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Overall equipment effectiveness (OEE) analysis to improve the effectiveness of vannamei (*Litopenaeus vannamei*) shrimp freezing machine performance at PT. XY, Situbondo-East Java

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Abstract. PT. XY is a company engaged in the production of frozen vannamei shrimp which cannot be separated from the problems related to the proficiency of machine or equipment. Therefore, steps needed to be taken to resolve the problem. This study aimed to improve the efficiency and effectiveness of production using Overall Equipment Effectiveness (OEE) analysis. The steps taken were as follows: Availability calculation, Performance Efficiency calculation, and Quality Product calculation. A result from the 15 observations showed availability of 96%, performance of 65.84% and quality of 99%. The OEE results from these observations were 62.87%. The data illustrate the need for improvement until the OEE score reached 85% or more. The focus of improvement was aimed at improving performance. Things that must be done to overcome the low value of performance is the monitoring of employee performance at the glazing and packaging stages to reduce the inefficient work of the engine.

Keywords: OEE, PT. XY, vannamei shrimp

1. Introduction

Increasing productivity is very important for companies to achieve success in their business processes. One example of increasing productivity is evaluating the performance of production facilities in companies. In general, problems from production facilities that cause production to be interrupted or stopped completely can be categorized into three, namely due to human factors, machinery, and raw materials. These three things can affect each other [1].

PT. XY is one of the companies engaged in freezing Vannamei shrimp by producing various types of products and sizes as well. In general, it was identified that significant problems in freezing machine operations were related to speed reduction which was concluded to be an unsatisfactory OEE. World-class OEE standards are 85% from three OEE factors with availability (90%), performance (95%) and quality (99%) [2]. But in reality, this standard is often not fulfilled. For this reason, it is necessary to calculate and analyze the OEE as an engine effectiveness indicator by calculating six large losses to determine the influencing factor of six factors six large losses. By doing OEE calculations, it will be known where the company position and company weaknesses. points can be known and then corrected [3].

2. Materials and Methods

2.1. Materials and tools

The materials used in this study, namely vannamei shrimp products peeled deveined tail on (PDTO), peeled undeveined (PND), headless easypeel. The freezing device used is the individual quick freezer (IQF) machine.

2.2. Research methods

In this study conducted the calculation of availability, performance, and quality to find out the OEE on the IQF machine in April-May 2018. Then an analysis of the causes of the problem was done by knowing the six big losses that occurred and then carried out corrective steps by using the fishbone diagram method.

2.2.1. Overall equipment effectiveness (OEE). OEE is a measurement method that is commonly used by companies on their way towards a production wherein specified it is a percentage number that is usually defined by multiplying the calculated availability rate, performance rate, and quality rate. This is a measurement of how well the equipment in a production is. The main objective to measure OEE is to make constraint equipment run more efficiently. OEE and its individual factors will give the plant numbers to see where the equipment is losing time [4]. Successful data that reflects the real equipment utilization based on the utilization estimated, managers can identify the causes of the time losses and attempt to reduce these losses [5]. OEE is the product of three percentage factors: availability, performance efficiency and quality rate.

$$\text{Availability} = \frac{\text{Operation time}}{\text{Loading time}} \times 100\% \quad (1)$$

$$\text{Performance} = \frac{\text{Total production}}{\text{Total capacity}} \times 100\% \quad (2)$$

$$\text{Quality} = \frac{\text{Good product}}{\text{Total production}} \times 100\% \quad (3)$$

$$\text{OEE} = \text{Availability} \times \text{Performance} \times \text{Quality} \quad (4)$$

- a) Availability is a ratio that shows the use of the time available for operating a machine or equipment which is expressed in percentages. Observation in one day by looking for the time determined according to the company, rest hours, which are scheduled, the time to set the size change. Then from these results, a reduction will be obtained when the engine turns on optimally. Then the operating time divided by the scheduled operation will get the availability value.
- b) Performance efficiency a ratio that shows the ability of equipment to produce products expressed in percentages. Observation in one day by finding the optimum production time, operating time then from the results will get the amount that can be produced in the operating time. The total production divided by the amount that can be produced in the operating time will get the performance value.
- c) Quality is a ratio that shows the ability of the equipment to produce a product in accordance with the standard expressed in percentages. Observation in one day by searching for total production, rejecting products, and reworking products. After that reduce the total production with reject and rework. The assets divided by the total production will get the quality value.

2.2.2. Six big losses. In the world of machine maintenance, known as the six big losses, this is something that every company must avoid. Six big losses are six losses that must be avoided by every company that can reduce the level of effectiveness of a machine. Six big losses consists of:

$$\text{Breakdown losses} = \frac{\text{Downtime}}{\text{Loading time}} \times 100\% \quad (5)$$

$$\text{Setup and adjustment} = \frac{\text{Setup time}}{\text{Loading time}} \times 100\% \quad (6)$$

$$\text{Idling and minor stoppages} = \frac{\text{Non Productive time}}{\text{Loading time}} \times 100\% \quad (7)$$

$$\text{Speed losses} = \frac{\text{Operating time} - (\text{ideal cycle time} \times \text{Processed amount})}{\text{Loading time}} \times 100\% \quad (8)$$

$$\text{Process Defect} = \frac{\text{Ideal cycle time} \times \text{Defect amount}}{\text{Loading time}} \times 100\% \quad (9)$$

$$\text{Reduced Yield Losses} = \frac{\text{Ideal cycle time} \times \text{Defect amount}}{\text{Loading time}} \times 100\% \quad (10)$$

- a) Breakdown losses is caused by the damage to the existing machine so that it cannot operate, which results in the production process being disrupted.
- b) Setup and adjustment is losses of time due to adjustments and setup processes carried out by the machine operator.
- c) Idle and minor stoppages is idle state due to disruption of a process so that other processes cannot run. Minor stoppages occur when the equipment stops shortly due to a temporary problem.
- d) Reduced speed is difference between the speed of engine design and the actual speed that occurs on the production floor.
- e) A defect in the process is defective products that are produced from imperfect production processes.
- f) Reduce yield is difference in quality due to the interval of time the machine needs from startup to settle down in a stable state.

2.2.3. Fishbone diagram. A fishbone diagram is a structured approach that allows for a detailed analysis of the causes of existing problems, discrepancies, and gaps. In this diagram, there are two main parts, namely the fish head which is described as the result or the main problem caused and the fish bones are described as the causal factors of the occurrence of existing problems, such as human, machine, method, material, and environmental factors. The root of the problem can be branched out until the root cause of the real problem is found [6].

3. Result and Discussion

3.1. Overall equipment effectiveness (OEE)

3.1.1. Availability analysis. Availability is one variable that is directly related to the value of the three factors that are needed to calculate the value of overall equipment efficiency (OEE). The definition is the availability of time for production activities by machines. Viewed from table 1, the lowest time availability is on April 20, which is 81%. The results are below standard, which is 90%. That means there is downtime on that date. Downtime itself is affected by several factors including losses due to damage to equipment or machinery, power outages, and setting time too long. On April 20, the value of low time availability was due to a problem caused by the liquid sprayed on the IQF machine that had not reached the specified freezing point so the engine was turned off to wait for the liquid to be sprayed with the IQF Machine to reach the correct freezing point. The overall value of availability is still according to the standard. The level of availability of the machine is in accordance with the standard, this indicates that the machine has the readiness to use it at any time [7].

Table 1. Availability calculation.

Date	Operating Time (minute)	Loading Time (minute)	Availability	Standard
9 April	680	692	98%	90%
10 April	552	552	96%	
11 April	468	480	98%	
12 April	565	565	100%	
13 April	427	433	99%	
14 April	278	290	96%	
16 April	268	280	96%	
17 April	236	242	98%	
18 April	680	710	96%	
20 April	693	860	81%	
23 April	324	330	98%	
24 April	637	667	96%	
25 April	668	680	98%	
26 April	688	700	98%	
27 April	818	830	99%	
Average			96%	

3.1.2. Performance analysis. Performance is a measure of the efficiency of a machine's performance in carrying out the production process. Performance is related to speed losses that describe how the engine's performance is based on the amount of production and the ideal cycle time of the operating process [8].

Based on the calculations that have been performed the average performance value is below the standard of 95%. This is because the engine does not run according to the installed capacity which is supposed to be 500 kg/hour but currently, the engine is only 350 kg/hour. If the engine runs according to the installed capacity, many shrimp accumulate after the freezing process. The factors that cause the engine not to run in accordance with the installed capacity are the absence of targets applied by the company in the glazing and packaging section which causes employees to be undisciplined in carrying out their duties will have an impact on the decrease in engine speed and losses of costs incurred by the company.

Table 2. Performance calculation.

Date	Total production (kg)	Total capacity (kg)	Performance	Standard
9 April	3,722	5,665	65.71%	95%
10 April	3,061	4,400	69.56%	
11 April	2,655	3,900	68.07%	
12 April	3,051	4,705	64.41%	
13 April	2,289	3,555	64.38%	
14 April	1,525	2,315	65.88%	
16 April	1,489	2,230	66.75%	
17 April	1,276	1,965	64.91%	
18 April	3,982	5,650	70.48%	
20 April	3,835	5,775	66.41%	
23 April	1,767	2,700	65.39%	
24 April	3,120	5,305	58.82%	
25 April	3,690	5,565	66.32%	
26 April	3,775	5,730	65.88%	
27 April	4,408	6,815	64.70%	
Average			65.84	

3.1.3. Quality analysis. Quality is a comparison of the number of products that are good for the number of products that reject or describe the ability of the equipment to produce products that meet the standards. Quality is focused on quality losses in the form of how many damaged products that occur related to equipment, which is then converted into time with an understanding of how much time the equipment is consumed to produce the damaged product.

Based on the table above shows that the value of quality has met the standard. At PT. XY is assumed to be 99%. Because in the production process it gets supervised so that not many products or materials are wasted. The resulting quality rate value is still classified safe because according to the world-class standard that is 99% [8].

Table 3. Quality analysis.

Date	Good product (kg)	Total production (kg)	Quality	Standard
9 April	3,690	3,722	99.14%	99%
10 April	3,027	3,061	98.81%	
11 April	2,628	2,654	99.00%	
12 April	3,005	3,051	99.17%	
13 April	2,269	2,289	99.12%	
14 April	1,507	1,525	98.72%	
16 April	1,475	1,489	99.12%	
17 April	1,260	1,276	98.76%	
18 April	3,937	3,982	98.87%	
20 April	3,799	3,835	99.07%	
23 April	1,758	1,766	99.59%	
24 April	3,080	3,120	98.73%	
25 April	3,650	3,690	98.91%	
26 April	3,741	3,775	99.09%	
27 April	4,344	4,409	98.52%	
Average			99%	

3.1.4. Overall equipment effectiveness (OEE) Analysis. This stage calculates the OEE value of the IQF machine, to determine the total effectiveness of the performance of the equipment in carrying out a planned work, measured from actual data related to availability, performance, and quality. After measuring the three parameters, OEE values are measured.

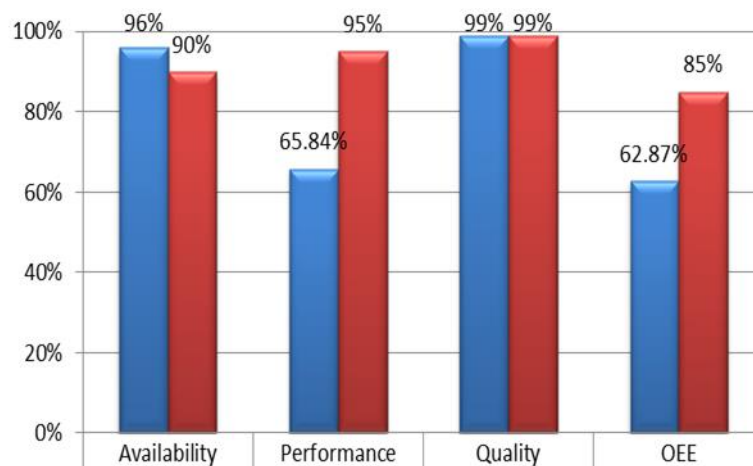


Figure 1. Diagram Overall Equipment Effectiveness (OEE) (■ Value; ■ Standard).

From the diagram, it can be seen that the OEE of the machine is below the standard OEE value, in which the IQF engine availability value is above the ideal availability value of 90%. This shows that there is a balance between operating time and load time where operating time is affected by machine downtime. IQF engine performance is below the ideal performance value of 95%. This shows that the use of the machine is not efficient because it does not match the capacity of the machine that should be. IQF quality machines are equal to an ideal quality of 99%. This shows that production runs according to the optimal point by taking into account the operating time that exists and shows that the product produced by the machine is very good. If the OEE is 60%-84%, production is considered reasonable but shows there is a large room for improvement [9].

3.2. Six big losses

After obtaining the OEE value, then the identification process of the six big losses is carried out. Analysis of the six big losses calculation is done so that the company knows the magnitude of the contribution of each factor in the six big losses that affect the level of effectiveness of using IQF machines.

Table 4. Percentage of six big losses.

Six big losses	Total time losses (minutes)	Percentage (%)	Cumulative percentage
Reduce speed losses	2,723	87	87
Idle and minor stoppage losses	185	6	93
Setup and adjustment losses	168	5.3	98.3
Defect losses	38	1.2	99.5
Yield losses	16	0.5	100
Breakdown losses	0	0	0
Total	3,130	100	

Based on the ordering of the total time losses value of the six big losses factor shown in table 5. It can be seen from the six factors of the six big losses that affect the effectiveness of the IQF engine during production activities at PT. XY. From the factor six big losses percentage obtained then can be used Pareto diagrams to identify causes due to IQF machine effectiveness during production activities. The Pareto diagram for the six big losses can be seen in figure 2.

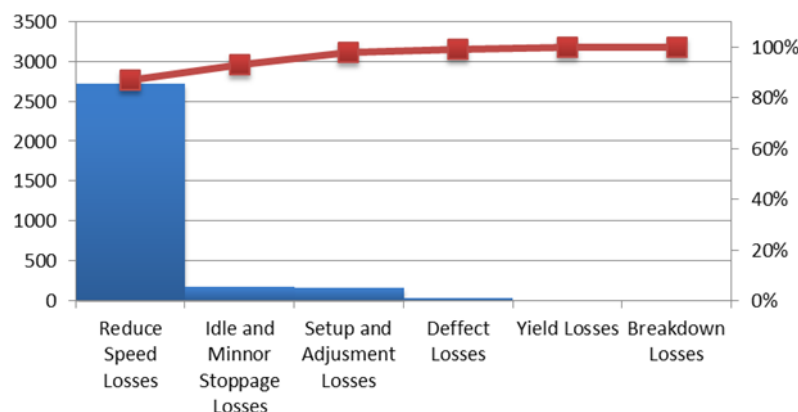


Figure 2. Pareto diagram, ■ total time losses; — percentage.

According to the Pareto rule, the cumulative percentage value approaching or equal to 80% is a priority of the problem [10]. Based on the Pareto diagram, there is the highest factor, namely reducing speed losses of 87% with an accumulated percentage of 87%, so this factor is the priority of the problems that will be analyzed further using a causal diagram.

3.3. Fishbone diagram

This diagram is used to analyze the factors that cause damage by finding or finding and describing the factors that cause problems. Decomposition is carried out in such a way that the elements identified and ascertained that damage will be made as an improvement program [11].

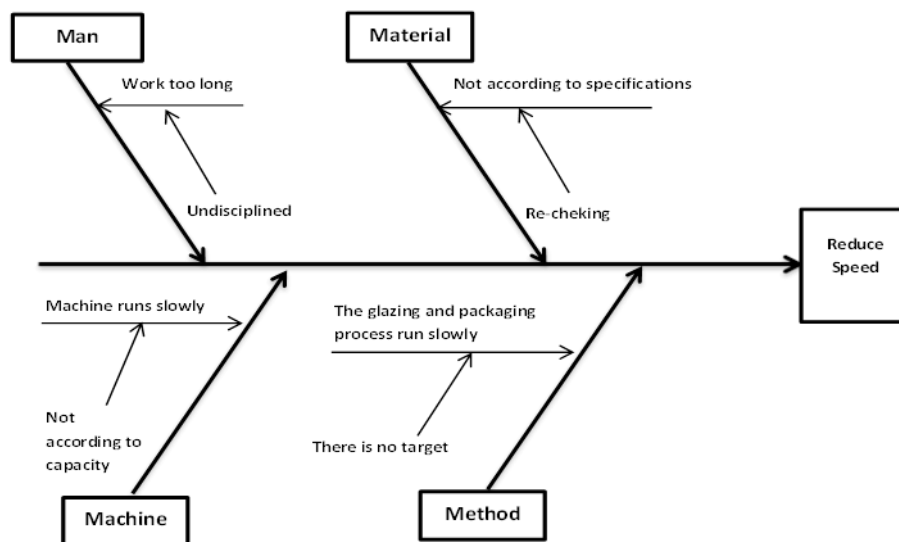


Figure 3. Fishbone diagram.

From the picture above the factor that causes reduce speed is:

- 1) Method
Factors occur because under the standard of use of the machine because it does not have a target in the process of glazing and packaging, which causes time wasting when moving shrimp each process.
- 2) Man
This is due to the employee's indiscipline in carrying out the task so that the process becomes slow.
- 3) Machine
This is caused by the use of machines that make production capabilities decrease because the speed of the engine does not run according to the installed engine capacity.
- 4) Material
Materials that do not meet specifications will hamper the course of the production process by example if the material does not match specifications, it will often re-freeze it causes the production process to be hampered.

4. Conclusion

The average value of IQF machine OEE is 62.87% with an availability value of 96%, performance 65.84%, and quality 99%. OEE values on IQF machines are still below the standard OEE value in the world, which is 85% which is considered still low. The main factor influencing the low OEE value on IQF machines is a reduction in engine speed (reduce speed) with a percentage of 87%. Other factors that cause losses are 6% (idle and minor stoppage), 5.3% (setup and adjustment), 1.2% (defect losses), and 0.5% (yield losses). From the analysis using cause and effect diagrams can be known the cause of the decrease the speed of the engine is in humans with the factor of employee indiscipline in carrying out the task so that the process becomes slow.

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