

EVALUATION OF THE TOTAL QUALITY MANAGEMENT OF SOLAR POWER PLANTS AT IBU KOTA NUSANTARA, INDONESIA

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Abstract. The construction of Solar Power Plants in the new capital city of Indonesia requires a dedicated approach to meet expectations, both from the government, citizens, and the environment. To achieve these expectations, the construction of Solar Power Plants must be assured in terms of quality, safety, and environmental preservation. This study aims to evaluate the implementation of Total Quality Management (TQM) at PLN UP3 in Ibu Kota Nusantara, Indonesia. The analysis method used in this study is descriptive qualitative. The evaluation is based on the ten key elements of TQM, including an obsession with quality, a scientific approach, long-term commitment, teamwork, education and training, controlled freedom, unity of purpose, and employee involvement and empowerment, which have all been optimally implemented within the company. However, the focus on customer satisfaction and continuous improvement has not yet been fully optimized.

1. Introduction

Ibu Kota Nusantara (IKN) is Indonesia's new capital, established by Law No. 3 of 2022. Located in Sepaku, North Penajam Paser, and part of Kutai Kartanegara, Ibu Kota Nusantara, Indonesia aims to be a sustainable global city, a national symbol, and an economic hub. Designed as a green, smart, and forested city, it targets zero emissions by 2045, with 100% renewable energy.

The initial renewable energy supply for Ibu Kota Nusantara, Indonesia will come from Solar Power Plants, with a projected need of 200 MW by 2030. PLN aims to build 50 MW by the end of 2024, with 10 MW already established as of February 29, 2024. Planned developments include ground-based and floating solar farms, as well as rooftop and dam-integrated systems. By 2045, Ibu Kota Nusantara, Indonesia's renewable energy mix will expand to include hydropower, wind, and other sources.

PLN Nusantara Power, a subsidiary of PT. PLN (Persero), is developing Solar Power Plants at Ibu Kota Nusantara, Indonesia in partnership with Sembcorp Singapore. President Jokowi led the groundbreaking in November 2023. The first phase, a 10 MW solar plant with 21,600 panels on 80 hectares, was connected to the grid on February 29, 2024, employing 337 local workers. Ibu Kota Nusantara, Indonesia now benefits from renewable energy.

A quality management system evaluation is essential to maintaining standards in the installation of solar PV at Ibu Kota Nusantara, Indonesia's Solar Power Plant. This study applies

ISO 9001:2015 to assess policies, SOPs, work instructions, and personnel, ensuring quality throughout the 50 MW project.

Gasperz defines a Quality Management System as documented procedures and standard practices ensuring compliance with process and product requirements. ISO 9001:2015 is a quality management standard that enhances customer satisfaction and strengthens company branding[1].

This study assesses the quality of personnel, materials, and Standard Operating Procedures (SOPs) in Solar Power Plant construction to ensure regulatory compliance and stakeholder satisfaction. Quality, often linked to standards, applies to products, services, processes, and environments. The American National Standards Institute defines standards as guidelines for optimal benefits, while ISO/IEC describes them as consensus-based rules. In ISO 9000, Quality Management Systems (QMS) cover organizational structure, responsibilities, procedures, and resources for maintaining quality.

2. Methods

The method used in this study includes conducting interviews with project leaders, employees, and workers involved, reviewing documents related to the quality management system, and direct observation at the Solar Power Plant installation site in Ibu Kota Nusantara, Indonesia. Data obtained from interviews and on-site observations are compared with Total Quality Management principles. The research is conducted through interviews, document reviews, and field visits.

3. Data and Discussion

3.1 Data Collection

The Solar Power Plant in Ibu Kota Nusantara, Indonesia is planned to have a capacity of 50 MW and is located in Pemaluan Village, Sepaku District, North Penajam Paser Regency. The project developer is a joint venture between PLN NR (51%) and Sembcorp (49%). The Power Purchase Agreement (PPA) scheme is a 25-year Take-or-Pay (BOO) arrangement. The project's financing scheme involves equity financing and refinancing after the Commercial Operation Date (COD), with an investment value of USD 64.2 million and a PPA tariff of 8.499 cUSD/kWh.



Figure 1. Ibu Kota Nusantara, Indonesia Solar Power Plants project profile

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The Ibu Kota Nusantara, Indonesia Solar Power Plant is planned to reach 50 MW, with groundbreaking by President Jokowi on November 23, 2023. PLN subsidiaries handle the installation from November to January 2024, followed by testing and commissioning in February. The first 10 MW, inaugurated on February 29, 2024, covers 89 hectares, with an additional 40 MW requiring 300 more hectares. The 10 MW plant received a synchronization feasibility certificate on February 29 and operational certificates for STS 1 and STS 2 on June 3, 2024.



Figure 2. Ibu Kota Nusantara, Indonesia Solar Power Plants layout

Previously, Sepaku's electricity was supplied via a 20 kV line from Ibu Kota Nusantara, Indonesia Mobile GIS (Gersik) and G Petung. A 150 kV transmission system was later built to GIS 4, which distributes power through the distribution line. GIS 4 connects to GI Kariangau via a High Voltage Overhead Line (SUTT) and an underground High Voltage Cable Line (SKTT) as it enters the KIPP Ibu Kota Nusantara, Indonesia area, where all cables must be buried. Refer to the guidelines document for further details.



Figure 3. Illustration of electricity infrastructure development in Ibu Kota Nusantara, Indonesia

The Solar Power Plants in Ibu Kota Nusantara, Indonesia will feature a Smart Grid, enabling

two-way electrical data flow via digital communication technology. This enhances issue detection and accelerates power recovery. Smart grid technologies like Advanced Metering Infrastructure (AMI) will allow real-time energy monitoring and management.

The OIKN deputy office also plans to implement Grid Monitoring and Control systems for improved supervision, rapid failure detection, and optimized grid operations. Additionally, hydrogen energy and Battery Energy Storage Systems (BESS) will support efficient energy storage, ensuring a stable and reliable renewable energy supply.

3.2 Electrical Commissioning Procedures in Grid Solar PV Systems



Figure 4. Solar Power Plants site



Table 1. Prerequisite conditions for each equipment/system

System	Equipment	QC Checklist Pre-comm	Pre-comm
MV System	MV Swgr Service Breaker	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O
	PV MV Swgr	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O
	PV Power Transformer	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O
	MV Cable	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O
STS System	MV Swgr STS	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O
	Power Transformer STS	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O
	LV Panel STS	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O
	MV Cable from/to STS	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O
	LV Cable from/to STS	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O
PV System	PV Module	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O
	Solar DC Cable	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O
	PV String Box	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O
	PV Inverter	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O
	Data logger	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O
DG System	Generator control panel	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O
	Unit Generator set	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O
Control System	Panel RMS	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O
	Cable Control/ communication	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O
	Sensor/ Instrument	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O
Utility/ Auxiliary System	Trafo Auxiliary (UAT)	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O
	Utility/ Aux pane	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O
	LV Cable	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O
Grounding System	Grounding Rods	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O
	Lightning Arrester	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O
	Bonding & PE	Ok/ Not Ok/ NA O	Ok/ Not Ok/ NA O

Prerequisites Conditions: Before starting commissioning activities, ensure that all prerequisite conditions for each equipment/system have been met.

3.3 Commissioning Procedure

Comissioning Edg System

EDG commissioning is carried out at the beginning with the aim of providing electricity supply for the power house utility needs (AC, lighting, etc.) and additional supply for the MV and LV systems. The following is the commissioning procedure.

Commissioning Aux System	Commissioning Panel Control / Scada	Back Feeding	Commissioning Pv Inverter	Abnormal Condition	Performance Test
<ul style="list-style-type: none"> Energize Auxiliary Transformer Energize Utility/ Aux Panel Lvmdp101 Energize S Performance Test Ac/ Dc Ups (Rectifier) 	<ul style="list-style-type: none"> Energize Panel Control (Scada) Setting Parameter, Register And Test Communication Function Test 	<ul style="list-style-type: none"> Energize Mv Swgr Output 1 Energize Pv Mv Swgr Energize Smart Transformer Station 	<ul style="list-style-type: none"> Pv Inverter - Setting Parameter 2 Pv Inverter - Energizing Synchronization Pv Inverter - Function S Monitoring 	<ul style="list-style-type: none"> Temperature Monitoring Abnormal Condition Monitoring 	<ul style="list-style-type: none"> Performance Ratio (Pr) Reliability Run (Rr)

4. Results and Discussion

Nusantara Power is responsible for building and managing Ibu Kota Nusantara, Indonesia's Solar Power Plants, with quality as its top priority. The project adheres to strict regulations, following SOPs to ensure systematic completion by qualified personnel using standardized materials. A data-driven approach supports decision-making, reinforcing quality and customer satisfaction.

Based on the interview, teamwork is considered essential at PT. Nusantara Power, with strong collaboration across employees, leaders, and departments to ensure efficiency and synergy. The company is committed to continuous improvement through prompt issue resolution, documentation, and preventive actions. Integrated systems and quick complaint handling further enhance work quality and stakeholder trust.

Training and education are key strategies to improve employee and leadership competencies. PT. Nusantara Power conducts targeted programs, including on-the-job training and workshops, to develop skills in communication, strategy, administration, finance, and monitoring.

PT. Nusantara Power promotes controlled freedom, allowing employees to express ideas while maintaining accountability. This approach fosters ownership and drives quality work. A unified purpose, guided by a Code of Conduct, ensures consistency in Solar Power Plants construction and energy distribution. The company empowers employees, encouraging responsibility and collaboration, with clearly defined job roles to enhance accountability and performance.

5. Conclusion

Based on the evaluation conducted on PT. Nusantara Power, it was found that Total Quality Management (TQM) has been implemented and is a commitment upheld by the company's leadership. The TQM principles have been effectively applied, including an obsession with quality, a scientific approach, long-term commitment, teamwork, education and training, controlled freedom, unity of purpose, employee involvement, and empowerment, all meeting expectations. For customer focus, the orientation is toward internal customers and stakeholders, specifically PLN. The TQM implementation at PT. Nusantara Power has become a shared commitment among both management and employees.

It is recommended that PT. Nusantara Power further prioritize TQM tools and apply them more broadly across the company. Continuous communication regarding quality should be maintained, with a view to formalizing these standards into comprehensive corporate policy.

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