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Design of a Decision Support System for Power Plant Thermal Efficiency Management at PLTU X

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Abstract: - Efficiency management is one of the important pillars of the asset management system implemented at PLTU X based on PJBS guidelines to manage the power plant reliably and efficiently, which can support realising the company's vision of becoming a trusted power plant manager in Southeast Asia. As with efficiency management functions in other lines, the aim of power plant efficiency management is also to reduce production costs and ensure that the plant can operate efficiently all the time by controlling thermal losses in the power plant cycle. Determining efficiency management recommendations is very necessary to minimise the level of thermal losses that occur in the power plant's thermal cycle after evaluation. There is a series of evaluation processes that must be carried out to determine recommendations for optimising generator efficiency management; however, the process is currently still manual and takes a long time. With the advantages of a decision support system, which is usually used in determining systematic strategic decisions, it is hoped that this design can help engineers determine steps based on recommendations produced by the system precisely and in real-time so that they can be executed immediately to increase the efficiency of power plants even more. optimal.

Keywords: PLTU, efficiency management, thermal losses, decision support systems.

I. INTRODUCTION

PLTU X is a coal-fired steam power plant with a capacity of2x16.5 MW owned by PT. PLN (Persero), which is managedby PT. PJB Services. In the management process, PLTU X implemented an asset management system based on the guidelines applicable at PT. PJB Services with several supporting pillars, one of which is thermal management efficiency. Based on trend data on the efficiency rate (net plant heat rate) at PLTU X, it shows that the efficiency performance of the power plant has decreased, so to speed up the response to these conditions, thermal efficiency management in PLTU X, which is currently still running manually, needs to be developed into a digitalization system to produce recommendations for handling that are faster and accurate. Decision Support System is identified as a system intended to support managerial decision making in semi-structured decision situations[1], By utilizing the data centralization that has been carried out and considering the advantages of decision support systems, this research will develop a data-based decision support system model to accommodate these conditions.

The methodology used in this research starts from the user identification process, analyzing system requirements, designing a decision support system for generating efficiencymanagement, integrating the system design with a database containing PLTU operating parameter data, testing the system design and ending with an evaluation process of the test results that have been carried out..

B. Materials

The materials needed by the system are requirements for a system to function well and produce appropriate output. In the decision support system that will be designed, the materials needed are data, especially power plant parameter data which will later be processed in the system to produce analysis and recommendations for handling efficiencyproblems (thermal losses). Currently, data centre facilities areavailable that can capture data from the transmitter parameters of each generating unit, especially PLTU X, ontoa centralised server, and the data can be accessed by employees who need it. The types of parameter data that canbe accommodated by the data center include:

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Table 1. List of Data Requirements

Parameter	Data Type
Turbine Steam Input	Numeric (Float)
Boiler Steam Output	Numeric (Float)
Exit Gas Boiler	Numeric (Float)
Combustion Air	Numeric (Float)
Condensate System	Numeric (Float)
Power Input -Output	Numeric (Float)
Fuel Usage	Numeric (Float)

II. METHOD & DATA

A. Method

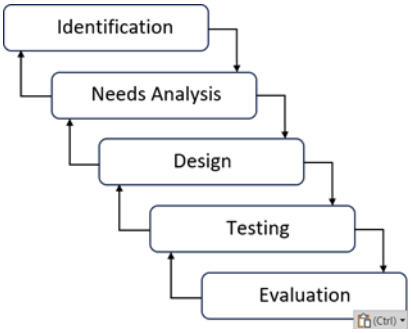


Figure 1. Research Waterfall Diagram

III. RESULT

A. Database Design

The database design in the thermal efficiency management decision support system has an important role in ensuring that the relevant data needed for decision making can be collected well, accessed efficiently, and can be analyzed appropriately.

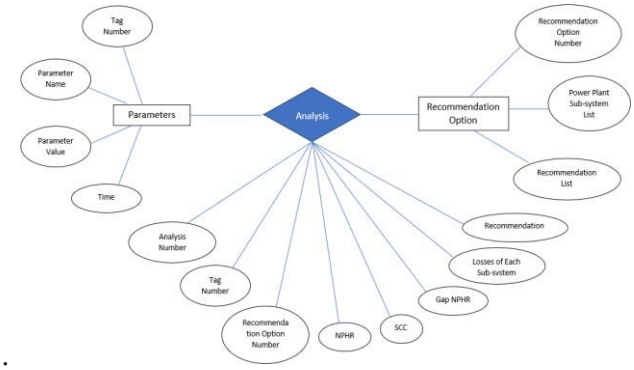


Figure 2. Entity-Relationship Diagram (ERD) of DecisionSupport System

The thermal efficiency management decision support system for PLTU power plants has 2 entities, namely "Parameters" and "Recommendation" Options with each attribute as follows.

Table 1. List of Data Requirements

Parameters	**Recommendation**
Tag Number (Primary Key)	Recommendation Option Number (Primary Key)
Parameter Name	Power Plant Sub-system List
Parameter Value	Recommendation List
Time	

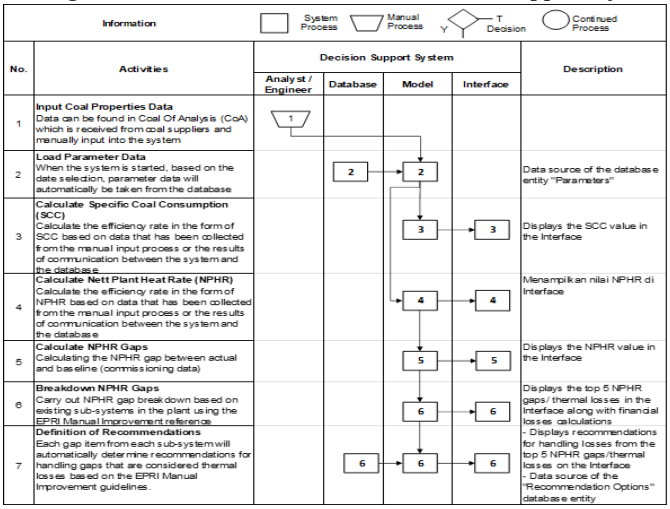
The “Parameters” entity is an entity that contains data and is connected to the data centre (OLE Database), which has 4 attributes with “Tag Number” attribut as the primary key. Apart from the “Tag Number” as the primary key, in the Parameter entity there are 3 other attributes, namely“Parameter Name” which contains the specific name of the parameter being measured, “Parameter Value” which contains the measured values and the “Time” attribute whichcontains the history related to the recording time of themeasured values.

The “Recommendation Option” entity is an entity that contains recommendation options for handling thermal lossesthat have been measured in the system. The recommendationoptions entered into the database are based on existing references and are commonly used to support analysis of the causes of thermal losses by the general public in powergeneration field, where in this research the reference used is the EPRI Manual Improvement. In the EPRI Manual Improvement, engineers and analysts can see options for handling thermal losses based on which sub-systems areindicated to cause thermal losses, so that by identifying the source of thermal losses based on the sub-systems in the power plant concerned based on the division of sub-systems,power plants which also refer to the same reference, namely the EPRI Manual Improvement, can also determine recommended handling steps to minimize or even eliminate these thermal losses. In the “Recommendation Option” entity there are 3 attributes with the “Recommendation OptionNumber” attribute as the primary key, the “Power PlantSub-system List” attribute is an attribute that contains a list ofpower plant sub-system divisions based on the EPRI Manual Improvement and the “Recommendation List” attribute is an attribute that contains steps for handling thermal losses basedon sub-systems in the EPRI Improvement Manual.

In the ERD diagram, there is also a relationship that connects the “Parameters” and “Recommendation Option” entities. With relationships, you can see how these entities areconnected to each other and how data can move or be connected between these entities. In the power plantefficiency management decision support system database, the relationship that connects the “Parameters” and “Recommendation Option” entities is the “Analysis” relationship. The analysis relationship has 8 attributes that describe the analysis results which are a relationship between2 entities, namely Parameters and Recommendation Options.

B. Model Design

Table 2. Design of Communication Flow for DecisionSupport System Model



In this decision support system, the coal property items that need to be entered are the calorific value of the coal,

ultimate analysis and proximate analysis used during thetesting process. After the user inputs coal property data, the next data that needs to be input is the time period for data collection in the data center as a function of selecting the time period for which the efficiency performance wants to be measured. The data that has been called up automatically based on the function of the data call program in the decision support system that is integrated with the data centre and other data that has been input by the user will then be processed into information, namely the efficiency rate which is represented by NPHR (Nett Plant Heat Rate) as explained in equation[2],

$$Heat\ rate = \frac{Coal\ Consumption\ (kg)\ x\ Coal\ Calorific\ Value\ (KCal/kg)}{Nett\ Power\ Output\ (kWh)}$$

After the efficiency rate value can be determined and displayed, then the actual efficiency rate or NPHR value is compared with the NPHR value for the baseline condition tofind out how big the efficiency rate gaps or thermal losses. After the gap is found, then the gaps will be broken down based on the parameters and change factors for each parameter to be converted to heat rate units (KCal/kWh). [3]

$$\text{Breakdown Losses} = \left[\%\ Heat\ Rate\ x\left(\frac{Nett\ Heat\ To\ The\ Cycle\ (Heat\ Input)}{Output}\right)\right]\ x\ Deviasi\ Parameter$$

After each breakdown gap from each sub-system has been converted into heat rate units, then the model will be sorted based /ranking on the sub-system contributing to the highest heat rate gap and potential financial losses will be calculated Next, recommendations for handling gaps which are considered losses will automatically be determined for each gap or thermal losses item based on the guidelines used (EPRI Manual Improvement).

For system testing of the thermal efficiency management decision support system design at PLTU, a simple model forimplementing the design in question was created using VBA (Visual basic for application). After the simple model has been created and integrated with the database, the system design testing process will then be carried out. The hope is that when the system design is tested, the results will be in accordance with the desired standards, in accordance with best practice for PLTU efficiency management and the function of this digitalized system can run more effectively than the previous manual system.

Figure 3. Decision Support System Model Prototype

Based on the system testing that has been carried out, each of the functions previously described in Table 2 shows that the system can function well and of course will make it easier for users to obtain efficiency rate information, heat rate losses mapping and recommendations for handling heat rate losses quickly and accurately, so that with The speed of the analysis process will reduce waiting time in implementing efficiency rate improvements in the future.

IV. CONCLUSION

The conclusions obtained based on this research are:

1. The design of the decision support system was made based on the thermal efficiency management process, which runs manually at the PLTU X with standard procedures for analyzing and determining

recommendations.

2. The design of the decision support system database thathas been prepared and has been tested shows that the PLTU X thermal efficiency management decision support system can be connected to a series of data available in the database and selected according to system needs based on input from the user.

3. In the system testing that has been carried out, the PLTU thermal efficiency management decision support system has been able to implement management efficiency calculation functions with output values of NPHR (net plant heat rate), SCC (specific coal consumption) and gap/thermal losses rate values based on value comparisons. actual and baseline.

4. The process of breakdown thermal losses, which isrepresented in the NPHR gaps or thermal losses can be carried out with the breakdown losses calculation function, which is added to the system to map the distribution of thermal losses that occur in each sub-system and then the system will automatically determine the priority of sub-system losses based on how large the number of losses that arise in each sub-system.

5. By determining the distribution of thermal losses in each power plant sub-system, recommendations will automatically appear for thermal losses that occur in thesub-systems in the interface by utilizing the attribute relationship "Power Plant Sub-sistem List" and "Recommendation List" in the “Recommendation” entity based on EPRI Manual Improvement recommendations.

6. The list of recommendations that appears in the system can be used as consideration for determining an action plan for handling thermal losses for immediate execution.

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