# Fostering Learning Organization in Asset Management as an Enabler for Energy Transition

Developing an Analytical Framework and Implementing a Case Study to Understand Asset Management Challenges at PLN Indonesia in Support of the Energy Transition

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# Acknowledgements

Writing this thesis has been an incredibly challenging yet rewarding experience, much like my entire journey at EPA and TU Delft over the past two years. I would like to take a moment to express my gratitude to the many people who have supported me along the way.

First and foremost, I would like to thank my graduation committee for their continuous support throughout this thesis journey. Mark de Bruijne, thank you for your guidance, patience, and encouragement, not only on the research but also in providing broader insights from our discussions. As someone new to the research world, I truly admire your commitment despite your incredibly busy schedule. Jaco Quist, with your deep understanding of energy research in Indonesia, your insightful and constructive feedback, especially on writing (ine of the area where I struggle) was invaluable. From PLN, I am deeply grateful to my mentor, Pak Herry Nugraha, who has played an important role not only in my thesis but also in my overall TU Delft studies. A leader at PLN who greatly supports staff development. Bu Anita Pharmatrisanti, an important figure in transmission asset management development and my mentor since I first joined PLN, thank you for your continuous support, trust, and for encouraging me to pursue my studies in EPA. Bu Anita, I finally graduated!

I would also show my appreciation to all the respondents who took part in my research. Their willingness to share their experiences and insights are crucial part in executing this research.

To my colleagues and friends at the TU Delft, my lovely Asian friends, Misa, Zelin, and Haekal, you guys know you are also a key factor in surviving this master journey. Please never forget our trip to Anna Paulowna. To the EPA Family, Haiko, our program director, who is always friendly and encouraging—thank you also for finding me my thesis supervisor. Lillian, our EPA Manager, thank you for welcoming me with such a friendly and positive attitude. And to all my EPA classmates, thank you for all the support throughout the courses.

A special mention goes to my family for their tremendous support and belief in me. My husband Pak Andro, who sacrificed his job to move with me to the Netherlands. My parents, Pak Yacub, and my mother-in-law, Bu Kindar, for their endless advice and prayers. And my beloved siblings, Kak Kris, Acci, Kak Chrisma, Suri, Veri, and Juni. Your love and encouragement have been my greatest motivation, and I could not have reached this milestone without you.

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# Executive Summary

**Background and Research Focus:**
Despite being one of the well-known standards in managing physical assets worldwide, as regulated by the ISO 55000:2014 series, the implementation of asset management remains challenging for many organizations. Including PLN, a state-owned electricity provider in Indonesia, which manages assets across generation, transmission, and distribution. PLN faces obstacles in transitioning from conventional practices to asset management practices. This is particularly concerning, as asset management can bring significant benefit towards realizing the energy transition, which currently become one of the objective of PLN.

By limiting the scope to PLN's transmission sector, this research aims to examine the difficulties PLN faces in the learning process in asset management practices especially in supporting the energy transition initiatives. Based on the identified research gap, two organizational theories—learning organization and asset specificity—are identified to help examine these difficulties. Therefore, the main research question addressed is:
*"How can PLN enhance its learning processes to effectively implement changes in transmission asset management by understanding their asset specificity, in order to fully support the energy transition?"*

**Research Methodology:**
This research follows an exploratory study design, comprising two main parts: developing a conceptual framework combining the theories of asset specificity and learning organization, also asset management requirements as the context of specificity and learning. The framework will be developed using a literature review method, identifying elements from learning organization, asset specificity, and asset management requirements. After developing the framework, the next step is its implementation within the organization, using a case study method focusing on the transmission planning process at PLN UITJBB (Western Java Transmission Unit). Data collection combines semi-structured interviews and desk reviews of internal documents and online resources. The case study data then will be analysed using comparative method and thematic analysis to recognize the challenge faced by PLN and proposed the improvement plan.

**Case Study Findings:**
The case study data reveals that PLN's transmission planning process combines a top-

down approach through projects derived from the Electricity Supply Business Plan (RUPTL) from the Ministry of Energy and Mineral Resources, which lists 10-year infrastructure projects (new assets or upgrading existing assets). At the transmission unit (UITJBB) level, they do not directly initiate projects, as this is done by other units. However, they are responsible for proposing planning to deliver these projects, starting with proposing projects to obtain budgets. The second approach is a bottom-up approach known as risk-based annual budget planning, where UITJBB proposes projects to mitigate risks in existing assets, known as maintenance project capex. This approach was carried out from 2015 to 2021, with the recurring issues such as lack of standardized approaches, competence gap and data quality.

**Organizational Transformation:**
From 2021 to 2022, PLN launched an organizational transformation to become a green, innovative, customer-focused, and lean company, emphasizing cost efficiency. This led to the introduction of the Four Eyes Principle, a governance structure designed to prioritize projects based on mandates, revenue generation, and budget availability. The new governance focusing on evaluating the proposal investment project are made, with significant changing in terms of the top management roles in evaluation and analysis requirements for the process. Due to the ineffectiveness, this governance then revised, focusing only on the proposal with significant investment budget. However, this governance did not provide detailed guideline for the UITJBB which resulted in difficulties in the implementation at the operational level.

Simultaneously, asset management was integrated into the organizational structure with the creation of the new Division. However, there is a gap in the design of these new structure which prevent them to properly functioning per asset management requirements.

**Findings and Recommendations:**
The analytical framework's implementation uncovered thirteen challenges (identify as C1 until C13) that hinder PLN's transformation and energy transition efforts. Therefore this analysis provide several recommendations (R1-R14). Addressing the strategic and operational disconnect (C1) requires ensuring the RUPTL includes existing asset maintenance (R1) and broadens its scope (R2). Developing a Strategic Asset Management Plan (SAMP) (R3) is crucial for alignment. Governance issues (C3, C4, C7) can be mitigated by improving evaluation processes (R4) and enhancing coordination (R5). Data-driven decision-making (C5, C12) needs a dedicated data management function (R6), and addressing unclear roles (C8) and planning inaccuracies (C13) involves creating clear frameworks and ongoing training (R7, R8, R10, R13).

**Discussion:**
This study contributes to bridging the gap between theoretical and empirical applications of asset specificity and learning organization theories, particularly in the context of Indonesia's state-owned utility, PLN, during its energy transition. Academically, it broadens the application of asset specificity, suggesting alignment with organizational strategic goals beyond economic transactions, thereby supporting long-term objectives

like energy transition. It also highlights the need for asset management as a key asset specificity, shaping strategy and structure within PLN. The research further visualizes PLN's systemic responses, revealing how the absence of systems thinking leads to ineffective solutions, emphasizing the importance of learning organization principles.

In the societal context, the study addresses the complexities of Indonesia's energy transition, particularly within PLN, which is challenged by overcapacity and long-term fossil fuel contracts. It underscores the need for a long-term strategic planning approach beyond project perspectives, aligning all existing assets from generation, transmission and distribution. For large corporations, this research contributes to broader discussions on managing the shift to sustainable energy effectively.

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# Acronyms

**AIS** Asset Information Strategy. (*p. 66*)

**AKHLAK** Organizational Culture: A = Amanah (Trustworthy), K = Kompeten (Competent), H = Harmonis (Harmonious), L = Loyal (Loyal), A = Adaptif (Adaptive), K = Kolaboratif (Collaborative). (*p. 63*)

**AM** Asset Management. (*p. ix, 4*)

**AMO** Asset Management Objective. (*p. 66*)

**BoD** Board of Director. (*p. 64*)

**BOT** Build, Operate, and Transfer (BOT) scheme. (*p. 50*)

**CAPEX** Capital Expenditure. (*p. 55, 56, 58–62, 64, 65*)

**CCS** Carbon Capture Storage. (*p. 49*)

**CNG** Compressed Natural Gas. (*p. 49*)

**COD** Commercial Operating Date. (*p. 51, 52, 55*)

**ENS** Energy Not Served. (*p. 60*)

**EPA** Engineering Policy Analysis. (*p. ix, 9, 10*)

**EVP** Executive Vice President. (*p. 57, 63, 64, 66*)

**FEP** Four Eyes Principle. (*p. 56*)

**GFMAM** Global Forum on Maintenance and Asset Management. (*p. 2*)

**HLAIS** High-level Asset Information Strategy. (*p. 66*)

**IAM** Institute of Asset Management. (*p. xiv, 32*)

**IDR** Indonesia Rupiah. (*p. 43, 56, 59, 62, 65*)

**IPP** Independent Power Producer. (*p. 49*)

**JMB** Java, Madura and Bali (Regional). (*p. 45*)

**KI** Investment Committee for project appraisal. (*p. 57*)

**LIC** Lower Income Country. (*p. 1*)
**LNG** Liquified Natural Gas. (*p. 49*)

**MIC** Middle Income Country. (*p. 1*)
**MVA** Megavolt-amperes. (*p. 43*)

**PLN** Indonesia State-owned Electric Utility. (*p. 2*)
**PPL** Private Power Developers. (*p. 50*)

**RAS** Risk Appetite Statement. (*p. 66*)
**RJP** Long-term Plan PLN. (*p. 51*)
**RKAP** Annual Budget Plan. (*p. 49*)
**RUKN** National Electricity General Plan. (*p. 48*)
**RUPTL** National Electricity Supply Business Plan. (*p. 48*)

**SAIDI** System Average Interruption Duration Index. (*p. 43*)
**SAIFI** System Average Interruption Frequency Index. (*p. 43*)
**SAMP** Strategic Asset Management Planning. (*p. 36*)
**SOE** Ministry of State-Owned Enterprises. (*p. 43*)

**TVV** Validation and Verification Team for Project Appraisal. (*p. 57*)

**UITJBB** Western Java Transmission Unit. (*p. 43, 45*)
**UITJBT** Central Java Transmission Unit. (*p. 45*)
**UITJBTB** Eastern Java and Bali Transmission Unit. (*p. 45*)
**ULTG** Transmission and Substation Service Units. (*p. 46*)
**UPT** Transmission Execution Unit. (*p. 46*)

**VP** Vice President. (*p. 70*)

**WLC** Whole Life Cost. (*p. 78*)

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# 1 Introduction

## 1.1 Asset management as energy transition enabler

To mitigate the impacts of climate change, a global effort is underway to transform the energy sector. Electric utilities worldwide are expected to significantly increase the share of renewable energy in their generation portfolios, modernize their networks to integrate these variable power sources into the grid, and manage the increasingly diverse and complex energy demands of industry, households, and transportation (World Bank, 2024)

However, achieving this energy transition is particularly challenging for utilities in low-income and middle-income countries (Lower Income Country (LIC)s and Middle Income Country (MIC)s). Only 40% of utilities in developing nations are financially sustainable. The rest struggle to provide affordable and reliable power due to high supply costs, low tariffs, operational inefficiencies, and poor sector planning and procurement. These issues create persistent cycles of underperformance in the sector (World Bank, 2024)

These challenges mean that efforts by electric utilities in developing countries to realize energy transitions are exceptionally difficult. They must not only consider how to increase the share of renewable energy sources in the generation mix but also how to enhance the performance of existing assets, particularly in transmission and distribution, to ensure reliability and prepare the network for future green energy distribution.

A key strategy adopted by electric utilities worldwide to manage risk and performance while optimizing asset life cycles is the implementation of an asset management system (ABS Group, 2014). ISO (2014a) defines asset management as a coordinated set of activities undertaken by an organization to derive value from its assets. Since 1993, these practices have been widely accepted and applied, resulting in the development of various standards (Ruiter, 2015). The importance of asset management has continued to grow among organizations with engineered physical assets, proving critical for infrastructure managers. It facilitates the efficient balancing of performance, risk, and resources, which is essential for both short-term and long-term planning (Almeida et al., 2020; Maletič et al., 2022). Currently, there are 75 global power com-

panies certified under ISO 55000 (data from the ISO/TC 251) with many more using this standard as a guideline for asset management without formal certification (ABS Group, 2014).

ISO (2014a) highlights that implementing asset management brings several benefits, such as enhancing performance, effectively managing risks, ensuring business growth and improvement, facilitating reliable decision-making, and boosting stakeholder confidence through compliance and an enhanced reputation. These benefits imply that by adopting the asset management approach, electric utilities can not only improve their asset performance but also enhance their business processes, making them better prepared to plan and execute energy transition strategies.

Therefore, Indonesia, as a developing country with significant ambitions for energy transition, including a target to achieve net-zero emissions by 2060, needs to enhance its asset management activities. Indonesia State-owned Electric Utility (PLN), the state-owned company responsible for managing and providing electricity throughout the country, is currently in the process of implementing asset management. However, realizing and implementing asset management has proven to be a challenge for many organizations (Siswantoro et al., 2022; Kellick, 2010), including PLN. This will be discussed further in the following section.

## 1.2 Asset management journey in PLN

As previously mention, PLN is an Indonesia's state-owned company responsible for providing reliable electricity to over 85 million customers across the country (PLN Company Secretariat, 2023). In delivering its service, PLN is responsible for managing the generation, transmission and distribution sector. Initially, the generation sector started to implement asset management in early 2000s and this was subsequently followed by the transmission unit in the Java region (Pharmatrisanti et al., 2023). The aims of the transmission unit were to implement asset management to upgrade the overall performance of the network, which allegedly result in the capability to provide higher reliability and availability of the service to the customers. Both the generation and the transmission units have started to work with asset management and are already certified based on the ISO (2014b) standard.

In response to significant challenges, including the goal to increase renewable energy capacity to 23% by 2025 (Bagaskara et al., 2024), PLN has been tasked with achieving a set of very strict project completion targets. Additionally, PLN must identify and manage the differing and sometimes conflicting needs of various stakeholders (Pharmatrisanti et al., 2023). In 2021, PLN expanded its asset management practices to a corporate level, indicating it should be implemented across the entire PLN group, including the headquarters, subsidiaries, and all operational units across the country. This expansion was aimed at achieving national electrification, sustaining business growth, and adopting greener energy approaches. Beyond merely meeting the requirements of ISO (2014b) for asset management certification, PLN adopted the Global Forum

on Maintenance and Asset Management (GFMAM) 39 subject areas, which detail the specific capabilities necessary for effective implementation.

PLN started its implementation journey by conducting the Gap Assessment against the ISO (2014b) standards and 39 subjects of GMFAM in the corporate level and the results indicate that the level of maturity in PLN currently is at an early "developing" stage as shown in Figure 1.1. PLN aims to reach a "Competent" level which indicates that the asset management practices comply with the ISO 55001 requirements in 2024 and seeks to continue the improvement to beyond compliance after 2024.

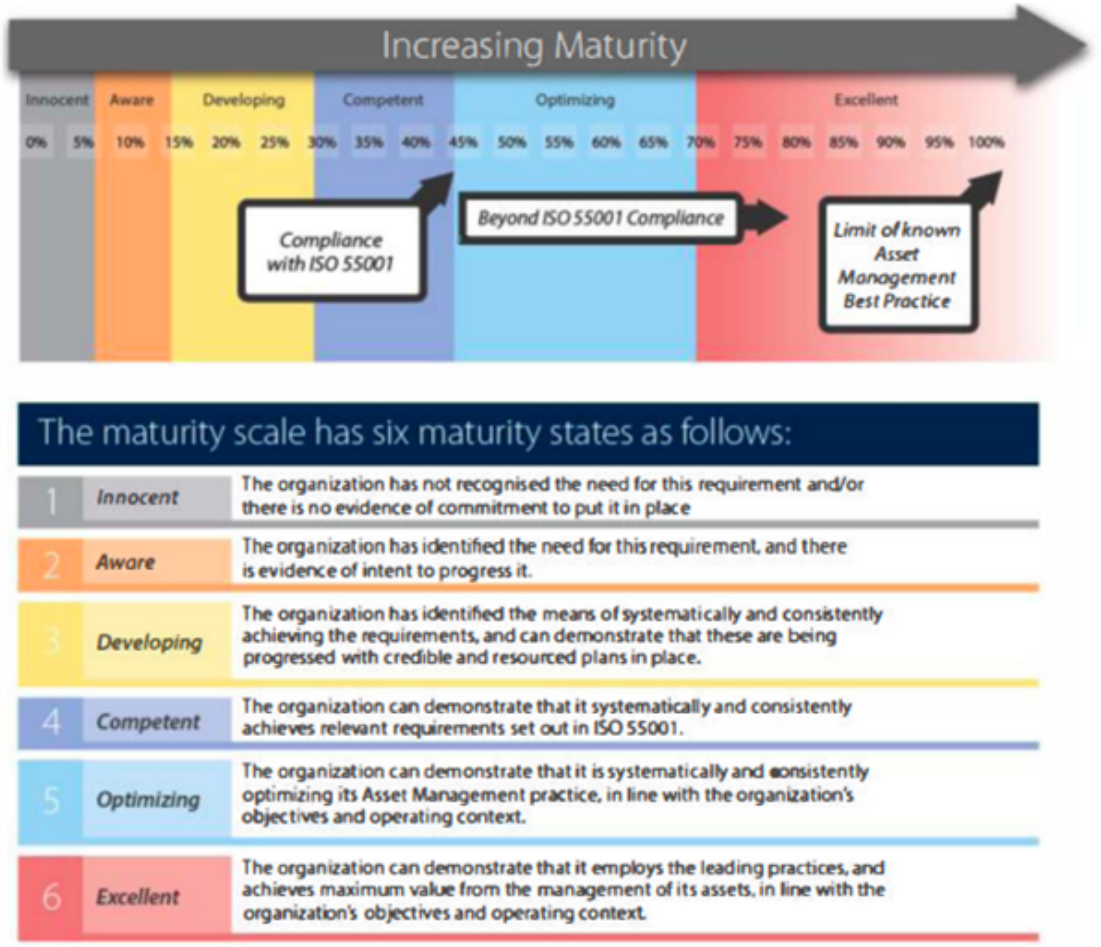


**Figure 1.1:** *AM Capability Maturity Scale (Sharp et al., 2014)*

To fulfil its targets, PLN has crafted a roadmap until 2024, focusing on addressing gaps in existing standards and policies while, in parallel, communicating the changes within the organization to shift from conventional operations to an asset management approach (PLN Center of Excellence, 2021). The change management strategy includes a mix of bottom-up and top-down approaches: identifying organizational pain points solvable by asset management (and communicating these in regular meetings), engaging leadership, transitioning to risk-based operational methods, balancing technical and non-technical expertise, and applying suitable change management techniques Pharmatrisanti et al. (2023).

The change strategy established by PLN encompasses various aspects, including communication, leadership, operations and maintenance, and competence. This implementation is intended to foster organizational learning and adaptation especially in the core business of managing the generation, transmission and distribution assets throughout its life cycle.

## 1.3 Asset Management (AM) progress and issue

Despite PLN setting a target to achieve 'competent' maturity in asset management by 2024, and having prepared both a roadmap and a change management strategy, the evaluation of implementation at PLN reveals that the transition has not fully progressed as anticipated. Several issues that have emerged during the process. These include resistance to accepting the results of gap assessment findings, particularly in the sector that had already been certified under ISO 55001:2014 (Pharmatrisanti et al., 2023). Additional challenges are the elimination of organizational silos and ensuring that change across the organization occurs systemically, such that it is not dependent on the individuals of the leader, and that there is integrated planning which accommodates asset management principles. Consequently, asset management practices have not yet been fully integrated into the daily business processes of various divisions or operational units. While the asset management development team is dedicated to creating key policies and guidelines for the implementation, these documents have not been adopted in daily activities.

The conditions outlined above imply that two distinct processes are occurring simultaneously within the organization: asset management development and routine business operations, which currently lack interconnection. This issue is compounded by the extensive scope of PLN's core activities, which include generation, transmission, and distribution, where each of these sectors operates under its own unique processes and assets. Therefore, the asset management implementation must be tailored accordingly. Consequently, it is crucial to determine what is needed by the organization, to accommodate the change process of asset management learning towards a more mature level of implementation, to fully support the organization overall objectives, especially in energy transition.

## 1.4 Problem statement

This situation at PLN suggests that there are significant barriers within PLN as an organisation which influence organizational change, particularly in learning and adapting the asset management practices into business processes. Addressing this issue is crucial, as the company cannot afford to allocate substantial resources to implement asset management without reaping the benefits for organizational objectives. This would result in a failure of the change process, undermining the intended advantages of asset

management initiatives. Therefore, it is crucial for PLN to understand why changes in the context of asset management practices are so challenging, despite considerable efforts. By gaining this understanding, PLN can enhance its approach to asset management implementation and move forward, ensuring that the AM transformation is implemented, and act as an enabler of the energy transition initiatives.

## 1.5 Analysis scope

As mentioned, the scope of PLN's operations includes generation, transmission, and distribution, with the implementation of asset management varying by context. Therefore, this analysis will focus on the transmission sector. This sector is chosen because it serves as the backbone for delivering energy from generation to distribution. Additionally, given the intense discussions around energy transition emphasizing more on the power plants and distribution as directly involved sectors, this analysis will provide the perspective from the transmission sector, which will provide valuable insights into the overall process. Furthermore, the scope of transmission asset management in this research will be specifically focused on the planning activities within PLN. Planning has been selected as the focal point because it plays a critical role in determining the organization's direction in achieving its objectives and one of the problem faced by PLN is lack of integrated planning (Pharmatrisanti et al., 2023). The rationale for this choice and further details on the scope will be elaborated in Chapter 3.

## 1.6 Problem analysis

Based on the problem statement, which outlines the real-world challenges faced by the organization, this issue then translates into the following scientific problem:

1. There is unclarity with regards to what is needed institutionally in the context of PLN, to foster the learning in asset management implementation in light of energy transition.
2. There is unclarity what specific aspects are needed to improve the asset management implementation in PLN to support the energy transition.

## 1.7 Research gap

Building on the identified scientific problem, this section will explore the existing literature for each of the problem.

### 1.7.1 Scientific problem 1: institutional needs for fostering learning in implementing change to asset management in light of energy transition

Institutional elements are defined as the rules, norms, and shared beliefs that shape how organizations and individuals behave and interact, providing structure and mean-

ing to social life (Möllenkamp et al., 2007). In this research context, institutional elements refer to the internal components within organizations that influence the transformation process towards implementing new asset management approaches to support energy transition initiatives. These institutional elements are expected to help organizations continuously evolve and improve their asset management practices to meet the challenges of the energy transition. This section seeks to identify what is already known from previous studies regarding the institutional needs necessary for fostering learning in the context of implementing changes to asset management, particularly in light of the energy transition.

#### Gap in Institutional Elements for the Energy Transition

Scientists and policymakers have recognized that transitioning to clean and renewable energy is crucial for mitigating climate change and its impacts (Medved et al., 2023). Since 2015, research on energy transition has increased significantly, focusing on renewable energy sources and the socio-technical aspects influencing them. However, operationalizing this transition—especially regarding policy frameworks, infrastructure development, and future demand estimations—remains underexplored (Harichandan et al., 2022). This lack of exploration is partly due to the limited focus on the roles of various actors involved in these significant changes (Medved et al., 2023). Specifically, the literature lacks detailed insights into the actors driving the energy transition, their specific roles, and the activities that can facilitate this shift (Dóci et al., 2015; Medved et al., 2023). This underscores the need to better understand the institutional elements required by organizations, particularly in developing countries, to foster learning and successfully navigate the energy transition.

#### Gap in Asset Management Change to Enable the Energy Transition

Asset management (AM) has become a favored strategy among successful organizations, including power utilities. AM is recognized as an effective approach that delivers value from assets, helps manage risks, and ensures the sustainability of business operations. It comprises a range of interdependent activities within a multilevel structure, including people, technologies, organizational units, processes, and management (Kazagic et al., 2022). Despite the increasing number of studies addressing change management within asset management (Gopinath et al., 2022; Mohn et al., 2023), a significant knowledge gap persists in understanding how organizations can successfully transition to asset management practices, particularly in diverse settings or contexts. Current studies have demonstrated that asset management plays a crucial role in facilitating the energy transition toward a carbon-neutral future and is essential for addressing the energy trilemma of security, affordability, and sustainability (Vandenberg, 2024). By implementing ISO 55000 standards, organizations aim to align asset management practices with energy transition goals, addressing aspects such as organizational alignment, work control, management accounting, and sustainable resource

management (Hasselmann, 2015). Furthermore, asset managers in electric utilities are encouraged to develop visionary strategic plans that allow for radical changes through new technologies in the asset base (Wijnia, 2020). Although asset management is acknowledged as an effective strategy for preparing infrastructure to support the energy transition, a significant knowledge gap remains in understanding how organizations, particularly electric utilities, can effectively implement this approach.

#### Gap in Learning Organization for Asset Management

A learning organization is a model designed to integrate systemic learning throughout all levels, enabling continuous evolution and adaptation. Such organizations embed mechanisms for capturing and sharing knowledge within their structure, ensuring a continuous improvement process (Senge, 1990; Watkins et al., 1992; Herrera, 2007). Senge's (1990) concept of the learning organization is one of the most widely studied frameworks (Yusuf, 2024). Research has demonstrated that learning organization principles are crucial for driving change across various sectors (Chai et al., 2018; Witherspoon, 2021; Martins et al., 2016; C. Williamson et al., 2023; Shoukat et al., 2023; Leyer et al., 2018; Brandenberger et al., 2023; Reese, 2020; Montuori, 2000; Koskinen, 2010). However, there is limited empirical work on effectively applying these concepts in organizations (Nwoke et al., 2017). Furthermore, Kringelum et al. (2020) argue that the learning organization is a complex social phenomenon that addresses wicked problems with no guaranteed uniform outcomes across different settings. Thus, implementing these concepts requires a contextual understanding to develop effective strategies, as there is no one-size-fits-all solution. While learning organization theory and asset management originate from distinct domains—one from theoretical organizational studies and the other from practical asset management—the integration of these approaches presents a significant challenge. Although Senge's work on learning organizations is well-regarded, there remains a critical gap in understanding how these theories can be effectively applied within the context of asset management learning. This gap highlights the need for further research to explore how organizations can foster learning while implementing asset management practices.

### 1.7.2 Scientific problem 2: specific aspects needed for asset management implementation

The second scientific problem focuses on the unclarity regarding what specific aspects are needed to improve the asset management implementation in the light of energy transition. One theory emerging from the literature is the concept of asset specificity in Transaction Cost Theory by economist Oliver E. Williamson. Asset specificity refers to the uniqueness of the resources required by the organization (Neal et al., 2018). The implementation of asset specificity in previous studies often depends on the context of change, commonly in outsourcing and insourcing strategies (Jain et al., 2013), technology outsourcing decisions (Ceccagnoli et al., 2010), and hotel outsourcing decisions

(Espino-Rodríguez et al., 2017). Other studies examine the impact of corporate governance on innovation within firms dealing with agency problems and asset specificity (Belloc et al., 2016), how asset specificity influences perceptions in customer-supplier relationships (Bates et al., 2004), and decision-making rules affected by transaction costs, governance, and capabilities (Gancarczyk, 2016). The research indicates that asset specificity plays a vital role in various organizational decisions and outcomes. However, there is a lack of specific research addressing asset management in light of energy transition. This gap highlights the need for targeted research to identify the unique aspects necessary for improving asset management practices in this context.

### 1.7.3 Research gap formulation

Despite the growing emphasis on the energy transition, there remains a significant lack of understanding regarding the specific needs of organizations as they attempt to learn and transition into effective asset management practices. Theories such as the learning organization, which highlights the importance of fostering a systemic approach for continuous adaptation and evolution, and asset specificity, which focuses on tailoring organizational design to specific asset characteristics, offer promising frameworks. However, the challenge lies in integrating these theoretical concepts and applying them to real-world organizational challenges within the context of energy transition. This integration remains largely unexplored, particularly in large, state-owned enterprises like PLN. This research gap will guide the formulation of the research questions and will serve as a basis for assessing the scientific contributions of this study.

## 1.8 Research Question

As this research seeks to address the gap in the existing literature by developing an approach that combines key theories and applies them to the empirical context of asset management for transmission network planning within PLN, it aims to tackle the current challenges in transitioning to effective asset management, in order to support the energy transition initiatives. Consequently, this research formulates the main research question as:

***How can PLN enhance its learning processes to effectively implement changes in transmission asset management by understanding their asset specificity, in order to fully support the energy transition?***

To answer this main research question, the first step is to develop an analytical framework from various literature, to identify the institutional element or internal components within organizations that influence the transformation process towards implementing new asset management approaches to support energy transition initiatives. These elements will revolve around the concept of learning organization, asset specificity and asset management requirements (further explanation in Chapter 2). Therefore the first sub-research question formulated as:

- Sub-RQ-1: How can institutional elements from different theoretical perspectives be integrated into a framework to improve the learning process for implementing asset management in transmission sector planning?

The next step would be understanding the existing process within PLN, especially how the activities of transmission network planning conducted within organization. Thus, the second sub question can be framed as:

- Sub-RQ-2: How have infrastructure planning and asset management practices at PLN evolved over the last decade?

The analytical framework is then applied to the empirical data from PLN, enabling us to pinpoint key challenges and suggest strategies for improvement. Therefore, the third sub-research question is:

- Sub RQ-3: What challenges does PLN face in implementing asset management for the transmission sector in the context of the energy transition, and how can these challenges be addressed based on insights from the theoretical framework and case study analysis?

## 1.9 Research Objectives

The primary objective of this research is to provide insights into what PLN needs to learn for effective asset management implementation to significantly contribute into energy transition, by understanding why PLN faced the difficulties in the learning process. While the main focus is on addressing the specific challenges faced by PLN, the findings may also contribute to provide insight for other organizations, especially those that have not yet fully implemented asset management.

The research objective of this study are:

- to develop a framework from various literature to examine the difficulties faced in transmission asset management planning
- to understand the reason why PLN experience difficulties in transmission asset management
- to identify the key factors in PLN transmission asset management
- to improve the learning process in implementing transmission asset management

## 1.10 Research Relevance

### 1.10.1 Engineering Policy Analysis (EPA) Relevance

Nugraha et al. (2024) demonstrate that within PLN, a key player in Indonesia's energy transition, AM plays a pivotal role in guiding strategy, planning transitions, and optimizing assets to lower carbon emissions, enhance energy efficiency, and transition to

sustainable energy sources. Despite its pivotal role, PLN has encountered challenges in organizational transformation, potentially impacting its contributions towards reducing carbon emissions on both national and global scales. This problem reflects a grand challenge addressed in the Engineering Policy Analysis (EPA) course, underscoring the need for a comprehensive analysis to understand the complex interplay between organizational behavior and policy implementation within PLN.

This study diverges from the more commonly employed data and information-centric methodologies like simulation and modeling found in Engineering Policy Analysis (EPA) studies. It applies an organizational theoretical framework, better suited to explore and address the subtle complexities of PLN's situation. By integrating this theoretical perspective, the research contributes to broadening the scope of Engineering Policy Analysis (EPA), offering holistic understanding of organizational transformations in the context of large-scale public enterprises.

### 1.10.2 Scientific Relevance

This research seeks to bridge a significant gap in the literature on organizational learning and asset management, specifically within the context of the energy transition. While theories such as the learning organization and asset specificity provide valuable frameworks for understanding how organizations can adapt and evolve, their integration and application in real-world scenarios, particularly in large corporations remain underexplored.

This understanding is particularly crucial in the context of large state-owned enterprises like PLN. Previous studies have categorized organizations into five types, placing PLN between machine bureaucracy and professional bureaucracy (Mintzberg, 1984). Such organizations are characterized by stable, conventional business methods and a strong resistance to change. Mintzberg emphasizes the significance of studying these organizations due to their inherent resistance to change, while Chai et al. (2018) further notes that policy intentions in such settings often fail to materialize due to numerous barriers.

# 2

# Introduction to the Theory and Asset Management

The previous chapter in the research gap section identified two organizational theories, namely the learning organization by Peter Senge and asset specificity by Williamson. Therefore, this chapter will provide an overview of these theories and also explain asset management as the topic to be examined in this study. To conclude, the chapter will discuss the alignment of these theories with the research design, setting the stage for the detailed exploration of the research methodology in the following chapter.

## 2.1 Learning Organization

According to Senge (2006), the leading organization will be the one that masters the art of harnessing the commitment and learning capabilities of its individuals across all levels. Such an organization will not only survive by learning through adaptive learning but will also thrive by integrating this with regenerative learning to renew and enhance its capabilities continuously. This concept of adaptive and generative learning is an interpretation of single-loop and double-loop learning founded by Argyris and Schon's (1978) (Argyris et al., 1978; Montuori, 2000) where the adaptive learning represent the single-loop learning and the generative learning represent the double-loop learning. This meant that learning organizations should systematically and continuously question existing patterns of thinking and be willing to change the beliefs, processes, and systems to act on new knowledge (Prahalad et al., 1986; Senge, 1990; Herrera, 2007). Senge (1990) discusses the concept of learning organizations by identifying the common "learning disabilities" that hinder them, as characterized in his comparative Table 2.1Table 3.1 These showcase the gaps between organizational behaviors incapable vs capable of learning. To bridge this gap and transform into true learning organizations, Senge outlines five key disciplines that are essential for the development: personal mastery, mental model, shared vision, team learning and system thinking, which will be explained in the next subsection by taking the key information from the Senge's book The fifth Discipline Senge (2006).

**Table 2.1:** *Disabilities and abilities in forming learning environment* (*Senge, 1990*)

| | Disabilities | | Abilities |
|---|---|---|---|
| 1. | I am my position | vs | I am part of the whole |
| 2. | The enemy is out there | vs | I am part of the problem |
| 3. | The illusion of taking charge | vs | I am willing to change myself to effect broader change |
| 4. | The fixation on events (on immediate cause and effect) | vs | The ability to identify pattern and root cause |
| 5. | The parable of the boiled frog | vs | The ability to slow down and detect gradual insidious change |
| 6. | The delusion of learning from experience (when cause and effect are removed from time and space) | vs | The ability to anticipate effects through the use of management practice field |
| 7. | The myth of the management team | vs | The learning team (balancing advocacy and inquiry) |

### 2.1.1 Personal Mastery

Organizational learning is fundamentally rooted in individual learning, which is a necessary prerequisite for organizational learning. Personal mastery, a discipline of personal growth and learning, involves continually clarifying and deepening personal vision, focusing energy, developing patience, and seeing reality objectively. It embodies two key movements: continually clarifying what is important and continuously learning to see current reality clearly. As the spiritual foundation of a learning organization, personal mastery limits the organization's capacity and commitment to learning by the abilities and dedication of its members. To foster personal mastery, leaders should create a supportive environment that promotes personal vision, commitment to truth, and acknowledges gaps between them, emphasizing personal growth and "on-the-job training (Senge, 2006)

### 2.1.2 Mental Models

Mental models are ingrained assumptions, generalizations, or visual representations that shape our understanding of the world and guide our actions. New insights often struggle to be accepted because they conflict with these internalized images, confining individuals to familiar patterns of thought and behavior. The challenge with mental models arises when they operate implicitly, beyond our conscious awareness, preventing scrutiny or modification. As the world evolves, the gap between our outdated mental models and changing reality grows, leading to counterproductive actions. In the early 1970s, Shell recognized the impact of hidden mental models, with Ari De Geuss noting that adaptation and growth in a changing environment depend on institutional learning. This involves management teams altering their collective mental models about the company, its markets, and competitors, viewing planning as a form of institutional learning. Working with mental models involves uncovering and ex-

amining our internal representations of the world, engaging in learning conversations that balance inquiry and advocacy, and developing tools that enhance personal awareness, infrastructures for regular engagement with mental models, and a culture that encourages questioning and challenges conventional thinking (Senge, 2006)

### 2.1.3 Shared Vision

A learning organization cannot exist without a shared vision, which sets ambitious targets that necessitate new ways of thinking and acting and guides the learning process during challenges. This vision encourages individuals to question assumptions, abandon entrenched beliefs, and acknowledge flaws, making learning transformative yet demanding. It promotes risk-taking and experimentation, as people engage in purposeful trials and errors to achieve their objectives. A shared vision also addresses the challenge of fostering long-term commitment to systems thinking. However, without systems thinking, a shared vision lacks essential support. Many leaders create corporate visions and mission statements to unify their teams, but expected boosts in productivity often fail to materialize, not due to the vision's quality but because of a reactive approach to current realities. Managers often feel detached from shaping their circumstances due to linear thinking, which focuses on reacting to changes rather than initiating them. As organizational members understand how policies and actions shape their reality, they become more receptive to the vision, fostering confidence that they can influence and change their reality (Senge, 2006)

### 2.1.4 Team Learning

Team learning is the process through which a team aligns and develops its collective capacity to achieve the outcomes its members truly seek. It is built on the foundations of shared vision and personal mastery, recognizing that effective teams are composed of competent individuals. However, possessing talent and a common vision alone is insufficient. The world has many talented groups who share goals but falter because they lack the capability to learn collaboratively. The urgency for mastering team learning is becoming increasingly apparent in organizations today, whether they involve management teams, product development groups, or cross-functional task forces. These teams, composed of those who rely on one another to act, are becoming the principal units of learning within organizations. This shift is driven by the fact that most significant decisions are now made collaboratively within team settings (Senge, 2006)

### 2.1.5 System thinking

System thinking, or what Senge refers to as The Fifth Discipline, is the element that integrates the previous four disciplines. Systems thinking equips the organization to anticipate and adapt to environmental shifts, thereby reducing the need for reactive

changes and ensuring that changes are comprehensive and holistic (Montuori, 2000). Integrating the five disciplines as a cohesive whole is crucial, yet challenging, because it is far more complex to synthesize these disciplines than to apply them individually. Without a systemic perspective, there's little incentive to examine how the disciplines interconnect. For instance, a vision without systems thinking might yield an appealing future scenario but lacks a profound understanding of the dynamics needed to transition from the current state to the envisioned future.

When non-systemic thinking predominates, and we fail to achieve our goals or realize our vision, the tendency is to assign blame to external factors rather than critically assessing our own role in creating the issues at hand. Systems thinking enables individuals to transform their perspective, moving from viewing themselves as apart from the world to recognizing their interconnection with it. It shifts the focus from blaming external sources for problems to understanding how our own actions contribute to the challenges we face.

Furthermore, The essence of the discipline of system thinking lies in a shift of perspective in seeing:

- interrelationship rather than linear cause-effect chains and
- seeing process of change rather than snapshots

Based on the concept of "system dynamic" by Jay Forrester, which inspire the system thinking concept (Cabrera, 2023), according to Senge, the practice of systems thinking can be understood through the concept of system dynamics modeling, which includes several key elements

- Feedback: The practice of systems thinking starts with understanding feedback, a simple concept that shows how actions can either reinforce or counteract each other. It builds to recognizing types of structures that recur persistently within these feedback processes.
- Reinforcing Feedback: There are two distinct types of feedback processes. Reinforcing (or amplifying) feedback loops are the engines of growth, driving expansion in systems where they operate. Whenever there is noticeable growth or expansion in a situation, it is often due to the presence of reinforcing feedback mechanisms. However, these same mechanisms can also lead to accelerating declines.
- Balancing Feedback: Balancing feedback plays a critical role in goal-oriented behaviors, functioning similarly to how brakes operate in a car. It comes into play to regulate and stabilize systems, aiming to maintain or achieve a specific state. The goals in such systems can be either explicit or implicit, which adds complexity to understanding and managing these feedback loops.
- Delays: Moreover, many feedback processes are characterized by delays—interruptions in the flow of influence that cause the effects of actions to manifest gradually. These delays can complicate the system's response and make it challenging to

directly correlate actions with their consequences, often leading to unexpected results or the need for adjustments over time.

### 2.1.6 Critique of Senge's Work

The Fifth Discipline (Senge, 1990) is widely recognized as one of the most important and influential management books in history. Evidence shows that this concept has significantly increased interest in the idea of the learning organization within the academic community (Hsu et al., 2020). However, this interest has also sparked criticism regarding its application. Some researchers argue that Senge's concept of the learning organization reflects the managerial interests of the 1980s, particularly the push to reduce bureaucracy in business organizations (Meyer et al., 1985; Lawler et al., 1987; Hsu et al., 2020). Consequently, the theory places greater emphasis on organizational structure, ultimately limiting its ability to meet broader societal demands for ecologically responsible and socially equitable learning organizations (Hsu, 2013; Jørgensen et al., 2019; Pedler et al., 2017; Pedler et al., 2014; Pedler et al., 2019; Hsu et al., 2020).

This critique likely arises from Senge's strong focus on "systems thinking" as the most crucial component within organizations. However, validating this criticism is challenging, as the research gap highlights that, in practice, there is still no clear method for measuring the presence or absence of systems thinking within an organization. There is difficulty in translating the concept into a model that allows for systematic evaluation of the process of creating a learning organization is compounded by the current lack of conceptual frameworks to measure these elements within organizations (Bui et al., 2010; Caldwell, 2012).

## 2.2 Asset Specificity

Asset specificity is identified as one of the key dimensions of Transaction Cost Theory, along with uncertainty and frequency (O. E. Williamson, 1991) as cited in Greve et al. (2015). These three dimensions help characterize transactions within organizations or the capabilities of organizations. Despite existing research, there remains an ongoing focus on clarifying the relationship between organizational capabilities and transaction costs (Greve et al., 2015), indicating that this area still holds significant academic interest and relevance. Asset specificity describes how specialized resources are for a particular exchange. Assets refer to durable resources (Zott et al., 2006). Furthermore, O. E. Williamson (1985) identifies four distinct types of specific investment, including:

- **Site specificity** refers to specific location investment to minimize the inventory and transportation costs.
- **Physical asset specificity** refers to specific investment in equipment and machinery customized or tailored specifically for the organization's needs. This specificity can lead to lower value or utility if used for other purposes.

- **Human asset specificity** refers to investments in relationship-specific human capital that often arise through a learning-by-doing process.
- **Dedicated asset** refers to general investments made by a supplier that are specifically intended for a particular customer and would result in significant excess capacity if the customer relationship ended.

As research progresses, the dimensions of asset specificity have become increasingly diverse, including brand capital specificity, temporal specificity, and procedural specificity (Imbayani et al., 2021). This indicates that asset specificity depends on the assets deemed important by an organization for carrying out its activities and achieving its objectives, which can vary between different organizations.

Compared to other policy-related disciplines, transaction costs theory, characterized by asset specificity, frequency, and uncertainty, is relatively little used in planning (Shahab, 2021). However, Alexander (1992) has expanded the focus of this theory from private organizations and their relationship in the market into public and government organizations and activities in the planning domains. Alexander mentions that asset specificity can be in the form of specific technology, skills, or intangible assets such as trust and service, and these specificities influence the frequency, duration, and uncertainty. Therefore, the complexity of these specificities in an organization will determine their planning activities, how to implement, monitor, and control the planning, and these series of activities will affect organizational structure.

As asset specificity significantly influences how an organization governs an activity, a precise understanding of this aspect is crucial (Zott et al., 2006). However, the uniqueness of each asset can make it challenging to find relevant references or case studies. Nonetheless, the impact of asset specificity on organizational structure underscores its importance within an organization.

## 2.3 Asset Management

The term Asset Management began to be used in the management of physical assets in the private and public sectors in the 1980s, starting in the UK to boost performance, safety, and productivity. The public sectors in Australia and New Zealand adopted this strategy to enhance strategic planning, prioritization, and value for money. By 1988, US federal asset management policies were advocating for the attainment of desired service levels while minimizing lifecycle costs, providing structured funding for sectors like transportation, water, and wastewater. This focus on asset management led to the creation of numerous standards and guidelines, culminating in the publication of the Total Asset Management Manual in 1993 and evolving to the ISO 55000 series standards introduced in 2014 (Asset Management, 2015).

Asset management is defined as the coordinated activity of an organization to realize value from its assets, according to ISO 55000:2014. An asset is any item or entity that holds potential or actual value to an organization. Furthermore, the "realization of

value" typically requires balancing costs, risks, opportunities, and performance benefits. Additionally, the term "activity" encompasses a broad scope that includes the approach, planning, plans, and implementation processes, as outlined by Asset Management (2015). Thus, asset management focuses on how an organization manages its assets to optimize their value throughout the entire lifecycle of the assets.

ISO 55001 outlines the requirements for a management system specifically designed for Asset Management. It encompasses a combination of interacting elements that ensure direction, alignment, coordination, control, and continuous improvement in asset management. Essentially, it is a set of components that collectively deliver performance and provide assurance of effective asset management practices. This asset management system is then measured against the ISO 55001:2014 certification standards. However, ISO 55001 does not cover all aspects of asset management. It focuses solely on the mandatory items, without addressing the optional or recommended elements. Additionally, it does not consider the appropriateness, degree of refinement in methods used, or the potential to exceed the minimum requirements. Therefore, the management system should be viewed as a subset of the broader field of asset management, as illustrated in Figure 2.1 (Asset Management, 2016).

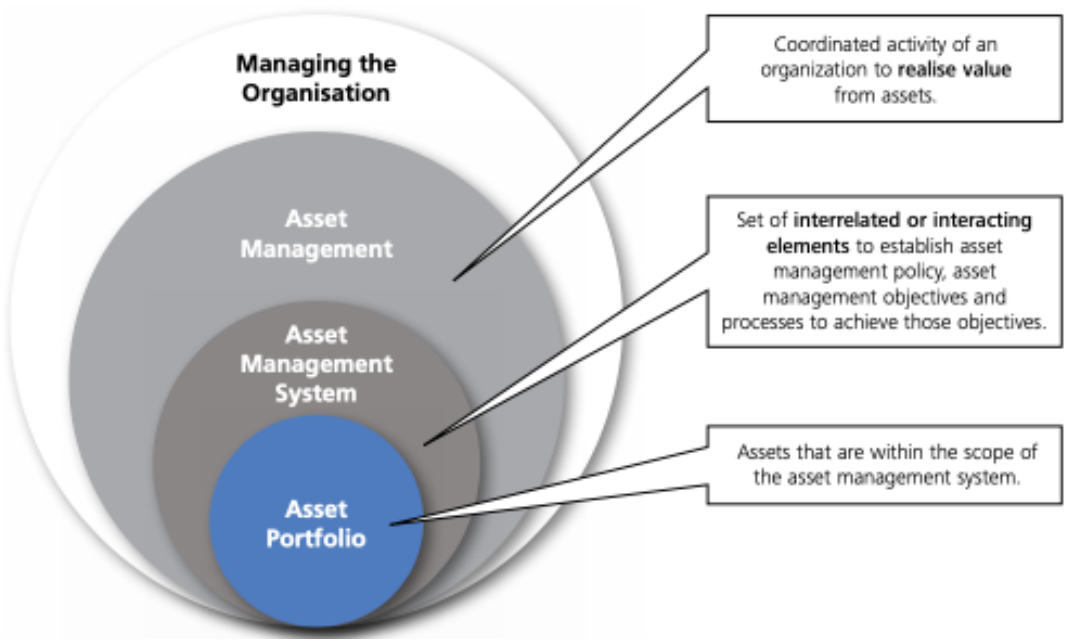


**Figure 2.1:** *Key-term of asset management and their interrelationship* (*Asset Management, 2015*)

The development of asset management stems from organizational needs to enhance operational approaches and adapt to various changes: from tactical to strategic actions, from managing isolated life phases and functional disciplines to adopting a comprehensive life cycle view, from focusing on individual assets to managing asset systems and systems of systems, and from overseeing discrete activities to implementing an integrated management system (Asset Management, 2015).

### 2.3.1 Asset Management Scope

Asset management discipline encompass various activities across the organization to ensure that the objective of realizing value from the asset can be achieved. The scope of asset management illustrate on the Figure 2.2 where this figure outline six group activities in asset management, how this group interacts and their relationship with the organizational strategic plan (Global Forum on Maintenance and Asset Management (GFMAM), 2014). This scope presented in a conceptual model known as the conceptual model of asset management (Asset Management, 2015).

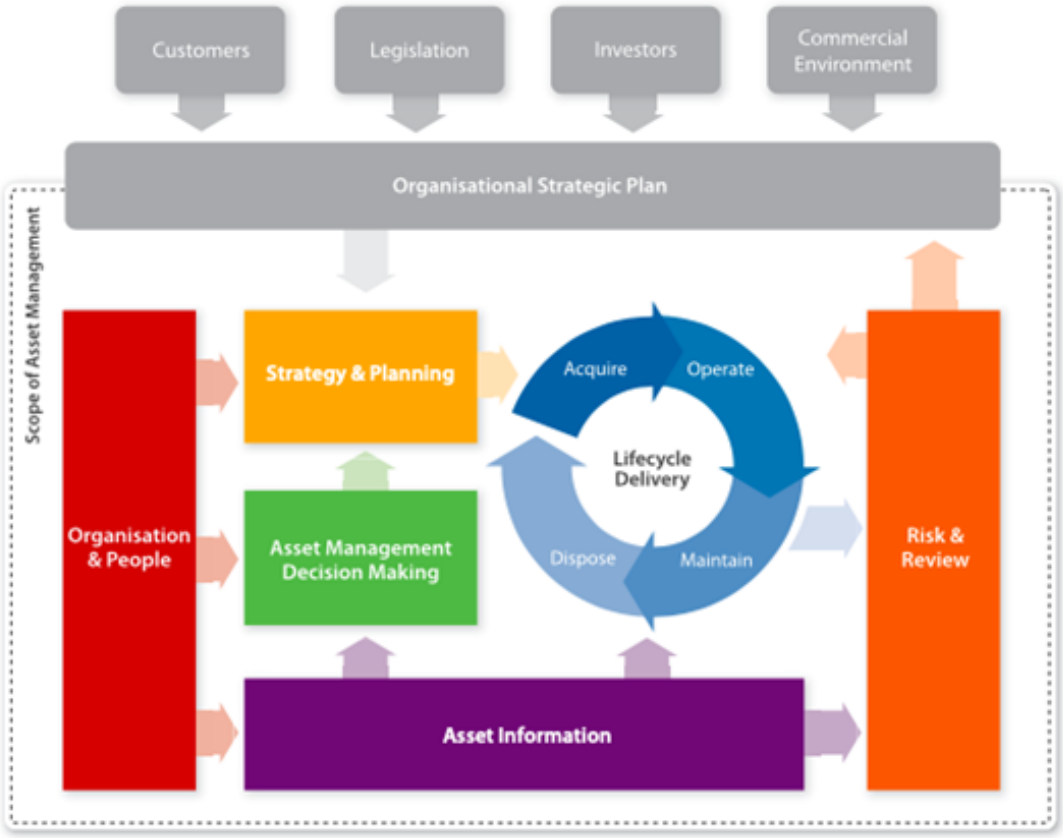


**Figure 2.2:** *Asset management scope* (*Asset Management, 2015*)

- Strategy and Planning: This group emphasizes aligning organizational objectives with asset management activities. Therefore, high-level organizational goals are translated into everyday asset management tasks. As this research focuses on this group, the next sub section will give more explanation on this group.
- Asset Management Decision Making: This group aids in decision-making processes that maximize the value of assets throughout their lifecycle, including acquisition, operation, maintenance, and disposal. Decisions at each stage influence subsequent stages; for instance, the decision to acquire an asset affects its performance, risk, and maintenance during the operation and maintenance phase.

- Life Cycle Delivery: this group implements the asset management plans developed in the strategy and planning phase and is supported by other groups. It includes eleven components, from technical standards to asset decommissioning and disposal.
- Asset Information: Positioned as the foundational element in the model, this group underscores that organizations relying on physical assets need accurate asset data and information as key enablers for all asset management activities. Asset information, which may be modified or created through the asset management process, includes strategies, standard systems, and management practices.
- Organization and People: Implementing asset management requires a shift from traditional ways of thinking and working. This group focuses on facilitating such changes to ensure the organization's ability to successfully adopt and embed asset management. It covers practices from asset management leadership to organizational structure and culture and managing asset management competence.
- Risk and Review: This group involves the identification, understanding, and management of risks. It also establishes effective feedback and review mechanisms to ensure that objectives are met and supports the continual improvement of asset management processes.

## 2.4 Insight from theories towards research design

This research aims to bridge the gap between theoretical perspectives and practical approaches within organizations by focusing on the challenges PLN faces in implementing asset management to support the energy transition. Learning organization theory offers a philosophical framework for fostering organizational learning, but lacks operational guidance. Asset specificity theory complements this by emphasizing how specific assets—whether technological or knowledge-based—shape organizational transactions and the learning process.

Understanding PLN's asset characteristics and their impact on learning is crucial, especially in the context of asset management where standards like ISO 55000 set requirements but do not address the unique challenges of individual organizations. To address these gaps, a framework integrating learning organization elements and asset specificity will be developed and applied in a case study of PLN to examine asset management challenges. The research methodology will be further detailed in the Chapter 3, covering the overall process of developing the conceptual framework and the implementation in the case study including the analysis process.

# 3

# Research Approach

As this research seeks to answer the main question of how PLN can enhance its learning processes to effectively implement changes in transmission asset management by understanding their asset specificity, in order to fully support the energy transition, this chapter will explain the research design suitable for this type of question and the methodology employed to answer the sub-research question.

## 3.1 Research Design

### 3.1.1 Exploratory research approach

As outlined in the first chapter, the primary objective of this research is to provide insights into what organizations need to learn for effective asset management implementation by understanding the difficulties they face in the learning process. To achieve this goal, one of the aims is to develop a framework that can serve as a basis for measuring organizational conditions and as a reference for improving existing practices. Therefore, a combination of two theories discussed in previous chapters: learning organization and asset specificity, will be used to create the analytical framework.

The framework will integrate elements from asset specificity, particularly in strategic planning, which refers to the resources deemed essential by the organization for executing strategic and planning activities. The second set of elements will be drawn from the learning organization concept, identifying components that indicate ongoing learning processes within the organization, aiming for continuous improvement in strategic planning. Additionally, since this research specifically examines the learning process in implementing asset management, asset management requirements will be combined with asset specificity elements to create a more targeted framework for this case study.

To explore and to be able to explain the issues faced by PLN in asset management, specifically in transmission planning, qualitative data is essential. This includes understanding how the organization currently conducts transmission planning, the organizational design supporting this process, existing policies, guidelines, procedures, the actors involved, and their individual experiences. Thus, the research will utilize

qualitative data from documentation and subjective experiences of the involved actors. The analytical framework will guide the focus, shaping the required information to gain insights from the participants.

Given the objectives and the data needed, an exploratory research approach is deemed appropriate. Exploratory research is particularly valuable when the research problem is not well-defined or understood, helping to identify the nature of the problem and generate hypotheses for further investigation. This approach provides flexibility and adaptability, enabling the researcher to delve into complex issues that have not been extensively studied. As Bhat (2024) notes, exploratory studies are crucial for uncovering new insights and understanding phenomena in their natural context. Furthermore, according to Saunders et al. (2016), (Olawale et al., 2023), an exploratory research design is a valuable method for discovering "what is happening; to seek new insights; to ask questions and to assess a phenomenon in a new light."

Given the nature of this research, which combines describing the phenomena in the transmission network planning process within the specific context of PLN and explaining why PLN as an organization faces difficulties in transitioning to asset management-based planning, a case study approach is most suitable. According to Yin (2014), case studies can be descriptive, explanatory, or exploratory, and the definitions of these types align with the aims of this research.

Therefore, this research will be divided into three stages:

- **Theoretical Part:** This part aims to develop a conceptual framework by incorporating elements from learning organization, asset specificity, and asset management requirements.
- **Case Study Part:** This part involves implementing the framework within the PLN case study, exploring which aspects of the framework are applicable to the existing processes.
- **Analysis and Interpretation Part:** This part compares PLN's existing conditions with the ideal scenarios based on theoretical concepts, identifying the extent of the gaps and key issues causing these gaps.

Overall, this process is illustrated in Figure 3.1. Detailed explanations of each part and the methods used will be provided in the next sub-section.

## 3.2 Research method

Based on the research design, it is crucial to map the sub-research questions to the selected methodologies before detailing the employed methods. This mapping will illustrate what information is needed within each method to answer the corresponding sub-research questions. The mapping is presented in Figure 3.2.

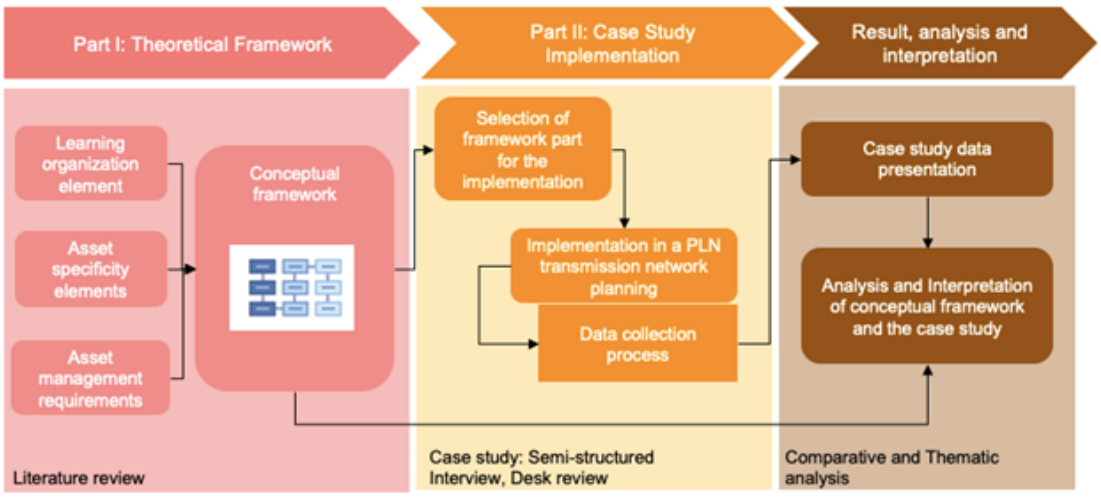


**Figure 3.1:** *Research design*

| | Sub-research question | Research method | Information needed or data source |
|---|---|---|---|
| **Sub-RQ-1** | How can institutional elements from different theoretical perspectives be integrated into a framework to improve the learning process for implementing asset management in transmission sector planning? | • Literature review to identify elements from various literature<br>• Analytical framework development by formulating the element and logical step in measuring the element | • Literature from online database (Scopus and web of science) on:<br>1. Learning organization element<br>2. Asset specificity element<br>• Literature from AM database on asset management requirements |
| **Sub-RQ-2** | How have infrastructure planning and asset management practices at PLN evolved over the last decade? | • Initial desk review to gain understanding on PLN process and to determine the respondent<br>• Semi structured interview to gain insight from the PLN employee<br>• Desk review on the existing internal and external document to complement the interview data<br>• Descriptive case study to describe the infrastructure planning and asset management practices at PLN evolved over the last decade | 1. Insight from the analytical framework to shape the interview question<br>2. Insight from the practitioner on conducting the infrastructure planning and asset management<br>3. Internal document:<br>• Organization design and structure<br>• Policy, guideline, and procedure in conducting infrastructure planning and asset management<br>• Existing methodology and tools in planning process<br>4. External document:<br>• Regulation and policy from the external<br>• Key issue in infrastructure planning especially energy transition |
| **Sub-RQ-3** | What challenges does PLN face in implementing asset management for the transmission sector in the context of the energy transition, and how can these challenges be addressed based on insights from the theoretical framework and case study analysis? | • Descriptive case study to identify the challenges faced by the organization in conducting infrastructure planning and asset management especially to support the energy transition<br>• Data analysis through comparative analysis to compare the analytical framework with the case study data, and thematic analysis or coding to identify the key challenge faced by PLN<br>• Analysis for recommendation to improve the learning towards asset management in regard to energy transition | • Analytical framework<br>• Case study data |

**Figure 3.2:** *Mapping of sub-research question, methodology employed and the information needed*

### 3.2.1 Theoretical Part: develop the conceptual framework

***Literature review to identify the elements***

The objective of this literature review is to develop an initial overview of a conceptual framework aimed at determining whether combining the theories of organizational learning and asset specificity can be applied to understand asset management issues, specifically in the context of transmission network planning at PLN. Since this serves as an initial overview, the literature review will not seek to produce an exhaustive conceptual framework by identifying all elements from previous research. Instead, it will summarize findings from selected literature and identify key elements within them. Given that this framework builds upon the conceptual theories of organizational learning and asset specificity, and is tailored to the domain of asset management, the literature review will be conducted in three stages to ensure comprehensive coverage:

- Step 1: Literature Review of Learning Organization Elements
  This stage aims to list and identify the critical factors that indicate learning is taking place within an organization. By examining the characteristics and processes that define a learning organization, we can identify the essential elements that support continuous learning and improvement.
- Step 2: Literature Review of Asset Specificity Elements
  This stage focuses on listing and identifying the vital resources within an organization that play a crucial role in strategic planning. By understanding asset specificity, we can determine how specific resources are managed and utilized to support the strategic planning process.
- Step 3: Literature Review of Asset Management Requirements
  This stage aims to list and identify the requirements for asset management in the context of strategy and planning. By reviewing relevant standards and practices, we can identify the necessary components that must be integrated into the strategic planning process to ensure effective asset management.

By following these steps, the literature review will provide a structured and focused examination of the relevant theories and practices. Figure 3.3 illustrate the literature review approach used in this research

In order to ensure the literature found is of high quality, databases such as Scopus and Web of Science will primarily be used. For asset management requirements, the search will be extended to the Institute of Asset Management (IAM) database because asset management is more of an organizational practice than an academic research area, and IAM provides numerous guidelines for asset management standards and practices, including contributions to developing ISO standards.

For each step, the keywords used to search for literature will be tailored to meet the specific objectives. General filters such as open-access articles, English language, and management field will be applied, with further adjustments based on the volume of literature obtained to ensure a manageable review scope. The final selection of ar-

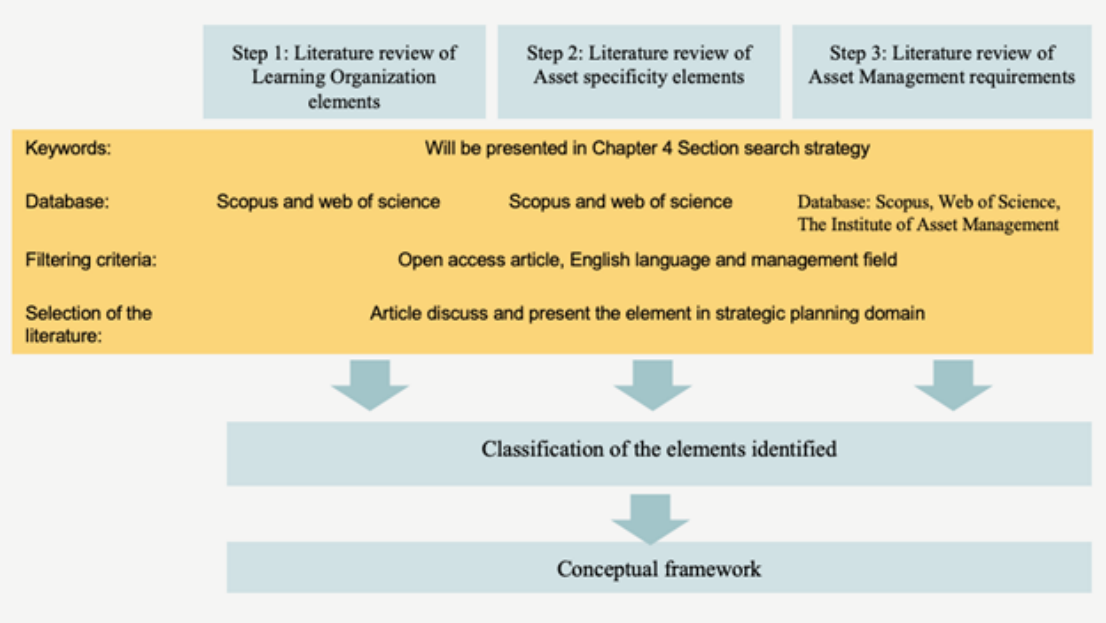


**Figure 3.3:** *Literature review approach*

ticles will be those that discuss and present elements within the domains of strategy and planning. If the identified elements are spread across various organizational processes, such as structural elements, competency elements, knowledge elements, etc., these elements will be grouped into certain categories (determined based on the literature review results) and then organized into the framework.

### *Integration of the framework*

After identifying elements from various literature sources on learning organization, asset specificity, and asset management requirements, the next step is to construct the analytical framework. This process involves:

- Creating a list for each set of elements (learning organization, asset specificity, and asset management).
- Categorizing these elements based on their characteristics to simplify and streamline the identified elements, making it easier to visualize the framework and conduct the analysis.
- For each category, the list of elements is further classified into high-level elements to reduce complexity and focus on key aspects. This approach ensures that the framework remains manageable and highlights the most critical factors for effective analysis.

It is important to note that the categorization and classification of elements might be subjective, as it depends on the interpretation of the literature and the specific context in which the analysis is conducted. This subjectivity could influence the final framework, and therefore, it is essential to acknowledge this limitation when applying the framework in practice.

### 3.2.2 Case study approach

#### *Scope of the case study*

As the asset management scope encompasses various activities in the organization therefore for this research, it is decided to limit the research scope as follows:

- The focus of asset management will be limited to the strategy and planning activities in the transmission network. This selection was made based on the criticality of planning towards the life cycle asset management, an as Infinity (2023) points out, Asset Management planning is a fundamental aspect that serves as a roadmap, guiding both the implementation and the effectiveness of an asset management system. Moreover, Pharmatrisanti et al. (2023) highlight that PLN still lacks integrated planning, making this area particularly critical to study.
- Given PLN's nationwide transmission planning, this study will focus specifically on the transmission unit in the Java-Madura-Bali region. This unit has been selected due to its critical role in serving the capital city of Jakarta, which demands high reliability in the transmission network. Additionally, the researcher's connection with this unit will facilitate the data collection process

#### *Case selection*

Yin (2014) introduced four types of case study: single case (holistic) design case study focusing on thorough exploration of entire single case, single case (embedded) design includes more than one embedded unit of analysis within a single case to examine various components inside the case, multiple case (holistic) involves studying several cases, each treated as a complete unit, and lastly multiple case (embedded) design, where the case study are multiple and for each case study there is also multiple unit of analysis, as illustrated in the Figure 3.4.

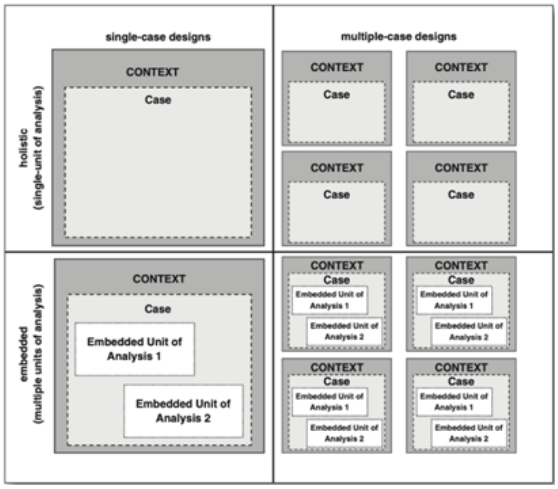


**Figure 3.4:** *Four different types of case study* (*Yin, 2014*)

The selection of the case study type to be implemented is highly dependent on

the objectives to be achieved through the case study. In this context, the study aims to examine the difficulties faced by PLN in transitioning towards asset management practices. Furthermore, Section 2.4 has limited the scope of this research to transmission planning activities, highlighting two main processes within the company: strategic planning at the holding-company level and planning at the transmission unit level, specifically UITJBB.

Therefore, this case study will adopt a single-case (embedded) design, positioned in the lower-left quadrant (Figure 3.4), where the context focuses on the asset management of the transmission network within PLN. Within this single case, the embedded units of analysis will include two organizational components: the strategy and planning activities at PLN headquarters and those at the operational unit, specifically the Western Java Transmission unit (UITJBB).

Understanding how strategy and planning are developed from the perspective of PLN Holding will provide insights into the organization's strategic approaches. Additionally, examining UITJBB's perspective on aligning the planning process will highlight the challenges faced in transmission network planning.

#### *Methods of data collection*

The data collection for this research involved a combination of desk review and semi-structured interviews, both of which were systematically integrated to ensure an understanding of the transmission planning process at PLN.

1. Initial desk review
   The initial phase of data collection was conducted through a desk review. This involved a thorough examination of PLN's organizational structure document to develop an overall understanding of the planning processes within the organization. This initial desk review served several purposes:
   - Initial Case Study Description: By reviewing organizational structure documents, a preliminary sketch of the planning processes at PLN was created. This sketch provided insights into the formal and documented procedures of planning within the organization, offering a starting point for understanding the structural and procedural aspects of transmission planning.
   - Interview Preparation: The insights gained from the desk review were instrumental in selecting appropriate respondents for the interviews and in developing the interview protocol. This process included identifying key processes and roles within the organization, which helped initiate discussions with respondents by asking them to identify the processes they are involved in and the gaps between the formal procedures and actual practices.
2. Semi-Structured Interviews

Following the desk review, semi-structured interviews were conducted with key stakeholders involved in the transmission planning process. According to Grant et al. (2012), interviews are invaluable for understanding thoughts, feelings, beliefs, and behaviors. This method will help gather first-hand experiences of staff involved in PLN's business processes. The chosen format for these interviews is semi-structured, which, as Stuckey (2013) and Adhabi et al., 2017 describe, involves a flexible approach where the researcher prepares an outline of topics and questions but remains open to following the interviewee's responses for deeper exploration. This approach ensures focused yet adaptable conversations, allowing for an in-depth understanding of employees' experience and perspectives on transmission network planning. The approach to the interviews was as follows:

- **Participant Selection**
  Participants were selected based on their involvement in strategic planning activities at both PLN headquarters and the UITJBB unit, ensuring a diverse range of perspectives and experiences. An initial desk review of PLN's organizational structure identified two main directorates involved in transmission network planning: the Transmission and System Planning Directorate and the Corporate Planning and Business Development Directorate. Based on these findings, participants were chosen from relevant divisions, including the Strategic Planning Division, Transmission Strategic Planning Division, and the Asset Management, Engineering, and Integrated Management System Division. Additionally, as UITJBB operates as an operational branch of these directorates, the Planning Department of UITJBB was also included as a key source of information for the interviews.
  In total, ten interviews were conducted, covering a diverse range of respondents from various levels within the organization. Within the transmission division, interviews were conducted with four employees, including those at the EVP level, managers, and staff. In the corporate planning division, one VP-level individual was interviewed. From the asset management and engineering integrated management system division, two interviews were conducted with individuals at the EVP and manager levels. Furthermore, in the UITJBB division, three employees, including staff and assistant managers, were interviewed.
  While it is recognized that ten interviews represent a small sample size relative to the overall employee population, this number was deemed sufficient given time constraints and the consistency of the information provided. However, it's also acknowledged that this limitation may result from questions that were not probing enough.
- **Interview Preparation**
  Before conducting the interviews, two key preparations were necessary to ensure they were executed appropriately according to TU Delft procedures.

First, the interview protocol needed to be developed. This protocol included brief information about the research, data management details, the consent form, the HREC (Human Research Ethics) checklist, and the set of interview questions.

The interview questions were developed based on a conceptual framework and divided into three parts. The first part aimed to explore the existing processes, methods, tools, and knowledge used in planning activities, as identified in the initial desk review. The second part focused on measuring the maturity of this knowledge and the tools/methods employed. The third part aimed to verify the conceptual framework from the practitioners' perspective. This three-part focus was selected based on the literature review results, as the interview process aims to collect case study data to apply the conceptual framework, which will be explained in detail in Chapter 4, specifically in section 4.2.

The second preparation activity involved arranging meetings with the respondents and sending them the interview protocol, informed consent form, planning visualizations, and interview questions. This step was also in response to the respondents' request to receive the questions beforehand to better anticipate the direction of the interview. The interview protocol is attached on the Appendix 1.

- **Interview Execution**
  Given the geographical and cultural differences, the interviews were conducted online using an appropriate platform. To facilitate a smoother conversation, the interviews were held in Bahasa Indonesia, the local language. All interviews were recorded to ensure accurate translation. The duration of the interviews varied, ranging from 45 minutes to 1 hour and 30 minutes.

3. Iterative Desk Review
   The interview data complemented the initial desk review. To ensure comprehensive information, an iterative desk review was conducted to organize and verify the interview data:

   - Data Triangulation: The information obtained from the interviews was cross-referenced with organizational documents to validate the respondents' accounts and fill in any gaps. For instance, if respondents described an analysis process but missed certain steps, these details were checked against existing guidelines and documents to ensure the completeness.
   - Additional Information Gathering: Based on insights from the interviews, further desk research was conducted to gather additional details about specific processes or challenges highlighted by the respondents. This involved reviewing internal documents related to planning processes at both the PLN holding level and the UITJBB level, including PLN annual reports, policies, guidelines, and procedures. Documents from 2015 to the present were ex-

amined to capture organizational changes since UITJBB's establishment in 2015. Although the research focused on the internal dynamics of the organization, external data was also considered to understand current issues affecting PLN's planning processes.

### *Methods of Data Analysis*

In this segment will be described how the data is analyzed, and which methods were used. The various activities in the analysis are discussed, and the rationale is given for certain considerations.

- **Making transcripts of the interviews**
  Since the interviews were conducted in the local language (Bahasa Indonesia), the recorded interviews were manually transcribed by listening to the recordings and typing the spoken content into a document on a laptop. This step was crucial to capture the words and nuances expressed by the respondents, ensuring that no important details were lost. After transcription, the text was translated into English using an online translation tool. This translation step was necessary to facilitate analysis and reporting in English, ensuring clarity and consistency in the presentation of the data.
- **Select the interview data that is relevant with the research and categorizing the data**
  The next step in the analysis involved selecting relevant data from the interviews. The criteria for selecting this data required it to be directly related to the transmission planning process. This step was crucial to ensure that the scope of this research remained well-defined and to prevent the inclusion of excessive information.
  The relevant data were then categorized into three stages. The first stage involved classifying the data into positive and negative points. This categorization was chosen because the data were broad and organizing them in this way helped to clearly identify the strengths and weaknesses within the organization.
  The second categorization mapped this data into different planning types: long-term plans, medium-term plans, and short-term plans. This grouping was based on the types of planning identified during the initial desk review of PLN. By categorizing the data this way, we could identify the strengths and weaknesses of the organization within each type of planning.
  The final categorization involved mapping each data point to the institutional elements of the planning process, such as structural, methodological, knowledge, competence, etc. (depend on the aspects identified during the data collection process). This step was necessary to understand how each aspect of the planning process contributed to the overall process and to identify specific areas for improvement.
- **Descriptive analysis: reporting the case study**

The next step of the analysis is to present the case study data, for the implementation of analytical framework and interpretation process. Since this study aims to explain the issues in transforming within a specific time range, from 2015 to the present, a descriptive analysis using a chronological narrative has been chosen to describe the case study data. Yin (2018) explains that one of the strengths of a chronological narrative is its ability to capture changes over time and help understand the progression of events and their impact. Therefore, the interview data, combined with categorized desk review data, will be used to illustrate the dynamics and complexities of the transmission network planning process at PLN from 2015 to the present.

- **Applying the analytical framework through comparative and thematic analysis**

  The conceptual framework developed in Chapter 4 will be applied to the case study data to gain insights into the extent of the gap between the theoretical framework and the reality in practice. This analysis aims to understand the implications of these gaps for PLN's learning process and its progression towards a mature asset management practice.

  The application of the framework involves several stages. Initially, all of the elements identified in the conceptual framework, for example "continual improvement," will serve as reference points or keywords during the analysis. These elements will be systematically compared with the actual practices observed in the case study, allowing for the identification of which theoretical elements are present in PLN's practices and how these elements are managed within the organization. This step will help in assessing the current state of PLN's practices and determining the gaps between theory and practice.

  Following this, a thematic analysis will be conducted to identify recurring themes and frequent issues within the planning process. This method will involve manually reviewing the analysis, to detect patterns that highlight key issues in PLN's planning process. Then, this findings will be grouped into certain challenges themes. to make the analysis easier, this theme will be assigned unique number, to properly link them with the proposed recommendations. The thematic analysis will provide insights into how these gaps influence the overall learning process within the organization, affecting the development of a comprehensive and mature asset management system.

  The detailed examination of these gaps and recurring themes will lead to the identification of the recommendations. These recommendations will focus on bridging the identified gaps, enhancing learning processes, and improving the integration of asset management principles within PLN, ultimately supporting the organization's journey towards a mature asset management practice.

# 4

# Developing the Conceptual Framework

This chapter will explain the process of developing the framework starts from the literature review which including search strategy, followed by the synthesis of the literature to obtain the framework elements, and integrate all of the element to develop the framework. Due to the large size of the framework, the last part will elaborate on the scoping to select particular element in the framework to be implemented.

## 4.1 Literature review

As the research method has already outlined the step-by-step process for conducting the literature review, including the databases used and the filter criteria, it is important to reiterate that the aim of this literature review is not to provide a comprehensive framework. Instead, it serves as an initial overview to measure the implementation of asset management in a case study of PLN.

### 4.1.1 Search strategy

- Literature review of Learning Organization elements
  The initial search in the Scopus and Web of Science databases using keywords directly related to the topic, such as ”learning organization” AND ”strategic planning,” yielded no results, indicating a limited number of specific studies in this field. The keywords were then broadened to include ”creating learning organization” OR ”creating learning organisation.” When the literature was limited to the ”management” category and English language, 21 articles were found. These 21 articles were then filtered by selecting the article that discusses the strategy and planning process by reviewing their abstract, resulting in 4 final selection literature.
- Literature review of Asset specificity elements
  Similar to the previous stage, the initial search was conducted using the keywords ”Transaction Cost Theory” AND ”Asset Spec*,” which yielded over 100 articles. However, when adding the keywords ”plan*” OR ”strategic plan*,” no results were found. Therefore, the keywords were adjusted to only ”strategic

plan*" OR "plan*" to focus on identifying specificity in an organization related to the strategic planning process. This search still resulted in an overwhelming number of articles. To refine the results, additional keywords "electricity" were included, and the search was limited to the "management" category and English language. This refinement resulted in 40 articles. The abstracts of these 40 articles were then reviewed to ensure that the selected literature discussed specificity in strategy and planning. After this review, 7 final articles were selected.
The justification for choosing specific keywords related to strategic planning in the context of electricity companies is because the concept of asset specificity refers to specific assets such as knowledge, skills, technology, or other resources uniquely possessed by electricity companies in strategic planning activities. Therefore, even with these terms, relevant literature can still be found.

- Literature review of Asset Management requirements
  Using the keywords "strategic asset management planning" but only one was accessible. The keywords were then broadened to "strategic asset management," resulting in 57 articles. When limited to "electricity," only 2 results were found. A further restriction to "electricity" resulted in just two articles. Given that the focus of asset management is on physical assets and that electric utilities are part of infrastructure, the search was expanded again by including "infrastructure" as a keyword, which led to 21 articles. From these, articles were selected based on their accessibility and a content analysis that assessed their relevance to strategy and planning elements, resulted in five selected articles.
  As explained in Chapter 3, subsection 3.3, asset management guidance and standards emerge from the best practices shared by organizations engaged in asset management. One influential body in creating standards and guidance, including the conceptual AM model, is Institute of Asset Management (IAM). Therefore, it was deemed necessary to extend the literature review to include best practices. A review was conducted using IAM's database with keywords "strategic asset management plan," "asset management competence," "asset management knowledge," and "asset management tools." Based on accessible articles, two relevant pieces of literature were found. Combining these with the previous search terms, the total number of articles obtained in this third stage is seven.

### 4.1.2 Literature Synthesize

The results of the literature review will be presented in this section. Due to the variations in elements identified, the elements of asset specificity and asset management requirements will be grouped into organizational elements according to Table 4.1 below. This classification will help provide a clearer visualization of the framework and the elements that constitute it.

**Table 4.1:** *Asset specificity and asset management grouping elements definition*

| Input/ process/ output | Category | Definition |
|---|---|---|
| **Input** | | Set of information, rules, boundaries and consideration established by organization as an input for the planning process |
| **Process** | **Structure** | Organizational structure is a method by which organizational activities are divided, organized and coordinated (Ahmady et al., 2016) |
| | **Capability** | Measure of capacity and the ability of an entity (system, person or organization) to achieve its objectives (ISO, 2014a; Asset Management, 2015) |
| | **Competence** | Ability to apply knowledge and skills to achieve intended results (ISO, 2014a; Asset Management, 2015) |
| | **Knowledge/ tools/ method** | Specific knowledge/tools/method applied in conducting activities |
| | **People** | Requirements of people on certain job/activities |
| | **Culture** | Organizational culture is the way that things are done in an organization, the unwritten rules that influence individual and group behavior and attitudes (Chartered Management Institute (CMI), 2015) |
| **Output** | **Planning characteristic** | Planning output characteristic |
| | **Product** | Document output |

A. *Learning organization elements*
Based on the identified literature, only one explicitly mention element of learning organization to achieve the strategic planning outcome. The rest of the literature not identify the element, instead present the requirements and enabler of learning in the organization, as shown in Table 4.2 below.

B. *Asset specificity elements*
The literature on strategic planning identifies various specific elements that contribute to effective strategic planning (see Appendix 2 for a detailed breakdown).

**Table 4.2:** *Identified elements of learning organization*

| Source | Key Elements Identified |
|---|---|
| Bui et al. (2010) | To achieve the outcome of a strategic planning, organizations should focus on elements of **System thinking** |
| Yoo et al. (2013) | Not specified the element of learning organization, instead it directly proposed the Knowledge management system to foster the learning organization |
| Small et al., 2006 | Not specified the element of learning organization, but present the learning organization conditions to occur in the organization:<br>(a) Learning is a continuous process<br>(b) People development<br>(c) Listening to customers |
| Song (2008) | Not specified the element of learning organization, but identifies a set of learning organization enablers:<br>(a) Continuous learning<br>(b) Dynamic Inquiry & Dialogue<br>(c) Collaborative Team Learning<br>(d) Empowering for Shared Vision<br>(e) Environmental Connection<br>(f) Embedded System<br>(g) Supportive Leadership |

These elements range from specifying planning types such as symbolic, rational, transactive, and generative (Brews et al., 2007). Other studies emphasize the role of governance structures, information flow, and leadership in effective strategic planning (Ocasio et al., 2008). Additionally, elements such as long-term investment strategies, prioritization, and impact analysis have been highlighted as crucial for strategic decision-making (Lassila et al., 2011). Information systems designed for tracking and managing strategic plans, as well as strategic monitoring dashboards, have also been identified as essential tools in the planning process (Hernández et al., 2015). Furthermore, the financial implications of long-term strategies on maintenance and renewal have been discussed as key considerations (Suryani et al., 2015). Effective performance metrics, organizational design that supports strategic execution, and the alignment of human capital with strategic actions are also critical elements (Nazemi et al., 2015). Lastly, centralized planning approaches that synchronize generation, transmission, and distribution, along with updated tools for forecasting and budgeting, are necessary for a cohesive strategic planning process (Upreti et al., 2019).

These elements were initially detailed at a granular level. To facilitate a more streamlined analysis, these detailed elements were converted into higher-level elements and subsequently classified into broader categories (see Table 4.1), such as Input, Structure, Financial Resources, Competence, Knowledge/Tools/Methods, Culture, Planning Characteristics, and Product.

For example, detailed elements like "Adapt strategic planning for evolving cor-

porate needs and styles" were simplified into a higher-level element labeled "planning flexibility," which was then grouped under the category of Planning Characteristics. This step was applied to all identified elements to derive the final categories and high-level elements presented in Figure 4.1. The comprehensive breakdown and classification process can be found in Appendix 2.

| Input | Structure | Financial resources | Competence | Knowledge/ tools/ method | Culture | planning characteristic | product |
|---|---|---|---|---|---|---|---|
| Information for strategic decision making | • Governance and information flow of executive involvement in planning cycle<br>• Organizational design support strategic planning<br>• Human capital alignment<br>• Centralized planning of generation, transmission and distribution | Secure budget allocation | Strategic competence for managerial and planning team | • Long-term Investment strategic objective<br>• Workability issue<br>• Prioritization<br>• Impact analysis/risk<br>• Strategic planning information system<br>• Strategic monitoring dashboard<br>• Financial Impact Analysis on Maintenance and Renewal<br>• Performance management<br>• Updated planning tools for projecting, forecasting and budgeting | • Leadership for long term planning<br>• Strategic Planning Culture | • Symbolic planning<br>• Rational planning<br>• Transactive planning<br>• Generative planning<br>• Planning flexibility<br>• Integrated planning approach | Long term strategic plan |

**Figure 4.1:** *Elements of strategic planning specificity*

C. *Asset management requirements*

Similar to the process used in identifying elements of asset specificity, the same approach was applied to analyze the elements of asset management requirements. The elements identified in the literature are extensive and often overlap (see Appendix 3 for the complete list of identified elements), emphasizing the need to extract and categorize these elements. Given that the identified elements share characteristics with asset specificity, the same grouping method was employed.

Across various studies, several common elements are highlighted as essential for effective asset management. These include environmental considerations and government policy frameworks as critical inputs for strategic planning (Brown et al., 2013). Additionally, organizational strategy management and asset management policy and objectives are frequently identified as foundational components (The Institute of Asset Management, 2021; Brown et al., 2013).

Structurally, continual improvement and clear roles and responsibilities between strategic and operational asset management are emphasized as crucial for the on-

going effectiveness of asset management systems (Mathieu et al., 2017; Kellick, 2010). The literature also underscores the importance of cross-functional multidisciplinary teams and the information management function in supporting strategic and integrated planning processes (Kellick, 2010; Mathieu et al., 2017). From a tools and methods perspective, elements such as whole life costing principles and risk assessment tools are consistently highlighted for their role in ensuring informed decision-making (Sasidharan et al., 2021; Brown et al., 2013). Additionally, the IAM framework identifies over 40 elements of knowledge, tools, and methodologies needed to perform strategy development and asset management planning, with the Strategic Asset Management Planning (SAMP) serving as a key planning output (The Institute of Asset Management, 2014; The Institute of Asset Management, 2021).

All of the elements identified above are detailed in Appendix 3, while Table 4.3 below presents the high-level elements identified for each category: Input, Structure, Knowledge/Tools/Method, and Output.

**Table 4.3:** *Asset management requirements*

| Input | Structure | Knowledge/tools/method | Output |
|---|---|---|---|
| • Environmental considerations<br>• Government policy framework<br>• Organizational strategy management<br>• AM Policy, AM Objectives, AM strategy<br>• Planning scope and unit analysis<br>• Asset management value | • Continual improvement<br>• Clear roles and responsibility between strategic and operational asset management roles<br>• Strategic and integrated planning<br>• Cross-functional multidisciplinary teams<br>• Information management function<br>• The availability of roles strategy development<br>• The availability of roles asset management planning | • Analyze strategy requirements<br>• Forecast and analyze future user requirements and demands<br>• Develop the AM strategy<br>• Plan the implementation of the AM strategy<br>• Appraise investment planning<br>• Apply whole life costing principles<br>• Produce business case for creation and/or acquisition of assets<br>• Plan for contingencies<br>• Develop and communicate AM plans | • Strategic asset management plan (SAMP)<br>• AM Planning (Acquisition plan, Operation plan, Maintenance plan, Disposal plan) |

## 4.2 Framework integration and implementation scoping

### 4.2.1 Framework integration

The previous section has identified the three main components of the framework: the learning organization elements, asset specificity in strategic planning, and asset man-

agement requirements. The next step is to integrate these components into a cohesive framework for implementation. The integration process is as follows:

1. **Step 1: Identifying Relationships Among Elements**
   From Table 4.2 and Table 4.3, the asset specificity and asset management requirements share the same categories, allowing for their grouping. Table 4.1 presents the learning organization elements, which are characterized by the learning characteristics of an organization. These learning characteristics can be observed through the implementation of asset specificity and asset management elements, which further detailed in the next step.

2. **Step 2: Creating a sketch and implementation guideline of the framework**
   Based on the relationships identified in the previous step, a framework sketch will be created to visualize the interactions between various elements. The framework illustration, as shown in Figure 4.2, demonstrates the relationships among the elements of a learning organization, asset specificity, and asset management requirements. The illustration in Figure 4.2 highlights the two main parts of this

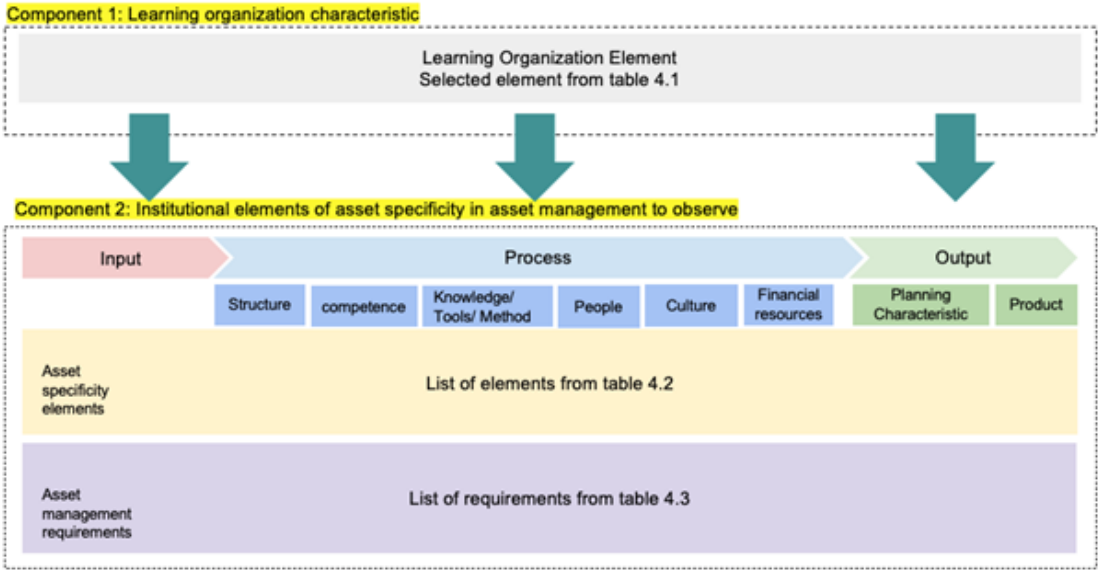


**Figure 4.2:** *Visualization of the conceptual framework*

analytical framework: the characteristics of a learning organization and the institutional elements necessary for asset management practices.

Firstly, the framework identifies the characteristics that indicate an organization is in the process of learning, especially in the context of strategy and planning. The literature review in Table 4.1 lists these characteristics. To understand which parts of the organization should be observed to see these learning traits, we move to the next component.

The second component includes the institutional elements that help an organiza-

tion transform according to asset management practices. Based on the grouping of asset specificity and asset management requirements, these institutional elements include: the flow of establishing and managing inputs for strategy and planning, how the organization's processes and structure support strategy and planning activities, the competency requirements for personnel involved, the necessary knowledge, tools, and methods to ensure alignment with asset management principles, how people, culture, and financial resources support strategy and planning activities, and The last component which are the nature of the planning output itself and the expected product.

This framework is designed to examine the challenges organizations face in learning to implement asset management through two approaches:

- Observing the institutional elements within the organization and comparing them with those identified in the framework.
- Observing whether the learning process occurs according to the characteristics of a learning organization.

By examining these two aspects, the framework aims to provide insights into the gap between theoretical concepts and real-world implementation. This will serve as valuable feedback for the organization in implementing changes.

3. **Step 3: Integrate the framework**
   Referring to the framework illustration in the previous step, a full-overview framework is developed by combining components identified from the literature review in Figure 4.1, Table 4.2, and Table 4.3. This integration results in the overall framework shown in Figure 4.4 below.

   The framework displays each element, with the learning organization elements in the top grey box and the organizational specificity elements in implementing asset management in the large brown box. These elements are grouped into inputs, processes (including structure, knowledge/tools/methods, people and culture, and financial resources), and outputs (output characteristics and products).

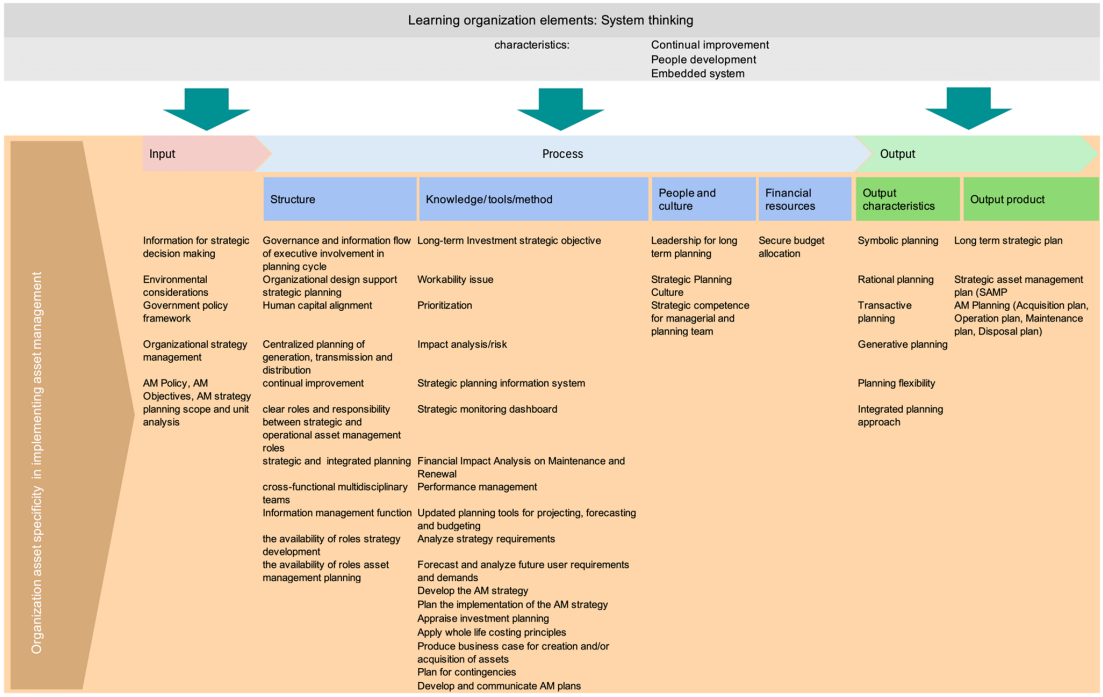


**Figure 4.3:** *Full-overview of framework: Learning organization and asset specificity in asset management implementation*

### 4.2.2 Framework implementation scoping for the case study

The overall framework presented in Figure 4.3 provides an extensive scope for observing various aspects of the organization. However, due to resource constraints and time limitations, it is essential to focus on specific categories and further narrow the framework for practical implementation in the case study. While the case study may eventually cover additional elements, the primary focus will be on depicting the overall process observed within the organization. This scoping is necessary to limit the analysis and interpretation processes in Chapter 6.

Figure 4.4 then constructed to become the final framework which will be implemented in the case study of PLN. This final framework not only limiting the implementation scope, but also detailed the step in observing these elements within the case study. The explanation of this final framework outlined as follows:

- **Scope limitation and observation**
  Upon reviewing the overall framework, two prominent categories emerge: structure and knowledge/tools/methods. These elements are considered critical due to their numerous components, indicating their importance and influence within the organization, as supported by extensive literature. Therefore, this study will limit the scope of implementation to these two categories. Consequently, the case study, particularly in data collection, will focus on how the organization designs its structure for strategy and planning in transmission and how knowledge/tools/methods support this process.

Figure 4.4 Present the final elements of structure and knowledge, tools, and methodology that must be observed. For the organizational structure element, there are 10 elements categorized into 3 groups as follows:

1. Governance and organization design, where the elements included in this group are:
   - Governance and information flow of executive involvement in the planning cycle
   - Centralized planning to integrate generation, transmission, and distribution
   - Organizational design supports strategic and integrated planning (short-medium-long term)
   - Organizational structure accommodates continual improvement
2. Roles and Responsibility consist of the following elements:
   - Clear roles and responsibilities between strategic and operational asset management roles
   - The availability of roles for strategy development
   - The availability of roles for asset management planning
   - Information management function
3. Coordination and collaboration, observed through the following elements:
   - Cross-functional multidisciplinary teams
   - Human capital alignment with strategic requirements

For Knowledge, tools, and methodology, there are 16 elements, also classified into three groups:

1. Strategy development (SAMP):
   - Analyze strategy requirements
   - Forecast and analyze future user requirements and demands
   - Develop the AM strategy
   - Plan the implementation of the AM strategy
   - Appraise investment planning
2. Asset Management Planning (AMP):
   - Long-term investment strategic objectives
   - Appraise investment planning based on a risk-cost-performance approach including prioritization and risk assessment
   - Apply whole life costing principles
   - Financial impact analysis on maintenance and renewal
   - Produce business cases for the creation and/or acquisition of assets including the workability issue
   - Plan for contingencies
   - Performance management
   - Develop and communicate AM plans

3. Supporting Tools:
   - Strategic planning information system
   - Strategic monitoring dashboard
   - Updated planning tools for projecting, forecasting, and budgeting

This categorization is conducted to facilitate easier analysis and interpretation processes. By evaluating and reporting each element based on its category, the analysis becomes more systematic and coherent.

- **Observation of the Learning elements**
  The result of observation in the structure and the use of knowledge in the previous step, will become the input for the next step in implementing the analytical framework (see Figure 4.4).
  This learning elements observed by answering three question, which represent the charachteristic of learning organization extracted from the literature. These question are:
  - Has the organization embedded systems thinking in its design?
  - Does the organization strive for maturity in the planning process through the use of knowledge/tools/method?
  - How are continual improvements reflected in the organization's structure and the use of knowledge, tools, and methods?
- **Understanding the gap between theoretical and empirical world**
  is to observe the learning element , presents these Finally, the framework implementation will addresses the main question by identifying the gap between theory and implementation, examining the barriers to fostering the learning process, and developing strategies for PLN to improve learning and implement changes in transmission asset management to fully support the energy transition. This structured approach aims to investigate the barriers preventing PLN from effectively integrating systems thinking and continual improvement into its strategic planning and asset management practices.

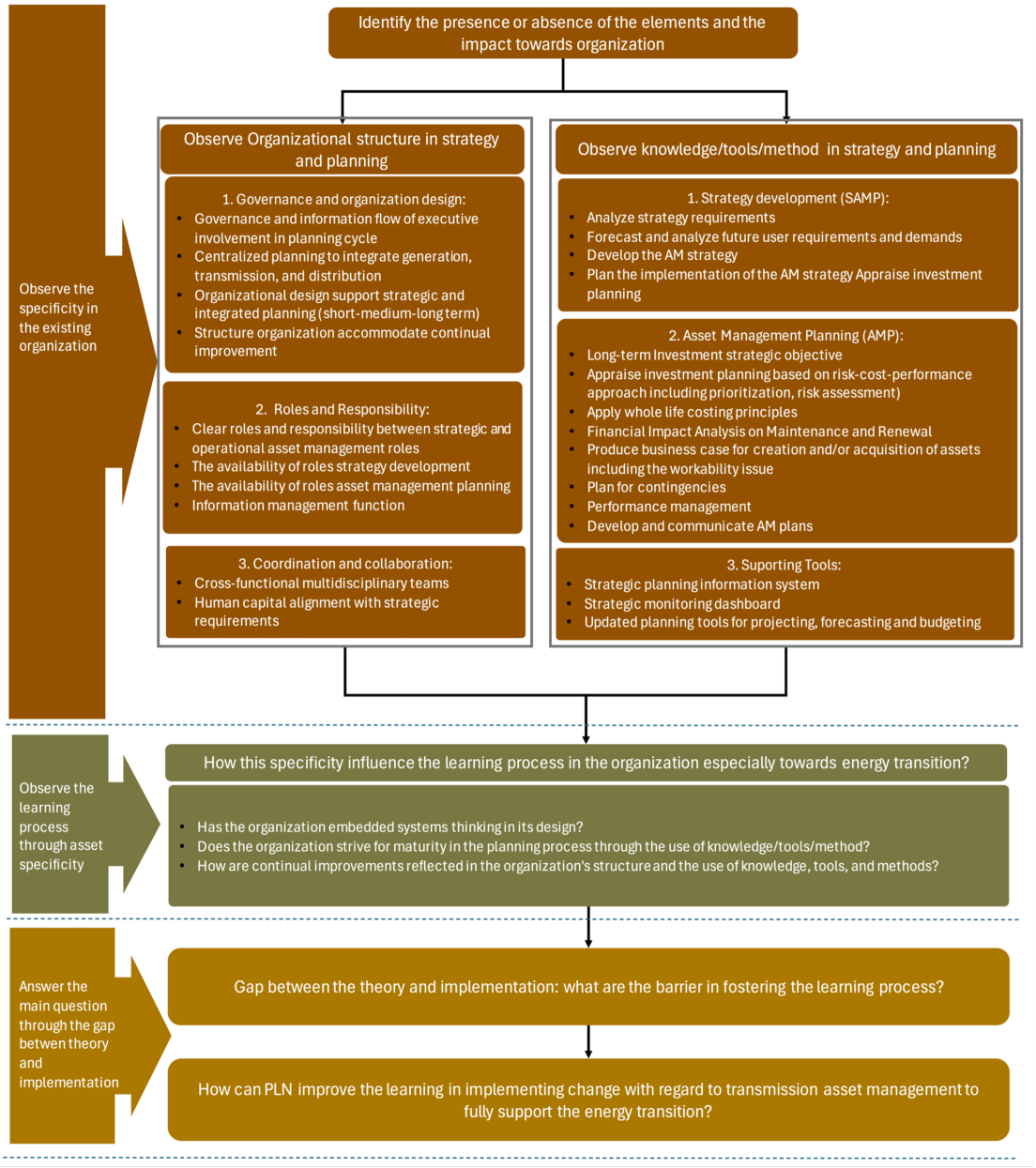


**Figure 4.4:** *Full-overview of framework: Learning organization and asset specificity in asset management implementation*

# 5

# Case Study of PLN

This chapters present the data of the case study, starting by explaining the general overview of PLN holding, then zoom into the transmission unit of Western Java Transmission Unit (UITJBB), and then following by the chronological story of planning evolution in PLN, emphasize the process, and the challenge faced by the organization

## 5.1 General Overview of PLN Holding

PLN, which has been operated for approximately 79 years, is a state-owned company whose shares are owned by the state and represented by the Ministry of State-Owned Enterprises (Ministry of State-Owned Enterprises (SOE) Ministry). According to the constitution, PLN's mandate is to manage the provision of electricity for the public interest in sufficient quantity and quality, to generate profit, and to fulfil government mandates in the electricity sector to support development while adhering to the principles of a limited liability company (PT PLN (Persero), 2022a).

Given that one of PLN's mandates is to provide electricity to the entire population of Indonesia, the operational coverage of PLN encompasses the whole Indonesian territory (Figure 5.1). The holding company is headquartered in Jakarta, with operational units allocated nationwide. Regionally, PLN's operations are segmented into three distinct regions (Figure 5.1): the Sumatra and Kalimantan region, depicted in blue in ; the Java, Bali, and Madura region, represented in red; and the Sulawesi, Maluku, Papua, and Nusa Tenggara region, shown in green (Ministry of State Owned Enterprise, 2021).

According to the PLN company profile (PT PLN (Persero), 2022b), PLN's current total assets amount to 1.638 trillion Indonesia Rupiah (IDR). The company operates 6,928 generation units, 68,206 kilometers-circuit of transmission lines, and over one million kilometers-circuit of distribution lines, with a substation capacity of approximately 155,000 Megavolt-amperes (MVA). These assets are utilized to serve 85.6 million customers across Indonesia. The overall System Average Interruption Duration Index (SAIDI) is 463.2 minutes per customer per year, and the System Average Interruption Frequency Index (SAIFI) is 5.62 times per customer per year.

**Figure 5.1:** *PLN operational area* (*Ministry of State Owned Enterprise, 2021*).

As of 2022, PLN had 42,151 employees spread across both the PLN holding level and operational units. Currently, PLN holding has eight directorates:

1. Directorate of Corporate Planning and Business Development (also overseeing the Research and Development Center and the Electricity Maintenance Center)
2. Directorate of Finance
3. Directorate of Legal and Human Capital Management (also overseeing the Education and Training Center)
4. Directorate of Project Management and New and Renewable Energy (also overseeing 11 Construction Units, the Certification Center, and the Project Management Center)
5. Directorate of Generation Management
6. Directorate of Transmission and System Planning (also overseeing 3 Load Dispatch Centers and 3 Transmission Units including UITJBB)
7. Directorate of Distribution (also overseeing 17 Distribution Units and 5 Regional Distribution Units)
8. Directorate of Retail and Commerce

Figure 5.2 below illustrates the main assets managed in PLN, which consist of three processes: generation, transmission, and distribution. Currently, generation is managed by a sub-holding company, while transmission and distribution remain under the management of PLN as the holding company. This structure ensures the delivery of electricity to every corner of the country, particularly to the Frontier, Outermost, and Least Developed (3T) areas, thereby providing equitable access to electrical energy and supporting the energy transition (PT PLN (Persero), 2022b).

### 5.1.1 Overview of generation management in PLN

Before 2022, power generation units were managed jointly by PLN (mostly for generation outside the Java, Madura, and Bali regions) and by two of PLN's main subsidiaries, Indonesia Power (IP) and Pembangkitan Jawa Bali (PJB). However, as part

**Figure 5.2:** *Electricity system in PLN (PT PLN (Persero), 2022b).*

of PLN's transformation, in 2022, the Ministry of State-Owned Enterprises officially launched PT PLN (Persero) Holding Subholding to consolidate PLN's previously scattered generation assets. The business processes for managing power generation were simplified, and the utilization of previously underutilized assets was optimized. This consolidation of generation assets formed two Subholding GenCos covering all of the power plants under PLN, with the aim of becoming the largest generation companies in Southeast Asia: PLN Indonesia Power and PLN Nusantara Power

### 5.1.2 Overview of transmission and distribution management in PLN

There are significant differences in the management of transmission systems between the Java, Madura and Bali (Regional) (JMB) and other regions. In the Java, Madura and Bali (Regional) (JMB) region, the power system at 500 kV and 150 kV levels is controlled by the Load Dispatch Center that covers Java, Madura, and Bali. The operation and maintenance of these transmission assets are the responsibility of the transmission units. Specifically, there are three transmission units: Western Java Transmission Unit (UITJBB), Central Java Transmission Unit (UITJBT) (Central Java), and Eastern Java and Bali Transmission Unit (UITJBTB) (Eastern Java and Bali). The distribution assets, on the other hand, are managed by the Distribution Unit.

In other regions, such as Sumatra, Kalimantan, and Sulawesi, the Load Dispatch Center also manages the power system at 275 kV and 150 kV levels, including the operation and maintenance of transmission assets. However, the distribution assets are still managed by the Distribution Unit.

In the regions of Maluku, Papua, and Nusa Tenggara, which mostly consist of small and isolated islands, the electricity management is unified under a single unit known as the Regional Unit. However the generation asset is currently in the process of transition to the sub holding of Gencos

## 5.2 Transmission Unit of Western Java (UITJBB)

Before 2015, transmission management in the regions of Java, Madura, and Bali was part of the load dispatch centre of the Java, Madura and Bali power system. However, following a major reorganization in 2015, this unit was separated into the Load Dispatch Centre and three transmission units, making the Load Dispatch Centre responsible for controlling the Java, Madura and Bali power system, while the transmission unit repsponsible to ensure the reliability and the availability of the transmission network equipment within the power system.

Based on the roles and responsibilities description, UITJBB responsible for managing the transmission assets in the areas of DKI Jakarta Province, Banten Province, and part of West Java Province is UITJBB. based on the 2021 data, UITJBB has 1076 employee which distributed to the UITJBB headquarters, and four transmission execution units, known as Transmission Execution Unit (UPT)s (Figure 5.3) which are UPT Cawang, UPT Durikosambi, UPT Cilegon and UPT Pulogadung.

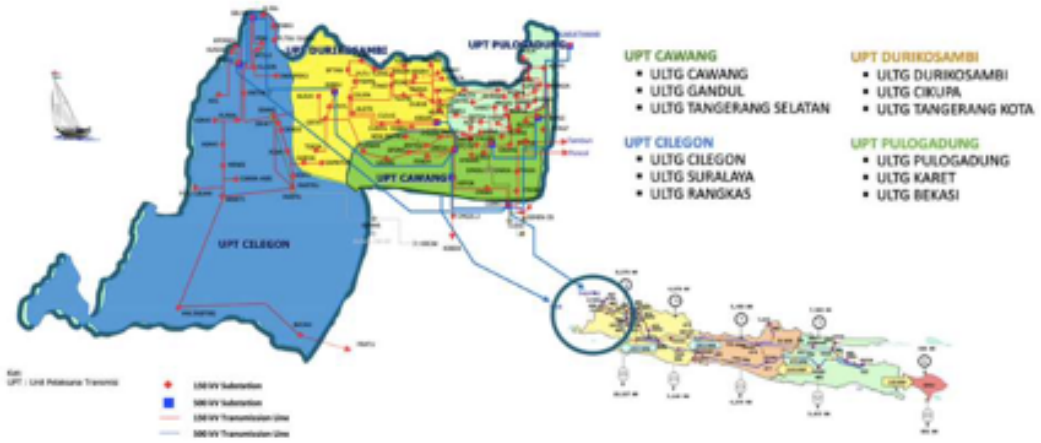


**Figure 5.3:** *Operational area of UITJBB (PT PLN (Persero) UITJBB, 2022).*

According to the organizational structure, Transmission Execution Unit (UPT) is responsible to ensure the optimal management of transmission network maintenance, substations, and protection systems, as well as the procurement and control of substation extension construction. In delivering these roles, Each UPT contains three Transmission and Substation Service Units, known as Transmission and Substation Service Units (ULTG)s, with main responsibilities to conduct the operation and maintenance in the transmission asset in their scope (Figure 5.4)

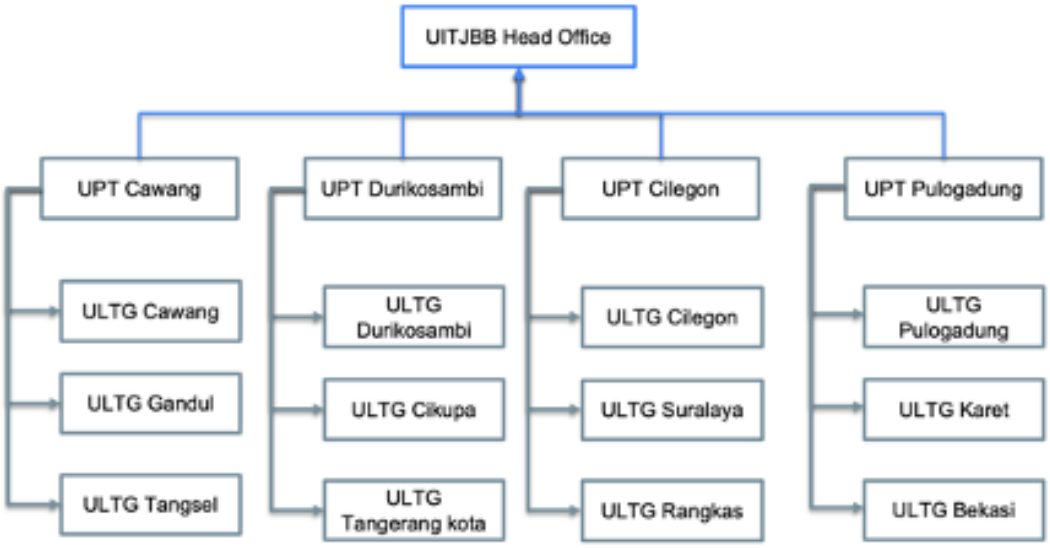


**Figure 5.4:** *Diagram Operational area of UITJBB* (*PT PLN (Persero) UITJBB, 2022*).

UITJBB is a critical unit for PLN, as its transmission services currently cover the national capital region and cater to various customers, including zero downtime areas, VIPs (President's official residence and national critical assets such as hospitals, etc. ), and high voltage customers which mainly the factories. Additionally, in terms of assets, UITJBB manages 23% of PLN's total MVA. A detailed overview of the assets of UITJBB is shown in Figure 5.5 below.

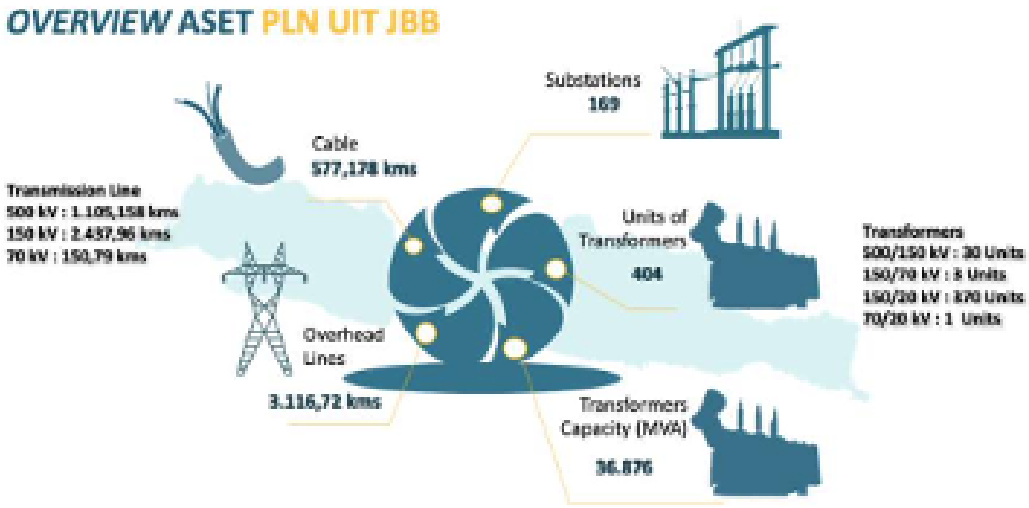


**Figure 5.5:** *UITJBB asset overview* (*PT PLN (Persero) UITJBB, 2022*).

## 5.3 Evolution of the Infrastructure Planning in PLN and UITJBB

The transmission network planning process in UITJBB is closely aligned with the planning process at PLN Holding. UITJBB employs a hybrid approach that combines a nationally organized top-down planning process with a bottom-up approach, where

UITJBB identifies and addresses its specific asset management needs. Before delving into the overall planning process at UITJBB, it is important to first discuss how the National Electricity Supply Business Plan (RUPTL) is developed, as this document is critical to PLN's planning process. Additionally, we will explore the role of the RUPTL in energy transition planning, how it translates the context of the energy transition specifically into generation and transmission projects, and how UITJBB, as a transmission asset manager, develops its asset management planning to support these energy transition initiatives.

### 5.3.1 Top-Down Approach: RUPTL Development

The Ministry of Energy and Mineral Resources issues the RUPTL (Electricity Supply Business Plan) document, which outlines a 10-year plan for electricity infrastructure projects, encompassing the development of new assets and the upgrading of existing ones across generation, transmission, and distribution sectors.

The latest RUPTL 2021-2030 aims to enhance the electrification ratio, support the achievement of new and renewable energy mix targets, and reduce greenhouse gas emissions. A key focus of this plan is the development of electricity infrastructure, particularly power plants that utilize new and renewable energy sources. In addition, although the RUPTL is a 10-year plan, this document has undergone significant revisions almost every year for the past nine years.

Although the RUPTL document is produced by the Ministry of Energy and Mineral Resources, it is developed by PLN through the following process:

- **Reference to the National Electricity General Plan (National Electricity General Plan (RUKN)):** The RUKN is a policy document issued by the Ministry of Energy and Mineral Resources. It outlines national electricity policies, the current state of electricity supply, projections for national electricity demand and supply up to the year 2060, and high-level strategies for the development of the national electricity supply system.
- **Establishing Policies and Assumptions:** PLN Headquarters establishes policies and basic assumptions after considering the RUKN and other government policies. These include assumptions about economic growth, population growth, inflation, electrification ratio targets, and renewable energy development targets.
- **Electricity Load Forecasting:** The electricity load forecast is initiated through a bottom-up approach. In this process, the electricity load for each province is calculated by the PLN Regional/Distribution Units under the supervision of PLN Headquarters, using demand forecast analysis.
- **Formulating Plans Based on Demand Forecast:** Based on the demand forecast, plans for generation, transmission and substations, distribution, and the development of isolated power systems are formulated by the PLN Regional/Distribution/Dispatch Centers and PLN Headquarters according to their respective responsibilities.

- **Planning Consolidation:** The next stage involves consolidating the plans to verify and agree upon the demand forecast, capacity balance, substation plans, transmission plans, and isolated power system generation plans produced by PLN Regional/Distribution/Dispatch Centers. During this workshop, verification of Commercial Operating Date (COD) schedules for PLN and Independent Power Producer (IPP) power plant projects, gas supply estimates from Liquified Natural Gas (LNG)/Compressed Natural Gas (CNG), specific needs, and rental power generation programs to address short-term electricity shortages are carried out.
- **Drafting and Approval of RUPTL:** The consolidated system planning product across all PLN business areas forms the Draft RUPTL. The submission for RUPTL approval to the Minister of Energy and Mineral Resources is conducted by the PLN Board of Directors. The RUPTL then serves as a reference for preparing the Company's Long-Term Plan (RJPP) for the next five years and as a basis for PLN's annual investment decisions within the Annual Work Plan and Budget (Annual Budget Plan (RKAP)).

### 5.3.2 RUPTL Perspective on Energy Transition

Related to the energy transition, the Ministry of Energy and Mineral Resources claims that there are significant changes in the RUPTL version 2021-2030, where this RUPTL is labeled as the 'greener' RUPTL because renewable power plants receive 51.6% of the share, bigger than the share of fossil power plants of 48.4%. Furthermore, this RUPTL does not contain any plans for new coal-fired power plants except for those that have already reached financial close or are under construction. Regarding the current hot topic of the early retirement of coal power plants, PLN has stated that this program is not yet included in the revised RUPTL for 2024-2033, as this option requires significant funding estimated at around US$27.5 million (according to a study conducted by IESR with the University of Maryland US, as cited in Zahira (2023)). However, PLN states that there will be efforts to reduce emissions through the addition of Carbon Capture Storage (CCS) technology (Zahira, 2023).

Based on the RUPTL perspective towards energy transition, it is clear that the highlights in the RUPTL are in the generation sector. For the power plan expansion, according to the RUPTL, generation projects can be executed by either PLN or Independent Power Producers (IPPs), depending on PLN's funding capabilities. Given the substantial investment requirements in the electricity sector, PLN cannot independently undertake the construction of all new power plants.

According to Presidential Regulation No. 4 of 2016 (as amended by Presidential Regulation No. 14 of 2017) on Electricity Infrastructure Development, power plants developed by PLN should meet the following criteria:

- PLN has the capability for equity funding and access to low-cost financing.
- Low construction risk.

- Availability of fuel supply.
- Peak load power plants (peakers) that help control operational reliability.
- Development of isolated systems.

For Private Power Developers (PPL), the criteria include:

- Substantial funding requirements.
- High construction risks, especially for new locations requiring land acquisition.
- High fuel supply risks or uncertainty in gas and/or infrastructure supply.
- Power plants utilizing new and renewable energy sources.
- Expansion of existing PPL power plants.
- Multiple PPLs willing to develop power plants in the specified area.

To ensure future supply security, PLN has strategies to include its subsidiaries in IPP ownership and utilize the Build, Operate, and Transfer (BOT) scheme (BOT) scheme, so the plant will eventually become PLN's asset at the end of the contract period. At times, PLN may allocate peaker plants to be executed by IPPs if there is a high fuel supply risk. However, PLN ensures that IPPs' share of peaker plants does not dominate the power system, allowing PLN to maintain control over the quality of electricity supply.

### 5.3.3 RUPTL Perspective on Transmission Projects

For the transmission project, the majority of the projects are carried out by PLN except for specific cases such as connecting the power plant produced by IPP to the nearest grid; in these specific cases, the project can be executed by IPP. Furthermore, RUPTL mentions that the development of transmission lines and substations aims to facilitate the evacuation of power generation to the load/demand, address system vulnerabilities, support electricity sales targets, overcome bottlenecks, and enhance system reliability and operational flexibility. In addition, RUPTL also includes an explanation of the transmission asset management strategy, including:

- Replacement of primary transmission materials, transmission conductors, and supporting equipment that have exceeded their effective operating ages.
- Replacement of primary transmission materials, transmission conductors, and supporting equipment that already show poor performance or condition.
- Replacement of primary transmission materials, transmission conductors, and supporting equipment that is already obsolete (old).

However, RUPTL also strictly mentions that *"If these asset management programs do not significantly increase capacity, do not change the existing configuration, or do not add assets, then these projects are not listed in RUPTL. The implementation of this program is accompanied by comprehensive and detailed studies covering economic studies, technical studies,*

*and workability to meet national or applicable international standards".* This statement implies that the main concern of the RUPTL is to address the development of new assets, while the existing assets fall into the operational unit responsibilities.

### 5.3.4 Role of UITJBB and Its Planning Evolution

Subsequently, UITJBB is not directly involved in initiating the RUPTL project, although in the process, UITJBB usually supplies the data and information asked by the Java, Madura, and Bali dispatch center unit in conducting the simulation.

On the other hand, to manage the existing assets which are not listed in the RUPTL, a bottom-up approach addresses these needs, which falls under UITJBB's domain. However, over time, the planning process has undergone significant changes in line with the organizational transformation initiated by PLN Holding. The process, in terms of its timeline, can be classified as follows:

- 2015-2021: Operational Unit in Control of Transmission Network Planning
- 2021-2022: The Starting Period of Efficiency and Energy Transition
- 2022-Present: Towards Centralized Planning and Asset Management

## 5.4 2015-2021: Operational Unit in Control of Transmission Network Planning

An illustration of the transmission system planning process is shown in Figure 5.6below. The transmission network planning process traditionally follows a top-down planning process. Transmission projects (upgrading of existing asset) are listed in the RUPTL (Electricity Supply Business Plan) where UITJBB takes the target Commercial Operating Date (COD) of the RUPTL into account and prioritizes projects with critical CODs, considering their project duration. For example, if a transmission line capacity upgrading project is planned to have its Commercial Operating Date (COD) in 2018 according to the RUPTL, then considering the typical duration for procurement, construction, and completion, which historically takes about 3 years, this project will be included in the 2015 annual budget proposal. Such projects are usually referred to as RUPTL investment projects.

A second source of the transmission network planning process follows from a bottom-up perspective. UITJBB identifies the operational and maintenance needs of the network by referring to risk assessments that inform the potential risk in the network that could hinder the fulfilment of UITJBB KPIs, which cascade from PLN's long-term plan documents (Long-term Plan PLN (RJP)). This part of the transmission network planning process is known as the risk-based annual budget approach. This approach will result in adjustments and mitigations to the transmission network plan in the form of non-RUPTL investment projects and operational projects which are

scheduled in the transmission network planning, including routine and non-routine maintenance.

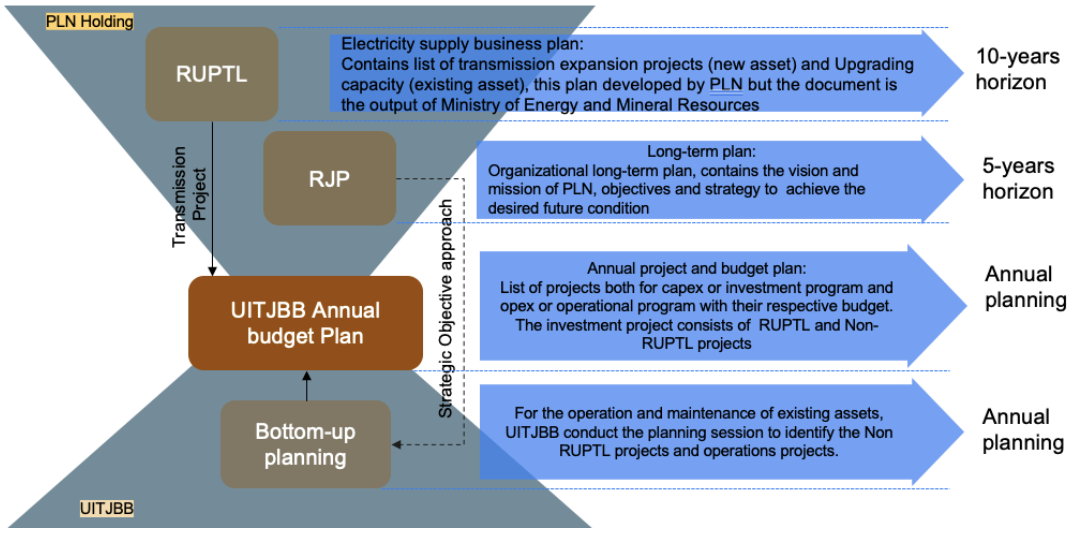


**Figure 5.6:** *Transmission system planning process at UITJBB.*

Both planning processes merge into an annual UITJBB budget plan which outlines the number of projects for a specific fiscal year. All proposals in the annual budget plan will be evaluated by PLN Holding, specifically by the Java Madura Bali regional transmission division and the budget division.

Although the proposal is prepared using a risk-based approach, there are several aspects in the evaluation process that are still not regulated, including:

- RUPTL projects are prioritized solely based on their Commercial Operating Date (COD), without reassessing the current relevance of these projects. Given that the analysis for the RUPTL was conducted several years ago, the data parameters might not be relevant to the current conditions. Changes in demand or other factors may have led to some new assets being underutilized. For example, in the transmission system, there are substations where transformers are still operating at low loads, around 10-20% of the transformer's capacity.
- There is no standardized approach or methodology for project prioritization, particularly for Non-RUPTL projects.
- There is no methodology to evaluate the achievement of objectives through proposed projects or to assess the contribution of these projects to the attainment of objectives.
- Although the proposed projects use a risk-based approach, the risk levels are calculated qualitatively. Given the large number of projects, it is challenging to prioritize based on the risk assessment documents.

Consequently, the evaluation process, which involves an iterative discussion between UITJBB and PLN Holding, focuses only on ensuring that the budget remains within the allocation set by the budget division. If the proposal's budget does not

align, the transmission unit will be asked to prioritize to ensure that the budget proposals match the allocation. But as a result, in the planning phase, UITJBB cannot ensure that the plan will meet the performance criteria. Once the proposals are aligned, PLN Holding will approve the annual budget, and UITJBB can then proceed with delivering each project on the list.

In the period 2015-2021, the burden of planning fell on the operational unit, which had to conduct extensive analyses such as risk assessments and budget plan prioritization. Meanwhile, the guidelines from PLN headquarters were very limited, and in the past, UITJBB lacked the expertise to perform these analyses. To increase its performance, in this phase, UITJBB initiated the implementation of asset management to increase its capability to perform the aforementioned techniques and analyses by collaborating with asset management consultants.

## 5.5 2021-2022: The starting period of budget efficiency and energy transition

Before explaining the changes taking place in the transmission system planning process in this era, it is important to first explain the organizational context that influences the transformation of this planning process:

### 5.5.1 Transformational background

In 2021, PLN underwent a large-scale transformation by refining their vision from the previous statement, "To be recognized as a world-class company that grows, excels, and is trusted, relying on human potential," to "Become the leading electricity company in Southeast Asia and the number one (#1) choice for customers seeking energy solutions." This major change was also driven by the global challenge of the energy transition. As part of the transformation, PLN formulated four strategic objectives to realize its vision:

- **Green**: Leading Indonesia's energy transition through a rapid and efficient increase in New Renewable Energy.
- **Innovative**: Stimulating growth through innovative business models and services.
- **Customer Focused**: Providing satisfaction to customers through world-class quality and service.
- **Lean**: Delivering lean, reliable, and lowest-cost electric power to customers.

In fulfilling its objectives, PLN faces significant challenges, particularly in meeting the green and lean objectives, which in practice often turn out to be conflicting rather than complementary. According to PLN's 2022 Annual Report, two performance indicators were not achieved in 2022: the annual increase in NRE (New and Renewable Energy) generating capacity reached only 75%, which is far from the overall target

of 23% NRE by 2025, with only 12.3% realized in 2022 (Bagaskara et al., 2024). Another unaccomplished indicator in the transmission sector was the projected increase in transmission network capacity, where PLN reached only 66% of the annual target. On the distribution side, the indicator for increasing the capacity of substations exceeded the target by 114%. Additionally, PLN currently faces an overcapacity issue in the generation sector, particularly in the Java, Madura, and Bali regions.

This situation highlights two main issues regarding the complexities in achieving PLN's strategic objectives. The first issue is the still low utilization of renewable energy as a primary source of electricity, while the overcapacity of the power plants adds more complexity to the fulfillment of this target. The second, equally important issue, is the bottleneck or lack of readiness in the transmission network to distribute electricity, despite the distribution network being well-prepared. This creates pressure on the existing network conditions, as they must be capable of handling the increased load. This issue needs to be emphasized because, even if the renewable energy scenario is met, the objective of delivering green, lean, and reliable energy will be difficult to achieve if the transmission network is not ready.

In this transformation, under the lean objective, PLN also aims to deliver the lowest-cost energy to customers, thereby requiring efficiency in terms of expenditure. This statement is supported by the recent annual reports (PT PLN (Persero), 2023), where PLN emphasizes that the implementation of PLN's strategy in 2023 focused on accelerating digital technology and strengthening inclusive and sustainable transformation to increase efficiency and maintain the company's financial sustainability. Consequently, in the planning process, PLN seeks the appropriate model to ensure that efficiency and maintaining financial sustainability are addressed in the transformation of the planning process.

### 5.5.2 Transformation on the Transmission Planning Process

The impact of implementing the above strategic objectives, aside from altering the composition of renewable energy in the revised RUPTL 2021-2030, which undoubtedly requires significant investment costs (Directorate General of New, Renewable Energy, and Energy Conservation, 2022), has led PLN to apply a new filter to verify the urgency and feasibility of the project implementation. Consequently, there has been a change in the planning governance structure. This change also addresses the previous process weaknesses by incorporating improvements, particularly the lack of guidelines provided by PLN Holding in the planning process.

During this period, PLN emphasized a more targeted investment planning process through careful and meticulous procedures, incorporating a check and balance mechanism by implementing the Four Eyes Principle (FEP) to ensure the fulfilment of investment requirements (PT PLN (Persero), 2021). Consequently, PLN classified investments into several categories:

- Development of new electricity infrastructure assets such as new transmission

networks and substations, and the enhancement of existing asset capacities through activities like rerouting or reconductoring transmission networks, and uprating or relocating substation equipment. It is important to note that the scope of the transmission in this project type is the upgrading or expansion of existing assets, such as the addition of transformers in an existing substation, or uprating the capacity of a transmission network line, while the new transmission line or new substation becomes the responsibility of the Project Unit.

- Maintenance Capital Expenditure (CAPEX) group, such as the replacement or relocation of towers, and the replacement or upgrading of substation equipment and measuring instruments.

In addition to the two groups above, there are non-electricity infrastructure investment categories such as general facilities and infrastructure, certifications, permits, and management consulting services. However, these will not be explained in this research as they are not directly related to electricity assets.

**Top-down project: Development of electricity infrastructures**

In planning electricity infrastructure projects, the projects in the RUPTL are not automatically proposed. The steps in planning are explained as follows.

1. **RUPTL projects identification**
   The first step is similar to the previous approach where UITJBB identifies the projects based on the Commercial Operating Date (COD) year in the RUPTL documents.
2. **Investment document preparation**
   For each project, UITJBB (possibly involving other units) prepares the necessary investment documentation, including several analyses and project justifications such as:
   - **Project urgency and alternative options:** This explains the urgency behind the need for the project and explores alternative options. Although there is exploration of alternative options, usually this is not conducted by identifying all potential solutions, but by comparing the solution with a "doing nothing" option.
   - **Operational feasibility study:** This study analyzes the power system to illustrate the existing system conditions and the improvements to the power system with the expansion or upgrading of assets. RUPTL projects are typically initiated by power system needs. Analyses such as load flow, short-circuit analysis, system stability analysis, power quality, and load analysis are conducted by the Load Dispatch Center.
   - **Financial feasibility study:** This provides financial justification for whether the expansion or upgrading project is profitable using Net Present Value (NPV) and Internal Rate of Return (IRR) analysis. For expansion projects

such as new transformers in existing substations, this study is conducted by the Distribution Unit, whereas for upgrading existing assets (e.g., upgrading the capacity of conductor lines), it is conducted by UITJBB. For this analysis, UITJBB also considers the asset lifetime to calculate the revenue, and this has been determined for each type of asset. For example, the lifetime of transformers is 40 years.

- **Risk assessment:** This is divided into two types: the initiation or project proposal risk assessment and the project implementation risk assessment.
- **Legal and compliance assessment:** This identifies any legal issues, such as land problems or potential conflicts of interest in carrying out the project.

3. **Classification of each project into budget group**
   Each project will then be categorized based on its investment budget (Indonesia Rupiah (IDR)) into five groups: A.I (>500 billion), A.II (>100-500 billion), A.III (>50-100 billion), A.IV (>10-50 billion), or A.V (<100 billion) ( Figure 5.7). Once the unit has classified the projects and completed the investment documentation, the planning process moves to the Four Eyes Principle (FEP) stage, which falls under the domain of PLN Holding.
4. **Evaluation by the transmission division and related division**
   According to the PLN Director's Decree PT PLN (Persero) (2021), the Transmission Division, acting as the maker in the Four Eyes Principle (FEP) process, will review the completeness of the documents and evaluate the proposed projects, focusing primarily on operational and financial assessments. While other analyses are evaluated by their respective responsible divisions (e.g., risk assessment by the Risk Division, legal assessment by the Legal Division, etc.), in practice, the entire evaluation process, including the Four-Eyes Principle process, involves UITJBB, as they are the ones conducting the analysis.
   According to a respondent in the transmission division, the evaluation of operational and financial feasibility studies is conducted by two different functions: the operational study is evaluated by the technical division, while the financial study is evaluated by the transmission strategic planning function. This is not as stated in the organizational structure, and is due to the insufficient number of personnel available to evaluate the large number of projects.
   Furthermore, infrastructure projects are assumed to be less challenging than maintenance Capital Expenditure (CAPEX), since these projects mostly stem from power system requirements or customer demand. However, not all projects can be approved because some were proposed several years ago, and the assumptions used may no longer be relevant to current conditions. Therefore, these projects are deemed not feasible to continue.
5. **Evaluation by the Team Verification and Validation (TVV)**
   For projects that pass the evaluation by the Transmission Division, the proposal is submitted to the Verification and Validation Team (TVV) based on the invest-

ment budget group to schedule a verification and validation meeting for the proposed project. According to the decree, the approach in prioritizing the project is as follows:

(a) Priority 1: Is the project mandatory? (high legal risk implication, Government assignment, funding from the government, take-or-pay clause, or RNE priority power plant)
(b) Priority 2: Is the project profitable?
(c) Priority 3: Is the budget still available?

The evaluation process is responsible for verifying the projects according to the above sequence, and the process is conducted in the form of a presentation by the maker, followed by discussion.
The composition of the Validation and Verification Team for Project Appraisal (TVV) includes several Executive Vice Presidents (Executive Vice President (EVP)s) for groups A.I to A.IV, and the relevant Vice President for group A.V. According to TVV members, the challenges faced in the verification and validation process are:

- There is no training provided for the TVV team, and no standardized approach exists to justify the project assessments. As a team, they rely on evaluations performed by other divisions, such as risk assessments by the Risk Division and financial analyses by the Financial Asset Management Division. Consequently, discussions and evaluations primarily focus on the urgency of the projects.
- There is a lack of methodological and data support for the analysis. For example, the risk was not calculated using a reliability approach, or there is no historical data or information regarding a particular asset, leading to low confidence levels when making decisions.
- There is a lack of optimization tools or methods to prioritize projects. The team verifies and validates many projects from all regions, making it very difficult to prioritize projects within a single region, let alone across different regions. There is no clear ranking method in place.

6. **Evaluation by the Investment Committee for project appraisal (KI)**
If the project is deemed feasible by the Verification and Validation Team, the next step is an evaluation by the Investment Committee. The Investment Committee makes decisions based on summaries prepared by the TVV team. These summaries emphasize the importance of the projects and confirm that the analyses have been evaluated by the TVV team.
The Investment Committee for groups A.I to A.IV includes the Board of Directors and even the Chief Executive Officer (CEO) for group A.I, while for group A.V, the team is primarily composed of the relevant Executive Vice President (EVP)s.
An illustration of this infrastructure planning process is shown in Figure 5.7.

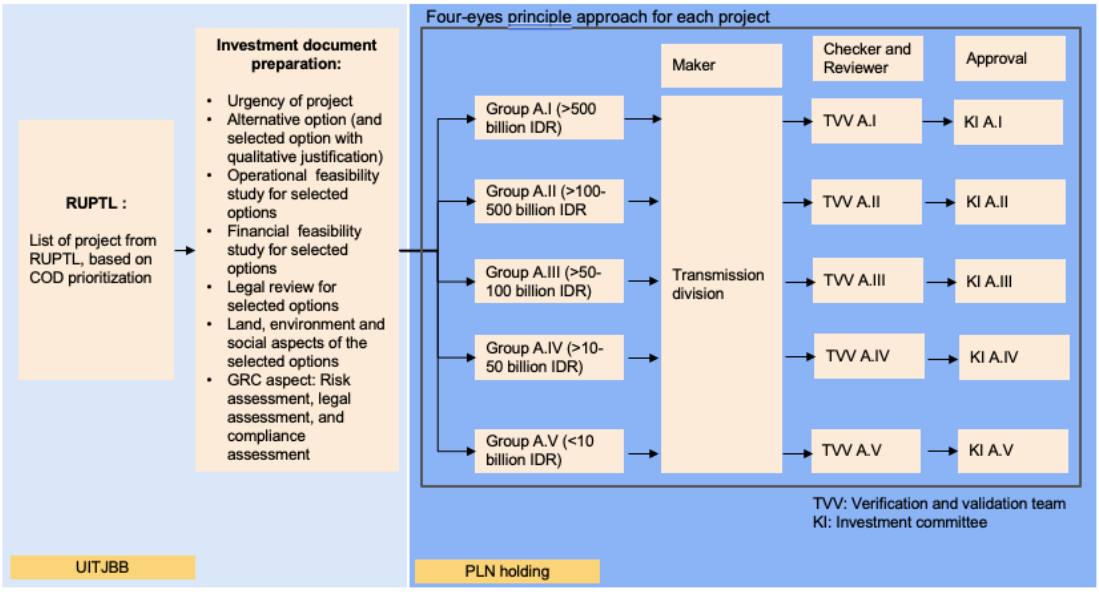


**Figure 5.7:** *Initial version of electricity infrastructure project planning for add new asset.*

**Bottom-up project: Maintenance capital expenditure**

In terms of the number of projects, the majority undertaken by UITJBB are this type of projects. The critical condition of substation equipment (based on UITJBB's assessment), delays in replacement realization, and limited procurement of materials and tools have hampered maintenance or asset replacement. In the transmission network, vulnerabilities stem from aging assets, high-pollution locations, and third-party activities that potentially cause disruptions to operating assets. These conditions result in numerous maintenance Capital Expenditure (CAPEX) proposals in UITJBB's investment planning.

A significant difference in the maintenance Capital Expenditure (CAPEX) planning process lies in the identification of projects and the preparation of investment documents.

**A. Bottom-up project: Maintenance capital expenditure**

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A significant difference in the maintenance Capital Expenditure (CAPEX) planning process lies in the identification of projects and the preparation of investment documents.

1. **Planning session: project identification process**

Due to the lack of an approach to prioritize project proposals at the operational unit level from PLN headquarters, and as part of improving the implementation of asset management based on ISO 55001:2014, UITJBB, together with other transmission units and the load dispatch center in the Java, Madura, and Bali Region, developed the risk framework of the power system in the Java, Madura, and Bali Region. This risk framework quantifies the likelihood and the consequence of the risk parameter for risk quantification in Indonesia Rupiah (IDR). Based on this framework, the UITJBB planning team developed tools in the form of spreadsheets to quantify risks for each project. These spreadsheets were internalized across all transmission execution units (UPTs) through planning session forums. Subsequently, each UPT and other departments in UITJBB conduct risk assessments using these spreadsheets to determine which mitigations will be proposed as investment projects by calculating the project's benefit and ranking them accordingly. According to UITJBB's risk sub-department, this approach ensures the optimization of risk, cost, and benefit since the benefit is obtained by:

$$\text{Benefit} = \text{Risk} - \text{Cost}$$

However, as the risk and cost are not directly comparable, and due to the perspective of conducting risk assessment per single equipment, while the proposal is on the sum of the similar equipment, UITJBB still relies on field expertise to finalize which project to propose and then adjusts the risk assessment accordingly.
The implementation of spreadsheet risk assessments did not automatically simplify the prioritization process at UITJBB. The fundamental challenges are:

- The mindset of the operational employees aiming to address any arising issues promptly, ensuring that all proposed projects are approved. This leads to conducting backward analysis, where they start with a pre-determined project and then create the risk analysis to justify it.
- Competency in conducting risk assessments, identifying risks and root causes, and quantifying them.
- Lack of adequate data to support the risk quantification process, leading to inaccurate risk level estimations.
- The project-based perspective, usually conducted by equipment type instead of by system or subsystem. This results in risk assessments within the same system having different risk levels, but when proposing, the highest risk level is chosen.

2. **Investment document preparation**
Similar to the stages of infrastructure projects, each maintenance Capital Expenditure (CAPEX) project is also accompanied by supporting documents. While

most of these documents are similar in content, there are two significant differences in the analysis for operational feasibility study and financial feasibility study.

**Operational feasibility study:** The analysis in this study focuses on explaining the existing condition of the asset and why it should be replaced. The analysis includes information on the existing system condition, asset data, loading data, supply area, asset criticality and substation criticality, the existing number of transformers in the substation, and historical outage data.

**Financial Feasibility study:** The guidance does not differentiate how to calculate between infrastructure projects and maintenance Capital Expenditure (CAPEX) projects, but both are required to calculate the project benefits. However, according to interviews, the financial feasibility analysis for maintenance Capital Expenditure (CAPEX) projects should use cost avoidance or least cost principles. In this case, UITJBB uses the assumption of Energy Not Served (ENS) by calculating the total energy lost if the breakdown happens. For example, if there is a transformer replacement project at substation A, it is assumed that if the transformers are not replaced, the electricity supplied by the transformer will stop. Since the analysis perspective is per project, while one transformer replacement project might involve three different transformer locations, the analysis assumes the Energy Not Served (ENS) equals the sum of the Energy Not Served (ENS) of the three locations, while for the duration, we take the average from the three locations. This assumption is not entirely accurate because, in reality, if a transformer fails, the load will be transferred to other transformers or even to other systems to prevent prolonged outages for customers.

Based on interview data, the majority of respondents at UITJBB mentioned that preparing the financial study is very challenging, particularly in determining the benefit assumptions mentioned above. This is mainly due to inadequate competencies and not all personnel conducting the analysis receiving formal training, and the lack of data to support the analysis. Therefore, the planning team at UITJBB sometimes conducts knowledge sharing with other transmission units in the same region to benchmark the approach.

This difficulty is further intensified by the project proposal timeline overlapping with the project evaluation period. Since proposals must be submitted in year-1, for instance, in 2022, UITJBB is in the process of evaluating projects to be executed in the same year through the Four-Eyes Principle. Simultaneously, they must also prepare analyses for projects to be proposed in 2023. This overlap makes it very challenging to produce high-quality analyses.

However, a different opinion was expressed by a respondent at PLN Holding, who believes that preparing the operational and financial study should not encounter significant challenges because it uses a common technical and financial approach.

3. **Four-Eyes Principle Process**

The Four-Eyes Principle process is essentially the same as for infrastructure projects, except for the composition of the TVV and KI (Figure 5.8 ). However, for the transmission division, the maintenance Capital Expenditure (CAPEX) program is more challenging to evaluate, as there are two divisions conducting the evaluations separately for operational and financial studies. Since most of the experts in the technical division previously worked in operational fields, the operational study evaluations generally do not encounter many issues, aside from the concern of whether the data used is up-to-date.

On the other hand, for financial analysis, the variability in calculation assumptions and the lack of standardized evaluation methods result in the quality of the evaluations being highly dependent on the evaluator. Some evaluators meticulously question the assumptions, while others do not thoroughly review the financial evaluations and instead revert to evaluating the technical aspects.

Although not frequent, there have been instances where proposed projects show benefits reaching 200%, which is clearly not logical. However, the transmission unit still proposed these projects despite the flawed assumptions, indicating a lack of understanding of the analysis. Therefore, the financial study requires more careful analysis.

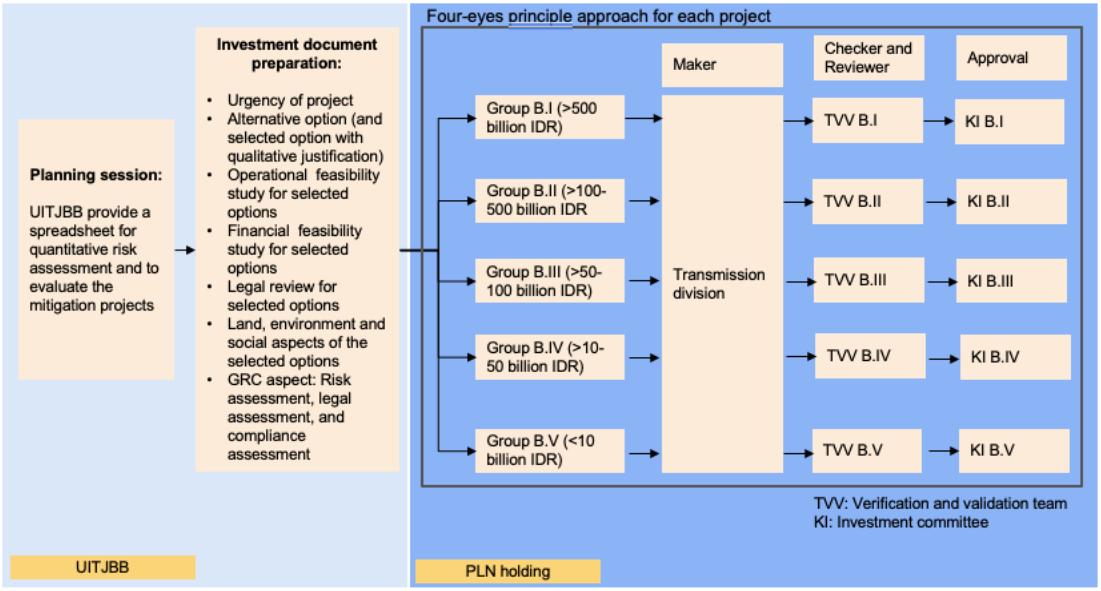


**Figure 5.8:** *Initial version of electricity infrastructure project planning for Maintenance capex project.*

The transformation in planning during the 2021-2022 period was extensive, emphasizing multi-layered evaluations to ensure that PLN's projects are very important and revenue-generating. However, it cannot be denied that these extensive layers also introduce several issues, as mentioned earlier, especially within the evaluation period. Due to the numerous processes that must be carried out for each project, the planning process becomes very lengthy, impacting project execution delays. Additionally, the limited composition of the TVV Team and Investment Committee, along with overlap-

ping roles among the five investment groups, further adds pressure to make decisions trade-off between quality versus time.

In addition to time pressure, PLN also recognized that during this period, they were unable to create an explicit link between strategic objectives and the projects undertaken, particularly regarding how projects contribute to the achievement of organizational strategic goals in the long-term plan (RJP). During this period, the implementation of systems and asset management capabilities at the corporate level also began, which played a role in the subsequent evolution of planning.

## 5.6 2022-present: Towards centralized planning and asset management

Based on the evaluation of the previous period, PLN made several changes such as developing standardized spreadsheet for financial feasibility study, this allow for automatic calculation of NPV, IRR, etc. However, there are no guidelines for determining assumptions, which still leads to a wide variation in analysis due to the diverse assumptions used to ensure the project provides significant benefits. Additionally, at the corporate level, there is an application to recapitulate the analysis results, so the calculation results must be manually transferred into the application, which can cause errors during the data transfer process.

Significant governance changes also happen in the four-eyes principle process by adding a centralized planning function and reducing the investment groups from five to three. Additionally, the governance of each group was revised. These changes are illustrated in Figure 5.9 for the infrastructure/ RUPTL projects, while the Figure 5.10 illustrate for the maintenance Capital Expenditure (CAPEX)

A. Infrastructure project planning

   For infrastructure projects, after being classified into three categories, A.I for projects with a budget $>$ 500 billion Indonesia Rupiah (IDR), A.II for projects valued between $>$ 150 and 500 billion Indonesia Rupiah (IDR), and A.III for projects $\leq$ 150 billion Indonesia Rupiah (IDR). Previously, all investment documents were evaluated together by the transmission division and the Governance, Risk, and Compliance (GRC) division. In this period, however, only investment categories A.I and A.II are evaluated in the similar manner, while category A.III projects undergo self-assessment by the transmission division to determine the feasibility of project execution.
   Projects that have passed document evaluation are then submitted to the centralized planning function within the corporate planning division for prioritization. This prioritization process, in addition to using the three prioritization principles (explained in subsection 5.2.2.1, sub 5), also considers priorities based on strategic programs formulated in the long term plan (RJP) to ensure that the projects

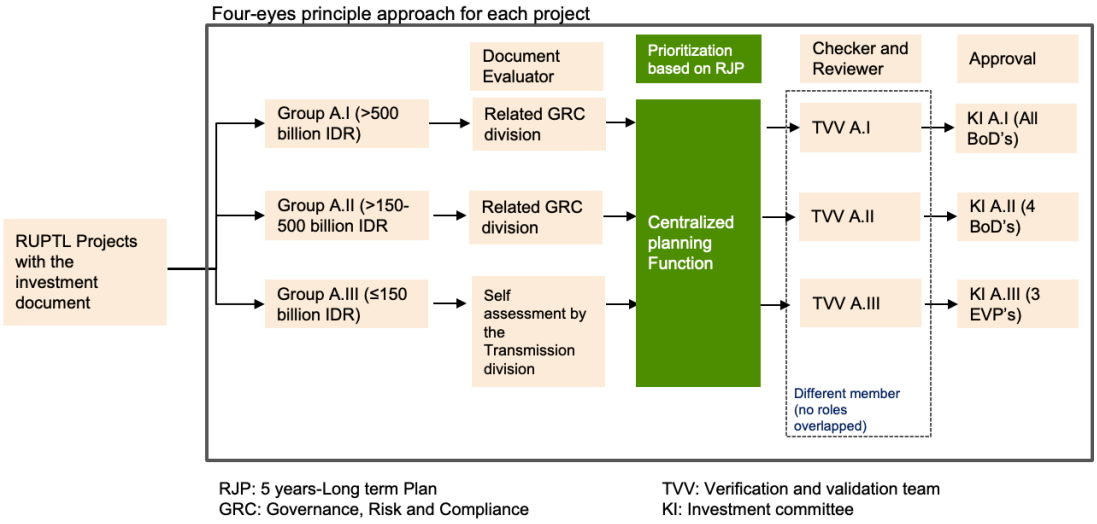


**Figure 5.9:** *Changes in the infrastructure project planning*

undertaken align with PLN's strategic programs. RJP identified three main focus of the organization through "moonshot program", with focus on three aspects, growth, digitalization, and net zero emission. This three moonshot then translated into 6 main program:

- Increasing electricity sales income by promoting an electrifying lifestyle.
- Increasing income from non-electricity services (beyond kWh).
- Continuing operational and investment efficiency.
- Organizing the corporate structure and unlocking the value of the business portfolio.
- Developing Environmental, Social, and Governance (ESG) practices and advancing the energy transition.
- Developing digitalization and management systems that can accelerate transformation programs based on the Organizational Culture: A = Amanah (Trustworthy), K = Kompeten (Competent), H = Harmonis (Harmonious), L = Loyal (Loyal), A = Adaptif (Adaptive), K = Kolaboratif (Collaborative) (AKHLAK) culture

These key areas, then used also by the centralized planning to ensure that the project proposal is aligned with this focus. Because the strategic program level is too high, while project levels are operational, there is a possibility that mapping at the centralized planning level will be difficult to prioritize, especially since there is no established method to measure the achievement of objectives through the projects undertaken.

In line with this, corporate planning also acknowledges that the measurement of project contributions has not been implemented and is currently in the pilot project stage, to be cascaded to the directorate or Executive Vice President (EVP)'s level, and eventually to the operational unit level in the future. Furthermore, corporate planning also plans to hold a strategic orchestration meeting at

the beginning of each project planning period where the CEO will provide guidance on organizational objectives to be used as a guideline by operational units in their project planning.

Another improvement is ensuring that the composition of the TVV team does not overlap between groups, as well as limiting the involvement of many Board of Director (BoD) members, primarily in groups A.I and A.II, to address the time constraints in the previous approach.

B. Maintenance Capital Expenditure (CAPEX) project planning

The same process changes also apply to maintenance capex projects. Since the majority of projects are in this group, this bring significant impact to the transmission unit.

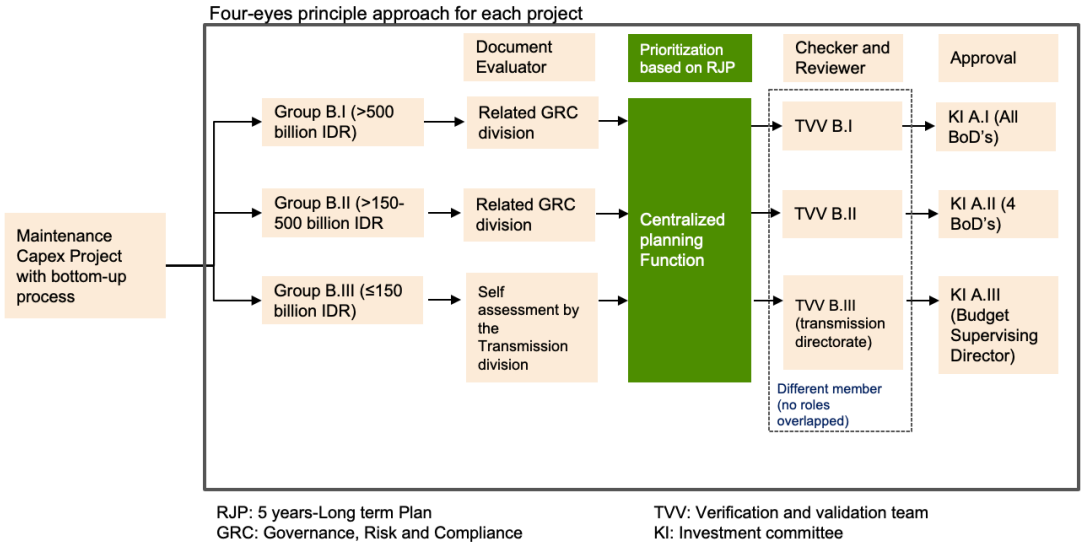


**Figure 5.10:** *Changes in the maintenance capex project planning*

The visualization of the revised maintenance CAPEX project planning shown in Figure 5.10. In the evaluation process, projects with larger budgets (B.I and B.II) involve directors and several Executive Vice President (EVP)s, similar with the previous planning version, learning from the previous experience where the discussion can be very intense, this governance forced transmission to be more careful in preparing the analysis document.

For B.III projects, evaluations are conducted through self-assessment by the transmission division, with the TVV involving the transmission directorate and approval from the budget director. Since the B.III process is considered simple and quick, there is a tendency from the operational unit to make proposals that fit into the B.III category. Furthermore, due to time constraints, not all projects can be thoroughly reviewed, so random checks are conducted. For example, a few projects are selected for detailed review, and the findings are used to guide the transmission unit in self-evaluating other projects to ensure such errors do not occur.

In addition, according to the respondents the issues from the previous process still persist in this period because the process improvements only target time acceleration, especially for the big projects.

C. Project Composition in UITJBB
The composition of projects in UITJBB is illustrated in Figure 5.11, where the data is based on projects from 2022 that were proposed in 2021. Out of a total of 63 projects, only 2 projects are RUPTL projects illustrate in the Figure 5.11 (top). Of these two projects, one falls into category A.II, which is an investment project in the range of 150-500 billion Indonesia Rupiah (IDR), while the other project falls into category A.III or <150 billion Indonesia Rupiah (IDR) (Figure 5.11down-left). Meanwhile, for the 61 maintenance capex projects, only 1 project is in category B.II, 60 projects are in group B.III or <150 billion Indonesia Rupiah (IDR), and there are no projects in category B.I (Figure 5.11 down-right)

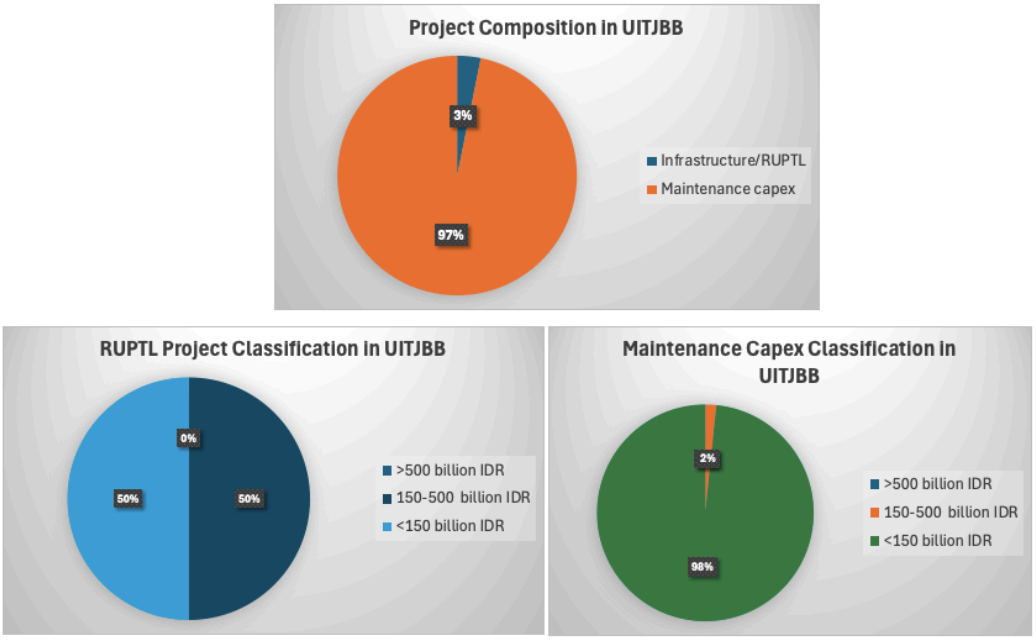


**Figure 5.11:** *Overall project composition in UITJBB, down-left: composition of RUPTL projects, and down-right: composition of maintenance Capital Expenditure (CAPEX)*

## 5.7 Asset Management Implementation in the PLN Holding

Simultaneously, during this period, implementing an asset management system and capabilities based on ISO 55001:2014 is also in progress. Based on the results from the maturity gap assessment, PLN has identified 62 major non-conformities and 10 minor non-conformities that must be addressed to achieve a competent level of maturity. To achieve this, two stages of programs are being conducted: building a solid foundation and subsequently establishing good practices for asset management at PLN. The primary outputs of this program for input into the strategy and planning process are:

- **Asset Management Policy (AM Policy)**: This is a set of guiding principles for Asset Management implementation at PLN, developed with the involvement of the Board of Directors, as it governs the principles of asset management.
- **Asset Management Objective (AMO)**: This is a set of asset management objectives derived from PLN's long-term plan (RJP) documents.
- **Risk Appetite Statement (RAS)**: This is a set of boundaries or guide rails for the organization to work within when making risk-informed decisions and sets the tone for risk management in the organization.
- **Asset Information Strategy (AIS) and High-level Asset Information Strategy (HLAIS)**: A majority of the non-conformity findings are in Asset Information management, therefore PLN developed this High-level strategy and standard.

However, since their establishment, there has been no clear link in organizational governance regarding how these three documents are used in PLN's planning process. According to respondents, the difficulties in implementing these documents are due to:

- **Limited understanding of asset management**: This issue is prevalent not only at the operational staff level but also at the Executive Vice President (EVP) level. Currently, many employees assume asset management is similar to operation and maintenance. Although the asset management program continues to conduct training, only a few can be accommodated each year, and the priority is given to top management. Therefore, the stereotype that asset management is solely the responsibility of the Asset Management Division is still widely encountered.
- **Lack of guidelines on "how to" implement these documents at the operational level**: For example, one principle in the AM Policy document is "Making risk management a key criterion in all asset management decision-making and activities." However, no guidelines have been provided on implementing this principle. Additionally, the current risk management process is managed by another division, requiring intense coordination to shift to an asset management-based approach.
- **Unclear roles and responsibilities**: Currently, the Transmission Division has an asset management function, however due to unclear roles and responsibilities descriptions and a lack of understanding on how to implement it. In the Transmission Division, for example, this function ends up handling financial study evaluations.
- **Unclear and undefined asset management objectives**: These objectives have not been clearly measured or detailed by region, making it difficult to cascade them down to the operational level.
- **Guidelines produced are not synchronized with the guidelines from the responsible division**: For example, AM has produced an Asset Information Strategy that regulates how data and information for assets are managed, including

their quality. On the other hand, the IT Division has created the SSOT (Single-Source of Truth) program, but this program has not yet accommodated the aspects regulated in the Asset Information Strategy. Therefore, time is needed to synchronize with the relevant division.

In addition, the asset management team is also still in the process of developing the Strategic Asset Management Plan (SAMP) document and, in that effort, attempted to develop an asset class strategy. However, they were unsure where to start due to the wide variety of assets. They attempted to work together with a consultant to conduct an assessment of the existing conditions. However, there are fundamental challenges that need to be addressed before this strategy can be developed, including:

- When PLN develops strategies, there is a lack of clarity regarding what constitutes a strategy, guideline, procedure, and work instruction, as all these elements are combined into a single document.
- The time-based maintenance strategy is applied differently by each unit, with varying methods, formulas, and data storage practices that do not adhere to the existing PLN regulations.
- Maintenance personnel's knowledge is not monitored (for example, Person A has tested a circuit breaker ten times, but the quality of Person A's work is not tracked). Additionally, it is unclear whether this responsibility lies with UITJBB or with the unit below it, the Transmission Execution Service (UPT).

# 6

# Analysis and Interpretation

Figure 4.4 in Chapter 4 outlines the final analytical framework, which will be applied in this chapter to compare the theoretical concepts with the case study results described in Chapter 5. The analysis will be conducted according to the steps outlined in the final framework as follows:

- **Observation and Analysis of Asset Specificity Elements**: This involves examining both the structural aspects and the knowledge, tools, and methodologies in use.
- **Observation and Analysis of Learning Organization Elements**: This step focuses on assessing how well the organization embodies the characteristics of a learning organization, particularly in relation to the implementation of structural elements and the use of knowledge, tools, and methodologies.
- **Identification of Emerging Challenges**: The final step in the analysis will summarize and outline the emerging challenges identified from the two preceding observations.

## 6.1 Step 1: Observation of the asset specificity in asset management strategic planning

According to the analytical framework in Figure 4.3, the first step involves observing and analyzing the specificity elements, focusing specifically on the structural components and the elements related to knowledge, tools, and methodologies. This analysis is conducted by examining the data presented in the case study in Chapter 5 and is divided into two main sections:

- Observation of the structural elements
- Observation of the knowledge, tools, and methodology elements

### 6.1.1 Observation of the structural elements

Based on the analytical framework, in the structural elements there are three categories identified: governance and organizational design, roles and responsibilities, and co-

ordination and collaboration. The following section will explain the observations for all of the elements within each category.

**Governance and organization design**

This category contains four elements as follows:

1. **Organizational design support strategic and integrated planning (short-medium-long term)**
   From a theoretical standpoint, organizations should be structured not only to support the creation of strategic plans but also to ensure these plans are integrated and aligned across different timeframes. Within PLN, the RUPTL (Electricity Supply Business Plan) is regarded as the cornerstone of long-term infrastructure planning, with a 10-year horizon. The current RUPTL reflects Indonesia's commitment to green energy by prioritizing renewable energy projects and excluding new fossil fuel power plants, except those already financially secured or under construction. This demonstrates a significant shift towards sustainable energy practices.
   However, the focus on energy transition in the RUPTL has primarily centered on generation projects, neglecting the essential role of the transmission network in delivering this green energy to consumers. The RUPTL does not adequately address the strategic condition of the existing transmission network or its readiness to handle the integration of renewable energy, which, if not properly managed, could destabilize the grid. A critical gap in the RUPTL is its emphasis on asset addition projects while overlooking maintenance interventions vital for preserving the condition of existing assets. As a result, critical components such as Gas Insulated Switchgear (GIS) and transformers, which require regular overhauls and significant funding, are not covered within the RUPTL's planning scope. This omission is particularly concerning given that the RUPTL dictates that renewable energy projects, managed by Independent Power Producers (IPPs), will be delivered on PLN's transmission grid, placing the highest reliability risk on this infrastructure.
   The lack of comprehensive strategic planning within the RUPTL also impacts the alignment of the 5-year RJP and the annual RKAP, leading to a disjointed approach that prioritizes RUPTL projects while underemphasizing the maintenance necessary for sustaining existing infrastructure. This misalignment forces operational units like UITJBB to prioritize maintenance tasks without a strategic framework, while the function of strategic transmission network planning is left unaddressed.
   This condition highlights a significant structural gap within PLN: the absence of a dedicated function for comprehensive strategic planning that ensures the organization's readiness to support the energy transition. Additionally, there is minimal involvement of transmission network managers, particularly UITJBB,

in shaping the strategic direction within the RUPTL, further compounding the challenges of aligning PLN's objectives with its operational realities.

2. **Governance and information flow of executive involvement in planning cycle**
   Leadership involvement in PLN's planning cycle is both direct and indirect. Indirectly, executives set the organizational direction through the vision, mission, and objectives in the RJP ensuring that the annual budget plan aligns with these goals. However, there is a significant gap in translating high-level strategic objectives into daily operations, leaving the impact of bottom-up projects on reliability largely qualitative, without clear metrics for measurement. Additionally, conflicting strategic objectives, such as balancing budget efficiency with high reliability, complicate implementation at the operational level.
   This disconnect between the RJP and RKAU leads to a loss of connection between strategic and operational planning processes. Corporate planners have expressed concerns that strategic planning has not yet become a primary focus, as evidenced by the infrequent reference to the RJP during interviews. While corporate planning intends to introduce strategic orchestration meetings with the CEO to guide RKAP development, these efforts may fall short if they fail to address how UITJBB can implement the directives.
   Direct executive involvement is evident through the governance structure that emphasizes their participation in the project appraisal process. This is increasingly highlighted by the direct involvement of the Board of Directors as part of the Investment Committee and the inclusion of EVPs and Vice President (VP) as members of the Verification and Validation team (TVV) to directly evaluate each project. While this strategy clearly shows top management's involvement, it has proven inefficient in terms of the executives' time and has caused delays in project execution. This is evident from the revision of governance to involve the Board of Directors only for projects with significant budgets (>150 billion IDR), while less significant projects are evaluated through self-assessment by the transmission division supervisors.
   Although governance shows clear top management involvement in the planning process, the focus on high-budget projects indicates that executives are primarily engaged in evaluating new power generation, transmission, and substation projects. This is because the majority of UITJBB projects fall under the <150 billion IDR category. Consequently, this diverts executive attention away from assessing the condition of existing assets.
   If this condition persists, it could create bottlenecks in energy transition planning. The leaders assume that the energy transition could be achieved through developing the new green power plant and new transmission line, without thinking about the integration of these new assets into the existing assets, while transmission network planning at the UITJBB level remains short-term-focused, aimed at securing the annual RKAP budget without considering the long-term risks of integrating new renewable generation and transmission. As a result, when large-

scale green energy projects are ready, it may be too late to take preventive action, leading to corrective planning that could incur significant costs to properly synchronize new energy sources with the existing grid.

From an information flow perspective, there is still no effective information flow to assist executives in decision-making. Although the organizational design implements multiple layers of evaluation, the confidence level in supporting analysis remains low due to the poor quality of data used for analysis, resulting in suboptimal information for decision-making.

3. **Centralized planning to integrate generation, transmission, and distribution**
   In PLN's current organizational structure, there is a centralized planning function within the corporate planning division. However, this function is not focused on fully integrating generation, transmission, and distribution. Instead, its primary role is to ensure that project proposals from operational units meet specific prioritization criteria, such as whether the project is mandated by the government or required for legal compliance. The second priority is whether the project generates revenue. Projects that do not fall into these categories are then prioritized based on budget availability, a process that often remains unclear, leaving the proposing units to determine their own priorities.

   Currently, as part of the project appraisal process for new power plants, the transmission lines that will evacuate the generated power are aligned with the plant's development. This means that the TVV team ensures that no power plant will be ready without the necessary transmission network in place. However, this effort to integrate generation, transmission, and distribution is primarily focused on new assets. Building new assets, however, comes with significant uncertainty, as evidenced by PLN's recent KPI achievements, where transmission development fell short of targets while distribution exceeded expectations. This situation often leads to a corrective approach, where power is evacuated through the existing grid, placing additional strain on it and potentially compromising reliability.

   In the context of energy transition initiatives, where integrating various energy sources could impact grid stability, the ability to project and predict the power system's condition under different scenarios becomes crucial for successfully shifting towards greener energy. Unfortunately, the existing processes in PLN leave a significant gap, as there is no dedicated function equipped to perform these critical projections and predictions. This gap underscores the need for a more integrated and forward-looking approach to planning that ensures grid stability and reliability amidst the transition to greener energy sources.
4. **Structure organization accommodate continual improvement**
   The ongoing large-scale transformation programs within PLN demonstrate the organization's commitment to improvement. This is evident in the recent organizational restructuring, where PLN established a division for Asset Management within the transmission directorate. However, this structural change has not been accompanied by a comprehensive asset management framework that

should be implemented across the entire organization.
A key issue is how the existing structure accommodates asset management requirements in terms of competencies and coordination. For example, there is currently an overlap in roles and responsibilities between the Asset Management division and other functions, such as risk management, which has its own risk approach that should be aligned with asset management. Despite these overlaps, PLN has yet to provide detailed guidance on how these functions should be integrated and coordinated to ensure alignment and avoid redundancy.
Moreover, the placement of the Asset Management division within the transmission directorate raises concerns about whether its scope is limited to transmission alone. If the structure remains unchanged, the critical function of integrating strategic planning, which has been identified as necessary, will continue to be absent. As a result, the ongoing efforts to improve the organizational structure may fall short of fully embracing a comprehensive asset management approach. Without this comprehensive approach, it will be difficult for asset management to serve as a significant enabler in achieving PLN's broader objectives, such as supporting energy transition initiatives and fulfilling the organization's overall goals.
In terms of structural improvements in the planning process, significant changes have been made over the past 3-4 years. PLN has established a governance framework for proposing the annual budget, where each project is classified into a specific budget category and undergoes a multi-layered evaluation process involving top management at the holding company. While this governance helps filter out irrelevant RUPTL projects, it still fails to address the fundamental question of how to prioritize the numerous bottom-up projects being proposed. This has led to further issues, such as the absence of a standardized approach to evaluating and prioritizing projects, which introduces inconsistency in decision-making. These inconsistencies can result in suboptimal resource allocation, with critical projects for the energy transition potentially not being prioritized appropriately. For asset management, this means that essential investments in grid modernization, and other vital areas might not receive the necessary attention to effectively support the energy transition.

**Roles and responsibility**

This category also contains four elements which are:

1. **The availability of roles asset management strategy development**
   According to Global Forum on Maintenance and Asset Management (GFMAM) (2014), key activities in asset management strategy development include creating an Asset Management Policy to outline asset management rules, establishing Asset Management Objectives (AMO) to align organizational goals with asset management, and developing a Strategic Asset Management Plan (SAMP) to

define the high-level strategy. At PLN, the Asset Management Division is formally responsible for these documents, but due to limited resources, they have been developed with the help of consultants. While the Asset Management Policy and AMO have been completed, the SAMP is still in progress.

The lack of sufficient personnel with the necessary expertise in the Asset Management Division, combined with the failure to fully integrate the Asset Management Policy (AM Policy) and Asset Management Objectives (AMO) into the existing project-oriented planning process, has significantly impacted PLN's planning efforts. Additionally, the RJP (Long-Term Plan) lacks the ability to measure the contributions of individual units toward organizational objectives, making the objectives in AMOs not measurable for each region and unit. This shortcoming has made it difficult to fully incorporate these objectives into UITJBB's planning process. Moreover, the Strategic Asset Management Plan (SAMP), which is intended to develop strategies across generation, transmission, and distribution within PLN and its sub-holdings, remains incomplete. Challenges in drafting the SAMP include gaps in competency, insufficient data and information, and the extensive scope covering all asset classes.

These issues significantly impact asset management's role as an enabler of the energy transition. The absence of a finalized SAMP has created a disconnect between the RUPTL, RJP, and RKAU, as the SAMP should bridge strategic planning from a high-level perspective to an actionable asset management strategy. In the context of asset management as an enabler of the energy transition, the SAMP can detail the strategies that operational units must implement to ensure asset readiness for integrating renewable energy into the existing grid.

2. **The availability of roles asset management planning** Asset management planning at PLN involves preparing projects for both expanding and maintaining existing assets to achieve Asset Management (AM) objectives. This process is conducted through the annual budget plan, known as RKAP, and currently represents a major focus at PLN, utilizing both top-down and bottom-up approaches that engage operational units and the PLN holding company.

   Reflecting on the planning transformation from 2015 to the present, a persistent issue has been the prioritization of projects proposed in the RKAP, particularly for investment planning. For RUPTL projects, the governance process involving TVV and KI has improved prioritization, moving from a focus solely on COD to a more comprehensive multi-layered evaluation that considers operational, financial, risk, and governance aspects. However, the process remains ineffective due to the lack of a standardized approach and evaluation system, leading to an over-reliance on top management's expertise. Additionally, this evaluation process is time-consuming, as it requires individual attention for each project, drawing top management into operational details and leaving significant gaps in strategic planning unaddressed.

   For bottom-up projects, which previously underwent the same evaluation pro-

cess as top-down projects, they are now assessed at the divisional level, specifically by the transmission division, since these projects are numerous and their budgets are considered less significant. However, similar issues persist, such as the lack of standardized evaluation and the inability to thoroughly assess all projects. Consequently, the responsibility for prioritization often falls back on UITJBB. This situation clearly highlights the unclear roles and responsibilities, especially between the supervisory division (transmission division) and its operational unit, UITJBB. The transmission division, which should provide strategic direction, needs to equip its operational units with proper guidance and methodologies for the planning process, rather than merely evaluating projects.
In the context of the energy transition, while new green power plants and the transmission networks connecting them are prioritized in the RUPTL due to their classification as government mandates, there are still concerns about how to integrate this massive influx of green energy in the future. The current approach ensures that these projects are top priority, but it does not address the broader challenge of managing the long-term integration of renewable energy into the grid. With asset management planning currently focused on short-term annual budget planning, there is a lack of consideration for future uncertainties, which could threaten the effectiveness of the energy transition.

3. **Information management function**
   During the observation, it was noted that PLN currently lacks a dedicated function for information management. While PLN does have a Digital and Information Technology Management unit, its primary focus is on business digitalization and managing reliable IT infrastructure. Furthermore, PLN has initiated a project to develop a Single Source of Truth (SSOT) to integrate data from various dispersed applications across the organization. However, this initiative has not been fully aligned with asset management principles, as it primarily involves asset management in operational and maintenance activities, rather than encompassing the broader scope of strategic asset management.
   The absence of a proper information management system dedicated to handling asset-related data and information has significant consequences. Currently, PLN lacks a robust database on the condition of its assets, a challenge also faced at the transmission level. For example, UITJBB is currently unable to calculate reliability data accurately due to poor data quality. This issue is foundational, particularly in supporting the energy transition, because reliable and accurate asset data is critical for effective decision-making, especially when integrating renewable energy sources into the grid. Without a solid understanding of the current state of assets, planning for future needs, addressing potential risks, and optimizing asset performance become extremely challenging. In the context of the energy transition, where the ability to predict and manage variability in energy supply is essential, the lack of quality data can significantly compromise efforts to achieve a sustainable and resilient energy infrastructure.

4. **Clear roles and responsibility between strategic and operational asset management roles**
   Previous observations and analyses in asset management planning have clearly highlighted the lack of clarity between strategic and operational roles in asset management, with the current organization placing too much emphasis on the operational side. This issue stems not only from the unclear definition of roles and responsibilities but also from the absence of a Strategic Asset Management Plan (SAMP) to guide high-level strategy. The development of the SAMP has been hindered by an organizational design that lacks the necessary coordination mechanisms, multidisciplinary expertise, and quality data. These condition further distance asset management from effectively supporting energy transition initiatives.

**Coordination and collaboration**

The last category contains two elements as follows:

1. **Cross-functional multidisciplinary teams:**
   As discussed in the roles and responsibilities section, there is a significant gap in how PLN has designed its asset management organizational structure. While the structure has been placed within the transmission directorate, it lacks sufficient resources from key multidisciplinary areas such as operations (spanning generation, transmission, and distribution), new and renewable energy expertise, finance, engineering, data management, risk management, strategic planning, and asset management specialists. Additionally, there is no clear mechanism for coordinating this team with other disciplines. This lack of organizational consideration suggests that asset management development is not fully aligned with the broader organizational objectives, particularly in advancing towards a more sustainable energy future.
2. **Human capital alignment with strategic requirements:**
   All of the previous analysis has clearly pointed out that the existing organizational structure does not adequately align human capital with the strategic requirements of asset management, especially given the absence of defined roles and competencies in performing effective asset management activities. Respondents also acknowledged this issue. At the operational level, personnel are not equipped with adequate competencies to perform bottom-up planning. Similarly, evaluators within the Transmission Division lack the necessary competencies to conduct thorough evaluations. Even at the Verification and Validation Team (TVV) level, top management, including EVPs, are assumed to possess the necessary skills or competencies to evaluate projects without the need for additional training.
   This misalignment has significant impacts. The lack of clearly defined competencies leads to inefficiencies and suboptimal performance in asset manage-

ment processes. Personnel at various levels may struggle to perform their roles effectively, resulting in flawed planning and evaluation. The assumption that top management inherently possesses all necessary competencies without additional training further exacerbates these issues. Consequently, the organization faces challenges in achieving its strategic objectives and optimizing asset management practices.

Furthermore, this misalignment of human capital with strategic requirements is particularly concerning in the context of the energy transition. The complexity and urgency of transitioning to a more sustainable energy system demand a workforce that is not only technically proficient but also strategically aligned with the organization's long-term goals. The absence of multidisciplinary expertise, especially in areas critical to the energy transition such as renewable energy, risk management, and strategic planning, hampers PLN's ability to innovate and adapt to emerging challenges.

Without addressing these gaps, PLN risks falling behind in its energy transition efforts, as the existing human capital may not be adequately prepared to manage the integration of renewable energy, enhance grid reliability, or support the development of new technologies. This underscores the critical need for better alignment between human capital and strategic requirements, ensuring that the workforce is equipped and positioned to drive the organization towards its future objectives.

### 6.1.2 Observation of knowledge, tools, and methodology in strategy and planning

The second elements from the asset specificity in asset management are categorized into three main components:

- Knowledge, tools, and methodology in strategy development (SAMP)
- Knowledge, tools, and methodology in Asset Management Planning (AMP)
- Supporting tools

#### Knowledge, tools, and methodology in strategy development (SAMP)

As the Strategic Asset Management Plan (SAMP) has not yet been developed, and the existing organizational approach still does not address the competence requirements for developing the SAMP, the elements of knowledge, tools, and methodologies identified in this framework can serve as valuable input for PLN. The identified knowledge, tools, and methods in the framework include:

- Analyzing strategy requirements
- Forecasting and analyzing future user requirements and demands
- Developing the asset management strategy
- Planning the implementation of the asset management strategy

- Long-term Investment strategic objective

These elements contain the required analysis within the SAMP to ensure that the SAMP could facilitate the energy transition initiatives and should be aligned with the personnel requirements within the PLN function which will develop the SAMP.

**Knowledge, tools and methodology in Asset Management Planning (AMP)**

In this category, there are six elements which will be further explained in detail:

1. **Knowledge, tools or method in appraising investment planning:** According to the theoretical perspective, the approach in appraising investment planning based on asset management principles includes criteria for identifying investment options, determining investment options to achieve asset management objectives and strategies, analyzing the risk-cost-benefit of investment options, and selecting the most optimal alternative to implement.
   In the current state at PLN, the starting point for appraising investment projects is based on the urgency of the project, whether it is top-down or bottom-up. Top-down projects are directly supported with studies, while bottom-up projects are identified through a risk-based approach. Since the risk management training from PLN holding is highly theoretical without guidance on how to conduct risk management at the asset level to identify and propose bottom-up projects from PLN Holding, UITJBB developed a method to quantify risks in collaboration with transmission units and the dispatch center in the Java, Madura, and Bali regions. UITJBB created a risk framework to quantify the likelihood and consequences of risks in financial terms (IDR), aiming to standardize risk assessments across transmission units using spreadsheet tools.
   This framework was then used as a reference to develop a risk assessment spreadsheet, designed to aid in the risk assessment process, including calculating benefits by subtracting costs from risks, using the formula: Benefit = Risk – Cost. Although this risk-cost-benefit approach can yield a quantitative benefit that analysts use to select the most beneficial project to propose, it is inherently flawed. Risks and costs are fundamentally different metrics and should not be directly subtracted. Risks represent potential future losses, while costs are current expenditures. This approach does not provide a logical or accurate measure of benefit.
   Furthermore, the spreadsheet risk assessments did not simplify the prioritization process as intended. Several fundamental challenges contribute to this outcome, including the tendency of operational employees to engage in backward analysis, justifying projects rather than objectively assessing them. Additionally, significant competency gaps exist in performing thorough risk assessments, leading to unreliable evaluations. Poor data quality further undermines the accuracy of risk quantification. Moreover, the fragmented approach of conducting risk as-

sessments at an individual equipment level, rather than from a holistic system perspective, results in inconsistent prioritization.

This condition implies a lack of comprehensive understanding within the risk division at PLN Holding and the transmission supervision division regarding how risk should be effectively implemented at the operational level. This gap has led to the establishment of a "risk-based budget proposal" approach without providing clear guidance on conducting risk assessments for assets, including how to calculate reliability and incorporate it into the risk assessment process. At the UITJBB level, while there is awareness of the importance of using risk to identify bottom-up projects, the methodologies employed are significantly flawed, leading to inaccurate project identification.

This deficiency in risk understanding is particularly critical in the context of the energy transition, as renewable energy introduces greater risk and uncertainty into the power system. As new green infrastructure is built, PLN should proactively identify the potential risks associated with this significant future influx. Without a robust and accurate risk assessment framework, PLN may struggle to manage these risks effectively, potentially compromising the stability and reliability of the grid.

2. **Apply whole life costing (WLC) principles:** According to the asset management approach, Whole Life Cost (WLC), also known as life cycle costing or total cost of ownership, is a method used to estimate the total costs associated with goods or services over their entire lifespan. This approach includes the costs of acquisition, operation, maintenance, and disposal or decommissioning, while also accounting for any income or revenue generated during the asset's lifetime. Although some respondents claimed to have considered WLC in their financial studies, further examination revealed that their approach primarily focused on maintenance costs throughout the asset's lifetime. The lifespan used in these studies is based on regulations from PLN headquarters, which provide a static list of expected lifespans for equipment, such as 40 years for transformers and 20 years for circuit breakers. However, this approach is incomplete, as it does not account for disposal costs and relies on static lifespan assumptions that may not accurately reflect the varying durability of different equipment brands. One of the key benefits of calculating WLC is its ability to convert total costs into unit costs, facilitating comparisons between different brands of the same equipment and helping decision-makers select the best investment. Therefore, it is crucial that WLC calculations are based on accurate historical lifespan data for each asset.

   Understanding Whole Life Cost (WLC) and unit cost is crucial for PLN, especially as the organization strives to optimize budget efficiency. By incorporating WLC into their decision-making processes, PLN can shift its focus from simply pursuing the least-cost options to adopting a more effective cost approach. This means considering not just the initial investment but also the long-term

costs associated with maintenance, operation, and disposal. For instance, certain equipment may have a higher initial investment cost but offer significantly lower maintenance expenses over its lifespan, ultimately proving to be the more cost-effective choice. However, calculating WLC requires high-quality data and detailed information on each asset's expenses, which PLN currently lacks. To address this, PLN should begin incorporating these cost data requirements into their data management processes to effectively track and manage asset-related expenses.

WLC is particularly important when selecting renewable energy technologies, where upfront costs can be substantial, but the long-term benefits in terms of reduced maintenance, fuel savings, and environmental impact can be considerable. By leveraging WLC, PLN can ensure that they are investing in technologies and equipment that will deliver the greatest value over time, supporting both their financial objectives and their commitment to sustainable energy development. This strategic shift not only promotes long-term financial sustainability but also aligns with global trends towards more responsible and efficient resource management in the energy sector.

3. **Financial Impact Analysis on Maintenance and Renewal:** Financial Impact Analysis on maintenance and renewal is crucial for asset management, especially towards energy transition, as it enables organizations to make informed decisions regarding resource allocation, budgeting, and long-term planning. By understanding the financial implications of these activities, organizations can enhance asset performance, extend asset life, and optimize resource allocation. Unlike the procurement of new assets, which is primarily revenue-oriented, maintenance and renewal activities, especially for critical assets in transmission lines and substations, focus on improving asset reliability and minimizing failure risk. These efforts are essential for ensuring the consistent performance of critical infrastructure and preventing costly outages, which are very important to support energy transition initiatives.

   In the context of UITJBB, financial studies are conducted to justify maintenance and renewal programs. Since these programs are part of the bottom-up plan, there is no standardized approach from PLN Holding. Therefore UITJBB measures the benefit through the Energy Not Served (ENS) assumption, which estimates the total energy loss at the location served by the asset multiplied by the average outage duration. ENS represents the lost revenue opportunity if the renewal or maintenance is not performed. However, UITJBB acknowledged that this approach does not accurately reflect the true financial impact, as in reality, load transfer will be performed by transferring the load to other parts of the system, preventing total energy loss.

   In the existing condition, PLN still does not pay full attention to the financial impact of maintenance and renewal activities, which results in them not providing guidance for UITJBB. On the other hand, UITJBB is already aware and tries to

calculate them but there is a significant competence gap, resulting in inaccurate analysis, which results in missed opportunities to convey the broader benefits of these activities to decision-makers, such as increased reliability, reduced operational costs, improved performance, etc. Unless PLN shifts to a more comprehensive analysis, this loop of unawareness will still continue.

Financial analysis for maintenance and renewal is crucial in supporting the energy transition, as transitioning to renewable energy is capital-intensive. Accurate financial assessments enable organizations to manage costs effectively and ensure the transition's financial sustainability. The energy transition requires balancing immediate needs with long-term sustainability. By understanding the financial implications of maintenance and renewal, organizations can plan for the future, ensuring that short-term savings do not compromise long-term reliability and performance. Moreover, the energy transition is about more than just adopting renewable energy sources; it also involves embracing sustainable practices. Financial impact analysis, including Whole Life Cost (WLC) assessments, ensures that maintenance and renewal decisions are made with a comprehensive understanding of their environmental and economic impacts over the asset's entire lifecycle.

4. **Produce business case for creation and/or acquisition of assets including the workability issue:** A business case is a value proposition for a proposed project that includes both financial and nonfinancial benefits. Business cases can range from comprehensive and highly structured, as required by formal project management methodologies. In asset management practice, a business case illustrates how the benefits of a project outweigh the risks, aiding decision-makers in evaluating the project.

   Formally, PLN does not mandate the presence of a business case but requires several supporting analyses to propose investment projects. These include a feasibility study comprising operational and financial analyses, risk assessments (covering both project initiation and delivery risks), and legal and compliance assessments. For RUPTL projects, operational feasibility studies involve simulations such as load flow and short circuit analyses conducted by the load dispatch center. For bottom-up projects, the operational study justifies asset replacement based on existing conditions. Issues in operational studies typically revolve around data quality and the timeliness of the assumptions used. Which resulted in inaccuracy of analysis.

   Financial studies, as previously mentioned, estimate benefits differently for RUPTL projects and bottom-up projects. RUPTL projects use revenue-generating metrics such as NPV and IRR, while bottom-up projects use benefit assumptions from ENS. Despite automated spreadsheets for calculations, the financial analysis process is challenging due to the assumptions that analysts must determine. There are competency issues in estimating financial benefits, especially for bottom-up projects. Training is provided only once, and some analysts have not attended

any training, resulting in varying quality of financial studies. This inconsistency is also evident at the transmission level, as mention in the previous section.
Risk assessment is divided into two parts: justifying the project proposal and ensuring its execution according to the plan. The risk assessment form used is qualitative and provided by the headquarters, classifying projects into five risk levels. Evaluators find it difficult to prioritize projects based on this qualitative risk assessment as it lacks quantitative reliability analysis. Although Asset Management has produced a Risk Appetite Statement (RAS) to guide risk treatment, awareness and understanding of this document are low, even among top management. Lastly, legal and compliance assessments focus on good corporate governance as required by regulators.
Overall, despite the extensive supporting documents, the lack of reliable data and information affects the accuracy and validity of assumptions in the analyses. The absence of standardized approaches for conducting analyses and the insufficient competency for performing and evaluating analyses impact the confidence level in decision-making.

5. **Plan for contingencies** During the case study, the examples provided by respondents did not include contingency planning. This may be due to incomplete selection of respondents or the interview questions not specifically addressing the topic of contingency planning.
6. **Performance management** During the case study, performance management was conducted by another division responsible for establishing KPIs for all directorates and operational units. Consequently, similar to the case of contingency planning, respondents did not provide information on how performance is managed. However, there is clear evidence that in conducting investment appraisals and project feasibility studies, the performance contribution of asset management investment projects was not identified. This resulted in the organization being unable to quantitatively measure and evaluate the effectiveness of undertaking such investment projects, especially in relation to grid performance. This condition leads to the existing organization unable to identifies the contribution of UITJBB towards the realization of energy transition program.

**Supporting Tools**

For this category, there are three elements as follows:

1. **Strategic planning information system:** During the case study, the examples provided by respondents did not include the strategic planning information system. However, based on observations, there is currently no clear alignment between the organization's strategic objectives and asset management activities at the operational unit level. Therefore, the primary priority is not on providing an information system, but on bridging the strategic and operational aspects through the development of the Strategic Asset Management Plan (SAMP).

2. **Strategic monitoring dashboard:** During the case study, the examples provided by respondents did not include the strategic monitoring dashboard. This may be due to incomplete selection of respondents or the interview questions not specifically addressing the topic of contingency planning.
3. **Updated planning tools for projecting, forecasting and budgeting:** Currently, projecting and forecasting demand is conducted by the Load Dispatch Center unit. Since this is outside the scope, the tools and approaches used could not be determined. However, an interesting observation is that the RUPTL document has been revised almost annually over the last nine years. Additionally, the evaluation processes by the TVV and KI teams have also noted that some RUPTL projects were rejected because the data used during their preparation was no longer relevant to the existing conditions. Furthermore, respondents from the transmission division also stated that there are substations with very low load due to the low accuracy of RUPTL projection.

## 6.2 Step 2: Observation of the learning organization: System thinking

After observing and analyzing the specificity elements, the next step in the analytical framework is to examine the learning organization element, to identify the existing learning process in PLN. The framework approaches this by presenting a series of questions that explore the characteristics of a learning organization, specifically within the context of structural elements and the use of knowledge, tools, and methodologies, which were explained in the previous section. The following section will detail each element along with the corresponding observations and analysis.

### 6.2.1 Has the organization embedded systems thinking in its design?

Based on the analysis of PLN's organizational design, it is evident that the current planning processes operate within a fragmented system. There is a clear lack of connection between different planning horizons, preventing the power system from being viewed as an integrated whole. Planning is conducted separately for new and existing assets, leading to an overemphasis on new asset projects, particularly those with significant budgets, as these receive special attention from top management. Meanwhile, existing assets are only addressed in the short-term annual budget planning by the operational unit.

The absence of systems thinking in the existing organizational structure suggests that PLN is not fully leveraging its capabilities to support the energy transition. The current focus is primarily on adding green energy capacity, but there is no dedicated function to plan how to reliably deliver and distribute this energy to consumers. While an asset management approach can contribute to this, this fragmentation or siloed approach is also apparent in the organizational design for asset management, where the

current structure does not allow for the full integration of asset management into existing planning activities. The asset management function is placed solely within the transmission directorate, raising questions about how this function can effectively integrate generation, transmission, and distribution as a whole. Furthermore, the governance of asset management is unclear in terms of developing strategic planning, and there is a lack of adequate resources, such as competent personnel and multidisciplinary experts. Asset information, a critical component of asset management, also lacks a dedicated function, resulting in a lack of awareness about data quality, despite digitalization being one of the organization's main programs.

### 6.2.2 Does the organization strive for maturity in the planning process with the use of knowledge/tools/methods?

Based on the observation of PLN's use of knowledge, tools, and methodologies in the planning process, it is clear that the organization operates at a low maturity level, particularly in asset management. The absence of a Strategic Asset Management Plan (SAMP) highlights significant knowledge gaps within PLN, hindering the development of this essential document. Additionally, the asset management planning process, which is central to PLN's operations, reveals a lack of expertise in applying critical methodologies such as risk assessment, reliability analysis, Whole Life Cost (WLC), financial impact analysis, and business case development.

The limited understanding of asset management principles in PLN Holding has led to the establishment of approaches without providing the necessary guidance for effective implementation. Although there is growing awareness in UITJBB of the need for more practical methodologies—driven by the challenges of prioritizing bottom-up projects—the existing competence gaps result in the selection of inappropriate methodologies, leading to inaccuracies in project justification. This issue is further compounded by the poor quality of available data, making it difficult for PLN to conduct complex analyses, as reliable data is lacking.

Moreover, PLN does not mandate consistent training for its processes. For instance, in conducting operational and financial analyses, there is no continuous process to ensure that analysts possess the necessary skills. This lack of focus on training means that the maturity of competencies required for these tasks is not assessed. Similarly, the quality of evaluations varies, as evaluators are not provided with adequate training, and there is no mechanism to measure how effectively they perform their evaluations.

The existing condition at PLN shows that as an organization, they are not yet fully prepared to transition into the energy transition era. Managing renewable energy requires not only technological competencies but also managerial competencies, particularly in strategic planning and asset management. Without these critical skills, the organization may struggle to effectively integrate and optimize renewable energy resources, making it difficult to achieve long-term sustainability goals and fully leverage the benefit of the energy transition.

**How are continual improvements reflected in the organization's structure and the use of knowledge, tools, and methods**

The Continual improvements yang dimaksud dalam konteks ini, adalah continual improvement menuju improved maturity of asset management practice, which clearly still not the case in PLN, both in the structure or the use of knowledge, tools, and methods. Despite undergoing significant transformations, the organization lacks clear mechanisms for continual improvement based on asset management principles, leading to slow or stagnant progress in asset management. Instead, the organization seems to follow a pattern of addressing symptoms rather than root causes, which creates additional side effect issues and ultimately exacerbates the root problem. By using a systems thinking approach, this pattern can be visualized through a models to illustrate the dynamics of how PLN focuses on symptoms, in this case, insufficient investment budget, rather than addressing the underlying causes.

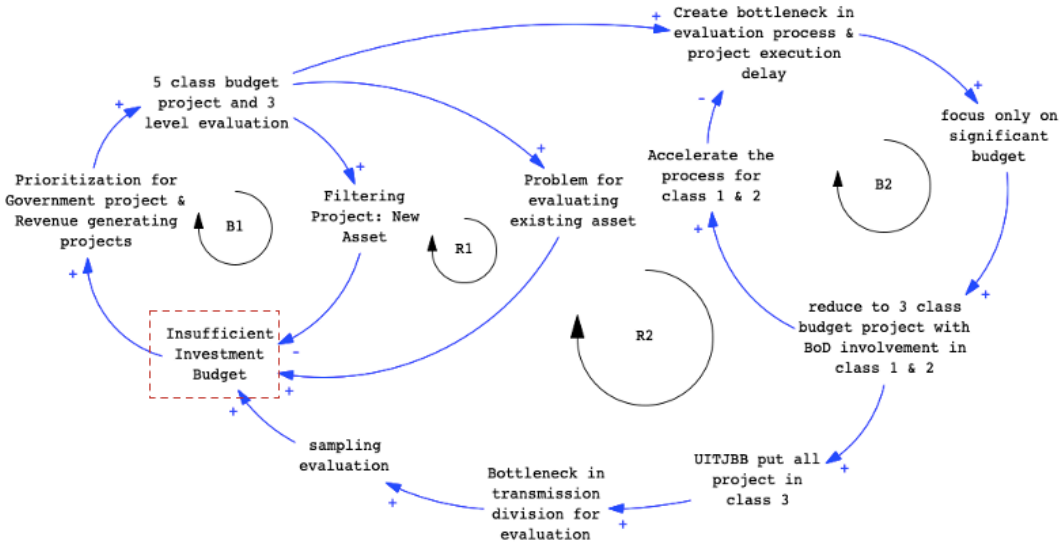


**Figure 6.1:** *Dynamic complexity of Learning process in PLN.*

The above diagram can be understood by identifying and analyzing its key elements, arrows, and feedback loops. Each element in the diagram represents a variable influencing the system, such as "Insufficient Investment Budget," "Filtering Project: New Asset," and "Focus Only on Significant Budget." Arrows between these elements show the direction of influence, with plus (+) signs indicating positive correlations (where an increase in one element leads to an increase in the next, or a decrease leads to a decrease) and minus (-) signs indicating negative correlations (where an increase in one element leads to a decrease in the next, or vice versa).

Start by recognizing the initial symptom: the "Insufficient Investment Budget." This central issue prompts prioritization efforts, initiating the balancing loop B1. In B1, prioritization for government projects and revenue-generating initiatives leads to the implementation of a five-class budget project and a three-level evaluation process.

This implementation appears to work in filtering projects for new assets, which reduces the symptoms. However, this approach leaves a problem in prioritizing existing assets, further reinforcing the initial symptom (Loop R1) and creating a new problem of bottlenecks in the evaluation process and project delays.

This new problem is then identified by the organization as a new symptom, leading to another short-term solution: reducing the classification from 5 to 3 budget classes, focusing on significant budgets in classes 1 and 2, and ensuring a different composition of evaluation teams. For classes 1 and 2, EVPs across the organization and the Board of Directors are involved, while class 3 is evaluated by the transmission division. This short-term solution seems to work, as the number of projects decreases, particularly for classes 1 and 2, as shown by the balancing loop B2. However, the transmission division learns that class 3 projects are only evaluated by them, leading them to fit the budget into class 3, creating additional bottlenecks for the transmission system and leading to sampling evaluations.

This new problem creates a loop that further reinforces the original symptoms (R2), so the initial symptom remains and even escalates. Through this visualization, it is clear that the emergence of new symptoms diverts attention away from the initial symptom. Because of the excessive focus on addressing the symptoms, PLN neglects more foundational issues that hinder the process of continual improvement in asset management.

## 6.3 Step 3: The Emerging Challenge: Barriers in Fostering the Learning Process

Based on the observations in the previous steps, this section identifies the emerging patterns of main challenges in PLN's efforts to implement asset management in support of the energy transition program. The findings reveal significant gaps in PLN's structure and the use of knowledge, tools, and methodologies, which pose serious challenges to its capacity to navigate the complexities of transitioning to a sustainable energy future. The following themes have been identified to connect these issues with further discussion and recommendations in the next chapters.

- **C1 - Strategic and Operation Planning Disconnect:** PLN's strategic planning is disjointed across timeframes—long-term (RUPTL), medium-term (RJP), and short-term (RKAP). The RUPTL focuses heavily on adding new assets, the RJP sets conflicting high-level objectives without clear operationalization, and the RKAP struggles to propose bottom-up projects due to a lack of alignment with organizational objectives. This misalignment results in planning that prioritizes new green power plants and related infrastructure but neglects the maintenance and reliability of existing assets. This imbalance poses a risk to grid stability, as the existing infrastructure may not be adequately prepared to handle the influx of new energy sources.

- **C2 - Absence of a Strategic Asset Management Plan (SAMP):** The SAMP, essential for defining high-level strategies for all assets within the scope of PLN asset management, is still not in place. Its development has been delayed due to the broad scope needed to address all asset classes, but the existing structure is not equipped with proper resources (governance, people, tools, and data). The absence of the SAMP is particularly concerning, as it is a critical document for planning energy transition initiatives in a more comprehensive and integrated manner.
- **C3 - Ineffective Governance and Leadership Involvement in Project Appraisal:** The current governance structure for investment project appraisal is time-consuming and heavily reliant on top management. This structure occupies top management with operational projects, particularly those involving significant budgets, diverting their attention from comprehensive strategic planning. As a result, there is insufficient focus from the top management on a holistic approach that considers both new and existing assets to effectively support long-term goals, such as the energy transition.
- **C4 - Existing Governance Risks Towards Potential Bottlenecks in Energy Transition Planning:** The existing governance approach risks creating bottlenecks in energy transition planning by assuming that developing new green power plants and transmission lines alone will suffice. This approach fails to integrate these new assets effectively into the existing infrastructure. Moreover, it overlooks the importance of comprehensive planning that proactively identifies and mitigates potential risks to the power system, emphasizing the need for a more preventive planning style to address future uncertainties.
- **C5 - Lack of Data-Driven Decision Making in the Existing Structure:** The current structure fails to equip evaluators with the tools and processes necessary for data-driven decision making. The lack of a standardized approach to project evaluation, coupled with foundational issues such as poor-quality data, results in low confidence in decision-making. This challenge is further exacerbated by the absence of a dedicated function for information management, which is crucial for ensuring the availability and reliability of data.
- **C6 - Ineffective Asset Management Structure for Supporting Energy Transition Initiatives:** The current asset management structure within the transmission directorate lacks clarity on how asset management will be implemented across generation, transmission, and distribution sectors. It also does not define how to coordinate with related functions or specify the appropriate team composition and competencies required for personnel. This limitation hinders asset management's ability to fully support the energy transition initiatives.
- **C7 - Existing Governance Creates Inconsistencies in Bottom-Up Project Prioritization and Evaluation:** The current governance framework for proposing the annual budget lacks a standardized approach for evaluating and prioritizing projects. This inconsistency in decision-making can result in suboptimal

resource allocation, potentially overlooking critical projects like grid modernization, which are essential for increasing reliability and supporting the energy transition.

- **C8 - Unclear Roles and Responsibilities:** The unclear delineation of roles and responsibilities between the transmission division (which should provide strategic direction) and UITJBB (the operational unit) creates confusion. The transmission division needs to provide guidance and methodologies beyond merely evaluating projects, especially for the bottom-up planning process, on how to align them with the broader energy transition initiatives.
- **C9 - Requirements for the SAMP Development:** As the SAMP document is not yet developed, this framework can serve as input to PLN on the type of knowledge, tools, and methods that should be available in developing the SAMP to ensure it bridges the misalignment between strategic organizational planning and asset management in the context of the energy transition.
- **C10 - PLN Holding Emphasizes Methodology for Top-Down Projects:** The existing approach provides a standard methodology for RUPTL projects but neglects existing assets. As a result, PLN applies the same methodology to both top-down and bottom-up projects, leading to inaccuracies in bottom-up project analysis.
- **C11 - Lack of Understanding in Asset Management Tools, Knowledge, and Methodology in the Context of Electric Utilities:** The current situation reveals significant competency gaps in applying appropriate asset management planning methods. This has led PLN Holding to implement approaches like risk-based budget proposals and financial studies without fully considering their operationalization at the UITJBB level. Moreover, PLN has yet to recognize the importance of methods such as Whole Life Cost (WLC) analysis, understanding the long-term financial impacts of maintenance and renewal, and developing robust business cases—critical elements for achieving their objectives.
- **C12 - Poor Data Quality:** The lack of a standardized approach at PLN is compounded by poor data quality and a lack of awareness about the importance of proper asset data management. This deficiency hinders the ability to perform accurate and complex analyses and limits the effectiveness of tools and methods that rely on high-quality data.
- **C13 - Planning Inaccuracy:** Observations indicate that the current knowledge, tools, and methodologies used at PLN are suboptimal, negatively impacting the quality of planning documents. The frequent revisions of the RUPTL and the absence of quantitative metrics to assess how program proposals contribute to organizational objectives highlight significant inaccuracies in PLN's planning processes.

# 7

# Discussion

This chapter presents a discussion that synthesizes the findings of this study with theoretical concepts and practical implications. The chapter is organized to address the theoretical implications of the research, and explore the broader scientific, societal, and organizational contexts.

## 7.1 Theoretical implication

This section connect the analysis and interpretation of the analytical framework implementation in the previous chapter, with the implication on theoretical concept of asset specificity and learning organization

### 7.1.1 Asset specificity implication

Since asset specificity is rooted in economic theory, its implementation is often observed in economic studies, primarily to assist firms in making strategic decisions about whether to internalize certain transactions (vertical integration) or rely on the market (outsourcing) (Ceccagnoli et al., 2010; Jain et al., 2013). This study applies the concept differently to offers new perspective in utilizing this concept within a state-owned organization, aiming to identify the specific resources the organization must possess to implement a new way of working, in this case, asset management.

An interesting finding in this study is that, given the interest of this study to implement the asset management approach within electric utility, consequently the elements of asset specificity identified in various literatures revolve around or align with the requirements of asset management. In other words, for PLN, asset management itself constitutes an asset specificity that by theory should influence transactions within the organization and serve as a reference for organizational structure design.

However, the type of asset specificity currently identified at PLN differs from that of asset management. The primary focus of asset specificity is on "projects with significant budgets." This conclusion is drawn from the observation that the current organizational design is heavily oriented towards evaluating large-budget projects, leading

to the establishment of governance principles like the four eyes principle, which includes the creation of the TVV function and an investment committee involving top management. The emphasis on significant budget projects has led to a new type of specificity, namely "human" specificity, where the role of top management in project evaluation becomes critically important.

This specificity identified in the PLN context has resulted in a lack of integrated strategic planning at PLN, which not only threatens the effective implementation of asset management but also hinders the achievement of organizational objectives, particularly those related to the energy transition. Therefore, an insightful addition to the asset specificity concept would be not only to identify asset specificity for transaction efficiency within the organization but, more importantly, to understand what type of specificity aligns with the achievement of organizational objectives. The goal should be to identify a specificity that allows the organization to be more effective in reaching its goals.

### 7.1.2 Learning organization implication

The learning organization theory emphasizes the importance of systems thinking as the fifth discipline, focusing on the interconnectedness of organizational elements rather than linear cause-effect chains. Aligned with the critique of this theory, it is indeed very difficult to identify the elements within existing studies on how to measure systems thinking within an organization. Therefore, by developing the framework containing the elements of a learning organization, this study seeks to contribute to connecting this theory with the empirical world. However, it should be noted that this study specifically explores the learning organization in the context of asset management to support energy transition initiatives.

One of the tools used in this study to operationalize this concept is the system dynamics modeling approach, as systems thinking is deeply rooted in this methodology. It can also be observed by identifying recurring patterns of behavior or structures that commonly occur in complex systems, often referred to as archetypes. These archetypes are essentially models that help explain why certain problems or outcomes consistently arise in different situations.

In the case of PLN, the relevant archetype is "fixes that fail," which is characterized by a cycle where solutions to a problem initially seem to address the issue but ultimately lead to unintended consequences that exacerbate the original symptoms. This "fixes that fail" archetype illustrates PLN's tendency to treat symptoms rather than addressing the root causes of issues, leading to repeated cycles of temporary solutions that do not resolve the underlying problems. The "fixes that fail" pattern highlights the lack of essential systems thinking disciplines observed at PLN. Two key disciplines are particularly missing:

- **Seeing interrelationships rather than linear cause-effect chains**: Currently, PLN relies on a traditional perspective that views problems as having direct cause-

and-effect relationships, usually in a straight line (e.g., "A causes B, which causes C"). This approach prevents the organization from recognizing variables as interconnected entities, which in turn hinders the continual improvement process from addressing issues at their roots. For example, prioritizing certain projects without considering their impact on overall resource allocation has led to bottlenecks and delays.

- **Seeing the process of change rather than snapshots**: Planning at PLN is still oriented towards single fiscal year budget allocations. This narrow focus overlooks the importance of understanding the process of change, which involves identifying long-term trends and considering the impact of previous decisions on current challenges. For instance, repeated short-term budgeting has not addressed the underlying issue of resource insufficiency, perpetuating the cycle of budget shortfalls.

The lack of these essential disciplines results in the learning process at PLN not yet achieving generative learning, where the organization continually evolves towards sustainable change. Instead, the learning process only reaches the stage of adaptive learning, as it is still focused on continually making necessary adjustments and improvements based on immediate feedback and experiences.

This approach of combining the observation of organizational elements identified in the literature with system dynamics modeling can provide valuable insights into specific organizational behaviors that hinder continual improvement. By visualizing these patterns, the organization can gain a clearer understanding of how certain behaviors and structures contribute to ongoing issues. Moreover, this approach can be expanded to predict the organization's future state if these patterns persist, highlighting how decisions that consistently produce unintended side effects may eventually lead to the collapse of the organizational structure. This predictive capability underscores the importance of addressing root causes rather than merely treating symptoms, enabling the organization to implement more sustainable and effective strategies for long-term success.

## 7.2 Implications for scientific context

This research is scientifically significant as it addresses a critical gap in the current body of knowledge concerning the intersection of organizational learning and asset management within the context of the energy transition. The application of theories such as the learning organization and asset specificity to real-world practices, particularly in large, state-owned enterprises like PLN, has not been extensively explored. By examining how these theoretical frameworks can be integrated and applied to enhance learning processes in asset management, this study advances both theoretical understanding and practical application of organizational theories.

The findings of this research offer valuable insights that can inform the develop-

ment of more effective strategies for organizational adaptation and evolution in response to the global shift towards sustainable energy. Furthermore, this study identifies specific institutional elements necessary for fostering a learning organization within the unique context of state-owned enterprises managing critical infrastructure. The outcomes of this research could serve as a foundation for further academic inquiry and provide practical solutions for organizations navigating the complexities of the energy transition.

### 7.2.1 Research Methodology Implication

This study contributes to the existing scientific literature by developing an analytical framework that can be used to investigate institutional elements from an organizational perspective. The added value of this research lies in the integration of different theories—specifically asset specificity and learning organization—into a cohesive framework focused on asset management. The application of the asset specificity concept allows for the identification of key institutional elements within the organization. By analyzing these elements, the research method facilitates an understanding of the learning process and highlights the barriers preventing the organization from adapting and evolving in response to new challenges.

The analytical framework identified through the literature review has two key impacts. First, it enables the identification of broad organizational aspects, ensuring that the developed framework is comprehensive. However, a limitation is that, due to the novelty of applying this theory, the literature search strategy required tailoring to obtain relevant sources. For example, in this research, identifying asset specificity in strategy and planning involved using broad keywords like ”strategy and planning” and then extracting specificity from the literature itself. This iterative process of developing the literature review was subjective and dependent on judgment.

As this analytical framework serves as a starting point for research in this area, future studies can refine and improve the framework with a more structured process to ensure that all organizational elements are well-defined. Initially, attempts were made to clarify with respondents whether the elements identified through the literature review were relevant to their conditions. However, respondents found these questions confusing, particularly due to unfamiliar terms used in the framework and the extensive range of identified elements, which resulted in minimal feedback.

Instead, more effective interview questions included those that prompted respondents to describe their experiences and provide specific examples. These open-ended questions made respondents more comfortable sharing their views, and sending questions in advance helped keep discussions focused. Thus, creating an analytical framework based on the literature review and observing its implementation within the organization proved more effective in uncovering organizational dynamics and identifying real problems. This approach was more productive than attempting to clarify the framework with practitioners, as academic terminology may differ from everyday

language used in organizations.

## 7.3 Implications for the societal context of Indonesia energy transition

In the context of energy transition, Indonesia faces the challenging target of achieving net zero emissions by 2060. This study highlights that the current approach taken by the government and PLN focuses predominantly on increasing green energy in the generation sector. While this strategy is not inherently flawed, it is complicated by a significant issue of overcapacity. Coal energy, which constitutes the majority of the energy mix, is being produced in quantities exceeding demand growth. Additionally, many coal power plants are bound by long-term contracts, meaning they have not yet generated the expected profit for the organization. This scenario creates profound uncertainty as the planned green energy projects will add to the existing capacity without clear visibility on future demand growth.

This situation underscores the complexity and deep uncertainty of Indonesia's energy transition, categorizing it as a wicked problem. Wicked problems are characterized by their complexity and lack of definitive solutions, requiring innovative and adaptive strategies.

Given the overcapacity and the financial constraints, PLN finds it challenging to consider the early retirement of coal power plants. Instead, the existing coal power plant will be combined with the Carbon Capture Storage (CCS) technology, to reduce the emission. While this approach is more corrective than preventive, it is a pragmatic solution considering the financial constraints and the risk to organizational continuity posed by the premature retirement of coal assets. However, as Indonesia has showed it commitments towards energy transition, it is crucial that Indonesia already take step by step to consider reducing dependency on the fossil fuels power plant.

In taking this step, PLN does not expect to directly implement the "coal-out" program. Instead, PLN should start considering strategic planning beyond 10 years. This long-term planning will allow PLN to project feasible scenarios, taking into account when fossil-fuel power plants will reach their break-even points, and begin to initiate the retirement of these fossil power plants. This means the program will be phased gradually to ensure that PLN does not suffer significant losses. To ensure that this phased coal-out commitment is put into action, PLN can incorporate this initiative into the RUPTL, making it a national initiative.

Furthermore, by creating a plan that extends beyond 10 years, PLN can adopt a more strategic orientation, not only focusing on detailed projects but also considering how the power system will evolve over the next 25 to 50 years. This includes contemplating whether PLN will integrate all the islands or start reaching out to neighboring countries, thus fulfilling its vision to become a top company in Southeast Asia. With this strategic orientation, PLN can focus on business sustainability, considering how

policies and regulations can accommodate PLN's long-term plans, projecting long-term financial impacts, infrastructure development, long-term risks, and identifying suitable innovations and technologies for future implementation.

Currently, even though the RUPTL is considered a long-term strategic plan, the project-based approach to strategic planning raises questions about whether it truly serves long-term purposes or is more operational in nature, or a mix of both. This aligns with the findings of this research, highlighting a significant gap in strategic planning. The focus remains on individual projects, particularly generation projects, neglecting the comprehensive view of how the power grid will handle massive energy demands in the future. PLN should not wait until its power plants are ready to start thinking about reliable transmission and distribution infrastructure.

## 7.4 Implications for organizations seeks to implementing asset management

Despite the abundance of guidance and standards governing asset management implementation, the readiness of the organization significantly influences whether the benefits of this implementation can be realized. Specifically, a bottom-up initiative for implementing asset management within an organization might face similar challenges as PLN, where there is a misalignment between the organization's direction and principles and those of asset management. Therefore, to achieve maturity in its implementation, careful consideration is needed for this approach. Without substantial support from the organization, combining it with a top-down implementation approach that aligns organizational objectives with asset management principles is crucial. Additionally, a prerequisite analysis of the organization's condition is necessary, including mapping resources, particularly the readiness of competencies and data, to support implementation. Without this consideration from the outset, the change process will be challenging to achieve.

# 8

# Recommendations

Section 6.3 highlights the challenges identified in the structural elements and the utilization of knowledge, tools, and methodology within PLN's planning process, which have hindered the effective implementation of asset management and prevented it from serving as an enabler for the energy transition. Furthermore, Chapter 7 explore the implications of this study for the energy transition in Indonesia, which also identifies some opportunities to bring the energy transition into practice. Considering above challenges and room for improvement, This chapter is specifically dedicated to providing an improvement plan for PLN to advance and enhance its ability to learn both in organizational structure and in the use of knowledge, tools, and methodology.

## 8.1 Improvement in the Organizational Structure

This section provides practical improvements related to the organizational structure in PLN to ensure that the structure accommodates the learning process towards asset management practice. The points are presented with unique codes for further mapping with the challenges identified in Section 6.3 .

- **R1** - Ensure that the RUPTL accommodates the integration of existing assets by explicitly listing significant maintenance and renewal activities for critical assets. To achieve this, involve the transmission unit in the planning process to gain a comprehensive view of the entire power system, from generation to distribution, and ensure that the RUPTL discusses how new projects will integrate with existing assets, especially in the context of renewable energy. This approach will push the government and PLN to start thinking and anticipating future challenges, especially with the anticipated increase in renewable energy coming online. This collaborative approach will ensure that both new projects and maintenance needs are adequately addressed.
- **R2** – Consider broadening the scope of the RUPTL from a project-focused approach to one that is more strategically oriented, emphasizing long-term objectives for the future of the electric system in Indonesia. This should include projections on network configuration and technology advancements, considering

island interconnections and a coal phase-out scenario. This strategic orientation can provide a comprehensive view of Indonesia's energy transition plan, better preparing PLN for future uncertainties.

- **R3** - Develop and implement a Strategic Asset Management Plan (SAMP) to bridge the gap between strategic and operational levels. Ensure that the strategy in the SAMP is aligned with the energy transition initiatives. Regularly update the SAMP to reflect changes in the organizational environment and technological advancements.
- **R4** - Reconsider the existing approach to the evaluation process by not relying solely on executives and EVPs for each project evaluation, as this limits their ability to focus on strategic matters. Instead, establish a clear framework that delegates evaluation tasks to subject matter experts, incorporates standardized criteria and metrics, utilizes appropriate tools and data analytics based on available data to streamline the process, and includes a feedback mechanism for continuous improvement. This will allow for more efficient and effective project evaluations, enabling executives to concentrate on higher-level strategic planning.
- **R5** - To effectively integrate PLN's asset management, the structure should be critically reassessed with a focus on:
  - **Governance**: Establishing robust governance mechanisms that enhance coordination with other key functions such as risk management, IT, generation, transmission, distribution, and related subsidiaries and sub-holdings.
  - **Role Clarity**: Defining clear roles and responsibilities to avoid functional overlaps and ensure accountability.
  - **Resource Allocation**: Ensuring adequate resources, not only in terms of staffing but also in competencies, with a particular emphasis on multidisciplinary expertise.
- **R6** - As there is a significant issue in data quality, while PLN appears ready for digitalization by integrating data from various scattered applications, this study advises PLN to pay more attention and commitment to improving data quality by establishing a function dedicated to managing data over its life cycle. This dedicated function should be responsible for setting data quality standards, implementing robust data governance practices, and ensuring regular audits and validations. By focusing on improving overall data quality, PLN can enhance the reliability of information used for decision-making, support more accurate planning and forecasting, and ultimately drive better outcomes in asset management and operational efficiency. Additionally, investing in staff training and development in data management practices will ensure sustained improvements and adherence to high data quality standards across the organization.
- **R7** - Develop and implement a competence framework to measure, map, and fulfill the competencies required for effective asset management. Conduct reg-

ular assessments and provide ongoing training and professional development opportunities to address competency gaps and keep skills current and relevant. Regularly review and adjust the structure and competence framework to ensure they remain effective and aligned with organizational goals and the evolving needs of the energy transition.

## 8.2 Improvement in the Utilization of Knowledge, Tools, and Methods

To support structural improvement, the utilization of appropriate knowledge, tools, and methodologies is critical to accelerating the learning process. Similar to the previous section, the points are presented with unique codes for further mapping with the challenges identified in Section 6.3.

- **R8** – Determine and implement the standardization methodology in developing asset management planning, especially in the project appraisal method. Clearly differentiate the approach for top-down and bottom-up projects based on their added value. Implement asset management methodologies such as WLC and other financial impact analyses for maintenance and renewal projects. It is important to note that the method selected should consider data quality to ensure relevance, and avoid using complex methodologies that do not bring significant impact.
- **R9** – Ensure that the relevant functions within PLN Holding understand and provide guidance on the implementation of risk management in the context of asset management, with a particular focus on the future energy transition. This includes how to connect reliability with risk assessment and how to ensure that future uncertainties—such as the integration of renewable energy sources, evolving regulatory frameworks, shifts in market dynamics, and advancements in technology—are effectively incorporated into the risk management process. By aligning risk management strategies with the goals of the energy transition, PLN can better anticipate and mitigate risks that could impact the reliability and sustainability of its energy infrastructure.
- **R10** - Improve the maturity of the employees who perform specific analyses, such as risk assessment, financial and operational analysis, etc., by providing regular training and implementing a maturity assessment framework.
- **R13** - Establish clear metrics and KPIs to quantitatively evaluate the effectiveness of asset management projects, particularly in terms of grid performance. Regularly review and adjust these metrics to ensure they remain relevant and accurate.
- **R14** - PLN should be careful in selecting tools to support the planning process, considering the current poor data quality. Avoid complex and high-function tools initially; instead, choose tools that are suitable for the existing resources.

Gradually improve data quality and subsequently upgrade the tools as the data quality improves.

## 8.3 Mapping of the challenge and recommendation

In this section, we focus on ensuring that the recommendations provided in this thesis directly address the challenges identified in PLN's asset management and energy transition efforts. By mapping challenges to recommendations, we aim to provide practical and actionable solutions that are relevant to PLN's needs. This approach enhances clarity by clearly linking each recommendation to a specific issue, ensuring that the solutions are not only theoretical but also grounded in the realities faced by PLN. The mapping presented in a Table 8.1 below.

**Table 8.1:** *Mapping of Challenges to Proposed Recommendations*

| **Challenge** | **Proposed Recommendation** |
|---|---|
| C1 - Strategic and operation planning disconnect | R1, R2, R3 |
| C2 - Absence of a Strategic Asset Management Plan (SAMP) | R2, R3, R6 |
| C3 - Ineffective governance and leadership involvement on project appraisal | R4 |
| C4 - Existing governance has risk towards potential bottlenecks in energy transition planning | R1, R4 |
| C5 - Lack of Data-Driven Decision Making in the Existing Structure | R6, R10, R14 |
| C6 - Ineffective Asset Management Structure for Supporting Energy Transition Initiatives | R5, R7, R9 |
| C7 - Existing governance creates inconsistencies in Bottom-Up Project Prioritization and Evaluation | R4, R8, R13 |
| C8 - Unclear Roles and Responsibilities | R5, R7 |
| C9 - Requirements for the SAMP development | R3, R8 |
| C10 - PLN holding emphasizes the methodology for top-down projects | R2, R8 |
| C11 - Lack of understanding in asset management tools, knowledge, and methodology in the context of electric utilities | R8, R9, R10 |
| C12 - Poor Data Quality | R6, R10, R14 |
| C13 - Planning Inaccuracy | R13, R14 |

# 9

# Conclusion

## 9.1 Conclusion

As this research's main objective is to answer the research question:

*"How can PLN enhance its learning processes to effectively implement changes in transmission asset management by understanding their asset specificity, in order to fully support the energy transition?"*

To answer this question, an analytical framework was developed and applied to a case study of PLN's planning activities. This approach provided valuable insights into the processes and challenges within PLN that hinder the effective contribution of asset management to the energy transition. In summary, the conclusions drawn from addressing the research sub-questions are as follows:

**Sub RQ-1: How can institutional elements from different theoretical perspectives be integrated into a framework to improve the learning process for implementing asset management in the transmission sector planning?**

This sub-question is addressed in Chapter 4, where institutional elements are identified through a comprehensive literature review. The elements from the learning organization literature are listed in Table 4.2, while Figure 4.1 presents elements from asset specificity in strategic planning, and and Table 4.3 covers elements from asset management requirements. These elements were integrated by categorizing the similar characteristics of asset specificity and asset management into three main categories: input, process, and output. The process category was further divided into structure, knowledge/tools/methods, people/culture, and financial resources. The output category was split into output characteristics and output products, as illustrated in Figure 4.3

To understand the learning process for implementing asset management in transmission sector planning, the initial framework was quite broad. Therefore, it was refined to focus on two key elements: structure and knowledge/methods/tools. The structure element was categorized into governance and organization design, roles and responsibilities, and coordination and collaboration. The knowledge/methods/tools element was divided into strategy development, asset management planning, and sup-

porting tools.

Additionally, the learning organization aspect was explored through three guiding questions: (1) Has the organization embedded systems thinking in its design? (2) Does the organization strive for maturity in the planning process through the use of knowledge/tools/methods? and (3) How are continual improvements reflected in the organization's structure and the use of knowledge, tools, and methods? This refined framework guided the case study implementation, with the detailed integration process outlined in Section 4.2.

**Sub RQ-2: How have infrastructure planning and asset management practices at PLN evolved over the last decade?**

The complete answer to this question is provided in Chapter 5, which offers a detailed exploration of the evolution of infrastructure planning at PLN. Below is a high-level summary:

Since 2015, PLN's transmission network planning followed two approaches: a top-down approach based on the RUPTL (national business plan), which details new asset projects like power plants and transmission assets, and a bottom-up approach for existing assets focusing on maintenance and renewal, aligned with PLN's five-year strategic plan (RJP).

In 2021, PLN underwent a major transformation, revising its vision to focus on becoming a Green, Innovative, Customer-Focused, and Lean organization. This led to a restructured RUPTL prioritizing energy transition and establishing a new project evaluation process using a four-eyes principle involving top management.

By 2022, this process was revised due to inefficiencies. Now, only projects with significant budgets (>150 billion IDR) undergo rigorous evaluation by the TVV and KI, while smaller projects are reviewed by division supervisors, such as the Transmission Division for UITJBB projects.

Simultaneously, asset management was integrated into the organization, creating a dedicated division and asset management functions within streams. Despite developing key guidelines, such as the asset management policy (AM Policy) and Strategic Asset Management Plan (SAMP), implementation faces challenges due to limited awareness, unclear roles, and insufficient coordination. Consequently, these guidelines are not yet fully utilized in planning processes, leaving the role of asset management at the transmission level unclear.

**Sub RQ-3: What challenges does PLN face in implementing asset management for the transmission sector in the context of the energy transition, and how can these challenges be addressed based on insights from the theoretical framework and case study analysis?**

Through the application of the analytical framework in a case study, several emerging challenges were identified, leading to the formulation of corresponding recommendations, which are summarized as follows:

To address the strategic and operational disconnect (C1), it is crucial to ensure that the RUPTL accommodates existing assets by explicitly including significant main-

tenance and renewal activities for critical assets (R1). Additionally, broadening the scope of the RUPTL to include long-term strategic objectives and projections on network configurations, considering future challenges such as island interconnections and coal phase-out scenarios, will provide a more comprehensive strategic orientation for the energy transition (R2). The development and regular update of a Strategic Asset Management Plan (SAMP) is essential to bridge the gap between strategic and operational levels, ensuring alignment with energy transition initiatives (R3).

Governance challenges (C3, C4, C7) can be mitigated by redesigning the evaluation process to reduce reliance on top management for every project appraisal, thus allowing them to focus on strategic matters. This includes establishing a framework that delegates evaluation tasks to subject matter experts, incorporates standardized criteria and metrics, and utilizes appropriate tools and data analytics (R4). Additionally, enhancing coordination mechanisms within the asset management structure, ensuring clear roles and responsibilities, and establishing robust governance will help integrate asset management across all levels (R5).

To improve data-driven decision-making (C5, C12), it is necessary to establish a dedicated function for data management, focusing on improving data quality through setting standards, implementing robust governance practices, and ensuring regular audits (R6). Selecting appropriate tools that align with existing resources and gradually upgrading them as data quality improves is also recommended (R14).

Finally, addressing challenges related to unclear roles and responsibilities (C8), understanding asset management tools and methodologies (C11), and resolving planning inaccuracies (C13) involves creating clear frameworks for asset management, ongoing training, and developing a competence framework to measure and fulfill the required competencies for effective asset management (R7, R8, R10, R13).

## 9.2 Research Limitations

As a qualitative study, this research has several limitations that could impact the results, as explained below:

1. **Assumptions in Literature Review**: It was challenging to identify literature that explicitly defines elements of specific theories. As a result, assumptions were made, especially when searching for literature on asset specificity, using keywords related to strategic planning. The assumption was that key factors found in strategy and planning processes could be categorized as asset specificity.
2. **Number of Respondents**: Not all representatives from different fields and divisions could be interviewed due to the large number of involved divisions. This might result in findings that are not fully representative. Although attempts were made to cross-check with internal documents, the risk remains.
3. **Interview Data Presentation**: Interview data is presented in aggregated form with the researcher's interpretation, which could introduce bias in determining

relevance for analysis. The analysis and interpretation processes might also contain researcher bias in deciding which data is relevant for inclusion.

4. **Limited Scope**: This analysis only considers the changes in the UITJBB organizational structure, without considering changes in the Transmission Division.

## 9.3 Future Research

Reflecting on the overall challenges encountered in this study, potential improvements are suggested for future research:

1. **Organizational Readiness for Energy Transition**: While many current studies focus on technology in energy transition, there is a lack of emphasis on the readiness of key actors to support this process. Studies measuring organizational readiness for energy transition could provide policymakers with insights to develop policies that better support the preparedness of key organizations involved.
2. **Refining the Analytical Framework**: The analytical framework developed in this study could be refined by conducting more structured and comprehensive literature reviews to ensure all organizational elements are well-defined and validated. Researchers can also apply the framework in different organizational contexts to test its robustness and adaptability.
3. **Development of an Ideal RUPTL**: Explore how an ideal RUPTL can be developed to fully accommodate Indonesia's energy transition goals. This research will pinpoint the actual strategies for integrating renewable energy, managing overcapacity, phasing out coal, and technological utilization.

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# Appendices

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# A

# Appendix 1: Interview protocol

## A.1 General explanation of research to the respondent

**INTERVIEW PROTOCOL FOR MASTER THESIS RESEARCH "CHANGE MANAGEMENT TO IMPLEMENT ASSET MANAGEMENT, CASE STUDY: STRATEGY AND PLANNING AT PLN INDONESIA"**

Information for Respondents
Dear Sir/Madam,

Thank you for your willingness to participate in my research, which is a requirement for the MSc. Engineering and Policy Analysis program at TU Delft. This research is part of the 2022 PLN Study Assignment Program.

The research topic is exploratory and relates to how organizational theory can be applied to understand the challenges faced by an organization when implementing new systems, methodologies, or ways of working. In this context, I am focusing on the implementation of Asset Management in strategy and planning at PLN.

My research consists of two parts: the development of a conceptual framework through a literature review and the implementation of this framework through interviews with PLN employees. Through this interview process, we aim to gain insights into the real processes involved in strategy and planning at PLN, which will then be compared with the developed conceptual framework.

As part of this document, and a requirement from TU Delft, I am sending you the Informed Consent Document to read, check, and sign. This document explains that the interview will be recorded, and the data and information provided will be processed anonymously and aggregated to ensure no sensitive information is disclosed.

**Figure A.1**

## A.2 Interview question

**Interview Questions**

Here are the questions we will ask during the interview. However, depending on the interesting insights provided for each one, we may focus more deeply on certain questions.

1. Existing Processes, Knowledge, and Tools/Methods in Planning Activities
    - Attached to this document is a PDF file titled "PLN Planning Visualization," which we created from the RUPTL document (planning process), PLN's organizational structure, and the current strategic AM documents available. To what extent does this visualization represent the activities at PLN, and which domain are you involved in within this process?
    - In your planning activities, can you provide a list of the knowledge, tools, or methodologies you use in planning?
    - Could you explain step-by-step the planning process you follow using the knowledge, tools, or methodologies mentioned in the previous question?
2. Measuring Maturity of Knowledge and Tools/Methods
    - How did you acquire the knowledge and tools/methods you mentioned in the previous question?
    - Is there a formal process at PLN to assess the maturity of knowledge or the skill level in using these tools/methods?
    - Are the current knowledge and tools/methods adequate? What do you need to become a better planner in the future?
3. Verification of the Conceptual Framework
    - At this stage, we will show you a list of knowledge, tools, and methodologies from our literature review (which will be adjusted according to your domain). According to you, could you prioritize them from most important to least important in the context of PLN?

**Figure A.2**

## A.3 PLN planning Visualization

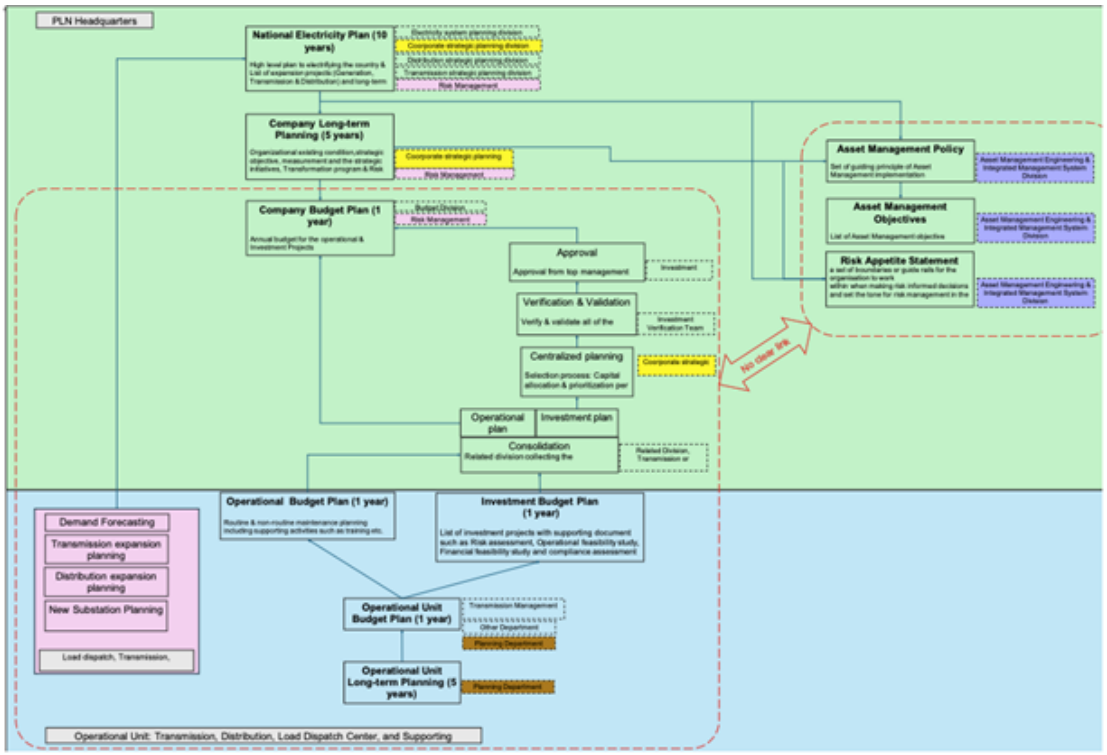
PLN Headquarters
National Electricity Plan (10 years)
Company Long-term Planning (5 years)
Company Budget Plan (1 year)
Asset Management Policy
Asset Management Objectives
Risk Appetite Statement
Approval
Verification & Validation
Centralized planning
Operational plan
Investment plan
Consolidation
No clear link
Operational Budget Plan (1 year)
Investment Budget Plan (1 year)
Demand Forecasting
Transmission expansion planning
Distribution expansion planning
New Substation Planning
Load dispatch, Transmission,
Operational Unit Budget Plan (1 year)
Operational Unit Long-term Planning (5 years)
Operational Unit: Transmission, Distribution, Load Dispatch Center, and Supporting

**Figure A.3**

# B

# Appendix 2: Asset specificity in strategic planning

## B.1 Detailed explanation of asset specificity in strategic planning

**Table B.1:** *Summary of Strategic Planning Specificity and Element Classification*

| Author | Strategic Planning Specificity | Element | Element Classification |
|---|---|---|---|
| **Brews and Purohit (2007)** | • Symbolic: Defines the company's mission and strategic direction<br>• Rational: Formalizes planning, from high-level goals to specific actions, reinforced by budgets and control<br>• Transactive: Allows iterative planning with continuous adaptation and real-time feedback<br>• Generative: Fosters innovation in products/services and internal processes | • Symbolic planning<br>• Rational planning<br>• Transactive planning<br>• Generative planning | Output: planning characteristic |
| **Ocasio and Joseph (2008)** | Dedicated channels streamline executive decisions and focus<br>Vital information flow through channels ensures strategic plan efficacy | Governance and information flow to involve executive in a planning cycle | Structure |
| | The CEO shapes strategic planning for lasting impact | Leadership for long term planning | Culture |
| | Adapt strategic planning for evolving corporate needs and styles | Planning flexibility | Output: planning characteristic |
| **Lassila et al. (2011b)** | Investment strategy, reliability aims, distribution fee development, and return targets | Information for strategic decision making | Input |
| | • Provides guidelines for network technologies, organization objectives and the investment strategies applied to the long-term planning<br>• Tackles network development execution questions, priority setting, and impact analysis | • Long-term Investment strategic objective<br>• Workability issue<br>• Prioritization<br>• Impact analysis/risk | Knowledge/ tools/ method |
| | Long-term implementation plan | Long term strategic plan | Output: product |
| **Hernandez et al. (2015)** | • An information system for tracking, reviewing and managing data regarding organizational strategic plan and defining metrics<br>• An information system possibly in a form of strategic dashboard using stoplight indicators in order to follow up on the plan | • Strategic planning information system<br>• Strategic monitoring dashboard | Knowledge/ tools/ method |
| **Suryani et al. (2015)** | Long-term prediction of the consequences of long-term financing on maintenance and renewal strategies | Financial Impact Analysis on Maintenance and Renewal | Knowledge/ tools/ method |
| **Nazemi et al. (2015)** | Implement effective performance metrics | Performance management | Knowledge/ tools/ method |
| | • Structure the organization to support strategic execution<br>• Form strategy teams from diverse organizational tiers | • Organizational design support strategic execution<br>• Human capital alignment | Structure |
| | • Align HR talent with strategic action requirements<br>• Ensure managerial competence on the organization's vision | Strategic competence for managerial and planning team | Competence |
| | Shift culture to value strategic planning for dynamic environments | Strategic Planning Culture | Culture |
| | Make plans flexible to external changes impacting the organization | Planning flexibility | Output: planning characteristic |
| | Secure adequate budget and resources | Secure budget allocation | Financial resources |
| **Upreti et al. (2019)** | Centralized planning to synchronize generation, transmission and distribution as well as other related industry sectors | Centralized planning of generation, transmission and distribution | Structure |
| | Updated planning tools that are efficient in projecting, forecasting and budgeting | Updated planning tools for projecting, forecasting and budgeting | Knowledge/ tools/ method |
| | Hybrid way of planning which involve both short-term, medium-term as well as long-term planning | Integrated planning approach | Output: planning characteristic |

# C

# Appendix 3: Asset Management Requirements

## C.1 List of identified asset management requirements in strategy and planning

**Table C.1:** *Summary of Elements and Classification*

| Author | Elements & Classification |
|---|---|
| **Sasidharan et al. (2021)** | Utilizing risk informed decision support tool with 2 important analyses (knowledge):<br>• Whole life cycle cost analysis [tools/knowledge]<br>• Risk Assessment [tools/knowledge] |
| **Mathieu et al. (2017)** | Core process of Transmission Asset Manager:<br>• Asset performance analysis [tools/knowledge]<br>• Continual improvement [structure]<br>• CAPEX (Capital Expenditures) and OPEX (Operational Expenditures) Management [tools/knowledge]<br>• Information management [structure]<br>• Risk management [tools/knowledge] |
| **Brown et al. (2013)** | Integrated Strategic Asset management Framework:<br>• Environmental factors (risk and sustainable consideration) [input]<br>• Effective stakeholders management practice [knowledge]<br>• Whole of government policy framework [input]<br>• Organizational strategic management (Governance, Corporate policy, vision & mission statement, Values) [input]<br>• AM Policy, AM Objectives, AM strategy [output product]<br>• AM Planning (Acquisition plan, Operation plan, Maintenance plan, Disposal plan) [output product] |
| **Kellick (2010)** | Improvement in developing strategic asset management framework:<br>• Clear roles and responsibility between strategic asset management roles and operational and service delivery roles [structure]<br>• Strategic and integrated planning [structure]<br>• Decision-making framework [tools]<br>• Cross-function, multidisciplinary teams [structure]<br>• Executive support [culture] |
| **Brito et al. (2020)** | Strategic asset management approach:<br>• Planning horizon: short (5 years), medium (20 years) and long-term (50–70 years) [planning characteristic]<br>• Planning scope: identify the mechanism of asset in delivering service to find the minimum unit of analysis [input]<br>• Decision based on functional area not per asset [knowledge/tools/method]<br>• Identification of functional asset class [input]<br>• Identify asset current value [input]<br>• Intervention alternatives with decision support tools [tools] |
| **The IAM (2021)** | Primary elements of the asset management system include development of Strategic Asset Management Plan (SAMP) with:<br>• Input from organization strategic plan and Asset Management Policy [input]<br>• SAMP including Asset Management Strategy, Asset Management Objective and Strategic Development Plan for AM capabilities which used as a guideline to develop Asset Life Cycle Management plans and Asset Management Resources, Processes, Competencies & Technologies [output/product] |
| **The IAM (2014)** | Role: Strategy development<br>Competence unit:<br>• Analyze strategy requirements:<br>– The organization's strategic plan<br>– Relevant other organizational policies and strategies<br>– Legislative and regulatory frameworks<br>– Organizational stakeholders and how their requirements are reflected in the organization's strategic plan and business goals<br>• Forecast and analyze future user requirements and demands:<br>– Market analysis techniques and econometric modeling<br>– Managing working capital<br>– Cash flow forecasting<br>– Asset condition assessment and degradation modeling<br>– Cost forecasting, budget preparation and financial management<br>– Relevant accounting terms and conventions<br>– Environmental management standards and excellence models<br>– Sustainability principles and the application of sustainable development excellence models<br>– The implications of severe weather and climate change<br>• Develop the AM strategy:<br>– How organizational AM strategies support business goals<br>– AM strategies and how these are reflected in AM objectives and plans<br>– AM decision-making: capital investment, operations and maintenance, lifecycle cost and value optimisation, resourcing strategy and optimisation, shutdowns and outage strategy and optimisation, aging assets strategy<br>– The inter-relationship of business and AM processes<br>– Content and applicability of relevant business excellence models<br>– The strengths and weaknesses of relevant business process excellence models<br>– Identification of appropriate metrics for analysis and interpretation of information to monitor the business benefits of AM strategies<br>– Processes and procedures for developing strategic options and comparing and assessing their benefits and impacts<br>– Methods and techniques for competitor analysis<br>– Relevant developments in the business environment and their impact on stakeholder expectations<br>• Plan the implementation of the AM strategy:<br>– Benefit tracking and the selection and use of appropriate methods<br>– Stakeholder management and consultation processes<br>– The effect of stakeholder expectations on AM plans<br>– The impact of changing economic/stakeholder expectations on day-to-day management of assets<br>– The impact of changing economic/stakeholder expectations on the long term management of assets<br>– Relevant national and international legal and regulatory frameworks<br>– The importance of identifying how future planning can be improved<br>• Asset Management Planning:<br>– Appraise investment planning<br>– Apply whole life costing principles<br>– Produce business case for creation and/or acquisition of assets<br>• Plan for contingencies:<br>– Relevant internal and external communications process and procedures<br>– Standards and procedures for incident and emergency response and recovery<br>– Management of materials, logistics and supply chains<br>– Procurement strategies applicable to the acquisition/creation of assets<br>– Design specifications: establishing client requirements<br>– Ensuring accuracy and practicability of design specifications and that they are achievable |