



Optimizing Asset Management: Comprehensive Analysis and Innovative Strategy Design to Increase the Effectiveness of Life Cycle Delivery at PT Pembangkitan Jawa-Bali Services

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ABSTRACT: Asset management is the art and science of making the right decisions and optimizing the delivery of value from organizational assets. (Institute of Asset Management , 2010). PT PLN Pembangkitan Jawa Bali Services, which is often abbreviated as PT PJB Services, is a subsidiary of PT Pembangkitan Jawa-Bali (PT PJB). This company operates in the field of power plant operation and maintenance services, as well as supporting services related to power plants. The company has a strong focus on asset management, given its role in managing and maintaining critical power generation assets. This research examines the implementation of multidimensional strategies in optimizing asset management at PT Pembangkitan Jawa-Bali Services (PJB Services). The main focus of the analysis is to test the variables that influence the success of asset performance at PT Pembangkitan Jawa Bali Services based on group 3 (*Life Cycle Delivery*) consist of 11 key dimensions of asset management: *Technical Standards & Legislation, Asset Creation & Acquisition, Systems Engineering, Configuration Management, Maintenance Delivery, Reliability Engineering, Asset Operation, Resource Management, Shutdown & Outage Management, Fault & Incident Response, Asset Decommissioning & Disposal*. The main aim of the research is to design an integrated approach to improve the effectiveness of corporate asset management. The method used in this research is *the Structural Equation Model* with the *Partial Least Square approach*. The research results revealed that the accepted hypothesis is H1, H2, H3, H4, H9, H10, H12, H16, H17, H18, and H19 are acceptable because they have t-statistic values > 1.96 and *p-values* < 0.05 . Meanwhile, the hypotheses H5, H6, H7, H8, H11, H13, H14, and H15 were rejected because they had *t-statistic values* > 1.96 and *p-values* > 0.05 .

KEYWORDS: Asset Management, Partial Least Square, Structural Equation Model.

INTRODUCTION

Management asset is knowledge And art management asset Which covers planning, acquisition, inventory, implementation auditing law, evaluation, operation, maintenance, renewal or shrinkage need asset, as well as its management in a way effective And efficient . (A. Gima Sugiana, 2013). Every private company or government organization certainly has assets, both (Febrina Fatma & JoniDevitra, 2019)*tangible* and *intangible* . Research was conducted at PT PLN Pembangkit Jawa Bali (PJB) Services is a subsidiary of PT PLN (Persero) which operates in the field of electricity generation which was established on March 30 2001 . The type of generator managed by PT. Java Bali power plants such as PLTU (Steam Power Plant), PLTGU (Gas and Steam Power Plant), PLTA (Hydro Power Plant), and PLTG (Gas Power Plant).

PT. Integrated asset management system. Pembangkitan Jawa Bali Services implements an integrated asset management system to manage all its power generation assets efficiently. Good asset management can also influence the number of assets owned by PT. Generation of Java Bali Services. The following is the number of assets owned by PT. Pembangkitan Jawa Bali Services in Figure 1.

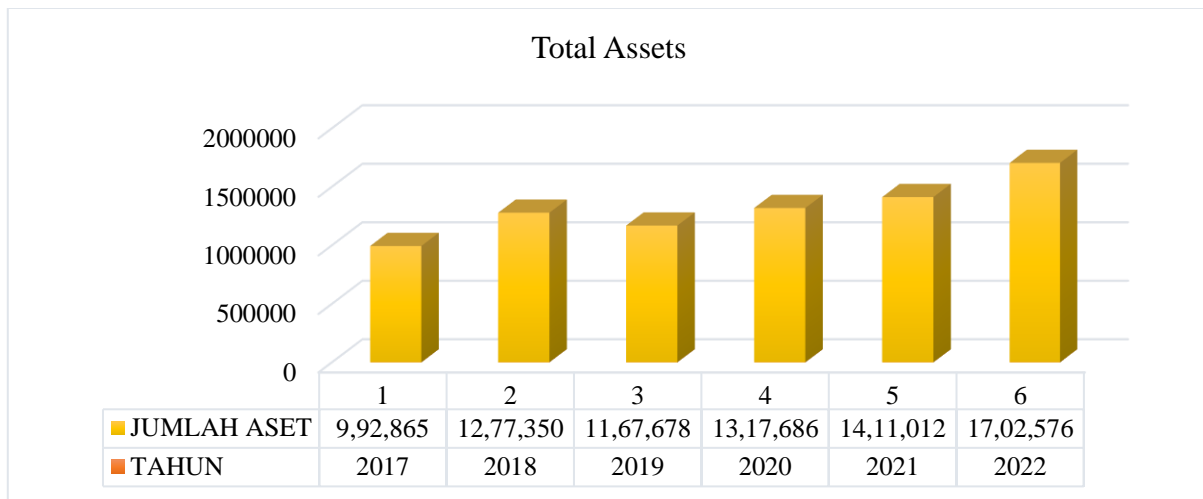


Figure 1 Total Assets of PT. Java Bali Power Plant

Based on the picture above, the total assets of PT. Jawa Bali Services generation increased from 2017 to 2018, but experienced a decline from 2018 to 2019. After that, it increased again from 2019 to 2022. This shows the company's ability to manage assets well. Based on *asset management - an anatomy*, there are six groups in asset management, namely, *strategy & planning*, *asset management decision-making*, *life cycle delivery*, *asset information*, *organization & people*, and *risk & review* (The Institute of Management Asset, 2015) as shown in Figure 2.

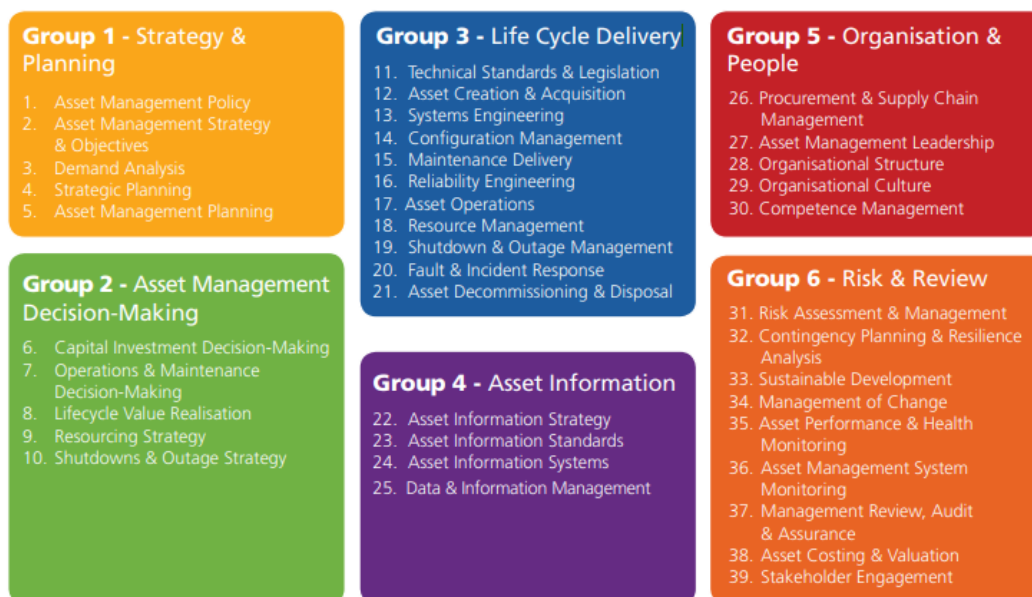


Figure 2. Asset Management Group

Based on Figure 2, Group 3 *Life Cycle Delivery* explains how the organization runs projects, manages assets, and maintains assets to ensure expected production. The stages in *Life Cycle Delivery* are determining the strategy being developed, arranging activities and risks related to the asset life cycle (acquisition, operation, maintenance and disposal) (Diop, et al., 2021). These stages are the stages in *the Life Cycle Delivery*. This stage is very challenging and may require significant financial resources (Cahyo, 2015). Therefore, it is very important to maintain asset performance and optimize costs resulting from asset life cycle delivery (Cahyo, et al., 2015).

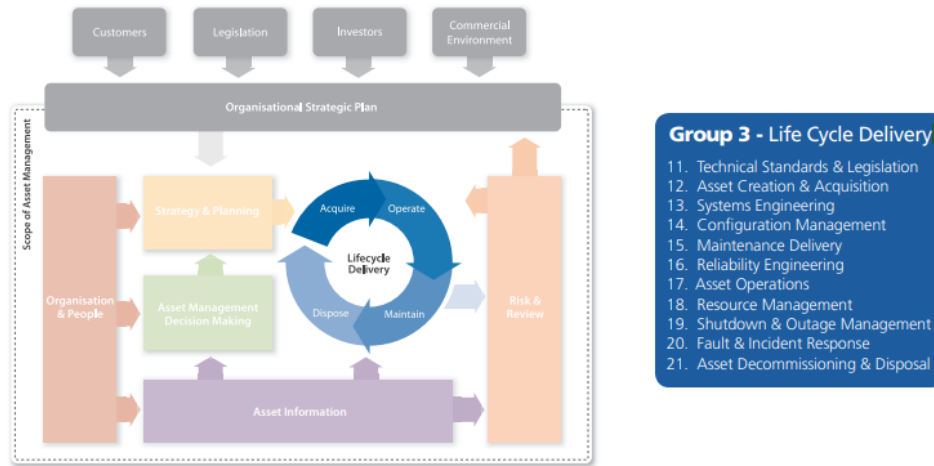


Figure 3. Group 3 (Life Cycle Delivery)

In writing the article on asset management grouping using Group 3 life cycle delivery), there are eleven variables, namely, *technical standards & legislation*, *assets creation & acquisition*, *systems engineering*, *configuration management*, *maintenance delivery*, *reliability engineering*, *asset operation*, *resource management*, *shutdown & outage management*, *fault & incident response*, and *asset decommissioning & disposal*. The aim and focus of this research is to determine the factors that influence the implementation of asset management at PT. The generation of Java Bali Services is based on group 3 (delivery life cycle) based on the problems above and the asset management model concept explained. PT. Pembangkitan Jawa Bali Services can accept suggestions for improvements from the research results. The limitation of the data collection research was only on PT employees. Pembangkitan Jawa Bali Services with division criteria such as: O&M, finance, engineering, project and unit support/rendal. The data collection process was carried out from November 2023 to January 2024. Data collection was carried out by distributing questionnaires via *Google Form* and interviews.

METHOD

Asset Management

Asset management is knowledge And art management asset, Which involve planning, acquisition, inventory, implementation auditing law, evaluation, operation, maintenance, update or shrinkage need asset, And its management in a way effective And efficient (A. Gima Sugiana, 2013). Asset management is the coordinated activity by which an organization realizes the value of its assets (Cahyo, 2019). Asset management is essentially the management of assets in such a way that they can provide maximum benefits with minimal costs and are not lost unless they are destroyed or written off (Ria Asih Aryani Soemitro & Supriyatno, 2018).

Structural Equation Modeling - Partial Least Square (SEM-PLS)

Structural Equation Modeling (SEM) is a second generation multivariate analysis technique that combines factor analysis and path analysis, allowing researchers to simultaneously test and estimate the relationship between multiple exogenous and endogenous variables with many indicators (Herokholiqi & Sidhi, 2018). SEM is a combination of factor analysis and regression analysis. SEM using PLS is divided into 3 components, namely the structural model, measurement model, and weighting scheme (Sigit & Nur Aini, 2022). 2019). The SEM-PLS method is not as strict as SEM, namely that it must be normally distributed, while PLS has an analysis method with soft modeling characteristics because it can assume data with a certain measurement scale with a relatively small number of samples and allows algorithms with ordinary least squares series analysis so that calculations can be more efficient.

Research Object

research object used in this research is a variable *technical standards & legislation*, *assets creation & acquisition*, *systems engineering*, *configuration management*, *maintenance delivery*, *reliability engineering*, *asset operation*, *resource management*, *shutdown & outage management*, *fault & incident response*, and *asset decommissioning & disposal* in the *life cycle delivery* group in PT. Generation of Java Bali Services.



Research Subjects

The subjects in this research were employees at PT. Pembangkitan Jawa Bali Services, especially the *divisions* namely, *Operations & Maintenance, Finance, Engineering, Project Support/Regional* and Units responsible for asset management are interrelated and interact to ensure effective and efficient asset management.

Method of collecting data

This data collection method is carried out using several methods, such as literature studies, interviews, and questionnaires. The literature study carried out was designing and drafting a questionnaire related to *technical standards & legislation, asset variables creation & acquisition, systems engineering, configuration management, maintenance delivery, reliability engineering, asset operation, resource management, shutdown & outage management, fault & incident response, and asset decommissioning & disposal* in the *life cycle delivery group*. Literature studies were carried out to strengthen the basis of the research carried out. Then an interview was conducted to verify and validate the questionnaire that had been designed by the researcher for the research supervisor at PT. Generation of Java Bali Services. Interviews were conducted to find out the actual situation and conditions of the company when using the findings from data processing as a comparison. Next, the questionnaire was distributed by collecting data from research subjects to determine the relationship between variables. Questionnaires were distributed online to PT employees. *Generation of Java Bali Services in Operations & Division Maintenance, Finance, Engineering, Project Support/Regional* and Units as parties responsible for company asset management

Research Variables

Research variables are based on the data obtained in the questionnaire and then processed using the SEM-PLS method which is assisted by using SmartPLS 3.0 software. The following research hypothesis in Figure 4 is the conceptual model used in this research.

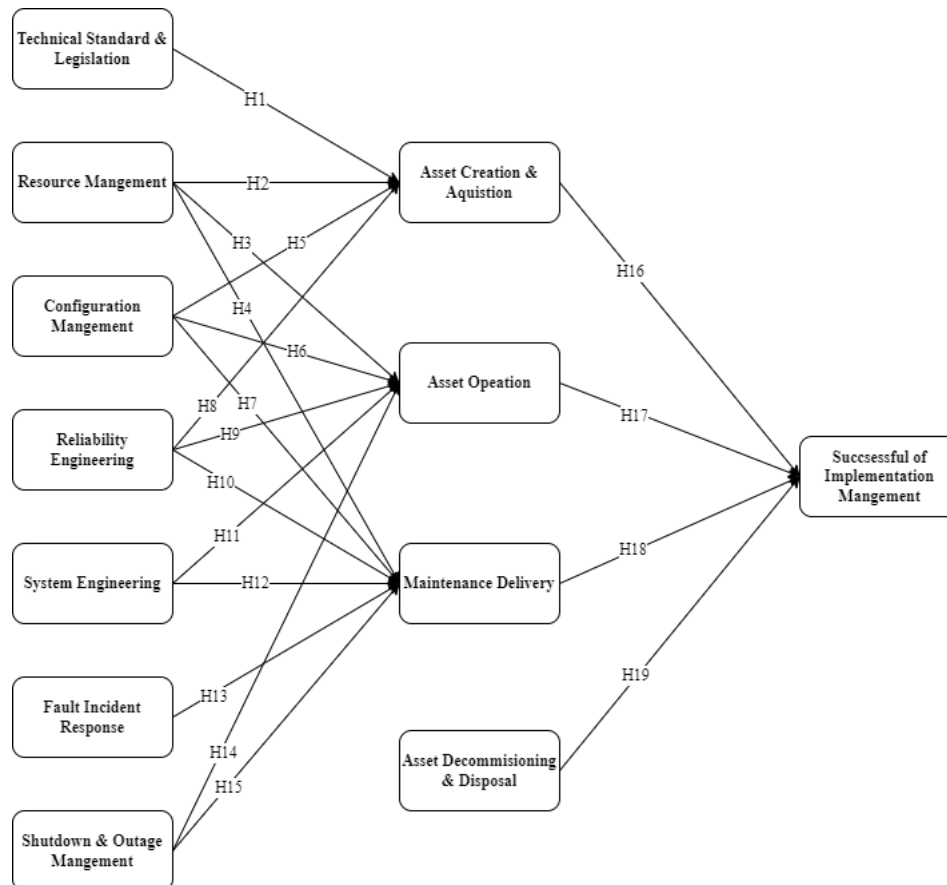


Figure 4 Conceptual model



RESULTS AND ANALYSIS

This research used employees at PT Pembangkitan Jawa Bali Services, totaling 121 respondents, as research subjects. There were 94 male and female respondents and 27 respondents respectively . There were 18 respondents from the O&M 1 division, 13 respondents from the O&M 2 division, 16 respondents from the O&M 3 division, 26 respondents from the finance division, 10 respondents from the engineering division, 11 respondents from the project support/retail division, and 27 respondents from the unit division. . There were 0 respondents whose work period was < 1 year, 1 respondent 1-3 years, 7 respondents 4-6 years, 71 respondents 7-9 years, 42 respondents > 10 years.

The measurement scale used in this questionnaire is the Likert scale. The Likert scale uses several questions according to the variables and individual opinions regarding an event (Likert, 1932). The research questionnaire uses five levels of choice for each question, with a scale of Strongly Agree given a score = 5, Agree given a score = 4, Neutral given a score = 3, Disagree given a score = 2, Strongly Disagree given a score = 1

Based on *asset management - an anatomy*, there are six groups in asset management , one of which is *life cycle delivery* (The Institute of Management Asset, 2015) *results of the life cycle delivery* questionnaire from the variables *technical standards & legislation* , *assets creation & acquisition* , *systems engineering* , *configuration management* , *maintenance delivery* , *reliability engineering* , *asset operation* , *resource management* , *shutdown & outage management* , *fault & incident response* , and *asset decommissioning & disposal* The model concept was obtained using *Smart PLS* software 3 obtained from 121 respondents as in Figure 5.

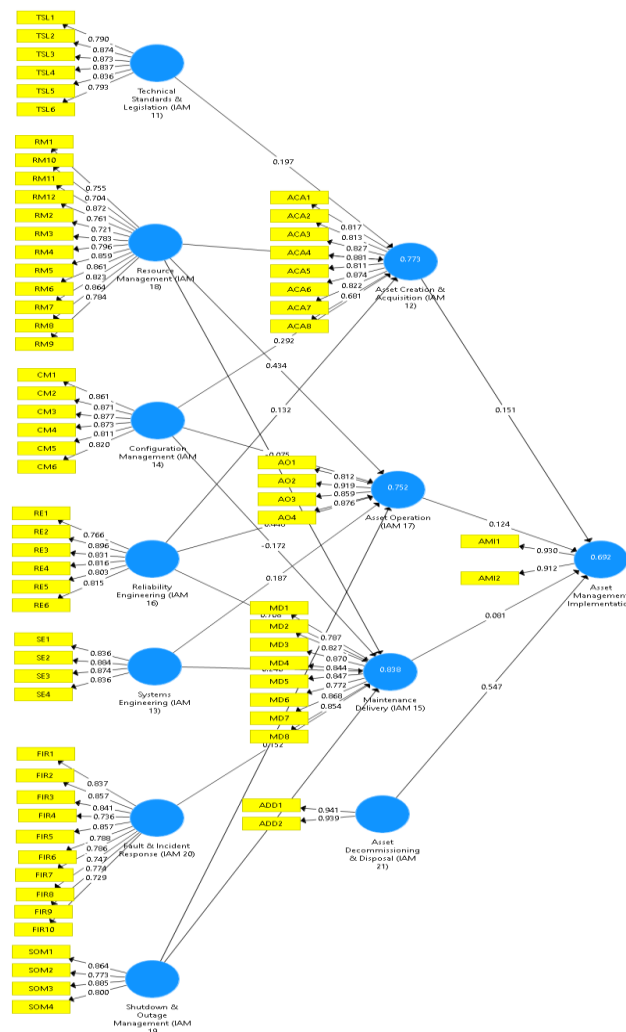


Figure 5. Concept Model



Validity and Reliability Test Analysis

In the validity test there are two stages, namely *convergent validity* and *discriminant validity*. In *convergent validity*, there is an *outer loading* calculation to determine the relationship between the question item scores and the measured index scores. *Convergent Validity* is seen from the validity indicators which are considered by *the loading factor value*. *Loading factor* is a numerical value that proves the relationship between the question item score and the index score measured by the component (Harsono, Ali, & Fauzi, 2023). The calculation results show that all indicators have a value of > 0.7, which means all indicators are valid. Next is the *discriminant calculation validity*. At this stage, it is carried out to find out the relationship between variables and their own variables better than the relationship between these variables and other variables. Based on *discriminant* calculations *Validity* is known that the relationship between a variable and its own variable is greater than the relationship between that variable and other variables.

Table 1. Outer Loading

Variable	Indicator	Outer Loading	Information
<i>Technical Standards & Legislation</i>	TSL1	0.790	Valid
	TSL2	0.874	Valid
	TSL3	0.873	Valid
	TSL4	0.837	Valid
	TSL5	0.836	Valid
	TSL6	0.793	Valid
<i>Systems Engineering</i>	SE1	0.836	Valid
	SE2	0.884	Valid
	SE3	0.874	Valid
	SE4	0.836	Valid
<i>Configuration Management</i>	CM1	0.861	Valid
	CM2	0.871	Valid
	CM3	0.877	Valid
	CM4	0.873	Valid
	CM5	0.811	Valid
	CM6	0.820	Valid
<i>Maintenance Delivery</i>	MD1	0.787	Valid
	MD2	0.827	Valid
	MD3	0.870	Valid
	MD4	0.844	Valid
	MD5	0.847	Valid
	MD6	0.772	Valid
	MD7	0.868	Valid
	MD8	0.854	Valid
<i>Reliability Engineering</i>	RE1	0.766	Valid
	RE2	0.896	Valid
	RE3	0.831	Valid



	RE4	0.816	Valid
	RE5	0.803	Valid
	RE6	0.815	Valid
	AO1	0.812	Valid
<i>Asset Operations</i>	AO2	0.919	Valid
	AO3	0.859	Valid
	AO4	0.876	Valid
	RM1	0.755	Valid
	RM10	0.704	Valid
	RM11	0.872	Valid
	RM12	0.761	Valid
<i>Resource Management</i>	RM2	0.721	Valid
	RM3	0.783	Valid
	RM4	0.796	Valid
	RM5	0.859	Valid
	RM6	0.861	Valid
	RM7	0.823	Valid
	RM8	0.864	Valid
	RM9	0.784	Valid
	SOM1	0.864	Valid
<i>Shutdown & Outage Management</i>	SOM2	0.773	Valid
	SOM3	0.885	Valid
	SOM4	0.800	Valid
	FIR1	0.837	Valid
	FIR10	0.729	Valid
	FIR2	0.857	Valid
<i>Fault & Incident Response</i>	FIR3	0.841	Valid
	FIR4	0.736	Valid
	FIR5	0.857	Valid
	FIR6	0.788	Valid
	FIR7	0.786	Valid
	FIR8	0.747	Valid
	FIR9	0.774	Valid
	ACA1	0.817	Valid
<i>Asset Creation & Acquisition</i>	ACA2	0.813	Valid
	ACA3	0.827	Valid
	ACA4	0.881	Valid



	ACA5	0.811	Valid
	ACA6	0.874	Valid
	ACA7	0.822	Valid
<i>Asset Decommissioning & Disposal</i>	ADD1	0.941	Valid
	ADD2	0.939	Valid
<i>Asset Management Implementation</i>	AMI1	0.930	Valid
	AMI2	0.912	Valid

Determining the criteria for AVE is, if the AVE value is > 0.5 , it can be said that the latent variable has good convergent validity (Seetianingias, Baiquni, & Kurniawan, 2019). Below, the *Average Variance Extracted (AVE)* value shows that all indicators have a value > 0.5 , which means all indicators are valid.

Table 2. Average Variance Extracted

Variable	Average Variance Extracted (AVE)	Information
<i>Asset Management Implementation</i>	0.848	Valid
<i>Asset Operations</i>	0.752	Valid
<i>Asset Creation & Acquisition</i>	0.669	Valid
<i>Asset Decommissioning & Disposal</i>	0.884	Valid
<i>Configuration Management</i>	0.727	Valid
<i>Fault & Incident Response</i>	0.634	Valid
<i>Maintenance Delivery</i>	0.696	Valid
<i>Reliability Engineering</i>	0.675	Valid
<i>Resource Management</i>	0.641	Valid
<i>Shutdown & Outage Management</i>	0.692	Valid
<i>Systems Engineering</i>	0.736	Valid
<i>Technical Standards & Legislation</i>	0.696	Valid

There are two types of reliability tests, namely *composite reliability* and *Cronbach' alpha*. *Composite reliability* testing aims to test the reliability of the instrument in a research model. An indicator is said to be good reliable if the latent variable value has a *composite reliability* or *Cronbach alpha value* > 0.7 . Based on the calculations, it can be seen that the value of *composite reliability* and *Cronbach alpha* is > 0.7 , which means the variables used are reliable.

R-Square Test Analysis and T-Statistic Test

The *R-squared value* is used to assess how much influence a particular independent latent variable has on the dependent latent variable. The *r-square value* is said to be good if it is above 0.5 because the *r-square value* ranges from 0 to 1 (Awalludin, 2010). Based on the table below, it can be seen that the *r-square value* of the *asset management implementation variable* is 0.692, which means that 69.2% is influenced by *asset creation & acquisition, asset operation, maintenance delivery, and asset decommissioning & disposal*. The *r-square value* of the *asset operation variable* is 0.752, which means 75.2% is influenced by *resource management, configuration management, reliability engineering, system engineering, and shutdown & outage management*. The *r-square value* of the *maintenance delivery variable* is 0.838, which means that 83.8% is influenced by *resource management, configuration management, reliability engineering, system engineering, fault & incident response, and shutdown & outage management*. And value *r-square* of the *asset creation & acquisition variables* are influenced by *technical standards & legislation, resource management, configuration management, and reliability engineering* by 77.3%



Table 3. R-Square Test

Variable	R Square	R Square Adjusted
Asset Management Implementation	0.692	0.681
Asset Operations	0.752	0.741
Maintenance Delivery	0.838	0.829
Asset Creation & Acquisition	0.773	0.765
Asset Creation & Acquisition	0.928	0.941
Asset Decommissioning & Disposal	0.868	0.938
Configuration Management	0.925	0.941
Reliability Engineering	0.903	0.926
Resource Management	0.948	0.955
Technical Standards & Legislation	0.912	0.932

The t-statistical test is basically carried out to show how much influence one independent variable has on each variable can explain variations in the dependent variable (Tehuayo, 2021). In hypothesis testing it can be said to be significant when the t-statistic value is > 1.96 and $p\text{-values} < 0.05$, whereas if the t-statistic value is < 1.96 and $p\text{-values} < 0.05$ then it is considered not significant (Ghozali, 2016).

Table 4. T-Statistic Test

Variable	T Statistics	P Values
Asset Operation -> Asset Management Implementation (H17)	1,435	0.023
Configuration Management -> Asset Operation (H6)	0.674	0.501
Configuration Management -> Maintenance Delivery (H7)	1,897	0.058
Fault & Incident Response -> Maintenance Delivery (H13)	1,631	0.104
Maintenance Delivery -> Asset Management Implementation (H18)	0.704	0.020
Reliability Engineering -> Asset Operation (H9)	4,019	0,000
Reliability Engineering -> Maintenance Delivery (H10)	7,768	0,000
Resource Management -> Asset Operation (H3)	3,401	0.001
Resource Management -> Maintenance Delivery (H 4)	1,091	0.276
Shutdown & Outage Management -> Asset Operation (H14)	0.932	0.352
Shutdown & Outage Management -> Maintenance Delivery (H15)	1,530	0.127
Systems Engineering -> Asset Operations (H11)	1,663	0.097
Systems Engineering -> Maintenance Delivery (H12)	2,497	0.013
Asset Creation & Acquisition -> Asset Management Implementation (H16)	2,687	0.023
Asset Decommissioning & Disposal -> Asset Management Implementation (H19)	5,593	0,000
Configuration Management -> Asset Creation & Acquisition (H5)	3,942	0.003
Reliability Engineering -> Asset Creation & Acquisition (H8)	2,105	0.062
Resource Management -> Asset Creation & Acquisition (H2)	3,226	0.009
Technical Standards & Legislation -> Asset Creation & Acquisition (H1)	2,673	0.023



Based on t-statistical test calculations using *SmartPls* 3.0 software, it is known that the hypotheses H1, H2, H3, H4, H9, H10, H12, H16, H17, H18, and H19 can be accepted because they have a t-statistic value > 1.96 and a *p value* -values < 0.05 . Meanwhile, the hypotheses H5, H6, H7, H8, H11, H13, H14, and H15 were rejected because they had t-statistic values > 1.96 and *p-values* > 0.05 .

CONCLUSION

Based on the results of the analysis and discussion of the research that has been carried out regarding the successful implementation of asset management in the organization & people group, then several conclusions can be obtained as follows:

1. Based on the hypothesis testing that has been carried out, a conceptual model design is obtained relationship between variables in the *Life Cycle Delivery group* and implementation Asset management at PT PJB Services which consists of *Asset Decommissioning & Disposal variables* as variables that have influence direct and significant impact on *asset management implementation* with value t-statistic is more than 1.960 and p-value is not more than 0.050. aside from that there is an indirect influence on asset management implementation which consists of asset management leadership through *Resource Management* and Configuration Management through *Asset Creation & Acquisition*. Then other variables were also found that had an influence but not significant to the proven asset management implementation with a t-statistic value of no more than 1.960 and a p-value that is not more than 0.050 which consists of the influence of *Shutdown & Outage Management*, *Fault Incident Response* through *Asset Operations* and *Maintenance Delivery* and *As set management implementation*.
2. Based on the results of the analysis of variables that have a positive influence and the most significant influence on the implementation of asset management to variables that do not have a significant influence on implementation Asset management is based on t-statistic values, preparation is carried out management intervention design as a study for related management parties for increasing the success of asset management implementation at PT PJB Services. A form of intervention to improve employee involvement in supporting the success of management implementation assets at PT PJB Services, the proposed strategy that can be given is as follows:
 - a. *Technical Standard & Legislation - Asset Creation & Acquisition*
 - Comply with and implement technical standards and applicable laws and regulations in generating unit operations.
 - Understand the legal risk standards that may arise as a result of operating activities with generating assets
 - b. *Reliability Engineering - Maintenance Delivery*
 - Carry out system reliability-oriented maintenance in a timely, targeted and appropriate manner.
 - Deeper dive into methods that have been applied to maintenance to improve asset reliability.
 - c. *Reliability Engineering - Asset Operations*
 - Increase understanding regarding clear and structured plans and procedures in asset operations.
 - Increase system reliability in accordance with asset specifications and operating needs.
 - d. *Resource Management - Asset Operations*
 - Have the number and composition of employees in accordance with needs and provide sufficient training.
 - Carrying out strict and consistent management, supervision and control over the use and allocation of funds for assets.
 - Increase understanding regarding material inventory management systems to support management of company asset resources.
 - Understand more about management procedures for managing resources so that plants run well and efficiently.
 - Manage supply chain and logistics distribution by ensuring the availability and quality of adequate transportation facilities and infrastructure in accordance with asset operating needs.
 - Increase awareness and ensure adequate infrastructure quality and in accordance with asset operation needs.
 - e. *Resource Management - Asset Creation & Acquisition*
 - Have a composition of employees who are trained according to the needs of generating assets.
 - Carry out consistent management, supervision and control over the use and allocation of funds for generation assets.



- Improve management understanding regarding material and spare parts inventory management systems to support asset resource management.
- Understand resource management procedures and processes so that the plant runs well and efficiently.
- Manage supply chain and logistics distribution by ensuring the availability and quality of adequate transportation facilities and infrastructure in accordance with asset resource management needs.
- Maintaining the infrastructure needed to support and ensure the quality of generating asset infrastructure.
- d. *Systems Engineering - Maintenance Delivery*
 - Carry out in-depth and objective needs and feasibility analysis in system planning.
 - Pay more attention to functional, operational and technical aspects to increase the reliability of generating assets.
- e. *Asset Operation - Asset Management Implementation*
 - Increase awareness of always maintaining assets and clearly understanding procedures before operating assets.
 - Ensure assets operate at optimal levels in accordance with clear and measurable performance indicators and targets to achieve company goals.
- f. *Maintenance Delivery - Asset Management Implementation*
 - Carry out a clear and structured treatment plan by paying attention to the risks that will occur.
 - Implement procedures and criteria in the *spare parts life cycle* and ensure the availability of *spare parts* for maintenance.
 - Foster a positive and conducive work culture and ensure the availability of trained and skilled workforce.
 - Carrying out quality maintenance in accordance with clear and measurable standards and procedures.
- g. *Configuration Management - Asset Creation & Acquisition*
 - Have clear and firm procedures and criteria for identifying and controlling system configuration.
 - Understand how to test and validate changes made to existing configuration items.
 - Conduct regular configuration audits to determine the conformance of existing configuration items with specifications, requirements, and related documents.
- h. *Asset Creation & Acquisition - Asset Management Implementation*
 - The technical and functional specifications of the generating assets acquired or manufactured are in accordance with the needs and standards of the generating unit.
 - Have a clear and appropriate strategic mechanism and mitigation plan to overcome risks that may occur in investment (creation) and acquisition (acquisition) of generating unit assets.
 - Allocate sufficient and appropriate resources for *asset creation & acquisition activities* in generating units.
- i. *Asset Decommissioning & Disposal - Asset Management Implementation*
 - Determine realistic and measurable priorities and targets in carrying out *asset decommissioning & disposal activities* by implementing appropriate procedures and predetermined plans

SUGGESTION

Suggestions that can be given from the results of the analysis of variables that influence *asset management implementation* at PT. Generation of Java Bali Services with analyzing the variables from the results of the validity test, reliability test, *r-square test* and t-statistical test, the results of this research can be a consideration for PT Pembangkitan Jawa Bali Services in evaluating the application of variables that influence *asset management implementation* at PT. Generation of Java Bali Services. In conducting research there are several limitations that can influence research results and it is hoped that they can be improved by future researchers. Therefore Better results can be obtained regarding this research if there are variables others that can be considered. Apart from that, for further research it is necessary to distribute questionnaires to a larger and more balanced number of respondents from all divisions in PT PJB Services.



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