Vol. 3, No. 1, June 2024, pp. 11-22
p-ISSN: 2963-8577
e-ISSN: 2964-3511
DOI: 10.57102/jescee.v3i1.78

JESCEE
Journal of Emerging Supply Chain, Clean Energy, and Process Engineering

ANALYSIS OF THE EFFECTIVENESS OF THE FILLING MACHINE KALIX PLASTIC 501 USING THE OF OVERALL EQUIPMENT EFFECTIVENESS (OEE) METHOD AT PT. XYZ

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Abstract
This study discusses the effectiveness of the Kalix Plastic 501 Filling machine at PT. XYZ with the Total Productive Maintenance (TPM) approach, namely by examining the Six Big Losses factors on the machine to increase the Overall Equipment Effectiveness (OEE) value. The TPM program aims to produce effectiveness in all production by participating in productive, proactive and planned activities. TPM effectiveness can be done by measuring the OEE value, where the performance of a machine can be said to be optimal if it has an OEE international standard value of > 85%. This paper provides valuable information about the performance of production machines and offers possible solutions to increase their efficiency. Based on the results of data calculations, it is known that the average value of the effectiveness of the Kalix Plastic 501 filling machine at PT. XYZ is 57,05%, meaning that this value is below the standard OEE value. Furthermore, it is known that the losses that cause low OEE values in this study are the result of deceleration loss (23%), setup and adjustment (14,78%), idle and minor stoppages (7,41%), breakdown failure (3,91%), scrap loss (0.24%), and yield loss (0%). The six losses occurred due to human factors such as lack of manpower and not following work instructions, machine factors such as sensor errors, broken filling valves, and procedural factors such as lack of PM schedules and product operations not continuing.

Keywords:
Overall equipment effectiveness (OEE); total productive maintenance (TPM); six big losses; fault tree analysis; filling machine

Article History:
Received: May 17th, 2024
Revised: June 21st, 2024
Accepted: June 28th, 2024
Published: June 30th, 2024

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1. Introduction

Companies that can sell quality over quantity can have a higher value so that they dominate the market and outperform their competitors, because not all companies can produce quality products. Production plants and machinery are the main systems that play an important role in producing high-quality production, so they must always be in a reliable state. Machine reliability is very important to achieve a good production process and obtain good production results as well. Then, based on this, it can be seen how reliable the machine is, to what extent the machine can work optimally and what components in the machine can work optimally within a certain period of time.

As is the case with PT. XYZ which was established in 2000 as a company engaged in pharmaceutical manufacturing. Operating under the auspices of PT Arya Noble Group which is based on a manufacturing area or CMD. The products produced by PT. XYZ is in the form of drugs and also cosmetics. There are two goals that PT. XYZ has, namely providing satisfaction and trust in customer products that can significantly increase their business and them (customers) and provide confidence and peace of mind to customers with product quality and supply. This goal can be achieved if PT. XYZ has machines that can work optimally so that the availability and quality of products can match consumer expectations, as well as provide satisfaction and maintain customer loyalty [1].

PT. XYZ has several machines in running production, which consist of Mixing, Filling and Packaging machines. Before the process in the filling machine, there is a mixing process, namely the process of combining raw materials. The mixing process produces product materials that are ready to be packaged or called bales, later the bales are packaged with the Filling process according to the type of bales and their packaging containers. Balak or product material that is ready has three types including liquid, semisolid and solid [1].

PT. XYZ has 3 types of filling machines with similar functions but differentiated according to the form and container. The plastic kalix filling machine fills the semisolid form into a plastic container or tube. The aluminum filling machine fills the semisolid form into the aluminum packaging, while the MH filling machine fills the liquid form into the glass bottle packaging. Kalix Plastic 501 filling machine, where this machine is able to work quickly and accurately so as to reduce failure or waste of materials or products. Kalix Plastic 501 Filling Machine, as shown in Fig.1, has high accuracy so that the dose in each package has the same size and weight. This machine produces cosmetic products such as face wash, suncream, and sunblock[1].

Figure 1. Kalix Plastic 501 Filling Machine (Manual Book PT. XYZ)

The Kalix Plastic 501 Filling Machine used at PT. XYZ produces cosmetic products such as face wash, suncream, and sunblock. This machine is a special object as a material for this research because the 501 Plastic Kalix Filling machine carries out the production process every day, so this machine produces more product output, in addition to carrying out routine production processes. This machine also experiences problems that cause production targets that are not achieved every month. In addition, the request from PT. XYZ is also one of the factors that lead to the focus of research on the Kalix Plastic 501 Filling machine [1].

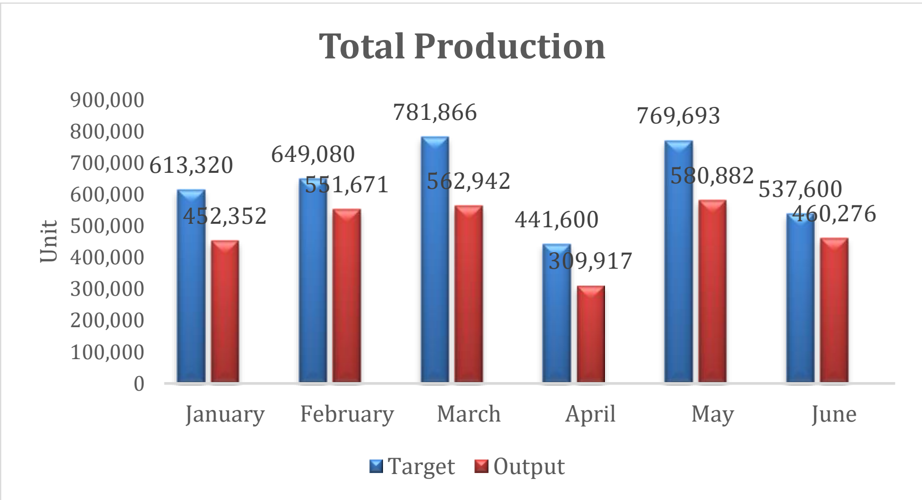

Figure 2. Graph of total production for the period January – June 2023

Based on Fig. 2, it can be observed the differences in the graphs for each month. It can be concluded that the value of the effectiveness of the Kalix 501 plastic filling machine is low, because almost every month the output

p-ISSN: 2963-8577
e-ISSN: 2964-3511

does not reach the production target. The purpose of the research is to determine the effectiveness of the Kalix 501 plastic filling machine. This research attempt to provide contribution in the field of measuring the effectiveness of Kalix 501 plastic filling machine which has never been performed before.

2. Method

A. Maintenance

Maintenance or better known as maintenance can be interpreted as activities needed to maintain or maintain the quality of equipment or machines so that they can function properly in ready-to-use conditions [2]. Companies from the lowest level to the highest level need to understand and care about the maintenance of the equipment and understand that poor maintenance can be annoying, inconvenient, wasteful, and very expensive. Good maintenance requires the need for connections between operators, machines and mechanics as well as appropriate procedures [3]. The purpose of maintenance is to return the system to its best condition so that it can function optimally, extend engine life and minimize damage. The purpose of maintenance management is to ensure the availability of devices that provide benefits, ensure the readiness of backup devices in emergency situations, maintain the safety of employees who use devices, and extend the useful life of devices [4].

B. Total Productive Maintenance (TPM)

Total Productive Maintenance (TPM) is a maintenance system that involves employees with the aim of producing effectiveness in all production with productive, proactive and planned participation and activities. So that production performance reaches the ideal of zero loss, which means zero defects, zero breakdowns, no accidents, no waste in the production process[5]. Total Productive Maintenance can be implemented through eight pillars that must be implemented by all elements within the company for successful TPM implementation.

1) *Autonomous Maintenance*
   Provide routine maintenance tasks for operators. Cleans instruments, checks instrument integrity and function, detects vibration and noise and ensures that instruments and production equipment are clean, maintained, and detects potential damage before serious damage occurs.
2) *Focused Improvement*
   Forming a work unit can be done so that it can aggressively identify instruments or work tools that are experiencing problems and provide suggestions for improvement. This pillar is preventive in reducing obstacles or losses caused by ineffective machines or equipment.
3) *Planned Maintenance*
   aims to design maintenance tasks based on the percentage of damage that has occurred or the level of damage that has been predicted, thereby reducing sudden breakdowns and providing better control over the level of component damage.
4) *Quality Maintenance*
   Discuss product quality by preventing errors during production that cause product failure and reduce the number of product defects and reduce production costs.
5) *Training & education*
   This pillar is needed to bridge the knowledge gap in implementing Total Productive Maintenance (TPM). If you don't know the tools and instruments used, it can damage the equipment and instruments, reduce labor productivity, and ultimately have a negative impact on the business.
6) *Safety Health and Environment*
   This pillar addresses companies that are responsible for three factors: safety, health, and environmental stewardship. Within this pillar, the company ensures a safe and healthy environment without any danger. For example, providing personal protective equipment to create zero accidents.
7) *TPM in Administration*
   Is administrative socialization whose aim is to ensure that all company parties have the same administrative concept. The concept is in the form of planning, purchasing, and finance in order to create a good administrative process within the company.
8) *Early Equipment Management*
   It is a pillar of TPM that uses experience from previous repair and maintenance activities to help the latest tools or instruments achieve optimal performance. The goal of this pillar is to enable the latest production instruments and systems to achieve optimal performance in the shortest possible time.

C. Overall Equipment Effectiveness (OEE)

Overall Equipment Effectiveness (OEE) is one of the measurement tools of Total Productive Maintenance (TPM) to measure and identify operational efficiency problems which will lead to actions that will improve the Company. OEE measurement is the most suitable step for semi-automatic and automated manufacturing processes. The main reason for the general application of OEE among researchers is that the OEE method is an internal but comprehensive measurement of effectiveness [6]. In particular, the measurement results are a step to make improvements so that improvement occurs.

There are 3 factors that influence the OEE value, namely, Availability loss, Performance loss, and Quality loss. This loss is the main component in measuring the OEE value on the Kalix 501 plastic filling machine. Availability loss consists of breakdown failure and setup and adjustment loss, performance loss consists of deceleration loss and idle and minor stoppages. Meanwhile, quality loss consists of scrap loss and yield loss. Basically, the OEE value is greatly influenced by the six big losses factors. Furthermore, it is known that the international standard for the OEE value is 85%, with the standard values for Availability, Performance rate, and Quality rate respectively 90%, 95%, and 99.9% [7]. To achieve optimal OEE values, it is necessary to calculate each component of these three values.

To perform the calculation of Overall Equipment Effectiveness (OEE), it is formulated as follows [8]:

$$OEE = Avaibility \times Performance\ efficiency \times Rate\ quality \tag{1}$$

1) *Availability*
   Is the ratio of active time to load time, to calculate instrument availability. The availability value is calculated using the following equation:

$$availability = \frac{Operating\ time}{Loading\ time} \times 100\% \tag{2}$$

2) *Performance Rate*
   Is a ratio that represents the capacity of equipment that produces products. To calculate the performance efficiency ratio. Performance Efficiency is calculated using a formula:

$$Performance = \frac{processed\ amount \times ideal\ cycle}{operating\ time} \times 100\% \tag{3}$$

3) *Quality Rate*
   Is a better ratio of the amount of production to the total amount of product processed. The rate of product quality can be calculated with the following equation:

$$Quality = \frac{processed\ amount - deffect\ amount}{processed\ amount} \times 100\% \tag{4}$$

D. Six Big Losses

There are losses related to equipment within the company that are observed using the Overall Equipment Effectiveness method, which is usually referred to as the big six losses or Six Big Losses. The six major disadvantages are as follows and are divided into three types [5]:

1) *Downtime Losses*
   Downtime losses are wasted time caused by production processes that cannot run due to constraints or damage to the machine [8]. The Downtime losses section consists of Breakdown losses, namely unwanted damage to factory equipment/machinery that causes losses to the company due to reduced production, time, and product rejection. Equipment failure can be classified as failure due to downtime and no operator. And Setup and adjustment, are losses caused by set up activities, including adjustments to replace the next type of product to improve the next manufacturing process. Where these two losses affect the availability value factor.

$$Breakdown\ failure = \frac{Breakdown\ time}{loading\ time} \times 100\% \tag{5}$$

$$Set\ Up = \frac{setup\ and\ adjustment}{Laoding\ time} \times 100\% \tag{6}$$

2) *Speed Losses*
Is a situation where the process speed decreases so that it cannot meet production targets [8]. The Speed Losses section consists of Idling and minor stoppages losses. This loss can be identified from the occurance of short-term machine outages, machine stalls, and loss of machine downtime. Deceleration losses (DL) is a loss caused by the actual speed of the process which is below the optimum speed of the instrument or standard, which means that the production machine/equipment is not running optimally. Both of which affect the Performance factor.

$$idling\ and\ minor\ stoppages = \frac{non\ productive\ time}{Loading\ time} \times 100\% \tag{7}$$

$$DL = \frac{(Actual\ cycle\ time - ideal\ cycle\ time) \times produced\ amaunt}{Loading\ time} \times 100\% \tag{8}$$

3) *Quality Losses*
Are losses that occur due to products that do not comply with specifications, defective products, material losses and decreased production [9]. In the Quality losses section, it consists of Defect Losses, is a loss caused by a defective product. And Yield loss, is a loss of time and material resulting from an unstable production process, improper handling and installation of tools/machines, and operator ignorance or lack of knowledge in the production process they operate. Both of which affect the quality factor.

$$Defect\ losses = \frac{ideal\ cycle \times defect\ product}{loading\ time} \times 100\% \tag{9}$$

$$Yield\ loss = \frac{Ideal\ cylce \times scrap}{loading\ time} \times 100\% \tag{10}$$

3. Result and Discussion

In carrying out this research, data obtained from various sources such as logbooks, work order data and statements by conducting interviews with technicians and operators were used. From these data, it can be recorded to fulfill the need to know the effectiveness value of the Kalix plastic 501 filling machine. The data obtained can be seen in Tables 1-2.

Loading time, which is the machine's availability to perform operations or work, the loading time data is obtained from Available time minus Schedule loss time, Operating time data is obtained from the total length of time the machine produces a product. Schedule loss time data is scheduled maintenance on a Kalix 501 plastic filling machine, Breakdown data is data obtained when the machine experiences problems, problems, or damage during the production operation process which results in the machine shutting down and until the machine is repaired. Meanwhile, setup and adjustment data are obtained from the length of preparation time until the machine returns to production. The data in Table 1 can be used to calculate the effectiveness value of the Kalix Plastic 501 Filling machine using the Overall Equipment Effectiveness method.

Furthermore, Table 2 is data on production results produced by the Kalix Plastic 501 filling machine within a period of six months from January – June 2023. The following is the production data for the Kalix plastic 501 filling machine. Based on Table 2, it is known that the Kalix Plastic 501 Filling machine has the ideal time to produce one product within 1.5 seconds. After knowing the ideal time to produce a product, we look for the actual time that occurs in the production process to produce one product. The value of the actual time needed to produce one product is obtained from the value of the operating time divided by the value of the processed amount. Then we know the Processed amount, good product, Defect product and Scrap data from the production of the Kalix Plastic 501 Filling machine. Meanwhile, in the production process of this Kalix plastic filling machine there is no Scrap result because all products that fail can be reused, by replacing them with new containers or repack.

Table 1. Kalix Plastic Filling Machine Data

Month	*Available time* (sec)	*Schedule Loss* (sec)	*Loading Time* (sec)	*Operating Time* (sec)	*Breakdown* (sec)	*Setup and Adj* (sec)	*Non–Productive time* (sec)
January	1,728,000	586,800	1,141,200	919,980	43,200	167,400	10,620
February	1,987,000	637,200	1,349,200	973,620	57,600	240,300	77,680
March	2,246,000	712,800	1,533,200	1,172,800	62,000	264,600	33,800
April	1,468,800	486,000	982,800	662,400	43,200	121,500	127,440
May	2,332,800	738,000	1,594,800	1,154,540	28,800	178,200	233,260
June	1,555,200	511,200	1,044,000	806,400	54, 000	154,600	29,000

Table 2. Production data for Kalix Plastic Filling machines January – June 2023

Month	*Ideal cycle time* (sec)	*Actual Cycle Time* (sec)	*Processed Amount* (sec)	*Good Product* (sec)	*Defect Product* (unit)	*Scrap* (unit)
January	1.5	2.03	452,352	449,484	2,868	0
February	1.5	2.15	551,671	548,868	2,803	0
March	1.5	2.08	562,942	562,014	928	0
April	1.5	2.13	310,513	309,917	596	0
May	1.5	1.98	582,351	580,882	1,469	0
June	1.5	2.21	463,641	460,276	3,185	0

A. *Data Processing*

1) *Availability*

Based on the calculation results, it is known that the average availability value of the Kalix 501 plastic filling machine does not meet the standard availability value of 90%. This means that the available loading time value of the Kalix plastic 501 filling machine is not used in its entirety. It can be seen that in April the value of the loading time is the smallest compared to other months, this is because in April the joint Eid holidays are cut off. The operating time value of the Kalix Plastic 501 filling machine was obtained from the length of time the machine carried out the operation process in creating the product, but as seen in Table 3 the Kalix Plastic filling machine was not able to meet the target of available time. The average availability time is 74.38%

The occurrence of problems or breakdowns affects the operating time value which cannot work fully with the available loading time. Judging from the results, the availability value in April has a value of 67.39%, this value is lower because there is less time available due to the Eid holiday, while in other months there are obstacles or problems, namely a breakdown which makes the machine unable to meet loading times as a whole. In fact, where the problems are in the form of check weight errors, jammed nozzles and loose filling stoppers. This damage makes the operating time value low, apart from the breakdown there is also setup and adjustment which results in reduced machine availability time due to setup activities. The setup activities include installing and washing balak containers, and changing batch codes which reduce the operating time value.

Tabel 3. Availability Data January – June 2023

Month	*Loading Time* (sec)	*Operation Time* (sec)	*Availability* (%)
January	1,141,200	919,980	80.61%
February	1,349,200	973,620	72.16%
March	1,533,200	1,172,800	76.49%
April	982,800	662,400	67.39%
May	1,594,800	1,154,540	72.39%
June	1,044,000	806,400	77.24%
Average			74.38%

2) *Performance*

Table 4 shows the average performance value of the Kalix 501 plastic filling machine that does not meet the performance value standard of 95%, where the product produced is processed amount which takes time in the production process. The performance values in the January – June period were all below standard values, because the Kalix plastic 501 filling machine did not run at the ideal time speed. Basically, the ideal time for the Kalix

p-ISSN: 2963-8577
e-ISSN: 2964-3511

plastic 501 filling machine to create one product is 1.5 seconds, but the actual time for the Kalix plastic 501 filling machine to create one product is above the ideal time every month from January – June 2023. The difference between the actual time and The ideal time that creates the problem of low performance values for the Kalix plastic 501 filling machine, where the actual values are January (2.03 seconds), February (2.15 seconds), March (2.08 seconds), April (2.13 seconds), May (1.98 seconds) and June (2.21 seconds). The difference between the actual time and the ideal time is due to the machine experiencing a decrease in speed in the production process, which is caused by several problems such as jams in the rotary table due to the tube not fitting properly in its seat, sensors which are often active if there is a minor error causing the machine to stop, and delays in lowering container or tube because the operator is tired and not focused.

Tabel 4. Performance Data January-June 2023

Month	*Processed amount* (pcs)	*Ideal Cycle time* (sec)	*Actual Cycle Time* (sec)	*Operating time* (sec)	*Performance* (%)
January	452,352	1.5	2.03	919,980	73.75%
February	551,671	1.5	2.15	973,620	85%
March	562,942	1.5	2.08	1,172,800	71.2%
April	310,513	1.5	2.13	662,400	70.31%
May	582,351	1.5	1.98	1,154,540	75.66%
June	463,641	1.5	2.21	806,400	86.24%
Average					77.03%

3) *Quality*

Table 5 shows that the quality value produced from the Kalix 501 plastic filling machine is in accordance with the international quality value standard of 99%. These results also meet the OEE standard value because products that experience failures such as leaking products, illegible batch dates and dirty containers can still be repaired by replacing them with new containers or repacking them. A product is declared a total failure if the contents of the product are contaminated. Products that have been contaminated cannot be reused, which causes material and time losses.

Table 5. Quality Data January-June 2023

Month	Processed Amount (pcs)	Defect Product (unit)	Good Product (unit)	Quality (%)
January	452,352	2,868	449,484	99.36%
February	551,67	2,803	548,868	99.49%
March	562,942	928	562,014	99.83%
April	310,513	596	309,917	99.80%
May	582,351	1,469	580,882	99.74%
June	463,641	3,185	460,276	99.27%
Average				99.58%

4) *Overall Equipment Effectiveness (OEE)*

The OEE value on the Kalix Plastic 501 filling machine is below the standard OEE value. Where the average OEE value of the Kalix 501 plastic filling machine is 57.05%. This value is far below the standard due to the availability (74.48%) and performance (77.03%) values that are too low, due to breakdowns and high setup and adjustments which affect the availability value and the actual machine time which is different from the ideal time which causes low performance value. The OEE value of the Kalix 501 plastic filling machine can be increased by focusing on the constraints that occur in the availability and performance values. Steps to increase the availability value can focus on routine daily maintenance of machines to reduce breakdowns which result in lost production time and a new procedure is needed, namely a continuous production process, in order to reduce setup and adjustment time in cleaning, changing batch codes, and preparing logs and containers. Meanwhile, to increase the performance value by reprogramming the sensor so that when there is a minor error the sensor is not active and causes the engine to stop, paying attention to the engine rpm speed so that the engine is maintained at its ideal time, and changing the container loading dock to a horizontal shape so that the container can move smoothly without causing buildup and jamming on the rotary table. The proposal is so that the Kalix 501 plastic filling machine can work optimally and to maintain the speed of the machine in the ideal time and maintain the quality & quantity of production. The results of the OEE calculation can be seen in Table 6.

Table 6. OEE VALUE

Month	*Availability*	*Performance*	*Quality*	OEE
January	80.61%	73.75%	99.36%	59.07%
February	72.16%	85%	99.49%	61.02%
March	76.49%	71.2%	99.83%	54.37%
April	67.39%	70.31%	99.80%	47.29%
May	72.39%	75.66%	99.74%	54.63%
June	77.24%	86.24%	99.27%	66.13%
Average	74.48%	77.03%	99.58%	57.05%

5) *Six Big Losses*

After knowing that the OEE value of the Kalix Plastic 501 filling machine is below the standard value, you must look for the losses that have the biggest impact on reducing the effectiveness value of the machine.

- Downtime Loss

Based on the calculation results, it is known that the largest breakdown failure value occurred in June at 5.17%. While the lowest value occurred in May of 1.8%. The breakdown loss value is affected by machines that experience problems or damage resulting in loss of production time. In May, there were 3 breakdowns where damage, obstacles or problems occurred including damaged blow and bulk nozzles, jammed nozzles and tube holders that were worn out or were no longer able to position the container perfectly. In February and March, there were high breakdown failure values, recording breakdowns 6 times, but the high loading time span did not cause high breakdown failure values like in June. These obstacles or problems cause the machine to lose time in the production process, the problems or damage occur due to the machine working fully and lack of attention to the machine components. Such as lack of attention in daily care in applying grase or grease, lack of perfect cleaning which causes some parts to become clogged. This problem causes the machine to experience damage which causes low availability values, and the machine cannot produce optimally.

Table 7 Data on the Breakdown Failure value of the Kalix Plastic 501 Filling Machine

Month	*Loading Time* (sec)	*Breakdown Time* (sec)	*Breakdown Failure* (%)
January	1,141,200	43,200	3.78%
February	1,349,200	57,600	4.26%
March	1,533,200	62,000	4.04%
April	982,800	43,200	4.39%
May	1,594,800	28,800	1.8%
June	1,044,000	54,000	5.17%
Average			3.91%

Furthermore, it is known that the setup and adjustment value on the Kalix 501 plastic filling machine is relatively high. This high value is caused by frequent setup activities such as washing the Filling tube, changing the batch code, and also cutting the batch. This activity becomes frequent because the Kalix 501 plastic filling machine often changes products, the Kalix 501 plastic filling machine does not work on one product continuously which causes a high setup and adjustment value. Activities carried out such as washing tubes and also changing batch codes can take as much as 45 minutes in one activity, and the lack of operators causes these activities to take a long time. On a filling machine there is only 1 operator in 1 shift where in 1 shift sometimes it can carry out setup activities 3 to 4 times, and sometimes unreadable batch codes and imperfect cutting batches require resetting and further adjustments.

Tabel 8. Setup and adjustment value data for the Kalix Plastic 501 filling machine

Month	*Loading Time* (sec)	*Setup and Adj* (sec)	*Setup and adjustment loss* (%)
January	1,141,200	167,400	14.66%
February	1,349,200	240,300	17.81%
March	1,533,200	264,600	17.25%
April	982,800	121,500	12.36%
May	1,594,800	178,200	11.17%
June	1,044,000	154,600	14.80%
Average			14.68%

- Speed Losses

The largest values that affect the value of idling and minor stoppages occur in April and May. The high value in April and May was due to problems with machines temporarily stopping operations which caused no production activity. Obstacles in May where the machine experienced damage problems in the form of a broken filling valve and required a replacement part, but the part had to be custom made to a company originating in France, there was an independent process which resulted in the machine not being able to produce at all until in the end the mechanic made an emergency part change by customizing using PVC. Whereas in April the constraints that caused the production process to stop temporarily, namely due to delays in the decline in logging caused by verification from the QC who were late in giving permits for the release of logs for processing of filling, so that there was no production activity on the Kalix 501 plastic filling machine until the logs were released. Apart from that, the existence of these obstacles, the checking from BPOM also made the production process temporarily stop, Table 9 below is a graph of the values of idling and minor stoppages for January – June 2023.

Table 9. Idling value data and minor stoppages

Month	*Loading Time* (sec)	*Non–Productive Time* (sec)	*Idling & Minor Stoppages* (%)
January	1,141,200	10,620	0.93%
February	1,349,200	77,680	5.75%
March	1,533,200	33,800	2.20%
April	982,800	127,440	12.96%
May	1,594,800	233,260	14.62%
June	1,044,000	29,000	2.77%
Average			7.41%

The value of deceleration losses is in Table 10, which shows the value of deceleration losses in the Kalix 501 plastic filling machine with a high average. The high value of deceleration losses is caused by the actual value in producing a product that is too high compared to the ideal time, where the actual value is greater and can be influenced by machines experiencing problems, problems that occur can reduce the speed of this machine. Some of these problems are the rotary table sensor which is often active, the sensor is too sensitive when an item or production container does not fit properly in its holder, and the container or tube is too late to lower due to over-tilting the container which causes the production process to experience delays. The high value of deceleration losses for this machine can be caused by the operator not paying attention to the ideal speed of this machine. Apart from this failure, the ideal speed of the machine is deliberately lowered in order to pay attention to production quality and notice if the tube is dislocated in the holder. If the machine is at its ideal speed, it will be difficult to notice failures in the production process and create obstacles in the production process.

Table 10. Deceleration losses value data

Month	*Loading Time* (sec)	*Ideal Cycle Time* (sec)	*Actual Cycle Time* (sec)	*Processed Amount* (unit)	*Decelaration losses* (%)
January	1,141,200	1.5	2.03	452,352	21%
February	1,349,200	1.5	2.15	551,671	26.57%
March	1,533,200	1.5	2.08	562,942	21.29%

April	982,800	1.5	2.13	310,513	19.90%
May	1,594,800	1.5	1.98	582,351	17.52%
June	1,044,000	1.5	2.21	463,641	31.53%
Average					23%

- Quality Losses

The average value of scrap losses that occur in the Kalix 501 plastic filling machine is very low, because the operator is very concerned about the production process that occurs. Apart from more observation, in the production process there is manual scanning and passing through machines, where manual scanning is done to find out whether there are leaks, dirt in the container, and also imperfect cutting batch results. Meanwhile, scanning passes through a weight checking machine to find out whether the product contents comply with standards. If a product is defective or does not meet product content tolerances, the product will be repackaged to meet product quality standards. Table 11 shows the data value of scrap losses.

Table 11. Scrap losses value data

Month	*Loading Time* (sec)	*Ideal Cycle Time* (sec*)*	*Defect Product* (unit)	*Scrap Losses* (%)
January	1,141,200	1.5	2,868	0.37%
February	1,349,200	1.5	2,803	0.31%
March	1,533,200	1.5	928	0.09%
April	982,800	1.5	596	0.09%
May	1,594,800	1.5	1,469	0.13%
June	1,044,000	1.5	3,185	0.45%
Average				0.24%

It is further noted that there is no yield loss value in the period January - June 2023, because products that experience failure can still be used, it's just that the container of the product is thrown away but the product contents are still reused by transferring the product contents to a new container or repacking.

Based on the 6 losses above, the deceleration loss has the highest value, namely 23%, where this loss greatly affects the decrease in the effectiveness of OEE, but if seen in Fig. 3, 80% of the problem is that there is a decrease in the effectiveness value of the Kalix 501 plastic filling machine, in addition to deceleration loss. Also, setup and adjustment loss, idle and minor stoppages, and breakdown failure. Where the four losses are the most impactful losses, for that after knowing the causes of the decrease in the value of effectiveness, repairs and maintenance must be carried out more optimally so that they can reduce the value of these losses.

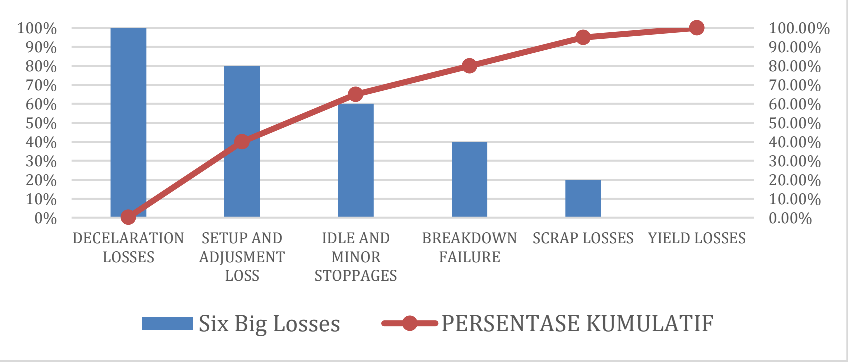

Figure 3. Pareto Charts

B. *Discussion*

Data collection was carried out over a period of 6 months starting from January – June 2023, the data was processed using equations (2.1) to (2.5) to find out the Overall Equipment Effectiveness value on the plastic kalix filling machine. Furthermore, it is known that the OEE value of the Kalix 501 plastic filling machine is below the international standard average, namely 85%. This is due to factors supporting the OEE value such as the Availability value which averages at 71.04% which is below the standard Availability value of 90% according to JIPM. The low Availability value of this machine is due to the low operating time value, the low operating time value is due to the large amount of breakdown time and also the setup and adjustment time which is recorded in Table 1.

Apart from the Availability value which is below standard, the Performance value of this machine is also below standard. The average value over a period of 6 months, the Performance value for the Kalix 501 plastic filling machine was 69.30%, this value was far below the Performance standard, according to JIPM the Performance value standard was 95%. The low performance value of this machine is due to production results that are not optimal, which is due to the fact that the actual value of the Kalix filling machine is far different from the ideal time to create a product. Where the ideal value of the machine in creating products is 1.5 seconds but the actual value of the machine in producing products is above that value. The actual high value occurs due to the container or tube dropping late due to stacking and sensors that are too sensitive which causes the engine to stop. For the Quality value of the Kalix 501 plastic filling machine, it meets the standards where the average Quality value is 99.59%. This value is high because none of the products experienced scrap or failure that could not be reused.

Therefore, after knowing the OEE value which is below the standard average, find out the cause of the decrease in the effectiveness of the machine by using the Six Big Losses analysis to find out what losses have the most impact on the decrease in the effectiveness of the Kalix 501 plastic filling machine.

Based on the Six Big Losses analysis after knowing the OEE value below standard, it is known that there are four types of losses that affect the low effectiveness of the Kalix plastic filling machine, namely Deceleration loss 23%, Setup and Adjustment 14.78%, Breakdown Failure 3.91% and Idle and minor stoppages 7.41%. The value of the deceleration loss is due to the difference between the ideal time and the actual time in creating the product, because the machine has decreased in speed. Setup and adjustment values are affected by setup activities that are too frequent because the production process of the Kalix 501 plastic filling machine does not continue, while the idle and minor stoppages values are affected by the machine having stopped which eliminates production time. The logs were late down and the machine was damaged which required the replacement of parts, but the parts were independent, which resulted in high values of idling and minor stoppages. The breakdown loss value is caused by the machine experiencing problems and stopping the production process, where filling errors, sensor errors and broken cutting bolts cause the machine to stop.

4. Conclusion

After processing and discussing using the data obtained, after that the results of the processing are analyzed using the OEE, Six Big Losses and FTA methods. It can be concluded as follows:

1. It is known that the average effectiveness of the Kalix 501 plastic filling machine in January-June 2023 is 57.05%. Where this value is below the standard OEE value of 85% according to JIPM.
2. The looses that show the greatest influence on the lower OEE values are due to deceleration loss (23%), setup and adjustment (14.78%), idle and minor stoppages (7.41%), and breakdown failure (3.91). The difference in ideal time and the actual Kalix plastic 501 filling machine is the biggest influence and high setup activity also influences the low OEE value.

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