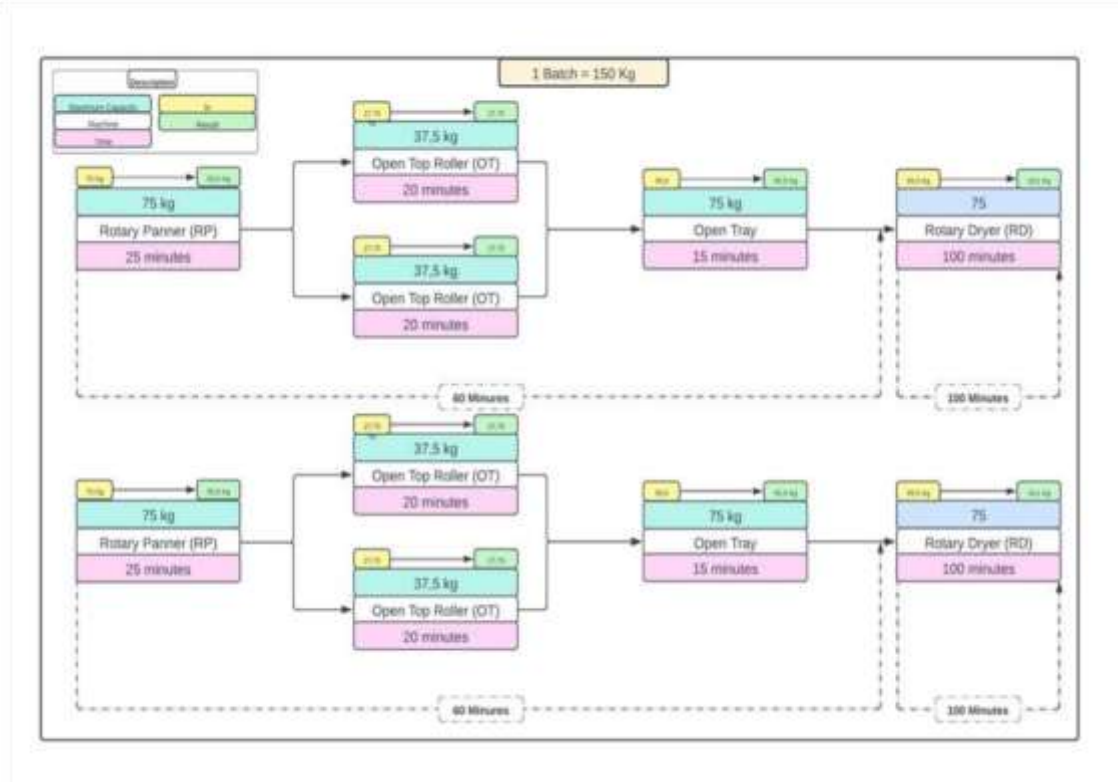

Figure 2. Oolong Tea Production Per-batch

According to Figure 2, the production process of 150 kg of oolong tea raw materials takes 160 minutes and yields 38.25 kg of oolong tea. If estimated over a year, the enterprise can only produce 106.78 tons of oolong tea, or 344.5 kg per day if computed per day. This is due to the fact that the procedure of one batch must be completed first. The inefficient process is also due to the bottleneck in figure 3 between the tray process and the rotary drier.

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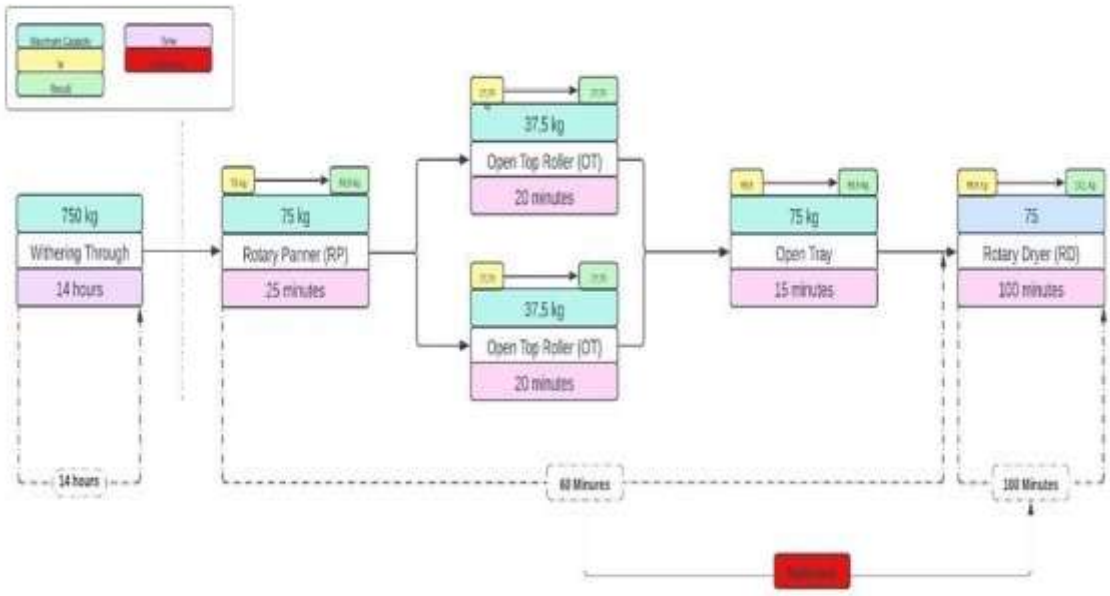

Figure 3. Bottlenek

The bottleneck has an impact on the manufacturing process since each machine cannot be directly filled when processing is done. If this is done again, the accumulation will multiply many times over. As a result, the capacity utilization rate is as shown in table 2.

Table 2. Existing Machine Utilization Rate Capacity

	Production Per Year
Capacity utilization Rate	0,63

The capacity utilization rate in the existing production process is 0.63 or 63%, indicating that capacity in the oolong tea production process is still low. That capacity analysis is required to increase the utilization percentage to 100% **b. Garden** The calculation is based on the machine capacity, where the raw material required to manufacture 150 tons per year is 588.24 tons. It is also necessary to assess the land's potential to gather tea for a year. According to calculations, the garden must be capable of producing 1898 kg of raw material every day. For the time being, the garden can offer up to 2500 kg of raw material per day if the capacity utilization rate is in table 3.

Table 3; Garden Utiliazation rate capacity

	Production Per Year (%)
Capacity utilization Rate	1,32

The garden utilization rate is 1.32 per cent, which is greater than 100% of the land capacity for raw materials for oolong tea production.

2. Additional Machine

The capacity utilization rate on the present machine is only 63%, according to the findings of the production calculation. This is because to bottlenecks created by a shortage of machinery. As a result, a machine production study is performed in order to generate up to 150 tons per year.

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a. Balancing the Machine Production

A five-minute calculation is performed in the time balancing calculation for each machine to determine the efficient time in the manufacture of oolong tea, as indicated in table 4

Table 4. Balancing Machine Calculation

Flow Machine Process	Entry of WT (Kg)	Accumulation Production Of Wt	Time	Total Time	Accumulative Time	Result	Production Perbatch (kg)	Production Per day (kg)
1	75	75	Rotary Panner / Open top roller / open tray / Rotary Dryer 1	160	160	19,125		
2	75	150	Rotary Panner / Open top roller / open tray / Rotary Dryer 2	25	185	19,125		
3	75	225	Rotary Panner / Open top roller / open tray / Rotary Dryer 3	25	210	19,125	95,625	
4	75	300	Rotary Panner / Open top roller / open tray / Rotary Dryer 4	25	235	19,125		
5	75	375	Rotary Panner / Open top roller / open tray / Rotary Dryer 5	25	260	19,125		
6	75	450	Rotary Panner / Open top roller / open tray / Rotary Dryer 1	25	285	19,125		
7	75	525	Rotary Panner / Open top roller / open tray / Rotary Dryer 2	25	310	19,125		
8	75	600	Rotary Panner / Open top roller / open tray / Rotary Dryer 3	25	335	19,125	95,625	
9	75	675	Rotary Panner / Open top roller / open tray / Rotary Dryer 4	25	360	19,125		
10	75	750	Rotary Panner / Open top roller / open tray / Rotary Dryer 5	25	385	19,125		
11	75	825	Rotary Panner / Open top roller / open tray / Rotary Dryer 1	25	410	19,125		
12	75	900	Rotary Panner / Open top roller / open tray / Rotary Dryer 2	25	435	19,125		
13	75	975	Rotary Panner / Open top roller / open tray / Rotary Dryer 3	25	460	19,125	95,625	484
14	75	1050	Rotary Panner / Open top roller / open tray / Rotary Dryer 4	25	485	19,125		
15	75	1125	Rotary Panner / Open top roller / open tray / Rotary Dryer 5	25	510	19,125		
16	75	1200	Rotary Panner / Open top roller / open tray / Rotary Dryer 1	25	535	19,125		
17	75	1275	Rotary Panner / Open top roller / open tray / Rotary Dryer 2	25	560	19,125		
18	75	1350	Rotary Panner / Open top roller / open tray / Rotary Dryer 3	25	585	19,125	95,625	
19	75	1425	Rotary Panner / Open top roller / open tray / Rotary Dryer 4	25	610	19,125		
20	75	1500	Rotary Panner / Open top roller / open tray / Rotary Dryer 5	25	635	19,125		
21	75	1575	Rotary Panner / Open top roller / open tray / Rotary Dryer 1	25	660	19,125		
22	75	1650	Rotary Panner / Open top roller / open tray / Rotary Dryer 2	25	685	19,125		
23	75	1725	Rotary Panner / Open top roller / open tray / Rotary Dryer 3	25	710	19,125	95,625	
24	75	1800	Rotary Panner / Open top roller / open tray / Rotary Dryer 4	25	735	19,125		
25	75	1875	Rotary Panner / Open top roller / open tray / Rotary Dryer 5	25	760	19,125		
26	23	1898	Rotary Panner / Open top roller / open tray / Rotary Dryer 1	25	785	5,865	5,865	

According to table 4 above, it requires the addition of three rotary dryers and one open tray so that it can produce 484 kg in only 785 minutes or 13 hours and 5 minutes. Based on these calculations, the flow is only one but it is done repeatedly, as shown in figure 4

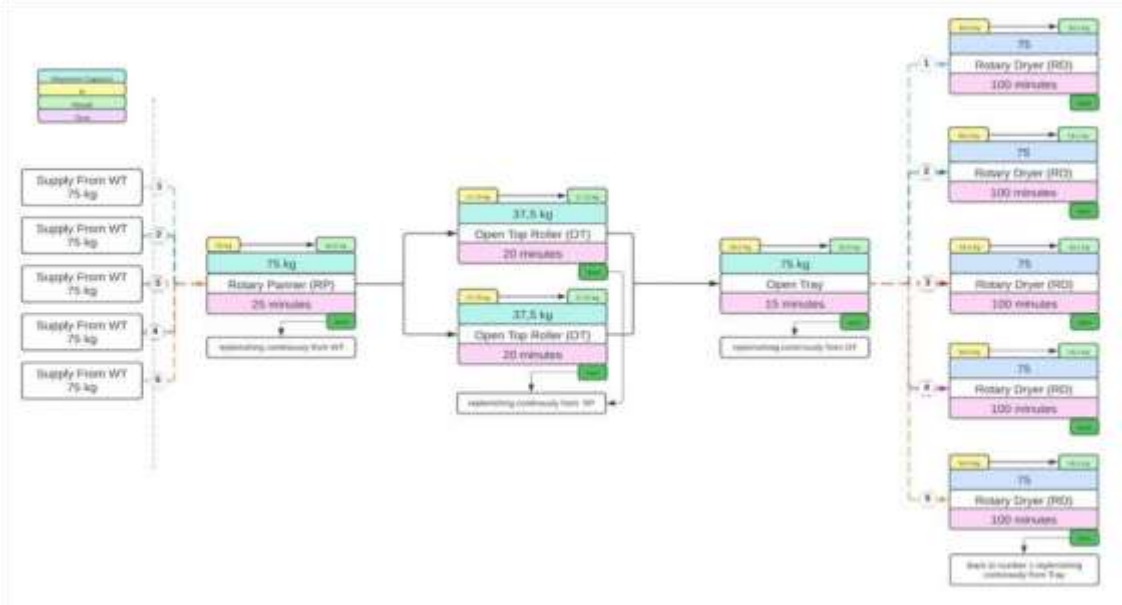

Figure 4. New Oolong Tea Process

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The number of processing machines used for oolong tea is shown in table 5 below.

Table 5. Machine Use for Oolong Tea Production

No	Machine	Maximum Capacity (Kg)	Enable Unit	Stand by Unit	Adding Unit	Total unit	Known
1	Withering Through	750	7	3	0	10	v
2	Rotary Panner	75	2	2	0	4	v
3	Open Top Roller	37,5	2	4	0	6	v
4	Open Tray	75	1	4	0	5	v
5	Rotary Dryer	75	2	1	3	6	v

The units that can be housed, according to table 5 above, are three withering through, two rotary panners, four open-top rollers, and one rotary dryer. Table 6 below lists the formula used to calculate annual production.

Table 6. Production Estimation Per day and Per year

Demand	Production Per Day (kg)	Production Per Year (kg)	Known
Customer	484,0	150000	kg
Production Planning	484,0	150000	kg

According to table 6, with a daily production of 484 kg, oolong tea production has met 150 tons of customer demand. In table 7 below, the capacity utilization rate is displayed.

Table 7. Production Planning utilization rate capacity

	Production Per Year
Capacity utilization Rate	1

The utilization rate can reach 1 or 100% with an estimated production of 13 hours 25 minutes a day, according to the capacity analysis findings

3. Payback Period Calculation

According to the production machine balancing analysis, the Pangheotan factory needs add three machines with total investment of IDR. 540,000,000. While negotiations are still ongoing, the price per kilogram of oolong tea is IDR. 40,000, or IDR. 6,000,000,000 per year. The firm has also fixed COGS per kilogram of oolong tea at IDR. 39,179, or IDR. 5,876,879,550 per year, with a profit of IDR. 6,000,000,000. The firm has also set COGS for 1 kg of oolong tea at IDR. 39,179 or IDR. 5,876,879,550 per year with a profit of IDR. 123,120,450, the results of which are displayed in table 8.

Table 8. Payback Period Calculation

Item	Nominal`(IDR)	Description
Contract Price	40.000	kg
COGS	39.179	kg
Contract Price in a year	6.000.000.000	ton
COGS in a year	5.876.879.550	ton
Profit	123.120.450	year
Payback Period	4,4	year

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The 4,4 years payback term is excellent for attaining the agreed-upon target demand of 150 tons per year because the ideal payback period for the machine's investment is around five years.

4. Implementation Plan & Justification

According to the analysis that has been conducted, the implementation plan that can be implemented in the oolong tea production process to meet the demands of Suntory Japan is listed in table 9 below

Table 9. Implementation Plan

number	program	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23
1	Propose to machine investation											
2	Approval machine investment											
3	Delivery new machine											
4	Instalation new machine											
5	Start produce oolong tea											
6	Develop monitoring and performance measures											
7	Maintain the optimum level of inventory											

CONCLUSION

In order to meet the 150-tons oolong tea Suntory Demand per year, the existing capacity cannot fulfill the demand. The firm need to be investing in the machine rotary dryer. To fulfill the demand they need to add three rotary dryers. Thus, by adding three rotary dryer machines, which will increase the oolong tea output to 150 tons per year. The payback period for this investment is estimated to be 4.4 years, which is considered a worthwhile investment if the contract with Suntory is only for five years. The additional production capacity will also result in an estimated profit of IDR 123.120.450 per year based on the contract and cost of goods sold for oolong tea.

RECOMMENDATION

The addition of three rotary dryer machines is expected to increase the daily production of oolong tea to 484 kg, or 150 tons per year. The payback period for this investment is estimated to be 4.4 years, which is less than the company's repayment term of five years. However, in order to further reduce the payback period, the company may need to negotiate pricing with its suppliers. The company must also provide training for its staff members in order to operate the new rotary dryer machines effectively, as the process is regularly modified. The company currently has a capacity planning analysis that includes three withering throughs, two rotating panners, four open-top rollers, and one rotary drier. These machines can also serve as backup equipment in case any of the production machinery experiences issues. Additionally, by operating the process 24 hours a day simultaneously, the company can increase its production of oolong tea even further. It is important for the company to carefully consider all factors and make informed decisions in order to meet the demand from its client while maintaining profitability.

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