Collaboration Holistic Enterprise Architecture and Asset Management System for Power Generation

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Abstract. Asset Management becomes the most important part of managing power generation sector. It will determine the success of efficiency and effectiveness as well as the economic value of an electric product that produced. Many power generation unit that must be managed and implementing asset management system according to the standard ISO 55001, the company no longer can not only focus on the operational terms but shifted to the strategic, where management is asked to be able to see the company in a holistic view and faster in making decisions. In this journal the authors convey the development done through the collaboration of Enterprise Architecture (EA) which is the blueprint of the organization that integrate between processes, data, applications and technology and asset management of the company as well as adding seven dimensions of performance indicators in one worksheet and linkage different from other EA through the development of application platform to digitalize the needs of the company in managing the asset that we called PJB-IMS 2.0, this concept can be a prototype for other generating company in implementing asset management system. The existence of EA realized in PJB IMS 2.0 is ensured to be in accordance with the challenges future business that increasingly complex.

1. Introduction
PT Pembangkit Jawa Bali (PT PJB) has implemented assets management through the Maintenance Optimization Program (MOP) since 2004, then it was developed according to the requirements of the PAS 55 asset management system standard in 2012 and upgraded to ISO 55001: 2014 in 2015. Starting in 1995 PJB manages 6 Unit owners as assets and now PJB manages 19 unit including as asset owners, asset managers and asset operators, operating from 6,511 MWh becomes 13,452 MWh in 2020. Asset management is crucial for the company, Asset Management can no longer be simple but must be integrated to facilitate the control throughout the existing power generation units.

Many power generations unit built, it made business processes have to be improved and many human resources involved. it will be more difficult to manage assets that are not only physical equipment but also humans in it. Managers and employees should be able to see a link between the strategy of an organization, the activities it employs day to day, and the indicators of success it uses. Looking down this ‘line of sight’ shows how the organizational objectives are met and looking up this ‘line of sight’ shows why activities are undertaken [1]. Operational capabilities represent organization abilities that allow an enterprise to make a living and they do this typically by realizing competitive advantage via improved processes whereby reducing firm costs [2]. Promoting the transformation of enterprises and improving their operational capabilities are the most important tasks of global
enterprises [3]. So that asset management is not only measured compliance with ISO 55001 standards but also supported by clearly information technology could integrated input-process-output flow which is connected between data, applications and supporting technologies and performance management dimensions.

Asset management concept is developed by IAM (Institute of Asset Management). Asset management enables an organization to realize value from assets in the achievement of its organizational objectives [4]. There are six component of management asset consist of Strategy and Planning, Asset Management Decision Making, Life cycle Delivery, Asset Information, Organizational & People and Risk and Review in Figure 1 The IAM’s Conceptual Asset Management Model. In the power generation industry, life cycle delivery component in asset management is the main work focus in which many business processes must be managed supported by accurate data and asset information. An asset management system is used by the organization to direct, coordinate and control asset management activities. Figure 2 is the relationship between the key elements of an asset management system, together with the related clauses in ISO 55001 [5].

![Image of Figure 1. The IAM Concept](image1)

![Image of Figure 2. Relationship IAM With ISO 55001](image2)

**Figure 1.** The IAM Concept

**Figure 2.** Relationship IAM With ISO 55001

IAM Anatomy made alignment two of them in checklist subject map to clauses table, to manage the current & future performance of asset a range of performance measures can be required, including lagging (or outcome) measures to monitor the past performance (e.g. For incidents, failures & defect) and leading (process) measures to predict future performance in order to avoid incident and failures. Monitoring can generate large quantities of data, which will impact on organization’s information system [4]. Because there are many business processes between fields involved and many data entered and issued as a result of an input – the output process, the company should describe its entirety in an integrated design framework that is more mature, made implementation of ISO 55001 effective and efficient.

From interviews to management and employees known that asset management is still not integrated and still carried out the management of the implementation in each of the work areas, there is still the junction of business process ownership, the data ownership is unclear, the demand for creating new applications that resemble the high, the risk and control less can be implemented, the company's strategy can not good be explained. With Enterprise Architecture (EA) was developed by TOGAF in Figure 3 which is a framework that contains a methodology and a set of supporting tools that provide a comprehensive approach to planning, designing, implementing and managing EA through the Architecture Development Method (ADM) method [6]. EA is a commonly used definition of architecture in the IT world, Architecture is the fundamental organisation of a system embodied in its components, their relationships to each other, and to the environment, and the principle guiding its
design and evolution [7]. This paper discusses not only the development of EA in IT but also the development of EA and the collaboration with asset management for a power generation corporation.

Figure 3. the Architecture Development Method [2]

Figure 4. Content EA Metamodel Overview [2]

EA is implemented because of its ability to integrate all information technology function relate to organization business process [8]. So, through this architecture, organization is able to determine starting phase, analyze requirements, and plan to implement required information technology components to achieve organization goals and objectives as explain in Figure 4. The four commonly accepted domains of EA are:

a. Business architecture – describes how the enterprise is organizationally structured and what functional capabilities are necessary to deliver the business vision. Business architecture addresses the questions WHAT and WHO: WHAT is the organization’s business vision, strategy, and objectives that guide creation of business services or capabilities? WHO is executing defined business services or capabilities?

b. Application architecture – describes the individual applications, their interactions, and their relationships to the core business processes of the organization. Application architecture addresses the question HOW: HOW are previously defined business services or capabilities implemented?

c. Data architecture – describes the structure of an organization’s logical and physical data assets and data management resources. Knowledge about your customers from data analytics lets you improve and continuously evolve business processes.

d. Technology architecture – describes the software and hardware needed to implement the business, data, and application services. Each of these domains have well-known artifacts, diagrams, and practices. [9]

The purpose of this collaboration is to help top management view business holistically and made faster take decision by mapping all company business process and its integration using information technology application as well as identifying process-main or critical process related to asset management so that company can be effective, efficient, and adaptive to change and alignment the business process with 7 dimension as a new concept in this paper, consist of corporate strategic, risk and compliance management, regulation, organization, capabilities, standard system management, KPI Management.

2. Method

The method to developed this collaboration consists of 5 main stages using TOGAF ADM references and modifies by writer with made linkage to asset management system and 7 dimension into the worksheet process modification base on corporate conditions in Figure 5, use SPARX Enterprise Architecture as a platform modeling tools [10] to draw and to integrate the business process. The all
data and information get from walk through and workshop for the owner process in PJB Head Office and Power Plant Unit.

Figure 5. Five Step to Collaborate EA and Assets Management System

2.1. Develop EA using ref. ADM Tools (Figure 3), consist of:
1. Preliminary Phase explain the preparation and initiation of everything needed in carrying out EA development activities.
2. Phase A: Architecture Vision explains the stages of initiation in the development of architecture. At this stage it includes determining the scope of architecture, identifying stakeholders and determining the principles in architectural development.
3. Phase B: Business Architecture explain the stages in developing business architecture. For developing Business Architecture required reference framework, among which are appropriate to the utilities or power generation company can be used APQC Process Classification Framework Cross Industry [11]
4. Phase C: Information Systems Architecture is the stage that identifies the data components and applications. Explain the data needs, one of them is by comparing the data needs for the future (target) with the current data (baseline). Likewise, the application, at this stage will identify application needs. The method used is the same, by identifying the target application with the baseline.
5. Phase D: Technology Architecture explain the technology components, including physical and logical technology. The method used is the identification of target technology with baseline technology.
6. Phase E: Opportunities & Solutions explain the identification of development needs needed based on phases B, C and D into a solution package or portfolio for development.
7. Phase F: Migration Planning explain how the implementation and migration planning is carried out.
8. Phase G: Implementation Governance explain the management of the suitability between needs and the implementation carried out.
9. Phase H: Architecture Change Management explain the management of changes and maintenance of architecture to keep it in accordance with the requirements that have been defined.

2.2. Validate All End-to-End Processes, Time and Resources.
All Business Processes have been drawn (Phase B) validated with the aim of evaluating the performance of the business processes, whether the business processes are valid, effective and efficient; Reducing completion of running business processes, discovering whether there are gaps in
the process flow and processing time in each work activity flow; Preventing under-utilization of human resources based on time analysis. Business Process Management (BPM) has popularized the discipline of using business processes at the center of all transformation related activities to keep a holistic view of the business at all times [12].

A business process can have inputs, process, outputs and boundaries. A business process can then be defined as a set of subsystems: people, tasks, structure, technology, etc., which interact with each other (internal relationships) and with their environment (external relationships) in order to fulfill some objective(s). Each subsystem can be seen as a system, which can in turn be hierarchically decomposed into further levels of detail. This in turn implies the definition of interfaces between subsystems so that they are able to communicate with each other[13].

2.3. Process Link to 7 Dimensions of Corporate Performance
Seven dimensions of corporate performance is built based on the company's performance needs which consist of corporate strategic, governance, risk and compliance management, regulation, organization, capabilities, KPI. The objective of this phase is to find out the integration relationship between the process and the company's performance measures and the key element of asset management according to figure 2. This is as new concept idea in develop Business Process Architecture as we name New Conceptual Model PJB-IMS 2.0 as shown in Figure 6.

![New Conceptual Model PJB-IMS 2.0](image)

2.4. Made Linkage with Asset Management System
Business process have been drawing, further identified, grouped and validated using the IAM Concept according to Figure 1.

2.5. Made Matrix Correlation EA and Asset Management System
For easy correlation and linkage from previous step and easy to hyperlink the process with the ISO 55001 clause and six asset management component, made matrix relationship IAM with ISO 55001 using this model as shown in figure 7 as a checklist [4].
3. Result and Discussion

The output of followed each activities in develop EA using ref. ADM tools to be done arranged into artifacts in Table 1. From this table we have identified artefact of architecture vision, business architecture, data architecture and technology architecture in a folder part of EA, made easy to link the strategic, business process, data and technology in one linkage as shown in Figure 8.

Table 1. Artifacts PJB by ADM Tools

| Artifacts                  | Activities                                                                                           | Output                                                                 |
|----------------------------|------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|
| Architecture Vision        | Identification and determination of EA principles and objectives; the business needs of the organization and related parties; a vision of architecture; organization value proposition and key performances indicator. | Architecture Principles; Architecture Goals; Vision and Mission; Value Chain Diagram; Business Model Canvas; Solution Concept Diagram; Organization Decomposition Diagram; and Stakeholder Map Matrix |
| Business Architecture      | Identification AS - IS business architecture; define the principles and targets of business architecture; perform gap analysis; identification all organization business process; and identify all actors interactions among work units within the organization. | Business Principles; Functional Decomposition Diagram as Business line; Business Interaction Diagram; Organizational-Actor Catalog; Business Process Diagrams; Dimension Process Matrix |
| Data Architecture          | Identification of existing data architecture; Define principles and target data architecture; Perform Gap analysis; Identify Data / Information available to all corporations, whether from business or ad-hoc processes; Identify correlations between data, work units and applications. | Data Principles; Conceptual Data Diagram; Logical Data Diagram; Data Entity-Data Component Catalog; Data Entity-Business Function Matrix; Application-Data Matrix |
| Artifacts                  | Activities                                                                 | Output                                                                 |
|---------------------------|-----------------------------------------------------------------------------|------------------------------------------------------------------------|
| Application Architecture  | Identify the current application architecture; Define the principles and targets of application architecture; Identify all applications used by the corporation from the SDLC side (software development life cycle); Perform Gap analysis; Identify correlations application between business processes, work units and organizational applications | Application Principles; Application Portfolio Catalog; Application Portfolio Assessment; Application-Classification Matrix; Application-Organization Matrix; Application Communication Diagram; Application User and Location Diagram; Application Use Case Diagram |
| Technology Architecture   | Identify existing technology architecture; Perform Gap analysis; Define the principles and targets of application architecture; Identify the correlation between technology and application. | Technology Principles; Technology Standard Catalog; Application-Technology Matrix; Environment and Location Diagram; Network Communication Diagram |
| Architecture Implementation | Identify the work packages or projects that will be implemented; Conduct risk analysis, strategy and implementation priorities of the architecture. | Architecture Implementation Planning; Architecture Governance; Architecture Repository |

![Figure 8. PJB Enterprise Architecture Artifact](image-url)

![Figure 9. Validation of Business Process](image-url)

![Figure 10. Simulation Resources Effectiveness and Time Analysis](image-url)
Figure 9 and Figure 10 is example of preventive maintenance process that has been validated and simulated, no processes are deadlocked, calculate the need of human resources, managing the time and human resources requirements to ensure that they can work in each process, which can help manage work efficiently so we know the work load analysis and time period for to do the process.

![Figure 11. Linkage Strategic Goal](image1)

![Figure 12. Linkage Risk & Control](image2)

![Figure 13. Example Flowchart of Outage Management Process with 7 dimension](image3)
Figure 11 and Figure 12 show the business process that has been carried out a simulation have been linked with strategic goal and Risk Control. Figure 13 shows completed worksheet linked end to end business process and the integration with data, applications, technology and 7 dimension. Furthermore that completed business processes identified and mapped carried out to the grouping of assets management component as shown in Figure 14.

**Figure 14. Mapping Asset Management Process**

The final step of the collaboration is to create an asset management system matrix in Figure 15 by adopting a modified subject map to clause checklist according to Figure 7, and adding linkage with process that has been made into a linkage matrix clause and business process. So, when we want to know the process that supports Life Cycle Delivery and its relation to ISO 55001 through EA, it can be directly connected and integrated between one process with another and integrated with 7 dimensions that support each other.

**Figure 15. Linkage Matrix Clause and Business Process Example For Lifecycle Delivery Key Element of Asset Management**
4. Conclusion
Asset management in power generation will not run effective, efficient and adaptive to change if there is no digitalization of business processes that have been running manually. By collaborate asset management into EA as the top management helicopter view in looking at business and making quick decisions because all business processes have linkage with organizational plans and organizational objectives, strategic management plans, asset management plans, implementation of assets to the measurement of process performance as part of performance evaluation. With this collaboration in PJB-IMS 2.0, PJB Asset Management can proved to be successful in continuous, flexible and adaptive performance with various plants with all kinds of difficulty, as well as fit with electricity business challenges. For the future research this collaboration can more be detailed and technique for each types of power generation according to clause scalability in ISO 55002:2018.

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