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Real-Time Data-Driven Utilization Affecting Business Processes on the Operation and Maintenance of Power Generation

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The usage of operation technology, internet technology and the inclusion of vast amount of data generated in business processes are increased and it might generate many benefits for almost all field of organizations. On the other hand, the realization of these benefits might be difficult if organizations are not able to handle and interpret these vast amounts of data. The purpose of this paper is to study how operation technology, internet technology and vast amount of data utilizations affect business processes in organization which operates and maintains power generation.

In this study the authors analyze the business processes of operating a 14 GW power plant located separately in more than 25 locations in Indonesia owned by PT. Indonesia Power. The development of Reliability and Efficiency Optimization Centers (REOC), a centralized system based on IT/OT and real-time data to analyze power plant reliability and efficiency, is investigated as a case study.

The results of the study show that business processes in the operation and maintenance (O&M) organization of power plants in governance, capabilities, organization, and workflow standardization can change. The new ability to be able to interpret changes must also be adapted by the organization.

Organizational transformation due to the use of IT/OT and real-time data driven has implications in the areas of decision making, improving power plant performance, and reducing operating and maintenance costs.

According to its findings, this paper shows decision making that affecting business processes in Asset Management System from the Asset Business Process itself, Asset Technology side and Asset People side in the context of power plant O&M organizations. Moreover, such organizational transformation can be adopted and applied to similar power plant O&M organizations.

Keywords: Real-time, Data-driven, Operation Technology, Internet Technology, Decision-making processes, Power generation, Operation & Maintenance

1. Introduction

1.1. IT/OT Motivation

IT/OT convergence is the integration of information-technology (IT) systems with operational-technology (OT) systems. IT systems are used for data-centric and data-driven, OT systems monitor events, processes, and devices, and make adjustments in enterprise and industrial operations.

Modern organizations grapple with two worlds. There is the traditional physical world composed of machines, electromechanical devices, manufacturing systems and other industrial equipment. Then there is the more recent digital world using servers, storage, networking, and other devices used to run applications and process data-centric and data-driven. These two worlds have largely occupied separate domains, shared little (if any) meaningful data-driven, and relied on oversight on business processes.

Today, the worlds of IT/OT are converging. Advances in technologies such as the internet of things (IoT) and big data analytics are systematically allowing the digital information world to see, understand and influence the physical operational world. When implemented properly, IT/OT convergence.

IT/OT adoption in operation, maintenance, and engineering strategies. Asset management as a type of business process is highly dependent on vast amounts of data from which relevant information can be created and is used for developing process business and decision-making process during the life-cycle of assets. Asset management is generally understood to be the set of activities of a business objective associated with identifying what assets are needed; identifying funding requirements; acquiring assets; providing logistic and maintenance support systems for assets; and disposing or renewing assets to meet the desired objective effectively and efficiently.

1.2. Real Time Data-driven

Real-time data is collected as events occur and can facilitate data-driven decision making. With data processing powered by Artificial Intelligence (AI), machine learning (ML), and automation, real-time data can be turned into actionable insights. This gives businesses a competitive advantage, with

the ability to make better and more timely decisions with real-time data.

Older systems with technology constraints only process data in batches. This means information will be delayed, and reports do not reflect real-time data. As a result, it is not possible to monitor the business in real-time to support data-driven decision making. In this case, the decision should be made in retrospect, using old data.

Vast amounts of data can sometimes slow down your system's ability to process data for later analysis. Analyzing data in real-time can give your business a strong competitive advantage - the ability to monitor your business in real-time and make better decisions faster and more precisely

1.3. Vast Amount Real-Time Data Driven

Reliability, efficiency, and optimization essentially creates a reliability digital twin of the facility and allows facility owners to simulate any action and optimize their plan to achieve the highest performance at the lowest cost, while meeting process safety requirements. Modeling the constraints of the entire system, facility owners can move away from individual asset analysis and task management, focusing on system-wide system task management. The data infrastructure backbone connecting every single data point and relating that to a measured impact on the system, optimization studies can be continuously run as new data enters the model, resulting in the world most predictive reliability plans based on real-time data driven.

Providing an integrated and real-time Power and Asset Reliability and Efficiency Information and Control Center as a means for analysis and decision making which includes Real Time Performance Management and Dispatch App.

2. Background Review

An asset management system is used by the organization to direct, coordinate and control asset management activities. it can provide improved risk control and gives assurance that the asset management objectives will be achieved on a consistent basis. However, not all asset management activities can be formalized through an asset management system. For example, aspects such as leadership, culture, motivation, behavior, which can have a significant influence on the achievement of asset management objectives, may be managed by the organization using arrangements outside the asset management system. The relationship between key asset management terms is shown in Figure 1.

In Asset Management activities and proper business processes, it is very dependent on existing asset information so that companies can develop an Asset Information System that describes the management and processing of real time data driven to be vast amounts of data, and the technology needed to monitor operational performance and reporting of information to support effective business processes and operational decision making and strategic decisions within the organization. Good asset information system supports the delivery of day-to-day asset management activities and enables better business processes and decision-making processes.

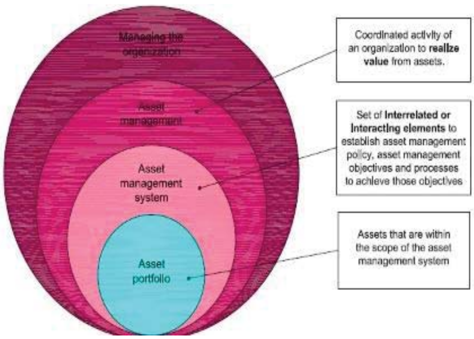

Figure 1. The Relationship of the Asset Management System to Asset Management

Companies deal with multiple assets and asset management activities that generate vast amounts of data in real time. In order to handle data and information, organizations make great efforts and investments to develop for many streams on asset management that consist of 4 factors that influence to increase the reliability of equipment and plant units and production, it can be seen in Figure 2, bellows:

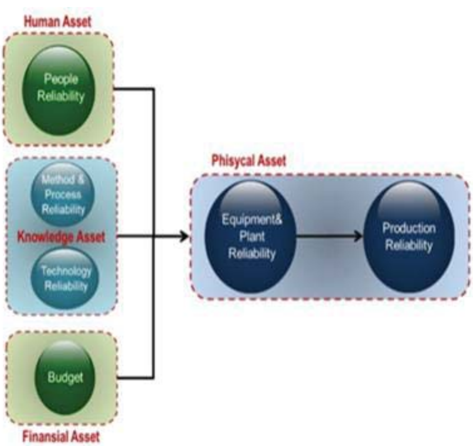

Figure 2. The Stream on Asset Management for Increase Value of Physical Asset

a. People who manage equipment and plant units.
b. Methods and processes for managing equipment and plant units.
c. Technology to manage equipment and plant units.
d. Budget allocated to manage equipment and plant units.

All aspects of asset management implementation are now visible and transparent to all relevant parties in the organization and make it easier to manage and improve continuous efforts in real time.

Real time data driven in very large quantities considering life cycle costs, data alignment with company goals and information needed to support business processes and asset management decision-making processes as well as digitalization technology to be used. It also includes information standards such as asset classification and hierarchy, required data, criticality, condition, performance or serviceability and asset utilization. Organizations must always assess and monitor the quality of real time data driven this is relevant, accurate and timely is the key to making accurate decisions in good business processes.

Asset Management System in a company that has many assets and spreads in various locations, the company will have the challenge of optimizing asset value. The following are some of the obstacles for companies to manage their assets properly:

1. There are many capable and competent employees who must be aligned to implement the asset management system.
2. The number of power plants with different capacities and brands spread across many locations difficulties in establishing asset information standards and technical standards to support supply chain operations, maintenance, and management.
3. Complex business processes generate a lot of data and information assets that need to be managed to support the decision-making process.
4. With assets that have different operating times and are very old, making it another challenge for the company to make good sustainability and investment plans.

To realize the expected value of the existing asset portfolio and the subsequent development of new assets, the company decided to implement an Asset

Management System (AMS) in 2009 which refers to the PAS 55, ISO 55000 series and and always keep abreast of digital technology developments by carrying out benchmarks of similar leading companies and in accordance with the recommendations of international consultants from the U.K. namely AMCL (Asset Management Consultant Limited, 2021) which effectively encourage the best company performance and can survive to be able to compete in the future. AMS is holistic identifying and managing all required AM activities from Strategic Planning, AM Decision Making, Life Cycle Delivery, Asset Information, People-Organization and Risk Review to realize value from assets (6 box model Asset Management Activities, in Figure 3). AMS integrates all AM activities systematically to provide optimal asset system results and ensure the sustainability of the asset system.

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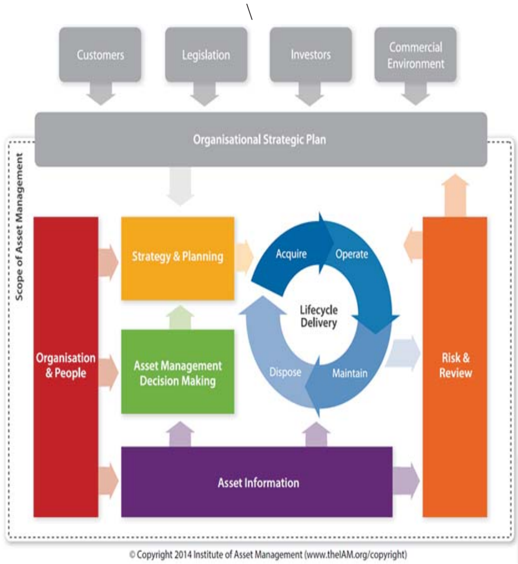

Figure 3. 6 (Six) box model Asset Management Activities

3. Asset Development

3.1. Asset Business Process Development

Asset management enables an organization to realize value from assets in the achievement of its organizational objectives. An asset is an item, thing or entity that has potential or actual value to an organization. The value will vary between different organizations and their stakeholders, and can be tangible or intangible, financial or non-financial. An organization may choose to manage its assets as a group, rather than individually, according to its needs, and to achieve additional benefits. Such groupings of assets may be by asset types, asset systems, or asset portfolios.

This section presents options for analyzing and making recommendations from real time data driven. In addition, from the results of the recommendations forwarded on how to optimize it. There are 4 stages in the use of real time data driven which consists of :

1. Analyze: monitor parameters and identify parameter anomalies that cause losses and loss of production potential and coordinate with supervisors for corrective actions against these anomalies
2. Advise : provide solution recommendations for the correction of parameter anomalies back to normal positions and coordinate to optimize operating parameters to achieve the expected optimal conditions
3. Optimize : how is this stage to control the operational conditions of the power plant in accordance with the recommendations in the advice stage to improve the reliability and efficiency of the power plant and provide feedback back to the advisor according to the effectiveness of the control
4. Dispatch : give orders to take action according to the results of the analysis and optimization of the anomalies that occur and return them to the best condition

Real time data driven application, which is integrated and has analysis, advise, optimize and dispatch stages which is being developed by PT. Indonesia Power as subsidiary PT. PLN (Persero) - A State Electricity Company of Indonesia. Development at PT. Indonesia Power is named REOC, which stands for Reliability Efficiency Optimization Center, which can monitor more than 13 GWh of various power generation technologies in more than 25 unit locations and more than 50,000 parameters.

Real time data driven which is integrated into vast amount of data with Artificial Intelligence (AI), machine learning (ML) is used to design for analyze, advise, optimize and dispatch (AAOD) and also used to design the Automatic Failure Detection System (AFDS) feature. AFDS will have the function of maintaining the reliability and efficiency of the power plant (Can be seen in Figure 4)

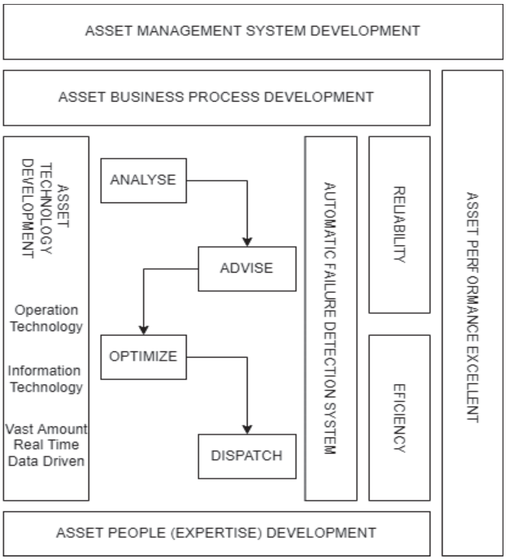

Figure 4. Asset Management System, Business Process Development

The processes in AAOD and AFDS for reliability management are carried out automatically, where state detection, health assessment, prognostic assessment, and advisory generation are carried out using advanced analytics, advanced diagnostic and techniques created in AAOD / AFDS in the REOC. Therefore, the process for reliability management should be online. There are 4 stages that must be carried out in advanced analytics, namely.

a. Descriptive analytics, which analyzes in determining an event (what happened?).
b. Diagnostic analytics, which analyzes in determining the cause of an event (why did it happen?).
c. Predictive analytics, which analyzes in predicting what will happen next (what will happen?).
d. Prescriptive analytics, which utilizes predictive analytics in predicting events and providing recommendations on what steps to take.

In designing AAOD and AFDS for reliability management, minimum specifications are required that must be met, namely.

a. Has an analytical server with a large capacity that functions to process data parameters and advanced information.
b. It has an HMI that functions to display data parameters and advanced information received by AAOD and AFDS for reliability management and displaying process data.
c. Having a central historian server (can be a cloud server) with a large capacity that functions to store data parameters and advanced information received by AAOD and AFDS for reliability management and storing process data.

AAOD and AFDS for efficiency management have 4 process stages in it, namely.

a. Collecting efficiency data, which is collecting parameter data from the process and condition of the plant unit.;
b. Data processing, namely calculating the efficiency of equipment and plant units based on the standards used and modeling.
c. Analysis and reporting, namely conducting heat rate gap analysis, Pareto auxiliary power consumption, and heat rate root cause analysis.
d. efficiency improvement, namely recommendations aimed at increasing the efficiency of equipment and generating units.

The processes in AAOD and AFDS for efficiency management are carried out automatically, where data processing, analysis and reporting, and efficiency improvement are carried out using the algorithms created and the processes therein are online diagnostics processing.

3.2. Asset Technology Development

In developing technology to carry out AMS properly and reliably in the AAOD stages, it requires operation technology, information technology and a vast amount of real time data driven which is measured with high accuracy. This accuracy is important because it serves to increase the reliability and efficiency of generating equipment by minimizing the level of risk and operational costs.

The unit plant has 2 types of data that are used as input for this development, namely.

1. Parameter data from the process and condition of the plant unit (process and condition data).
2. Data maintenance activities (maintenance activities data).

What is needed in data processing is the operating process parameters and condition of the plant unit obtained from readings and detection by sensors, transmitters, and analyzers installed in the plant unit. Parameter data will be sent to the Distributed Control System (DCS) or Programmable Logic Control (PLC) to be displayed in the Human Machine Interface (HMI), stored in the historian server, and processed to become a control signal for processes in the generating unit. Besides being sent to DCS or PLC, parameter data is also sent to AAOD to be diagnosed and known through vast amount of real time data driven.
In addition to parameter data from the process and condition of the generating unit, there is also maintenance activity data sent to AAOD and AFDS, but not in real time. Maintenance activity data is obtained from maintenance tools in the plant unit.
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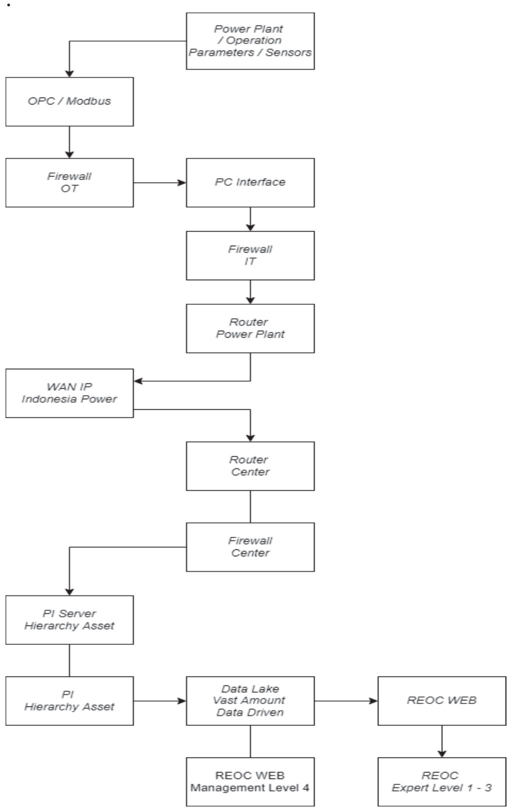


Figure 5. Technology Development for AAOD and AFDS

In designing the unit plant topology used for the application of AAOD and AFDS, minimum specifications are required that must be met, namely.

a. Verify and validate sensors, transmitters, and analyzers installed in the plant unit against the need for parameter.
b. data analysis.
c. Has a history server with a large capacity that functions to store parameter data sent to AAOD and AFDS.
d. Having a high-speed and reliable network to (networking) or IIoT that functions for communication between plant units with AAOD and AFDS.
e. Having a security server (antivirus and firewall) with high capabilities to protect communications between plant units with AAOD and AFDS from viruses, spam, hack, crack, and sabotage (cyber security).

Figure 5 shows the topology used for the application of AAOD and AFDS, start from the plant unit until the REOC. AAOD and AFDS in REOC all aim to analyze, advise as well as optimize and provide some recommendations and actions to the unit plant or if higher decision-making is needed because a difficult solution is needed, experts are required to be placed in the REOC.

3.3. Asset People (Expertise) Development

In AAOD and AFD it is necessary to prepare competent people or experts, where they are REOC. Experts will receive process data at AAOD and AFDS for further analysis by considering maintenance activity data as well. The data from the further analysis will be sent to the plant unit and used as input for carrying out maintenance activities. Therefore, further analysis is carried out by Experts with offline diagnostics.
In addition to conducting further analysis, the experts also have an obligation to validate the processed data in the AAOD and AFDS. If the results of the process are not suitable, then Experts will modify and/or redesign the algorithm.
Experts perform further analysis and validation based on knowledge and experience in their field of expertise. There are 8 areas of expertise needed to do this, namely.
a. Information technology expertise.

b. Data analyst expertise.
c. Data engineer expertise.
d. Instrumentation and control expertise.
e. Electrical expertise.
f. Mechanical expertise.
g. Performance and efficiency expertise.
h. Reliability and maintenance expertise.

With the needs of Experts and expertise, the Organization must also develop a suitable and supportive organization for the development of its technology and business processes. These requirements must be met by the organization so that AMS can run according to plan and generate value for the assets under management.

3.4. Example Case (Project Development)

Reliability and Efficiency Optimization Centers (REOC) is example case project, still under development owned by PT. Indonesia Power, authors analyzed the business process on the operation of 14 GW power generations which located separately in more 25 locations in Indonesia. The development of a centralized system that based on real-time data- driven to analyze reliability and efficiency of power generation, were investigated as the case study in this study.

Advanced analytics for AAOD and AFDS as Power Diagnostic Center in REOC is the activity of calculating and processing power equipment data which includes data input, machine learning understanding, graphical/trending analysis, predictive application, visualization, and data analysis. The application of advanced analytics that also supports proactive and predictive maintenance of generating equipment aims to:

a. Detect an anomaly or deviation of generating equipment operating data.
b. Determine an appropriate decision from the cause of a problem or equipment failure in real time.

The Advance Analytic Development in Power Diagnostic Centre is shown in figure 6.

The information in the Advance Analytic Development in Power Diagnostic Centre is described as follows:

a. Equipment is generating equipment which is the object of monitoring activities and advance analysis of equipment parameters.
b. Distributed Control System (DCS) is a platform for a system with control and automatic operation or work processes of an equipment.
c. Interface is a communication mechanism for conveying information from DCS with input parameters and providing information to the user to help direct the tracing flow and find equipment data anomalies.
d. Power Diagnostic Center is an integrated software to collect, store, view, analyze, and share equipment operational data from DCS to clients or users.
e. Client/user is a user who accesses requests for data or services from the Power Diagnostic Center.

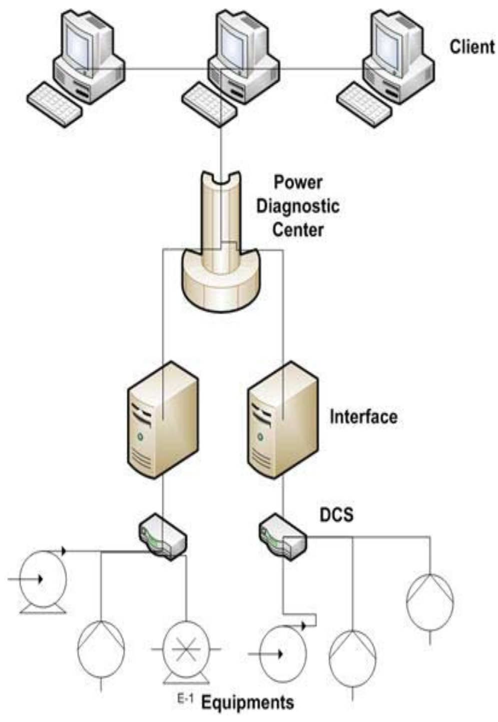


Figure 6. Advance Analytic Development for AAOD and AFDS as Power Diagnostic Center

Advanced Analytics activities consist of commissioning, performance tests, monitoring and improvement activities. In its application, the characteristics of generating equipment can be known in the form of curves, graphs, correction factors based on manual books, standards, EPRI documents and other documents that can be used as references. Meanwhile, the calculation of generator efficiency can use PLN Standards (SPLN) or appropriate international standards, such as ASME PTC 4.6.

MONITORING HPH#1 UNIT 2

Name	Description	Value	Units	Trend	Minimum	Maximum
BLT2.HP Heater 1.DCA.45eae890-80d8-5d9d-026		Calc Failed			No Data	No Data
BLT2.HP Heater 1.Feedwater Temperature Rise.8d		Calc Failed			No Data	No Data
BLT2.HP Heater 1.Drain Water Temperature	Temperature drain out heater 1	254.79			253.32	255.56
BLT2.HP Heater 1.Inlet Steam Pressure	Tekanan steam extraction 1	4.14			4.03	4.19
BLT2.HP Heater 1.Inlet Steam Temperature	Temperature steam extraction 1	343.15			338.38	343.33
BLT2.HP Heater 1.Outlet Feed Water Temperature	temperatur feedwater outlet heater 1	259.15			257.77	260.13
BLT2.HP Heater 1.TTD.b6b3cfb1-2610-5e37-282e-		-115.03			-115.6	-114.51

MONITORING HPH#2 UNIT 2

Name ▲	Description	Value	Units	Trend	Minimum	Maximum
BLT2.HP Heater 2.DCA.45eae893-80d8-5d9d-026e		Calc Failed			No Data	No Data
BLT2.HP Heater 2.Drain Water Temperature	Temperature drain out heater 2	226.22			224.89	226.98
BLT2.HP Heater 2.Feedwater Temperature Rise.8d		Calc Failed			No Data	No Data
BLT2.HP Heater 2.Inlet Steam Temperature	Temperature steam extraction heate	268.70			264.86	268.83
BLT2.HP Heater 2.Outlet Feed Water Temperature	temperatur feedwater outlet heater	230.91			229.65	231.61
BLT2.HP Heater 2.TTD.b6b3cfb2-2610-5e37-282e-		Calc Failed			No Data	No Data

MONITORING HPH#3 UNIT 2

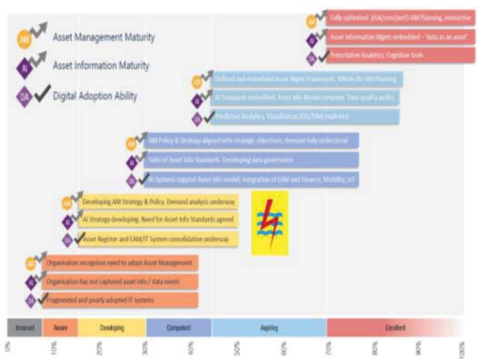
Name	Description ▲	Value	Units	Trend	Minimum	Maximum
BLT2.HP Heater 3.TTD.b6b3cfaf-2610-5e37-282e-b		-94.026			-94.394	-93.295
BLT2.HP Heater 3.Inlet Steam Pressure	Tekanan steam extraction 3	1.22			1.18	1.24
BLT2.HP Heater 3.DCA.45eae88e-80d8-5d9d-026e		26.773			25.698	27.34
BLT2.HP Heater 3.Feedwater Temperature Rise.8d		33.602			32.107	34.166
BLT2.HP Heater 3.Inlet Feed Water Temperature	temperatur feedwater inlet heater 3	165.00			164.24	166.04
BLT2.HP Heater 3.Drain Water Temperature	Temperatur drain out heater 3	191.78			190.69	192.47
BLT2.HP Heater 3.Outlet Feed Water Temperature	temperatur feedwater outlet heater 3	198.61			197.51	199.21

Figure 6. Advance Analytic Development for AAOD and AFDS in HPH (High Pressure Heater) from REOC

With the implementation of AAOD and AFDS in Advance Analytic, the need for Experts is necessary according to their scope of expertise. With the addition of experts, the organization and business processes that must be carried out have also changed.

4. Conclusion and AMS Future Development

According to the studies conducted in this paper, by utilizing information technology and operating technology (IT/OT), real time data-driven and vast amounts of real time data-driven it is possible to make important and strategic corporate decisions and through the verified and evaluated data. By parallel implementing Asset Management and developing an appropriate Asset Management System such as business processes development, technology development and people development can be full support the business to generate real-time insights and forecasts to improve the performance and value of the Company. The implementation of Asset Management must be accompanied by the development of technology for analyze - advise - optimize - dispatch (AAOD) and automatic failure detection system (AFDS) to control the reliability and efficiency of the Power Plant. AAOD and AFDS in REOC all aim to analyze, advise as well as optimize and provide some recommendations and actions for the unit plant or if higher decision-making is needed because a difficult solution is needed, experts are required to be placed in the REOC. In designing AAOD and AFDS for reliability management, minimum specifications are required that must be met, such as an analytical server with a large capacity that functions to process data parameters and advance information, HMI that functions to display data parameters and advanced information received by AAOD and AFDS for reliability management and displaying process data, having a central historian server (can be a cloud server) with a large capacity that functions to store it. Challenges in implementation are important to note, the challenges are how maturity is viewed from 3 sides namely, asset management maturity, asset information maturity and adoption of digital abilities according to the picture as bellow:



Management review must be carried out periodically with that the 3 sides in measuring maturity will increase and provide the effectiveness cost and the good benefits for the company. Currently seen from the picture above, the company is still in the awareness and development phase, this is a weakness and also a challenge going forward so that it can increase to the least competent phase.

Finally, this paper finds that by utilizing business processes, technology and people that will support business and best practices in O&M

management will provide some insights for operation and maintenance planning decision makers to achieve sustainable asset value growth.

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