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To cite this article: R Wiranata *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **278** 012082

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Effectiveness availability of Individual Quick Freezing (IQF) using Overall Equipment Effectiveness (OEE) analysis at PT. X, Karawang-West Java

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Abstract. There are 11 processing factories producing pangasius frozen fillets in Java and Sumatra, Indonesia. PT. X is a fisheries processing company engaged in catfish fillet freezing in Indonesia, identified problems with the effectiveness of the individual quick freezing due to machinery that suddenly stopped, decreased the speed of production, length of preparation time and arrangement. The problems cause loss, reduce the efficiency and effectiveness of the operation. This study aimed to investigate three steps needed to prevent and overcome the problem: availability, performance and quality. The data obtained from the observations determined an availability of 82.34%, performance of 75.21% and quality of 99.94%, with an overall equipment effectiveness (OEE) value of 60.43%. This study show that if availability values can be increased to 100%, it can save the company electricity costs by 329,611.37 IDR per day. The data show that the value of the OEE engine can still be increased to 85% or more. The results suggest that the matters should be addressed are increasing the coordination of the employees and creating a standard operating procedure (SOP) in the freezing stage 1 and 2 to improve the efficiency and effectiveness of the machine.

Keywords: availability, IQF, OEE, PT. X

1. Introduction

Pangasius is one of the commodities in fisheries and marine sectors in Indonesia and its production is most likely to increase as well as has an adequately large potential for its development with a high range of market opportunities, both at the local and abroad [1]. PT. X is a fishery processing companies engaged in catfish fillets freezing and having problems in using machine effectiveness. Overall equipment effectiveness (OEE) is a method that can be used to clearly identify the root of such problems and its causal factors, so as to make an improvement. This method has been applied thoroughly by many companies in the world [2]. The ideal OEE value is considered to be 85% [3]. This value is composed of three factors: availability (standard 90% or more), performance (standard 95% or more) and quality with a standard of 99% or more [2]. This study aims to generate effectiveness in using the freezing method of Pangasius fillet through OEE measurements consist of three points namely availability, performance and quality [4].

2. Methods

In the calculation, OEE measures effectiveness by using three points of view to identify six big losses, namely availability, performance and quality [4]. Availability is a ratio that shows the use of the time



available for the operation of machinery or equipment which is stated in percentage. Performance is a ratio that shows the ability of equipment to produce a product that is expressed in percentage. Quality is a ratio that shows the ability of equipment to produce products that are in accordance with standards expressed in percentages [5]. This freezing method is done by passing the product to be frozen in an insulated aisle, then the product is sprayed with cold air continuously. Processed fish or other types of food enter the freezer with a conveyor that continues to run at speed and temperature that can be regulated by the operator [6].

2.1. Measurement of availability rate

Availability measurement flow consists in assessing of how long the machine is turned on or how long the engine works, looking for how long it takes to prepare the machine to be ready for use in freezing and determining how much time is wasted during machine usage (Total Downtime). The availability calculation formulas (1) [7] are as follows:

$$\begin{aligned}
 \text{Actual operating time} &= \text{Machine working time} - \text{preparation time} \\
 \text{Availability} &= (\text{actual operating time}) / (\text{scheduled operating time}) \times 100\% \\
 \text{Engine working time} &= \text{From the start of the engine until the engine dies} \\
 \text{Preparation time} &= \text{The length of time required for an IQF machine to reach freezing} \\
 &\quad \text{temperatures according to company rules } (-28\text{OC}) \\
 \text{Total Downtime} &= \text{Time of failure and repair} + \text{Light off} + \text{Time wasted} \\
 \text{Electricity savings from the use of machine time} & \\
 \text{Losses} &= \text{Time wasted} \times \text{KWH machine} \times \text{Electricity costs required}
 \end{aligned}
 \tag{1}$$

2.2. Calculation of performance rate

Performance calculation flow consists of assessing the time needed to complete one freezing or freezing time per Lot and assessing the maximum production target that can be achieved according to the time needed for one freezing. This calculation is based on the hourly factory determination, determining production results obtained in one freeze or per Lot. The performance calculation formula (2) [7] is as follows:

$$\begin{aligned}
 \text{Performance} &= (\text{Production}) / (\text{Production target}) \times 100\% \\
 \text{Lot} &= \text{Any freezing on the observations of the day} \\
 \text{Freezing time} &= \text{time needed to freeze each lot (hours)} \\
 \text{Production target} &= \text{weight that must be frozen within 1 hour} \\
 \text{Production results} &= \text{weight froze in 1 time (Lot) freezing per fiber}
 \end{aligned}
 \tag{2}$$

2.3. Calculation of quality rate value

The quality calculation flow consists of assessing how much weight the product has when frozen, and determining how much product is frozen. Product must be rejected if it experiences incomplete freezing or is not meeting company standards. The quality calculation formula (3) is as follows[7]:

$$\begin{aligned}
 \text{Quality} &= (\text{total reject freezing and freezing}) / (\text{total freezing}) \times 100\% \\
 \text{Total clot} &= \text{Weight that is frozen in 1 machine life} \\
 \text{Reject and freeze product} &= \text{The weight of the product being rejected and frozen because it is not} \\
 &\quad \text{according to the factory standard.}
 \end{aligned}
 \tag{3}$$

2.4. Calculation of overall equipment effectiveness (OEE)

OEE calculation can be done by multiplying the availability, performance and quality values obtained in percent form. The OEE calculation formula (4) is as follows:

$$\text{OEE} = \text{availability}\% \times \text{performance}\% \times \text{quality}\%
 \tag{4}$$

3. Results and Discussion

3.1. Availability value

Availability was obtained from the machine working time, machine preparation time, scheduled machine operating time, total wasted time and actual operating time. The results of the availability value measurement can be seen in table 1.

Table 1. Availability value measurement results.

Observations	Machine working time (minutes)	Preparation time (minutes)	Scheduled operation time (minutes)	Total downtime (minutes)	Actual operating time (minutes)	Availability (%)
1	1,110	60	1,050	272.40	777.60	74.06
2	1,230	60	1,170	217.25	952.75	81.43
3	1,195	60	1,135	196.67	938.33	82.67
4	690	60	630	58.37	571.63	90.73
5	1,280	60	1,220	163.89	858.66	70.38
6	1,261	60	1,201	212.07	988.93	82.34
7	1,260	60	1,200	235.87	964.13	80.34
8	900	60	840	162.18	677.18	80.62
9	1,265	60	1,205	247.95	957.05	79.42
10	1,267	60	1,207	231.83	975.17	80.79
11	1,276	60	1,216	219.65	996.35	81.94
12	1,240	60	1,180	231.86	948.14	80.35
Average	1,164.5	60	1,104.5	204.22	883.83	80.42
Average						80.42

Based on the observations of table 1, the results of the IQF machine availability measurement based on 12 observations was 80.42%. These results do not meet the performance standard of 90% [2]. This is due to the time lapse wasted when the freeze changes from 1 to freeze 2 caused by a lack of coordination between the 1 freezing team and the 2 freezing, and employees who are late after rest. The average total time spent using the machine from 12 observations is 204.22 minutes or 3.4 hours. Of the total average wasted time, it can cause losses to the company, which can be seen with a rough calculation as below:

$$\begin{aligned}
 \text{Average time wasted (a)} &= 3.4 \text{ hours} \\
 \text{KWH engine (b)} &= 66 \text{ KWH / Hour (Engine specifications used)} \\
 \text{Electricity Price / KWH / Hour (c)} &= \text{Rp. } 1,467.28 \text{ (Obengplus, 2018)} \\
 \text{Losses obtained} &= a \times b \times c \\
 &= 3.4 \text{ hours} \times 66 \text{ KWH / hour} \times \text{Rp. } 1,467.28 / \text{KWH / hour} \\
 &= \text{Rp. } 329,611.37
 \end{aligned}$$

So the losses suffered by the company with 3.4 hours per day of wasted machine usage amount to Rp. 329,611.37. With this average, the company will experience a loss of Rp. 1,977,668.21 in a week with 6 working days and in a month with 25 working days will experience a loss of Rp. 8,240,284.22. In a year with 300 working days, the company will experience a loss of Rp. 98,883,410.63. This loss is obtained because the machine is operational but there is no freezing process on the product, given a large amount of time wasted and because there is no SOP implemented at the freezing stage. So, as to overcome this problem, it is suggested to establish an SOP at the freezing stage. For example, when you want to change the freeze 1 to freeze 2 or vice versa, coordination must be carried out between the freezing team 1 and 2 just before the change of freezing. Also, the preparation for freezing of 10-15 minutes before resting time should be determined.

3.2. Performance value

Performance values are obtained from the amount of production and production targets that have been determined. IQF performance engine at PT. AGFS is divided into 3 types: freezing performance of product freezing after the soaking process, freezing performance of product freezing after the glassing process and freezing performance. After the three performances are known, the amount is then calculated to get the performance value of the machine in one operation round. Measurement results of the value of Id freezing performance can be seen in table 2.

Table 2. Results of measurement of freezing performance I.

Observation	Freezing time (hours)	Production target (kg / hour)	Production results (kg)	Performance (%)
1	7.37	1842.5	1614.65	87.63
2	8.27	2067.5	1747.00	84.50
3	7.49	1872.5	1631.37	87.12
4	3.76	940.0	806.02	85.75
5	7.47	1867.5	1601.80	85.77
6	8.23	2057.5	1746.82	84.90
7	8.20	2050.0	1628.44	79.44
8	5.72	1430.0	1131.39	79.12
9	8.52	2130.0	1800.35	84.52
10	7.65	1912.5	1667.16	87.17
11	9.03	2257.5	1991.41	88.21
12	7.45	1862.5	1681.49	90.28
Average				85.38

Based on the 12 observations from table 2, the results of performance freezing are from stage I, which is freezing after going through the stages of the soaking processes were 85.38%. These results do not meet performance standards of 95% or more [2]. This is because the IQF engine conveyor velocity is not adjusted to the proper speed and the IQF conveyor machine is not as optimal as empty parts are not filled. Freezing data performance II can be seen in table 3.

Table 3. Results of measurement of freezing performance II.

Observation	Freezing time (hours)	Production target (kg/hour)	Production results (kg)	Performance (%)
1	5.11	2044	1761.14	86.16
2	5.87	2348	1999.91	85.18
3	5.22	2088	1766.10	84.58
4	3.16	1264	1094.63	86.60
5	4.54	1816	1546.40	85.15
6	5.71	2284	1956.72	85.67
7	6.04	2416	2025.04	83.82
8	4.69	1876	1576.51	84.04
9	6.28	2512	2011.17	80.06
10	6.18	2472	2057.38	83.23
11	6.08	2432	2022.61	83.17
12	6.08	2432	2016.65	82.92
Average				84.22

Based on observations from table 3, the results of Performance Freezing II are from stage II freezing, which is freezing catfish fillet products after going through the glassing process. The results of measuring IQF 2 performance 2 machines based on 12 observations were 84.22%. These results do not meet performance standards of 95% or more [2]. This is because the IQF engine conveyor rotation

speed is not adjusted to the speed that should be and the product is late into freezing 2 because the product is still in the glassing stage. Freezing performance data can be seen in table 4.

Table 4. Results of tetelan freezing performance measurement.

Observation	Freezing time (hours)	Production target (kg/hour)	Production results (kg)	Performance (%)
1	4.95	1237.5	725.0	58.59
2	5.01	1252.5	807.5	64.47
3	6.04	1510.0	717.5	47.52
4	3.32	830.0	432.5	52.11
5	4.95	1237.5	712.5	57.58
6	6.00	1262.5	687.5	54.46
7	5.1	1275.0	725.0	56.86
8	3.53	882.5	522.5	59.21
9	5.27	1317.5	790.0	59.96
10	5.21	1302.5	687.5	52.78
11	5.15	1287.5	732.5	56.89
12	6.05	1512.5	685.0	45.29
Average				55.48

Based on observations from table 4, the results from the Performance of freezing tether are the result of measuring the value of IQF machine performance 12 times and was 55.48%. These results do not meet performance standards of 95% or more [2]. This is because the product to be frozen is less and the utilization of freezing time and freezing time is less than optimal. The average freezing performance data can be seen in table 5.

Table 5. Results of average performance measurement.

Observation	Freezing time (hours)	Production target (kg/hour)	Production results (kg)	Performance (%)
1	87.70	86.17	59.38	77.75
2	84.53	85.17	64.70	78.13
3	87.11	84.67	47.27	73.02
4	85.73	86.64	52.09	74.82
5	85.79	85.21	58.12	76.37
6	84.92	85.64	54.87	75.14
7	79.49	83.91	57.01	73.47
8	79.20	84.08	59.26	74.18
9	84.59	80.08	60.72	75.13
10	87.21	83.36	53.25	74.61
11	88.27	83.31	57.63	76.40
12	90.31	82.97	47.37	73.55
Average				75.21

Based on observations from table 5, the average performance of the three types of freezing on IQF machines based on 12 observations is 75.21%. These results do not meet performance standards of 95% or more [2]. This happens because the engine conveyor rotation speed is not adjusted according to the standard, the product preparation that will be frozen on the machine conveyor is not optimal, the product is late to freeze because it is still in the previous process stage and the product is frozen less.

3.3. Quality score

The value of quality or product quality is obtained from the results of frozen products and bad or frozen products. The results of the quality calculation can be seen in table 6.

Table 6. Quality calculation results.

Observation	Freezing I (kg)	Freezing II (kg)	Ground meat (by process) (kg)	Total freezing (kg)	Reject and freezing products (kg)	Quality (%)
1	1614.65	1761.14	725.0	4100.79	0.00	100
2	1747.00	1999.91	807.5	4554.41	0.00	100
3	1631.37	1766.10	717.5	4114.97	0.00	100
4	806.02	1094.63	432.5	2333.15	0.00	100
5	1601.80	1546.40	712.5	3860.70	26.25	99.32
6	1746.82	1956.72	687.5	4391.04	0.00	100
7	1628.44	2025.04	725.0	4378.48	0.00	100
8	1131.39	1576.51	522.5	3230.40	0.00	100
9	1800.35	2011.17	79.0	4601.52	0.00	100
10	1667.16	2057.38	687.5	4412.04	0.00	100
11	1991.41	2022.61	732.5	4746.52	0.00	100
12	1681.49	2016.65	685.0	4383.14	0.00	100
Average						99.94

Based on observations from table 6, the results of the IQF machine quality average score based on 12 observations were 99.94%. This value is composed with the composition of the three ratios: Availability 90% or more, Performance 95% or more, and quality 99% or more [2].

3.4. Overall Equipment Effectiveness (OEE) value

The IQF value of OEE is derived from the multiplication between the three factors. The results of the measurement of OEE values can be seen in table 7.

Table 7. Results of OEE value measurement.

Observation	Availability (%)	Performance (%)	Quality (%)	OEE (%)
1	74.06	77.75	100	57.58
2	81.43	78.13	100	63.62
3	82.67	73.02	100	60.37
4	90.73	74.82	100	67.88
5	70.38	76.37	99.32	53.38
6	82.34	75.14	100	61.87
7	80.34	73.47	100	59.03
8	80.62	74.18	100	59.80
9	79.42	75.13	100	59.67
10	80.79	74.61	100	60.28
11	81.94	76.40	100	62.60
12	80.35	73.55	100	59.10
Average				60.43

Based on observations from table 7, the results of the average IQF engine OEE score based on 12 observations were 60.43%. The ideal OEE value is 85% [3]. Small OEE values that do not reach this standard are caused by small availability and performance.

4. Conclusions

Pangasius fillet industry in Indonesia that has grown in recent years will face global competitiveness. To face competitiveness from other countries, especially Vietnam as the largest pangasius fillet producer, this study was carried out with regard to generating effectiveness in using the freezing method of pangasius fillet through OEE measurements consist of three points namely availability,

performance and quality as a consideration in determining future strategies. The analysis result of the main problematic standard OEE values is the availability section. It could be increased up to 100 %, so the company will save IQF electricity usage costs of Rp. 329,611.37 per day. it is due to the absence of SOP at the freezing stage. The main objective of this study is focusing on the availability section and creating SOP at the freezing stage.

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