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# MAINTENANCE PRIORITIZATION FOR AN INDUCTION FURNACE WITH ANALYTICAL HIERARCHY PROCESS IN PT. LINGGA SAKTI INDONESIA

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**ABSTRACT**

**Abstract:** The effective operation of induction furnaces in steel casting is crucial for maximizing production efficiency, yet equipment breakdowns remain a significant concern for manufacturers like PT. Lingga Sakti Indonesia. Despite existing maintenance strategies, there is a need for a more systematic approach to enhance Overall Equipment Effectiveness (OEE). This study addresses the **knowledge gap** in maintenance system optimization by employing the Analytical Hierarchy Process (AHP) to prioritize predictive maintenance tasks. **The aim** of this research is to assess the current OEE, calculated at 73.26%, and propose an updated maintenance framework based on the AHP findings, which involved input from four respondents across six criteria and nine alternatives. **The results** indicate that electrical monitoring emerged as the highest-ranked maintenance task, suggesting its implementation as a critical strategy for improving equipment reliability. **The novelty** of this approach lies in integrating AHP for maintenance decision-making, offering a quantifiable method for prioritizing tasks based on expert criteria. **The implications** of this study are significant, as the recommended maintenance system could enhance OEE and operational efficiency, ultimately leading to reduced downtime and improved productivity. Future research should focus on the practical implementation of these proposals and their impact on long-term maintenance effectiveness within the steel casting sector.



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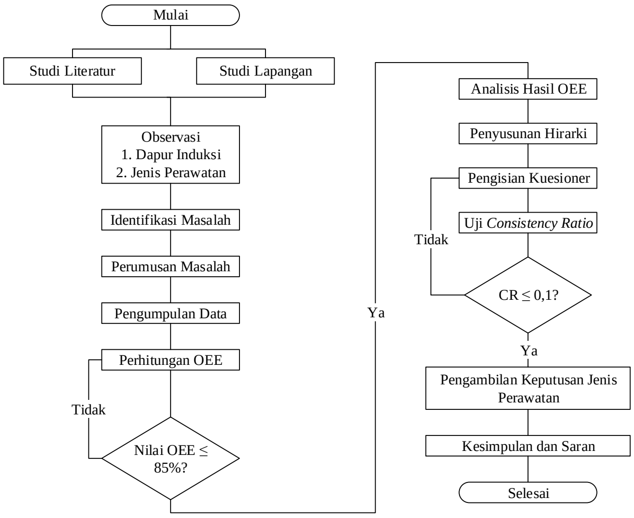
## INTRODUCTION

The casting process at PT. Lingga Sakti Indonesia is the most important process of the entire series of production processes. The material is melted using an induction stove with a capacity of 300 kg. Induction kitchens use electrical energy as their main supply of heat energy. The induction kitchen works using the rules of Faraday's Law. The induction stove is an application of the Faraday experiment, where a coil that is passed through alternating current (AC) acts as the primary coil and the smelting material as the secondary coil. In an effort to meet the needs of the induction kitchen market, it is expected to work optimally. However, the machine often experiences failures such as the kitchen does not turn on, the induction kitchen suddenly shuts down, and the coil leakage causes the amount of [1] downtime to be very high so that it affects the performance of the machine, the quantity and quality of the output produced. From the failure of the operation of the machine, it shows a decrease in production output of up to 28800 kg from a maximum capacity of 60000 kg per month. One of the causes of frequent engine failures is the lack of a precise maintenance system for the condition of the machine that has been applied and maintenance and repairs carried out after the machine has failed. Maintenance in an industry is one of the important factors in supporting a production process that has competitiveness in the market. The more developed the industrial world, the production machines will be able to do long and complex work, so it is necessary to carry out good and appropriate maintenance activities. The condition of the dead machine is also affected by [2] maintenance activities carried out during production hours, which interferes with the smooth running of the production process and hinders the achievement of targets. An OEE calculation is needed to find out how far the OEE value of an induction kitchen is below the standard where the international average standard OEE is 85%. The next thing is to analyze the cause of the low OEE value after the largest contributor to failure is known, then the types of failures are grouped into criteria in AHP so that alternative types of maintenance can be identified what is most relevant to the condition of the machine according to the perception of experts [3] , then data processing can be carried out using the Analytical Hierarchy Process method.

The purpose of this study is to determine the amount of OEE value of the induction kitchen and to know the application of the AHP method to provide proposals for updating the induction kitchen maintenance system obtained from the maintenance task of predictive maintenance that is most relevant to the condition of the induction kitchen. The application of the AHP method uses the help of expert choice software in data processing to determine the consistency of an element in the hierarchy.

The Analytical Hierarchy Process in this study will use 4 respondents consisting of the maintenance department workforce, the head of the maintenance section, the production supervisor, and the head of the cast section. Using 6 criteria according to the six big losses and 9 alternative maintenance tasks of predictive maintenance. This AHP serves to select the type of repair on the engine based on several important criteria. The selected alternatives according to the ranking results from data processing using Expert Choice as a result of the application of the AHP method will be used as a proposal to improve the maintenance system and efforts to increase the OEE value of induction kitchens. There are several advantages to AHP which is a decision-making method, especially when several attributes and preferences are involved in it, where the decision-maker needs to simplify the problem into a hierarchical form according to human perception. The selection of this method is based on its widely accepted use in various organizations, companies, and countries around the world. Ease of use and understanding of its application and results that are more consistent than other methods. [4] [5] This study is a development of the previous research Proposing Predictive Maintenance Strategy To Increase OEE Through System Upgrade Scenario and AHP using the AHP method and its application to induction kitchens as the research object.

## METHODS




**Picture 1.** *Flowchart* Research Flow

### *Overall Equipment Effectiveness*

*Overall Equipment Effectiveness* is a way to find out how effective a piece of equipment or machine is to produce a product. OEE benchmarks are established by measuring the performance of the machine. The measurement of engine effectiveness must exceed the availability or uptime of the machine and must consider all issues related to engine performance. [6] This calculation is essential for improving engine efficiency. The OEE calculation involves the value of availability level, performance level, as well as quality level. [7]

HEY = *Available rate % ×Performance rate % ×Quality rate %*

[8]

### *Availibility Rate*

*Availibility rate* indicates a measure of how well a machine performs its functions over a period of time and operates in accordance with the specified conditions [6] .

$$Availability = \frac{operation\ time}{loading\ time} \times 100\%$$

[9]

### *Performance Efficiency*

Performance efficiency *calculations* are useful for measuring the level of reliability of the machine producing products [6] . It takes operation *time* and *cycle time* data to find out the value of the *performance rate*. *Operation time* is the working time of the machine in a period of one working day and *cycle time* is the time it takes for the machine to produce 1 unit of product. [8]

$$Performance\ rate = \frac{output \times ideal\ cycle\ time}{operation\ time} \times 100\%$$

[8]

***Quality Rate***

*Quality rate* is a percentage to determine the performance of a machine in its ability to produce good products according to standards. Data on the number of production in one day minus the number of defective products is needed to determine the quality rate. [6] [8]

$$Quality\ rate = \frac{total\ output\text{-}defect\ unit}{total\ output} \times 100\%$$

[8]

***Six Big Losses***

*Six big losses* are the most common cause of low productivity levels based on equipment in the manufacturing sector. Identify losses related to the engine with the aim of improving the total performance and reliability of the machine using *the Six big losses* [10] . The role of *six big losses* in this study is the most influential criterion that is the reason why the engine does not run optimally.

***Fishbone Diagram***

*Fishbone Diagram* is one of the methods used to analyze a problem in a process from several supporting factors of the production system [11] The result or problem that occurs is on the far right, followed by the left with a drawing of a line or branch resembling a fishbone repressing the cause and categorized into several supporting factors such as machines, methods, materials, humans, and the environment. [12]

***Analytical Hierarchy Process***

The concept of AHP is the change of qualitative value to quantitative value. This method also combines the power of feeling and logic in relation to various problems, and then combines various kinds of considerations and presents judgments with results that correspond to the intuitive mind. [13] .

*The Analytical Hierarchy Process* is a powerful multi-criteria decision-making tool. AHP is useful for showing which *maintenance task* is better than the other by using the Consistency *Ratio calculation* through the consideration of experts [14] . This assessment is the core stage of AHP, as it will affect the priorities for each element. This principle is the weighting of the relative importance of two elements at a certain level that are related to one element at a higher level. The results of this weighting will be included in a matrix called the *pairwise comparison matrix.*

The data processing in this study uses the help of *Expert Choice software* which is useful in automating all AHP calculations. *Expert Choice* is designed to simplify the implementation of the steps of the analytical hierarchy process. The software was developed by *Expert Choice, Inc.* [15] .

## RESULT AND DISSCUSION

### A. Data Collection

### 1. Production Data

Data on product results produced by induction kitchens for the 2021 period obtained from the company.

**Table 1.** Production Data

| Periode | *Output* (kg) |
|---|---|
| Jan-21 | 60000 |
| Feb-21 | 48000 |
| Mar-21 | 38400 |
| Apr-21 | 60000 |
| Mei-21 | 50400 |
| Jun-21 | 60000 |
| Jul-21 | 62400 |
| Agu-21 | 57600 |
| Sep-21 | 62400 |
| Okt-21 | 31200 |
| Nov-21 | 60000 |
| Des-21 | 55200 |

### 2. Machine Failure Data

Data on engine failures for the 2021 period that caused induction kitchens to stop working

**Table 2.** Machine Failure Data

| Periode | Rincian | Jumlah Kejadian | *Downtime* (menit) |
|---|---|---|---|
| Jan-21 | Dapur induksi tidak menyala | 1 | 120 |
| | Keretakan dinding dapur | 4 | |
| Feb-21 | Korsleting | 2 | 60 |
| | Dapur induksi tidak menyala | 1 | |
| Mar-21 | Kerusakan *breaker* | 1 | 30 |
| | Dapur induksi tidak menyala | 2 | |
| Apr-21 | Kertakan dinding dapur | 5 | 50 |
| | Hz meter tidak berfungsi | 4 | |
| Mei-21 | Dapur induksi tidak menyala | 2 | 120 |
| | Kerusakan *cooling system* | 1 | |
| Jun-21 | Dapur induksi tidak menyala | 2 | 25 |
| Jul-21 | Kebocoran selang air | 1 | 180 |
| | Keretakan dinding dapur | 6 | |
| Agu-21 | Dapur induksi tidak menyala | 3 | 120 |
| Sep-21 | Keretakan selang kabel | 1 | 100 |
| | Kebosoran koil | 3 | |
| Okt-21 | Dapur induksi tidak menyala | 4 | 90 |
| | Kebocoran koil | 1 | |
| | *Overheat* | 3 | |
| Nov-21 | Korsleting | 2 | 30 |
| Des-21 | Keretakan dinding dapur | 3 | 120 |

## 3. Maintenance Activity Data

Data on engine repair activities for the 2021 period and the number of *downtime*

**Table 3.** Activity Data *Maintenance*

| Periode | Aktivitas | *Downtime* (menit) |
|---|---|---|
| Jan-21 | Penggantian *power supply*<br>Perbaikan dinding dapur | 120 |
| Feb-21 | pengecekan *water pump*<br>Pengecekan SCR<br>Pengecekan PLC | 60 |
| Mar-21 | Penggantian PLC<br>Pengggntian *breaker* | 30 |
| Apr-21 | Perbaikan dinding dapur<br>Penggantian analog meter | 50 |
| Mei-21 | Penggantian SCR<br>Penggantian potensio dioda<br>Penggantian *bearing water pump* | 120 |
| Jun-21 | Penggantian kapasitor | 25 |
| Jul-21 | Penggantian selang air<br>Perbaikan dinding dapur | 180 |
| Agu-21 | Penggantian potensia ground<br>Penggantian CT<br>Penggantian SCR | 120 |
| Sep-21 | Penggantian selang kabel<br>Penggantian koil | 100 |
| Okt-21 | Penggantian koil<br>Pengecekan SCR dan potensio dioda<br>Penggantian potensio ground<br>Penggantian CT<br>Penggantian potensio ground | 90 |
| Nov-21 | Penggantian potensio dioda<br>Penggantian kapasitor | 30 |
| Des-21 | Penggantian PLC | 120 |

## 4. Data *Total Breakdown*

Total breakdown *data* which is the total amount of time obtained from the number of planned *engine downtime* due to repair activities and the number of unplanned engine downtime caused by engine failure.

**Table 4.** *Total Breakdown*

| Periode | *Breakdown* (menit) | *Planned Downtime* (menit) |
|---|---|---|
| Jan-21 | 180 | 120 |
| Feb-21 | 2520 | 60 |
| Mar-21 | 5040 | 30 |
| Apr-21 | 420 | 50 |
| Mei-21 | 840 | 120 |
| Jun-21 | 300 | 25 |
| Jul-21 | 0 | 180 |
| Agu-21 | 0 | 120 |
| Sep-21 | 120 | 100 |
| Okt-21 | 4920 | 90 |
| Nov-21 | 1260 | 30 |
| Des-21 | 0 | 120 |

## B. Data Processing

***Availability Rate***

***Loading Time***

The following is the calculation of *loading time* in January 2021

*Loading Time =Total Availability - Planned Downtime*

=10500 - 120

=10380

***Operation Time***

The following is the calculation of *the operation time* for January 2021

*Operation Time =Loading Time - Total Downtime*

=10380 - 300

=10080

***Availability Rate***

The following is the calculation of *the availability rate* in induction kitchens in January 2021

$$Availability\ Rate = \frac{Operation\ Time}{Loading\ Time} \times 100\%$$

$$= \frac{10190}{10435} \times 100\%$$

$$=97{,}65\%$$

In the calculation of *the availability rate* in January 2021, a value of 97.65% was obtained. In that month, the total *downtime* was low, which also affected the achievement of the *availability score*.

**Table 5**. *Availability Rate* Induction Kitchen in 2021

| Periode | *Total Availability* | *Loading Time* (menit) | *Operation Time* (menit) | *Total Downtime* (menit) | *Availability Rate* |
|---|---|---|---|---|---|
| Jan-21 | 10500 | 10380 | 10080 | 300 | 97,11% |
| Feb-21 | 9660 | 9600 | 7020 | 2580 | 73,13% |
| Mar-21 | 10920 | 10890 | 5820 | 5070 | 53,44% |
| Apr-21 | 10500 | 10450 | 9980 | 470 | 95,50% |
| Mei-21 | 8820 | 8700 | 7740 | 960 | 88,97% |
| Jun-21 | 10500 | 10475 | 10150 | 325 | 96,90% |
| Jul-21 | 10920 | 10740 | 10560 | 180 | 98,32% |
| Agu-21 | 10080 | 9960 | 9840 | 120 | 98,80% |
| Sep-21 | 10920 | 10820 | 10600 | 220 | 97,97% |
| Okt-21 | 10500 | 10410 | 5400 | 5010 | 51,87% |
| Nov-21 | 10500 | 10470 | 9180 | 1290 | 87,68% |
| Des-21 | 9660 | 9540 | 9420 | 120 | 98,74% |

In table 5, it is known that the lowest average *availability* value in October 2021 is 51.87%. This value is far below the international standard of OEE which is 90.0%. The low *availability* in that period was influenced by the total *downtime* due to engine downtime due to damage.

***Performance Efficiency***

**% of Working Hours**

The formula for calculating the % working hours of an induction kitchen machine in January 2021 is as follows:

$$\% \text{ Jam Kerja} = 1 - \left(\frac{\textit{Total Downtime}}{\textit{Operation Time}}\right) \times 100\%$$

$$= 1 - \left(\frac{300}{10190}\right) \times 100\%$$

$$= 1 - (0{,}03) \times 100\%$$

$$= 0{,}9702 \times 100\%$$

=97,02 %

**Cycle Time**

The formula for calculating the cycle time in January 2021 is as follows

$$\text{Waktu Siklus} = \frac{\textit{Loading Time}}{\textit{Output}}$$

$$= \frac{10380}{60000}$$

$$= 0{,}17 \text{ minute}$$

***Ideal Cycle Time***

The following is the calculation of *the ideal cycle time* for January 2021

$$\textit{Ideal Cycle Time} = \text{Waktu Siklus} \times \%\text{Jam Kerja}$$

$$= 0{,}17 \times 97{,}02\%$$

$$= 0{,}17 \text{ menit}$$

***Performance Efficiency***

The following is the calculation of *performance efficiency* in January 2021

$$\textit{Performance Efficiency} = \frac{\textit{Output} \times \textit{Ideal Cycle Time}}{\textit{Operation Time}} \times 100\%$$

$$= \frac{60000 \times 0{,}17}{10080} \times 100\%$$

$$= \frac{10128{,}21}{10080} \times 100\%$$

$$= 1{,}00 \times 100\%$$

$$= 100\%$$

In the January 2021 performance efficiency calculation, a value of 100% was obtained, which is very good for engine performance. The achievement of this perfect value is due to the high number of *operation time* and *ideal cycle time* as well as the number of *outputs* reaching the target.

**Table 6.** *Performance Efficiency* Induction Kitchen in 2021

| Periode | *Operation Time* (menit) | *Output* (kg) | *Ideal Cycle Time* | *Performance Efiiciency* |
|---|---|---|---|---|
| Jan-21 | 10080 | 60000 | 0,17 | 100% |
| Feb-21 | 7020 | 48000 | 0,13 | 86,50% |
| Mar-21 | 5820 | 38400 | 0,04 | 24,12% |
| Apr-21 | 9980 | 60000 | 0,17 | 99,78% |
| Mei-21 | 7740 | 50400 | 0,15 | 98,47% |
| Jun-21 | 10150 | 60000 | 0,17 | 99,90% |
| Jul-21 | 10560 | 62400 | 0,17 | 99,98% |
| Agu-21 | 9840 | 57600 | 0,17 | 99,98% |
| Sep-21 | 10600 | 62400 | 0,17 | 99,95% |
| Okt-21 | 5400 | 31200 | 0,02 | 13,92% |
| Nov-21 | 9180 | 60000 | 0,15 | 98,03% |
| Des-21 | 9420 | 55200 | 0,17 | 99,99% |

In table 6, it is known that the lowest *performance efficiency* value in October 2021 is 13.92%. This value is far below the international standard of OEE which is 95.0%. The low *performance efficiency* in this period was influenced by low engine working time, output results, and *ideal cycle time.*

***Quality Rate***

The following is the calculation of *the quality rate* in January 2021

$$Quality\ Rate = \frac{Output\ -\ Reject}{Output} \times 100\%$$

$$= \frac{60000-2022}{60000} \times 100\%$$

$$= \frac{57978}{60000} \times 100\%$$

$$= 0{,}9663 \times 100\%$$

$$= 96{,}63\%$$

In the calculation of *the quality rate* in January 2021, a value of 96.63% was obtained, which is very good for achieving production results. This value was achieved because the number of *outputs* produced was high.

**Table 7.** *Quality Rate* Induction Kitchen in 2021

| Periode | *Output* (kg) | *Reject* (kg) | *Quality Rate* |
|---|---|---|---|
| Jan-21 | 60000 | 2022 | 96,63% |
| Feb-21 | 48000 | 800 | 98,33% |
| Mar-21 | 38400 | 490 | 98,72% |
| Apr-21 | 60000 | 123 | 99,80% |
| Mei-21 | 50400 | 660 | 98,69% |
| Jun-21 | 60000 | 122 | 99,80% |
| Jul-21 | 62400 | 6349 | 89,83% |
| Agu-21 | 57600 | 9440 | 83,61% |
| Sep-21 | 62400 | 303 | 99,51% |
| Okt-21 | 31200 | 8047 | 74,21% |
| Nov-21 | 60000 | 789 | 98,69% |
| Des-21 | 55200 | 235 | 99,57% |

In table 6, it is known that the lowest *quality rate* value in October 2021 is 74.21%. This value is far below the international standard of OEE which is 99.0%. The low *quality rate* in that period was influenced by low output and high *reject.*

***Overall Equipment Effectiveness***

The following is the calculation of the OEE value for January 2021

OEE = *Availability Rate%* × *Performance Efficiency%* × *Quality Rate%*

= 97,11% × 100% × 96,63%

= 94,29%

In the calculation of OEE in January 2021, a value of 94.29% was obtained. This value is above the international standard, which is 85%. The achievement of this value is influenced by the amount of value of the 3 components of the OEE calculation exceeding the limit of international standards.

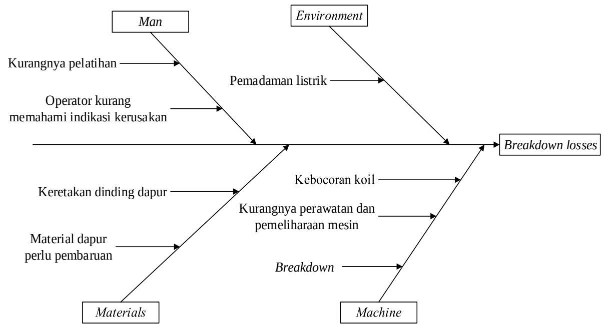
**Table 8.** Induction Kitchen OEE Value in 2021

| Periode | *Availability* | *Performance Efficiency* | *Quality Rate* | OEE |
|---|---|---|---|---|
| Jan-21 | 97,11% | 100% | 96,63% | 94,29% |
| Feb-21 | 73,13% | 86,50% | 98,33% | 62,20% |
| Mar-21 | 53,44% | 24,12% | 98,72% | 12,73% |
| Apr-21 | 95,50% | 99,78% | 99,80% | 95,09% |
| Mei-21 | 88,97% | 98,47% | 98,69% | 86,45% |
| Jun-21 | 96,90% | 99,90% | 99,80% | 96,60% |
| Jul-21 | 98,32% | 99,98% | 89,83% | 88,30% |
| Agu-21 | 98,80% | 99,98% | 83,61% | 82,59% |
| Sep-21 | 97,97% | 99,95% | 99,51% | 97,44% |
| Okt-21 | 51,87% | 13,92% | 74,21% | 5,36% |
| Nov-21 | 87,68% | 98,03% | 98,69% | 84,82% |
| Des-21 | 98,74% | 99,99% | 99,57% | 98,31% |
| Total | | | | 73,26% |

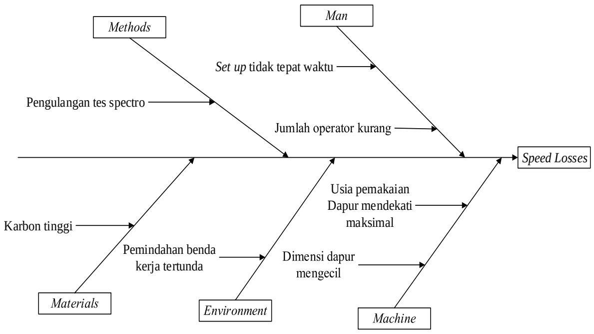
In table 8, it is known the amount of OEE value in the induction kitchen in one year. The lowest value in October 2021 was 5.36%. The cause of the amount of OEE value in that period can be known from supporting data such as *availability rate, performance efficiency*, and *quality rate.* And it is known that the average amount of OEE in 2021 is 73.26% where the value has not reached the OEE standard, which is 85% with the low value of the 3 OEE components so that it is the cause of the decline in the OEE value in that period. Efforts to increase the OEE value are needed by implementing relevant care systems on the dominant damage to induction kitchens. To find out the cause of the lack of OEE value, analysis using *Fishbone Diagram is needed.*

### *Fishbone Diagram*

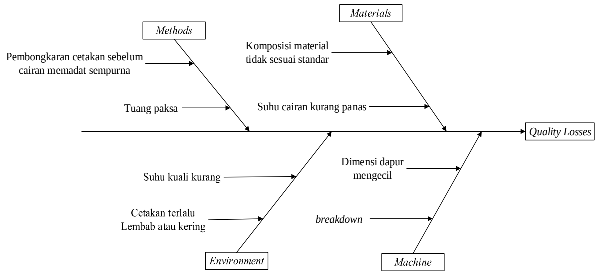
After being known, the average OEE of induction kitchens is 73.26%, where this value is far below the average standard. Then the cause analysis was carried out using *a fishbone diagram.*




**Picture 2.** Cause Analysis *Breakdown Losses*




**Picture 3.** Cause Analysis *Speed Losses*




**Picture 4.** Cause Analysis *Quality Losses*

**Table 9.** Relationship Between OEE and AHP Criteria

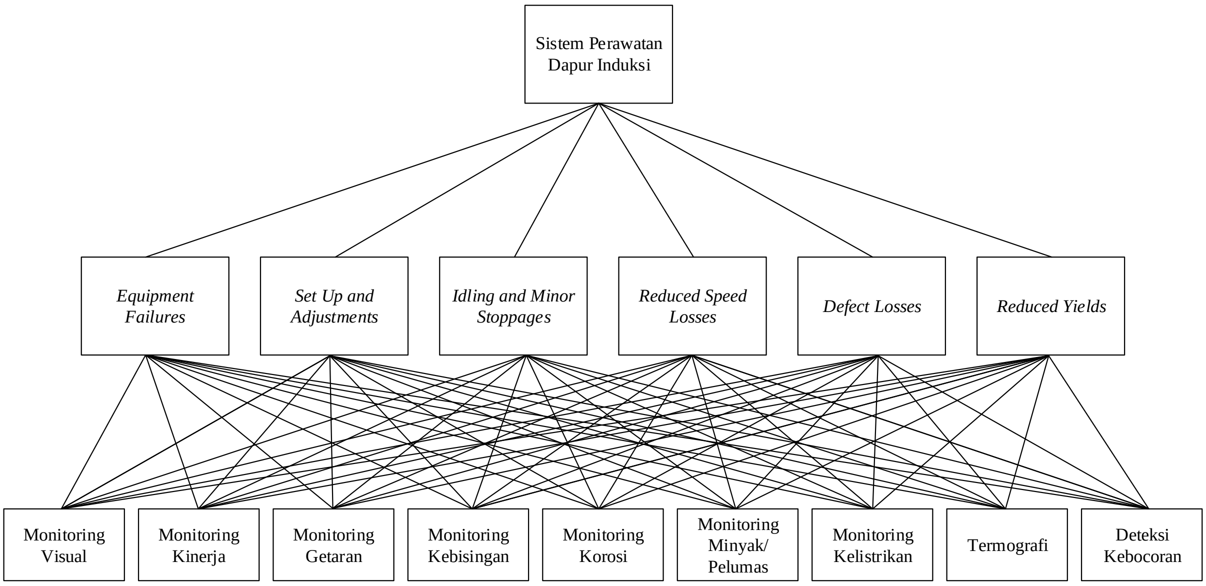
| OEE | Analisis Kegagalan pada *Fishbone Diagram* | Kriteria AHP |
|---|---|---|
| *Availability* | *Breakdown Losses* | *Equipment Failure*<br>*Set Up and Adjustments* |
| *Performance Efficiency* | *Speed Losses* | *Idling Minor Stoppages*<br>*Reduced Speed Losses* |
| *Quality Rate* | *Quality Losses* | *Defect Losses*<br>*Reduced Yields* |

Failure analysis in machines is carried out by looking for factors that affect significant machine failures such as *machines, man, material, method, environment*. Some of these supporting factors are then classified into failure groups such as *Breakdown Losses, Speed Losses*, and *Quality Losses* which can then be found to be related to OEE failure and AHP.

From table 9, it can be seen that the relationship between the OEE component and *six big losses* is a criterion in the AHP. The AHP criteria are engine failure factors used as a basis for considering the selection of alternative types of maintenance based on the condition of the machine itself.

***Analytical Hierarchy Process***

**1. Arrangement of Hierarchy**

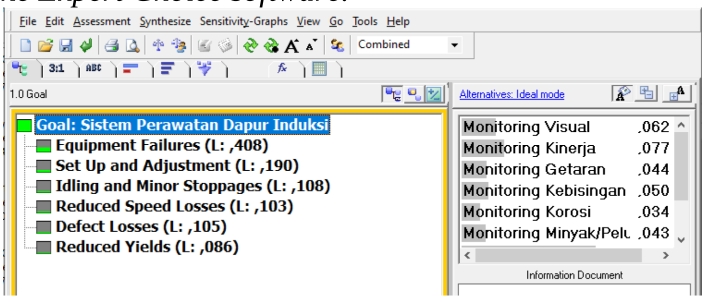



**Picture 5**. Hierarchy of Determining Types of Treatment

Figure 3 is known to be a hierarchical image of the determination of the type of treatment to be used in the *Analytical Hierarchy Process method.* The earliest step in the *Analytical Hierarchy Process* is the determination of goals. The goal to be achieved in this study is the type of treatment for induction kitchens. Then the determination of the second level by using *six big losses* as a criterion and for the third level is an alternative type of maintenance obtained from *the maintenance task* of *predictive maintenance.*

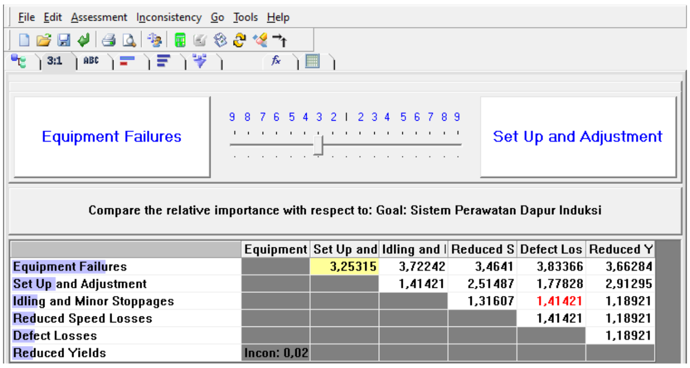
**2. Data Processing Using *Expert Choice***

Initial view *of the Expert Choice software.*




**Picture 6.** *Model View Expert Choice*

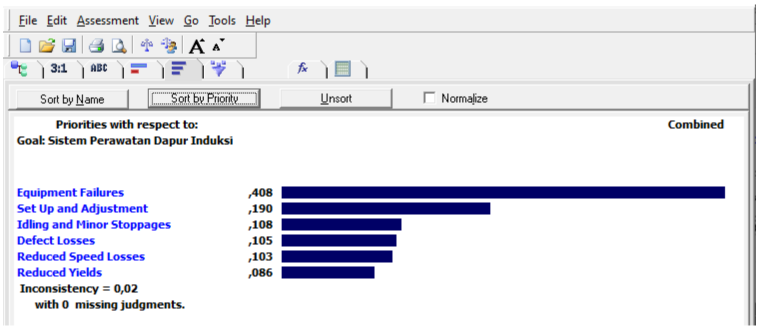
Paired comparisons for each combination criterion from all respondents




**Picture 7.** Paired Comparison Criteria

Figure 6 shows the process of comparing each criterion for the goals that have been combined. The assessment shows that *equipment failures* are more important than *set up and adjustments* based on the induction kitchen maintenance system.

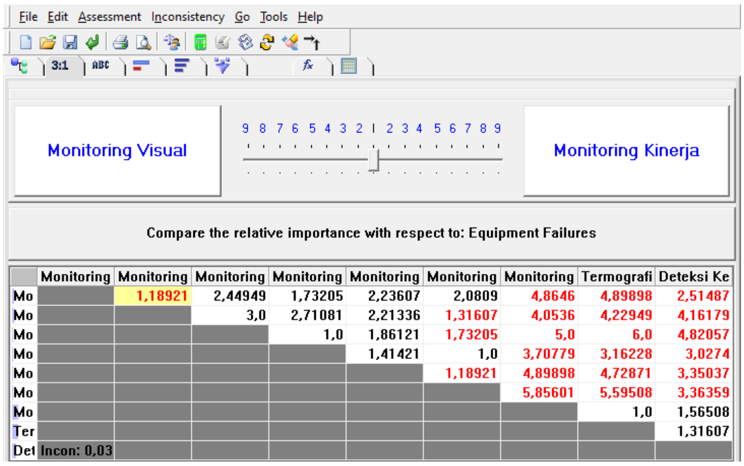
The results of the paired comparison of each combination criterion from all respondents.




**Picture 8.** Results of Comparison of Paired Criteria

In Figure 7, it is known that the results of the comparison of the paired criteria with the highest value are *equipment failures* with a value of 0.408 which will be a priority in the selection of alternative types of treatment. It is also known that the *overall consistency ratio* of paired treatment is 0.02 which means that it is consistent and acceptable because it is less than 0.10 or 10%, which will be a priority consideration in the selection of alternative types of treatment. The next step is to perform an alternative paired comparison for *the equipment failures* criteria.

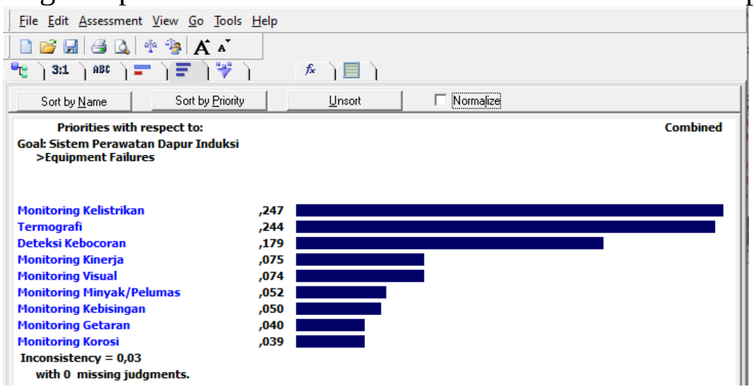
Comparison of each combination alternative combination from all respondents.




**Picture 9.** Alternative Pairing Comparison for Criteria *Equipment Failures*

Figure 8 is an alternative pairing comparison process between visual monitoring and work monitoring for *equipment failures* criteria that have been combined from all respondents. It can be seen that visual monitoring and performance monitoring have the same degree of importance to *the equipment failure criteria* with a value of 1.

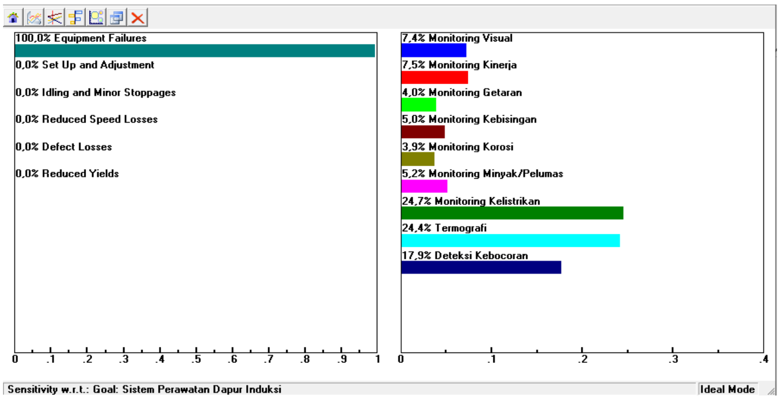
Results of pairing comparison of each alternative combination of all respondents




**Picture 10.** Results of Alternative Paired Comparison for Criteria *Equipment Failures*

In Figure 9, it is known that the results of the alternative pairing comparison for *the equipment failures* criterion with the highest value is electrical monitoring with a value of 0.247. It is also known that the *overall consistency ratio* of paired treatment is 0.03 which means that it is consistent and acceptable because it is less than 0.10 or 10%, which will be a priority in the selection of alternative types of treatment.

Alternative priorities for *the equipment failures* criteria are shown in the form of *dynamic sensitivity graphic diagrams.*




**Picture 11.** *Dynamic Sensitivity Graphic*

The *dynamic sensitivity graphic* shows the alternative priority of the maintenance system for *the equipment failures criteria.*In first place is electricity monitoring with a value of 24.7%. In second place is thermography with a score of 24.4%. The third place is leak detection with a value of 17.9%. The fourth is performance monitoring with a score of 7.5%. The fifth place is visual monitoring with a score of 7.4%. The sixth place is oil/lubricant monitoring with a value of 5.2%. The seventh place is noise monitoring with 5.0%. The eighth place is vibration monitoring with a value of 4.0%. And for the last order is corrosion monitoring with a value of 3.9%.

*Alternative ranking* results from data processing use *expert choice* for consideration in making decisions on the type of maintenance that is most suitable for the condition of the machine and then decided by experts as an effort to improve the maintenance system and improve machine performance.

**Table 10.** *Ranking* Priority of Selected Types of Treatment

| *Maintenance Task* | Nilai | Peringkat |
|---|---|---|
| Monitoring Kelistrikan | 0,247 | 1 |
| Termografi | 0,244 | 2 |
| Deteksi Kebocoran | 0,179 | 3 |
| Monitoring Kinerja | 0,075 | 4 |
| Monitoring Visual | 0,074 | 5 |
| Monitoring Minyak/Pelumas | 0,052 | 6 |
| Monitoring Kebisingan | 0,050 | 7 |
| Monitoring Getaran | 0,042 | 8 |
| Monitoring Korosi | 0,039 | 9 |

So that it can be determined for the improvement of the maintenance system according to the results of data processing using *expertchoice* , it is known that the first rank is electrical monitoring with a value of 0.247, thermography 0.244, leak detection 0.179, performance monitoring with a value of 0.075, visual monitoring with a value of 0.074, oil/lubricant monitoring with a value of 0.052, noise monitoring with a value of 0.050, vibration monitoring with a value of 0.040, and corrosion monitoring with a value of 0, 039.

## CONCLUSION

**In conclusion,** this research has established a fundamental finding that the Overall Equipment Effectiveness (OEE) of the induction furnace at PT. Lingga Sakti Indonesia is currently 73.26%, indicating room for improvement in operational efficiency. The application of the Analytical Hierarchy Process (AHP) has identified electrical monitoring as the most critical maintenance task to enhance equipment performance, thereby emphasizing the importance of targeted maintenance strategies in the steel casting sector. **Implications** of this study suggest that implementing the proposed maintenance system could lead to increased OEE, reduced downtime, and improved productivity, ultimately benefiting the company's operational efficiency. However, a **limitation** of this research is that it only presents proposals for improvement without conducting further empirical analysis on the practical implementation of these strategies within the company. **Further research** is recommended to explore the long-term effects of these maintenance strategies on OEE and to assess the operational feasibility and impacts of implementing electrical monitoring in the induction furnace maintenance system.

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