

DEVELOPMENT OF DIGITAL TRANSFORMATION SUPPLY CHAIN MANAGEMENT MATURITY MODEL AT PT PLN NUSANTARA POWER

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Abstract. PT PLN Nusantara Power, a subsidiary of PT PLN, has embarked on a digital transformation journey and implemented an effective organizational structure to support strategic initiatives in 2024. The digital transformation in the Supply Chain Management (SCM) sector began in 2021 with the introduction of E-Procurement. Maturity measurement of E-Procurement usage started in 2022 to encourage its adoption. Although technology has been integrated into SCM processes through supporting applications and Enterprise Resources Planning (ERP), a comprehensive maturity assessment of digital SCM application has not been conducted. In mid-2024, an enabler strategy for organizational effectiveness was applied to SCM processes in power generation units, impacting the uniformity of SCM maturity assessment loads. This research develops a SCM maturity model that includes digital SCM transformation assessment instruments and remaps the maturity model to ensure balanced and collaborative assessment loads. The model features four dimensions consisting of three SCM dimensions and a single dimension specifically for digital transformation, with nine indicators across five maturity levels: Fire Fighting, Stabilizing, Preventing, Optimizing, and Excellence.

Keywords: *maturity model, supply chain, power plant, digital transformation*

1 Introduction

The concepts of SCM and Logistics are also applied in asset management practices for power generation. According to Jelti et al. in [1], the importance of CM in the energy sector has attracted the attention of the public, private actors, and academic communities, with the knowledge that an effective supply chain for the energy deployment can extensively support power sector expansion. SCM also managed by PT PLN Nusantara Power (PLN NP) in power generation to support the procurement of goods and services needed for managing physical assets to produce electricity and maintain equipment reliability. To achieve this, PLN NP established a division called Satuan SCM (SSCM) at its headquarters and created Logistics Departments at its power generation units. This division handle supply chain activities, including material inventory planning,

procurement processes, material storage in warehouses, and supplier development. SSCM also functions as a process facilitator, developing the SCM maturity model and acting as an assessor in evaluating the maturity level of SCM processes implemented by generation units. Maturity model is a tool that enable the assessment of the current situation and show a potential, possible, and typical development path towards the targeted situation [2].

In 2024, PLN NP unveiled the PLN NP 2.0 transformation roadmap, which identified digital transformation and organizational development as key enablers for the success of corporate strategic initiatives. Digital transformation had previously been implemented during the PJB 2.0 transformation in 2020. In 2021, the SmartSCM application was launched, featuring E-Procurement as a response to the PJB 2.0 digital transformation initiative. In line with the PJB 2.0 Transformation program, the SCM Division introduced a new maturity model to assess the maturity of SCM business processes at power generation units. This model was used to evaluate SCM business process maturity from 2022 to 2024 and continues to be maintained by SSCM as a measure of digital transformation. The maturity model retains the Logistics function as one of its dimensions but includes criteria in the Logistics Planning and Procurement Process indicators to assess digital transformation maturity, specifically the percentage of E-Procurement usage based on the total Purchase Order processes conducted via the E-Procurement application. The use of technology in SCM processes at PLN NP is not new, as various supporting applications and ERP usage had been implemented long before the digital transformation initiative. The maturity model should capture all ongoing digital initiatives. However, there are no specific dimensions or indicators to assess the maturity of digital implementation in the SCM maturity model.

Continuing the organizational development enabler program, PLN NP launched a program called Quick Win PLN NP, which includes the Lean Organization Power Plant initiative aimed at simplifying the organizational design at power generation units to be more streamlined. This initiative resulted in the elimination of the Logistics Division in their power generation unit by merging the Inventory Control & Cataloger Team and Warehouse Administration Team into the Maintenance Division, and transferring the Procurement Team to the Business Support Division. As a result, the SCM business processes will be carried out by two different Division: Maintenance and Business Support. SSCM, as the SCM process supervisor, must develop a new maturity model because the previous model was based on dimensions corresponding to each SCM function at the power generation units. The new maturity model must accommodate the organizational restructuring to be applicable in assessing the maturity of SCM processes at PT PLN NP.

2 Theoretical Background

2.1 Digital Transformation

Several definitions of digital transformation have been proposed in previous studies. According to Kalender et al. in [2], digital transformation is defined as a process carried out to redesign organizations, economies, companies and people through digital tools. Utama et al. in [3] describe digital transformation refer to applying new digital technologies to bring about significant business improvements, resulting in enhanced customer experience, streamlined operations, or the creation of new business models.

Gong and Ribiere in [4] attempted to define digital transformation based on previous research, noting that the term is often used inaccurately. They define digital transformation as a fundamental change process driven by the innovative use of digital technology, accompanied by the strategic utilization of key resources and capabilities. The goal of digital transformation is to radically enhance the entity and redefine its value proposition for stakeholders. Gong and Ribiere [4] emphasize that digital transformation is not just about technology but also involves significant strategic changes in how organizations operate and create value. They highlight the importance of a strong theoretical foundation and systematic analysis of existing definitions as crucial steps to better understand and apply the concept of digital transformation.

2.2 Maturity Model

According to Sener et al. [5], a maturity model is a framework based on the successful implementation of organizational capabilities, encompassing a flow of objectives and sequential levels or stages. The maturity of an organization reflects its ability to manage the development and improvement of each business process [6]. Lasrado et al., in [7], analysed literature related to maturity models and identified five key components to describe the developed maturity model:

1. Maturity Levels: Also referred to as stages or maturity scores, each level must have distinct characteristics that can be empirically tested [8].
2. Dimensions: Defined as the main variables or success factors of a maturity model [9].
3. Subcategories: Secondary level variables influenced by their respective dimensions [10].
4. Path to Maturity: Tiered indicators that show the completeness of maturity fulfillment at a given level [7].
5. Assessment Questions: Statements directly related to maturity values used as achievement parameters [7].

Lasrado et al., in [7] identified three development models that can guide the development of a maturity model. These models have different procedural characteristics depending on the focus area [11]. Lasrado et al., in [7] reference the study by De Bruin et al., in [12] which presents a six-phase development model representing the scheme for defining maturity characteristics. In contrast, Becker et al., in [13] propose a procedural scheme aligned with the planned scientific design, focusing more specifically on the case of re-modeling previously applied maturity models. Solli-Saether and Gottschalk in [14] theorize the maturity model towards future growth development, utilizing knowledge sources and empirical data in each phase of development.

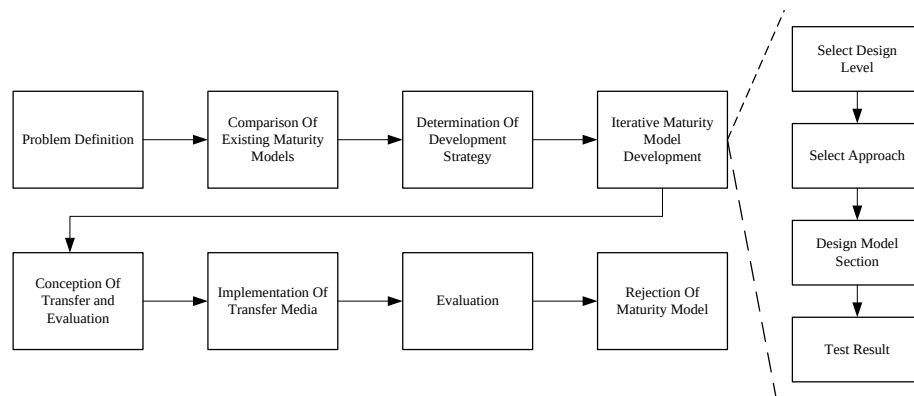


Figure 1 Becker et al., in [13] procedural maturity model development

2.3 SCOR Model

The SCOR (Supply Chain Operations Reference) model version 12.0, released in 2017 by APICS [15], represents a significant advancement in the global standard for supply chain excellence. The model continues to provide a comprehensive framework that links business processes, performance metrics, practices, and people skills into a unified structure. This enables organizations to measure, improve, and communicate their supply chain performance effectively. SCOR v12.0 is based on six distinct management processes:

1. **Plan:** Involves the activities associated with developing plans to balance supply and demand, aligning supply chain plans with business financial plans.
2. **Source:** Encompasses the processes related to procuring goods and services to meet planned or actual demand.
3. **Make:** Covers the processes that transform products to a finished state to meet planned or actual demand.

4. Deliver: Includes the processes that provide finished goods and services to meet planned or actual demand, including order management, transportation, and distribution.
5. Return: Involves the processes associated with returning or receiving returned products for any reason, including post-delivery customer support.
6. Enable: Encompasses the processes that support the other five processes, including managing business rules, performance, data, resources, facilities, contracts, and compliance

3 Development of digital transformation supply chain management maturity model

The basis model utilized in this study refers to the maturity development model by Becker et al., in [13]. This model was selected due to its inclusion of a comparative analysis between the old maturity model and the new maturity model to be developed. Becker et al., in [13] focus on developing additional criteria that were not present in previous maturity models to ensure broader applicability. The following are the stages of maturity model development from Becker et al., in [13] used in the development of the digital transformation SCM maturity model at PLN NP.

3.1 Problem Definition

According to the basis model by Becker et al., in [13], the first stage is problem definition. This study addresses the lack of a maturity model that evaluates the overall use of digital SCM technology in alignment with the company's digital transformation aspirations and necessitating an updated maturity model to assess the maturity of the new organizational structure.

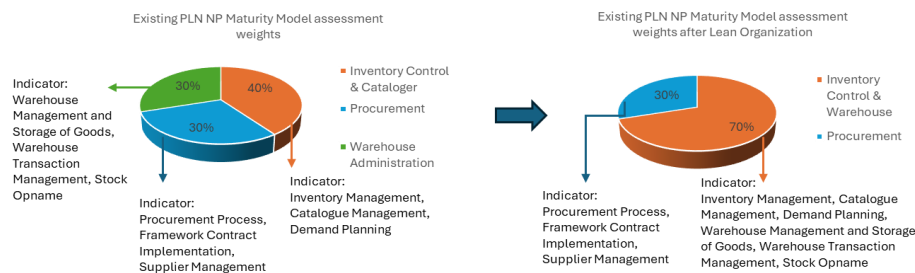
3.2 Comparison Of Existing Maturity Model

At this stage, a comparison with the previous maturity model is conducted to identify how the new maturity model can address the shortcomings of the previous one [13]. In Table 1, a comparative analysis is conducted between the existing maturity level of SCM at PLN NP and the maturity levels of SCM reported in other studies.

Table 1 Existing PLN NP SCM maturity model and other supply chain maturity model comparison

No	Authors	Focus	Supply Chain Operational Dimension	Digital Dimension	Supported SCOR Model V12 Processes (plan, source, make, deliver, return, enable)
1	Asdecker and Felch [16]	Outbond Logistics or Delivery Process	✓	-	Deliver
2	Frederico et al. [17]	Industry 4.0	-	✓	Enable
3	Mcormack et al. [18]	SCM performance	✓	-	Plan, Source, Make, Deliver
4	Weerebahu et al. [19]	Digital Supply Chain	-	✓	-
5	PLN NP SCM Maturity Model 2022-2024 [20]	Power Plant	✓	-	-

As previously mentioned, the Lean Organization program has restructured the organizational framework for SCM processes. Figure 2 illustrates the comparison between the conditions before and after the implementation of Lean Organization, highlighting the resulting differences in assessment weights.

**Figure 2** PLN NP SCM Maturity Model indicator & team in charge comparison

From Figure 2, we can observe that out of the 3 teams in the PLN NP power generation unit almost equally share their SCM maturity assessments weight. Due to the presence of a Lean Organization program there are only 2 teams in PLN NP power generation unit that responsible for SCM business processes. This results an uneven distribution of assesments weights. 70% weights by the Inventory Control and Warehouse Team, and 30% weights by the Procurement Team. This situation has triggered the need for remapping the maturity model to better balance the assessment load.

3.3 Determination Of Development Strategy

Based on the Table 1 and Figure 2, The absence of a digital dimension in the SCM PLN NP maturity model, the rigidity and lack of collaborative structure in the dimensions and indicators, and the follow-up of the Lean Organization

program, a strategy for developing a new SCM PLN NP maturity model can be formulated. This strategy involves:

1. **Aligning Dimensions and Indicators with Digital Transformation Aspirations:** Ensuring that the dimensions and indicators reflect the goals of digital transformation.
2. **Incorporating Collaborative Processes:** Developing indicators that reflect collaborative processes between SCM entities.
3. **Equal Distribution of Maturity Assessment Weights:** Adjusting the assessment criteria to reflect the new functions resulting from the Lean Organization program, ensuring an equitable distribution of assessment responsibilities.

3.4 Iterative Maturity Model Development

According to [13], the Iterative Maturity Model Development stage is pivotal in the development of maturity models. This stage comprises procedural steps essential for constructing the maturity model.

3.4.1 Select Design Level

There are two approaches to measuring maturity levels: the Staged Approach and the Continuous Approach. In the Staged Approach, a level is assessed based on the completion of criteria at one level before progressing to the next [11]. In contrast, the Continuous Approach indicates a sequential order for achieving improvements within each indicator, allowing companies greater flexibility in choosing areas for improvement [21].

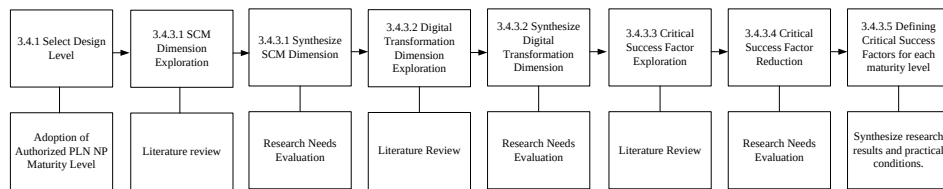
PLN NP employs the Staged Approach in its maturity assessments. This is because the maturity model developed within PLN NP is used to evaluate the extent of business process maturity and compare it with the performance contract targets each semester. This study adopts the PLN NP maturity levels as outlined in the board of directors' regulations regarding the Implementation of Performance Contract Assessment [20]. See Table 2 for levels of PLN NP maturity model.

Table 2 Maturity levels of PLN NP maturity model maturity model [20]

Level	Level Name	Level Description
≤ 1	Fire Fighting	Action taken after an incident occurs.
$1 < x \leq 2$	Stabilizing	Action taken in respond of incident.
$2 < x \leq 3$	Preventing	Action taken preventing incident.
$3 < x \leq 4$	Optimizing	Action taken for resource optimizing and continuous improvement.
$4 < x \leq 5$	Excellence	Achieving excellence in resource optimization & continuous improvement

3.4.2 Select Approach

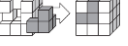
In this study, due to the adherence to the maturity levels established by PLN NP, a top-down approach is chosen for the development of the SCM maturity model. The illustration of the top-down approach for the maturity model design in this research is presented in Figure 3.

**Figure 3** Top-down approach for maturity model development

3.4.3 Design Model Section

According to Huner et al. in [22], there are five characteristics of adopting maturity model dimensions, each demonstrating different ways to adopt dimensions from existing maturity models. Those characteristics of adoption and are shown in Table 3.

Table 3 Model adoption characteristics [22]

Characteristics of Model Adoption Dimensions	Definition
Aggregation 	Adoption is carried out by combining the dimensions of several existing models.
Analogy 	Adoption of maturity model dimensions comprehensively, then refining them according to the needs of model development.
Configuration 	Adoption of dimensions is carried out only on the dimensions that are relevant to the research.
Instantiation 	Existing model dimensions are maintained, and new dimensions from other relevant models are added to the research.
Specialization 	Full adoption of a maturity model dimension by adding dimensions from other models according to the needs of the research.

According to the research by Pinto et al. in [23], the modelling of a new maturity model must be built by considering previous maturity models to maintain organizational balance and ensure a smooth transition to the new maturity model. Based on this hypothesis, the development of the model in this research will still be based on the existing SCM maturity model of PLN NP, which divides dimensions according to the functions of SCM processes in the unit, while adding digital transformation dimensions as an innovation of the model. Therefore, the characteristic of the dimensions chosen in this research is Instantiation, which means continuing to adopt the existing maturity model as the model's foundation, and then adding dimensions related to digital transformation as a response to the research needs.

3.4.3.1 SCM Dimension Exploration

A comprehensive literature review was conducted using keywords such as SCM maturity model, logistics maturity model, digital SCM maturity model, and logistics 4.0 maturity model. The findings indicate a common methodological approach in the development of maturity models, which involves adopting dimensions from the SCOR model developed by APICS in [15]. Synthesizing SCOR Model into SCM dimension for PLN NP maturity model shown in Figure 4.

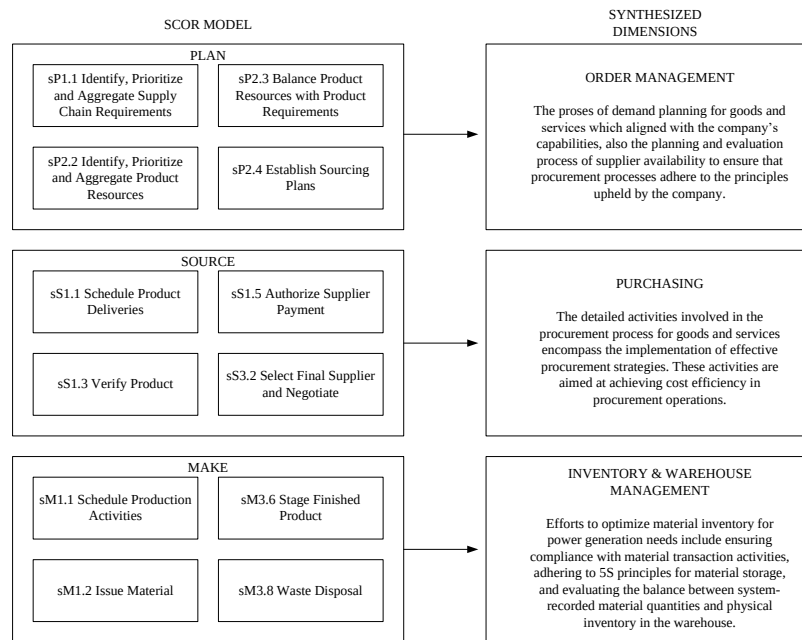


Figure 4 Synthesizing SCOR Model [15] into SCM dimension for PLN NP maturity model

3.4.3.2 Digital Transformation Dimension Exploration

Process of Digital Transformation Dimension Exploration follow the same procedural as SCM Dimension Exploration. After doing literature review, digital transformation can be extracted also from [15] in process called Enable. In addition to the study, research from Hellweg et al. in [24] has done literature review concerning dimensions of supply chain digital transformation. Figure 5 shows synthesized dimension regarding SCOR Model and Research from Hellweg et al. in [26].

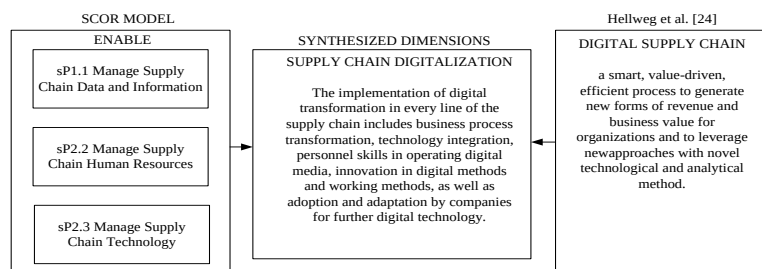


Figure 5 Synthesizing SCOR Model [15] and Hellweg et al. [24] research into digital dimension for PLN NP maturity model

3.4.3.3 Critical Success Factor Exploration

After designing dimensions for the maturity model, the next step is explore Critical Success Factor (CSF) from literature review to get the most accurate indicators regarding dimensions that has been determined before. The stop protocol for this step is when the data gathered sufficient enough to answer dimensions requirements and definitions. This step gathered 17 papers with 130 CSF. CSF gathered for this research are shown in Appendix A.

3.4.3.4 Critical Success Factor Reduction

As mentioned above, there are 127 CSF that need to be reduced accordance to indicator grouping of maturity model. The method of CSF reduction is to do CSF grouping with the similar meaning that match the definition of dimension. The grouping process of CSF reduction is shown in Appendix B. Table 4 show the result after CSF grouping and synthesized into model indicators.

Table 4 Digital Transformation SCM maturity model indicators

No	Dimension	Indicator	Definition
1	ORDER MANAGEMENT	demand planning	Strategic planning for procurement needs for goods or services in accordance with the PLN NP Procurement of Goods and Services guidelines by considering estimates of quality, quantity, time, place, socio-economic objectives, and costs in accordance with the appropriate procurement strategy based on the approved RUPTL and/or RKAP and the results of forecasting the provision of spare materials.
		procurement planning	Implementation of supply source planning to meet the needs of power plant reliability and the process of managing suppliers with the aim of obtaining goods or services of the right quality, right quantity, right time and right price.
2	PURCHASING	order processing	activities that include the procurement process, signing of Agreements/Contracts, implementation of Agreements/Contracts, handover of the results of implementation of Agreements/Contracts, and managing the billing process.
		purchasing efficiency management	the process of managing the procurement of goods and services in the most efficient manner, both in terms of time, cost, and use of resources with the aim of maximizing the value obtained from each procurement while minimizing waste and additional costs
3	INVENTORY & WAREHOUSE MANAGEMENT	Inventory Management	A process of controlling warehouse inventory that is carried out periodically, programmed, includes value, usage allocation, and usage plans, and measures the level of effectiveness and accuracy of planning needs, inventory, and purchases against usage realization.
		Warehousing	All physical material management activities include receiving, storing, issuing, returning used materials, material transactions and carrying out stock opname. This material management is supported by the implementation of the PLN NP Warehouse Management concept and the principles of 5S and safety rules.
4	SUPPLY CHAIN DIGITALIZATION	Enterprise Resources Planning	systematic organization, management, and maintenance of material information in digital format managed on the Ellipse information system.
		Procurement Platform	integrated software implementation that provides tools and functions to manage procurement processes
		ICT Capability	effectively use of digital technologies including the knowledge, skills, behaviors, and dispositions required for tasks and adapting capability to new technologies.

3.4.3.5 Defining Critical Success Factor to Each Maturity Level

After obtaining the dimensions and indicators, the next step is to define them into maturity level criteria or descriptions. The criteria created must align with the definitions of the adopted maturity levels. The definition of these criteria can be found in Appendix C.

4 Conclusion

The implementation of digital technology is crucial for companies to keep pace with the times. The diversity of technologies necessitates that companies have guidelines for assessing the application of digital technology in each business unit to realize strategic plans. A specific digitalization dimension can be used as a clear indicator of the achievement of digital implementation within an organization. Result of the digital dimension is expected to provide a clear and detailed pathway for each business unit to craft strategies of reaching higher maturity. For further research, the model must undergo testing, implementation, and evaluation to achieve the expected validity and reliability.

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