A quantitative analysis of system loss reduction trends in the First Laguna Electric Cooperative Inc. (FLECO) from 2021-2025: A public administration perspective

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Abstract

This study aimed to analyze the system loss reduction trends of First Laguna Electric Cooperative, Inc. (FLECO) from 2021 to 2025 and determine the relationship between technical and non-technical measures and public administration perspectives in terms of efficiency, accountability, and governance. The study utilized a descriptive-correlational research design focusing on annual system loss percentages, variance from the ERC allowable cap, and operational interventions implemented by the cooperative. The respondents consisted of 100 selected personnel directly involved in system loss reduction activities, chosen through purposive sampling from 192 employees of FLECO. Data were gathered using a structured questionnaire with a 5-point Likert scale and supported by actual system loss records. Statistical tools such as frequency distribution, weighted mean, and Pearson correlation coefficient were used in analyzing the data. Findings revealed a consistent decline in system loss from 2021 to 2025, with all values remaining below the ERC allowable cap, indicating improved operational efficiency and regulatory compliance. Technical and non-technical measures showed a significant relationship with efficiency but no significant relationship with accountability and governance.

Keywords: System loss reduction; efficiency, accountability, governance, electric cooperative

1. Introduction

Electric cooperatives play a significant role in providing reliable and affordable electricity services, particularly in rural and semi-urban areas in the Philippines, in support of the government's rural electrification program (National Electrification Administration [NEA], 2023). They are expected to deliver efficient electric service while complying with the regulations and performance standards established by the National Electrification Administration (NEA) and the Energy Regulatory Commission (ERC). One of the key indicators of electric cooperative performance is system loss, which refers to the percentage of electricity distributed that does not generate revenue due to technical and non-technical losses (Energy Regulatory Commission [ERC], 2019). High system loss negatively affects operational efficiency, increases electricity costs, and may weaken consumer trust, accountability, and governance within electric utilities (ERC, 2019).

The First Laguna Electric Cooperative Inc. (FLECO) serves the fourth district of Laguna, covering municipalities including Lumban, Cavinti, Pagsanjan, Kalayaan, Paete, Pakil, Pangil, Siniloan, Mabitac, Famy, and Santa Maria. As an NEA AAA Category Cooperative, FLECO meets strict standards for financial performance, institutional stability, collection efficiency, and service reliability. Despite this, it continues to face challenges in reducing system loss, particularly at the municipal level, where infrastructure, terrain, consumer behavior, and operational constraints differ.

In recent years, the ERC has enforced stricter system loss limits, emphasizing line modernization, efficiency improvements, and elimination of electricity pilferage. FLECO's performance from 2021 to 2025 is notable amid rising energy demands and infrastructure needs, requiring effective compliance and modernization efforts.

System loss reduction involves technical measures such as line upgrades, transformer efficiency improvements, preventive maintenance, and accurate metering, along with non-technical measures like anti-pilferage campaigns, consumer education, governance reforms, and regulatory compliance. These factors demonstrate that reducing system loss is not only an engineering issue but also a public administration concern, reflecting efficiency, accountability, and governance in resource use, service delivery, and public trust.

Limited empirical research has quantitatively examined FLECO's municipal-level system loss performance. This study fills that gap by analyzing five-year trends (2021–2025) in a selected municipality and assessing the contributions of technical, operational, and governance-related factors. It further evaluates how these trends indicate organizational performance in efficiency, accountability, and governance which are the core pillars of public sector management.

By linking system loss trends to institutional measures, this study provides evidence-based insights to guide FLECO and other cooperatives in strengthening loss reduction strategies, improving management systems, and reinforcing their role as accountable, efficient, and well-governed electricity service providers.

1.1. Background of the Study

Electric cooperatives (ECs) in the Philippines play a crucial role in rural and semi-urban electrification by providing electricity services and supporting local development. As mandated under the National Electrification Administration (NEA), ECs are expected to ensure reliable service delivery, operational efficiency, and strong accountability in their operations (National Electrification Administration [NEA], 2023). One of the major performance indicators used in evaluating ECs is system loss, which refers to the portion of electricity purchased but not recovered as revenue due to technical and non-technical factors. High system loss negatively affects financial performance, reduces operational sustainability, and may contribute to higher electricity rates, thereby influencing public perception, service credibility, and governance outcomes (Energy Regulatory Commission [ERC], 2019).

The Energy Regulatory Commission (ERC) establishes and enforces system loss caps as part of its regulatory framework to promote efficient utility operations, infrastructure modernization, and fair electricity pricing. According to ERC regulations, exceeding allowable system loss limits may result in reduced revenue recovery, regulatory penalties, and lower performance ratings for electric cooperatives (ERC, 2019). Because of these regulatory implications, system loss reduction has become a national operational priority among ECs, guiding planning, investment decisions, and governance strategies in the power distribution sector.

The First Laguna Electric Cooperative Inc. (FLECO) serves eleven municipalities in Laguna's fourth district. Classified as an AAA Category Cooperative, FLECO demonstrates strong financial performance and compliance. However, system loss remains a challenge, varying by municipality due to infrastructure age, feeder length, consumer density, and unauthorized electricity use. The 2021-2025 period is critical, with rising energy demand, changing consumption patterns, and pandemic-related operational disruptions placing additional pressure on FLECO to maintain efficiency, strengthen governance, and ensure regulatory compliance.

System loss arises from both technical factors such as line condition, transformer efficiency, and preventive maintenance and non-technical factors, including electricity pilferage, meter tampering, weak consumer education, and ineffective enforcement. Administrative measures, including transparency, policy enforcement, and adherence to NEA and ERC guidelines, are essential in shaping both technical and non-technical outcomes.

From a Public Administration perspective, system loss reflects how an EC manages resources

(Efficiency), fulfills responsibilities to stakeholders (Accountability), and maintains ethical, transparent operations (Governance). For FLECO, system loss is a key performance indicator that influences ratings, public trust, and service sustainability.

Despite the recognized importance of system loss reduction in electric cooperatives, existing studies primarily focus on general technical analyses, with limited attention to cooperative-specific and context-based evaluations. Moreover, there is a lack of empirical research integrating technical and non-technical measures with public administration perspectives such as efficiency, accountability, and governance in cooperatives like the FLECO.

1.2. Theoretical Framework

This study is anchored on several foundational theories in public administration and organizational management to explain the relationship between System Loss Reduction Trends and Public Administration performance in electric cooperatives. The independent variables of the study include system loss reduction trends from 2021 to 2025, measured through the annual percentage of system loss and variance from the ERC loss cap; technical factors, including line upgrades, transformer efficiency, and preventive maintenance; and non-technical factors, including anti-pilferage programs and administrative control measures. The dependent variable is the Public Administration perspective, specifically in terms of efficiency, accountability, and governance.

System loss reduction in electric cooperatives is not solely a technical concern but also an administrative and governance issue. To understand this dynamic, the study draws upon Frederick Taylor's Scientific Management Theory, which posits that organizational efficiency is achieved through the standardization, measurement, and optimization of work processes. In the context of this study, Taylor's principles explain how technical interventions such as line upgrades, transformer efficiency improvements, and preventive maintenance which enhance operational performance by minimizing technical losses. By improving physical infrastructure and implementing systematic maintenance schedules, cooperatives are expected to reduce the annual percentage of system loss, thereby demonstrating efficiency in the use of resources.

Complementing the technical perspective, Max Weber's Bureaucratic Theory emphasizes rule-based operations, hierarchical control, and disciplined institutional processes. This theory provides a framework for understanding the influence of non-technical factors, such as anti-pilferage programs and administrative control measures, on system loss reduction. Through clear policies, monitoring mechanisms, and enforcement of regulations, electric cooperatives ensure compliance with NEA and ERC requirements, including adherence to allowable system loss caps. Weberian bureaucracy explains how structured governance, institutional control, and procedural discipline reduce non-technical losses and enhance organizational accountability, one of the key dependent variables of this study.

The study also integrates New Public Management (NPM) Theory, which emphasizes performance measurement, output-based evaluation, and consumer-oriented service delivery. The indicators of system loss such as annual % system loss and variance from ERC caps serve as measurable outcomes that align with NPM's focus on results-oriented management. By adopting performance-driven practices, including digital monitoring, auditing, and continuous evaluation of both technical and non-technical interventions, electric cooperatives can achieve sustainable system loss reduction while improving efficiency and governance in their operations.

Furthermore, Good Governance Theory, as articulated by the World Bank and UNDP, highlights transparency, accountability, rule of law, and effectiveness as central to organizational performance. This theory provides insight into how non-technical factors, such as administrative control measures and anti-pilferage initiatives, strengthen institutional integrity and reduce opportunities for electricity theft or misuse. Effective governance practices ensure that system loss reduction is not merely a technical outcome but also a reflection of sound administrative management, thereby directly influencing the governance component of the dependent variable.

Finally, Accountability Theory (Romzek & Dubnick, 1987) identifies hierarchical, legal, professional, and political dimensions of accountability. These dimensions explain how electric cooperatives implement multi-layered oversight mechanisms: hierarchical accountability through internal monitoring and preventive maintenance; legal accountability through compliance with ERC rules, NEA regulations, and RA 7832 (Anti-Electricity Pilferage Act); professional accountability through adherence to engineering standards; and political accountability through transparency to member-consumers. By incorporating accountability mechanisms, cooperatives can ensure that both technical and non-technical interventions effectively contribute to system loss reduction.

In summary, the independent variables such as system loss reduction trends, technical factors, and non-technical factors are theorized to influence the dependent variable, public administration performance, through multiple theoretical lenses. Taylor's Scientific Management Theory explains the efficiency gains from technical interventions; Weberian Bureaucracy and Accountability Theory explain how governance and anti-pilferage measures improve accountability; New Public Management emphasizes measurable outputs and performance monitoring; and Good Governance Theory frames the reduction of system loss as a reflection of transparent and effective administration. Together, these theories provide a comprehensive understanding of how system loss reduction interventions contribute to the efficiency, accountability, and governance performance of electric cooperatives like FLECO.

1.3. Conceptual Framework

This study examines how system loss reduction interventions implemented by the First Laguna Electric Cooperative Inc. (FLECO) influence organizational performance from a public administration perspective. The framework conceptualizes the relationship between independent variables, the system loss reduction trends, technical factors, and non-technical factors, and the dependent variable, which is public administration performance measured in terms of efficiency, accountability, and governance.

The first independent variable, system loss reduction trends from 2021–2025, is operationalized through annual percentage of system loss and variance from the ERC allowable loss cap. These indicators serve as measurable outcomes reflecting the cooperative's operational performance over time. Changes in these trends indicate the effectiveness of both technical and non-technical interventions and provide a quantitative basis for assessing improvements in efficiency, accountability, and governance.

The second group of independent variables, technical factors, includes line upgrades, transformer efficiency improvements, and preventive maintenance. These interventions are designed to reduce technical losses by improving the reliability and efficiency of electricity distribution infrastructure. From a public administration perspective, technical improvements contribute primarily to efficiency, demonstrating the cooperative's ability to utilize resources optimally and deliver reliable service to its member-consumers.

The third set of independent variables, non-technical factors, encompasses anti-pilferage programs and administrative control measures. These initiatives target non-technical system losses, ensuring compliance with NEA and ERC regulations and strengthening institutional integrity. Effective implementation of these programs enhances accountability by enforcing rules and procedures and promotes governance by fostering transparency, stakeholder engagement, and ethical management practices.

The dependent variable, public administration performance is evaluated through efficiency, accountability, and governance. Efficiency reflects operational effectiveness in minimizing system loss through technical interventions. Accountability captures the cooperative's adherence to regulatory requirements, oversight mechanisms, and responsible administrative practices. Administrative control measures the cooperative's transparency, integrity, and responsiveness to member-consumers, demonstrating the overall quality of organizational management.

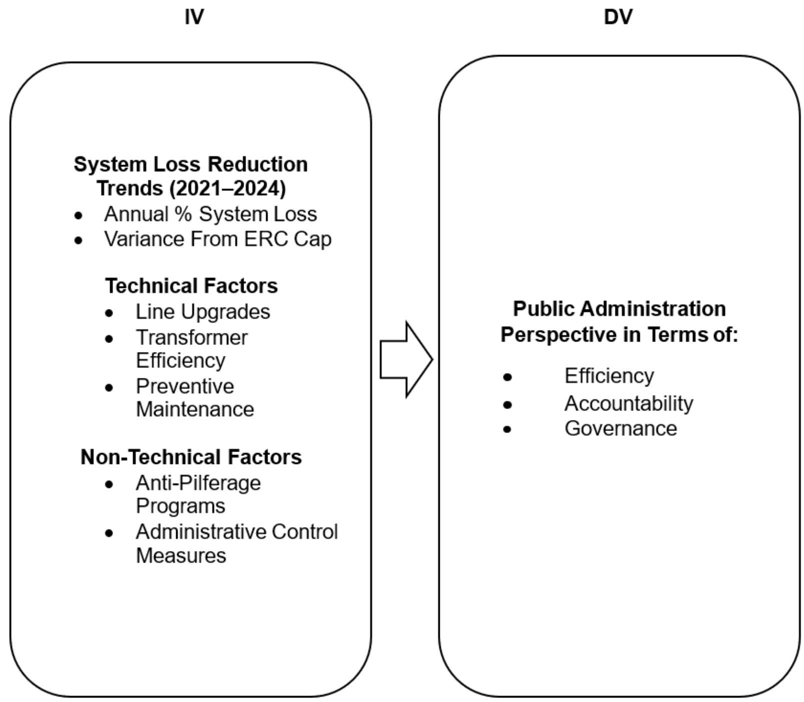

Figure 1. The Research Paradigm of the Study

1.4. Statement of the Problem

This study aims to determine the trends, determinants, and administrative implications of system loss reduction under the First Laguna Electric Cooperative Inc. (FLECO) from 2021 to 2025, within the context of public administration principles: efficiency, accountability, and governance.

Specifically, it seeks to answer the following questions:

* What is the demographic profile of the respondents in terms of:
    - Age;
    - Sex;
    - Educational attainment;
    - Department;
    - Position level; and
    - Years of experience?
* What technical and non-technical factors contributed to the observed system loss trends, specifically in terms of:
    - Line Upgrades;
    - Transformer Efficiency;
    - Preventive Maintenance;
    - Anti-Pilferage Programs; and
    - Administrative control measures and Regulatory Compliance?
* What are the system loss reduction trends of FLECO from 2021 to 2025 in terms of Annual Percentage System Loss and Variance from the ERC allowable cap, and what do these trends imply in terms of regulatory compliance and operational efficiency?
* What is the level of Public Administration Perspective in Terms of:
    - Efficiency;

- Accountability; and
- Governance?

* Is there a significant relationship between the technical and non-technical measures implemented by FLECO, their resulting system loss reduction trends from 2021-2025, and the public administration perspective in terms of efficiency, accountability, and governance?

1.5. Research Hypothesis

There is no significant relationship between the system loss reduction determinants such as technical and non-technical measures, and the public administration perspective in terms of efficiency, accountability, and governance.

1.6. Scope and Limitations of the Study

This study analyzes system loss reduction trends within the service area of the First Laguna Electric Cooperative Inc. (FLECO) from 2021 to 2025. It covers 11 municipalities in the 4th District of Laguna, namely Lumban, Cavinti, Pagsanjan, Kalayaan, Paete, Pakil, Pangil, Siniloan, Mabitac, Famy, and Sta. Maria. These municipalities are included as part of FLECO's coverage area, while the analysis is conducted at the cooperative level. FLECO, classified as a Cluster 2 AAA category electric cooperative, serves as the institutional context for evaluating operational and administrative performance.

The study investigates three categories of independent variables. The first is system loss reduction trends, which is measured using the annual percentage of system loss and the variance from the allowable loss cap set by the Energy Regulatory Commission (ERC). The second category is technical factors, which include line upgrades, transformer efficiency improvements, and preventive maintenance programs aimed at minimizing technical losses. The third category is non-technical factors, such as anti-pilferage initiatives and administrative control measures, which target non-technical system losses and strengthen organizational processes.

The dependent variable of the study is the Public Administration perspective, evaluated in terms of efficiency, accountability, and governance. By examining how technical and non-technical interventions impact system loss trends, the study seeks to understand how these efforts translate into measurable improvements in organizational performance from a public administration standpoint. A quantitative research design is employed, utilizing historical data provided by FLECO for the 2021–2025 period. This includes system loss reports, technical maintenance records, anti-pilferage program outcomes, and governance compliance documentation. Additionally, system loss levels are compared against ERC-established thresholds to assess regulatory compliance.

Despite its comprehensive scope, the study has certain limitations. First, it is limited to the 2021–2025 timeframe, which may not capture long-term trends or the effects of interventions outside this period. Second, the research is geographically confined to the 11 municipalities under FLECO's 4th district, and the findings may not be generalizable to other electric cooperatives in the country. Third, the study relies on the accuracy and completeness of records provided by FLECO; any missing, incomplete, or inconsistent data may affect the precision of the analysis. Fourth, only selected technical and non-technical factors are examined, excluding other potential determinants of system loss such as weather conditions, informal electricity theft, or sudden load variations. Fifth, the study emphasizes efficiency, accountability, and governance as the main dependent variables, while other organizational performance aspects, such as financial profitability or customer satisfaction, are not included. Lastly, the study is primarily correlational, meaning it identifies relationships between interventions and public administration performance but may not fully establish causation.

Overall, this scope and limitation narrative clearly defines the boundaries of the study, the variables under investigation, and the context of the research, while acknowledging potential constraints that may influence the results.

1.7. Significance of the Study

The study is significant as it provides a comprehensive, quantitative analysis of system loss reduction trends in the municipalities under the First Laguna Electric Cooperative Inc. (FLECO) from 2021 to 2025. By examining both technical factors (line upgrades, transformer efficiency, and preventive maintenance) and non-technical factors (anti-pilferage programs and administrative control measures), the research highlights how these interventions influence the Public Administration perspective, specifically in terms of efficiency, accountability, and governance.

For FLECO. The findings offer a detailed assessment of the effectiveness of its system loss reduction initiatives, enabling the cooperative to optimize operational strategies, enhance maintenance programs, and strengthen governance practices. This directly supports improvements in efficiency and organizational accountability, ensuring resources are utilized effectively and responsibly.

For Policy-Makers And Regulatory Agencies. (such as the Energy Regulatory Commission (ERC) and the National Electrification Administration (NEA). The study provides evidence-based insights into cooperative compliance with allowable loss thresholds and performance standards. This supports more informed regulatory oversight and contributes to the development of policies that promote operational excellence and accountability in the electric cooperative sector.

For consumers. Reducing system loss translates into more reliable and efficient electricity service, benefiting households and businesses across the municipalities. Lower system losses can improve service continuity, reduce unnecessary costs, and enhance overall satisfaction, reflecting the efficiency dimension of public administration.

For local government units (LGUs). The study offers actionable data for monitoring cooperative performance and ensuring transparency and accountability in electricity distribution. The findings enable LGUs to actively engage with service providers in promoting good governance practices and safeguarding public interest.

For Future Researchers. The research provides a foundation for future studies in power distribution efficiency, cooperative governance, and public administration interventions within the energy sector. By linking technical and non-technical interventions to measurable public administration outcomes, this study contributes to the broader understanding of how electricity service providers can enhance operational performance while upholding accountability and governance standards.

Definition of Terms

This section presents the operational and conceptual definitions of key terms used in the study to ensure clarity and uniform understanding of how they are applied within the context of the research.

Accountability. The responsibility of FLECO to report, justify, and be answerable for its operational, administrative, and regulatory compliance actions, representing one component of the Dependent Variable (DV) – Public Administration Perspective.

Annual % System Loss. The yearly measurement of system loss used to track System Loss Reduction Trends from 2021 to 2025.

Efficiency. In this study, it refers to the ability of FLECO to minimize system loss and maximize electricity delivery through optimal use of resources, representing one component of the Dependent Variable (DV) – Public Administration Perspective.

ERC. Energy Regulatory Commission (ERC) is the independent regulatory body of the Philippine electric power industry. Provides the regulatory framework for electricity pricing and policies that influence the operations analyzed in the research.

ERC Loss Cap. The maximum allowable percentage of system loss set by the Energy Regulatory Commission for electric cooperatives, used to evaluate System Loss Reduction Trends.

FLECO. First Laguna Electric Cooperative, Inc. (FLECO) is a distribution utility that supplies electricity to several municipalities in Laguna. Acts as the case study distribution utility supplying electricity and implementing policies examined in the thesis.

Governance. The structures, policies, and practices that ensure transparency, fairness, and effectiveness in the management of electricity distribution, forming the third component of the Dependent Variable (DV) – Public Administration Perspective.

NEA. National Electrification Administration (NEA) is a government-owned and controlled corporation (GOCC) in the Philippines responsible for the implementation of rural electrification programs. Serves as the supervisory body that ensures electric cooperatives operate efficiently and support rural electrification in the study.

NEA Standards. Operational and technical guidelines issued by the National Electrification Administration to ensure efficient and reliable electricity distribution, relevant to both Technical and Non-Technical Factors.

Non-Technical Measures. Administrative or behavioral interventions to reduce energy loss, including anti-pilferage programs and enforcement mechanisms, representing Non-Technical Factors that influence system loss reduction.

Operational and Administrative Measures. The combined technical, managerial, and procedural actions taken by FLECO to reduce system loss and comply with regulatory requirements, encompassing both Technical and Non-Technical Factors.

RA 7832. The Anti-Electricity and Electric Transmission Lines/Materials Pilferage Act of 1994, which penalizes illegal electricity connections and meter tampering, supporting Non-Technical Factors in system loss reduction.

RA 9136. The Electric Power Industry Reform Act of 2001, which provides the legal framework for efficient, reliable, and transparent electricity services in the Philippines, guiding governance and regulatory compliance.

System Loss. The difference between the energy purchased by the cooperative and the energy actually delivered and billed to consumers, expressed as a percentage of total energy purchased. It serves as the basis for analyzing System Loss Reduction Trends.

Technical Measures. Actions aimed at reducing energy loss through physical infrastructure improvements, such as line upgrades, transformer efficiency enhancements, and preventive maintenance, considered Technical Factors in this study.

Trend Analysis. The examination of system loss data over time to identify patterns, changes, and key determinants, forming the basis for evaluating System Loss Reduction Trends and their impact on efficiency, accountability, and governance.

Variance from ERC Cap. The difference between the actual system loss and the maximum allowable system loss set by the Energy Regulatory Commission, reflecting cooperative compliance and performance.

1.8. Review of Related Studies and Literature

1.8.1. Related Literature

System loss in electricity distribution encompasses both technical and non-technical dimensions, each affecting operational efficiency and public service outcomes. Technical system loss refers to energy lost due to inherent limitations in the distribution network, such as resistance in wires and transformers. Chen (2018), in the study Theoretical Line Loss Calculation of Distribution Network Based on the Integrated Electricity and Line Loss Management System, demonstrated that integrating electricity and line loss management systems enhances calculation accuracy while reducing the workload associated with traditional manual methods. Using the case of Fujian Putian Power Supply Company, the study illustrated that automated line loss calculation methods not only achieve high accuracy but also improve operational efficiency, supporting the idea that technical interventions including line upgrades, transformer efficiency enhancements, and preventive maintenance are essential for minimizing physical system losses in distribution networks.

Non-technical losses, encompassing electricity theft, billing inaccuracies, and other irregularities, pose a persistent challenge for distribution system operators. Esmael (2021) proposed a data-driven framework combining convolutional neural networks (CNNs) with information retrieval approaches to detect suspicious consumption patterns in the Brazilian utility CPFL Energia. By converting electricity consumption data into image representations and extracting deep features, the framework efficiently identified fraudulent activity without requiring extensive classifier training. This study emphasizes that advanced analytical tools can augment traditional monitoring systems, enhancing accountability and governance by efficiently targeting non-technical losses.

Distribution inefficiency also has broader social and economic implications. Francisco and Abrigo (2023) examined electricity supply interruptions in the Philippines and found that frequent outages resulted in substantial economic losses for local governments, including decreased revenues from business and real estate taxes and undelivered public services. Their analysis showed that a single interruption caused an estimated 10.7 billion PhP loss in economic revenue and 3.8 billion PhP in undelivered services. These findings highlight the critical link between system loss reduction and public service delivery, underscoring that operational efficiency in electric cooperatives has direct consequences for local government functionality and community well-being.

Regulatory frameworks play a central role in guiding system loss management. The Energy Regulatory Commission (ERC), under the Electric Power Industry Reform Act (RA 9136), establishes loss caps and performance incentive schemes to encourage efficient operation. The Resolution Adopting the ERC Rules for Setting the Distribution System Loss Cap prescribes technical criteria such as load density, sales mix, and delivery voltage for determining acceptable loss rates, ensuring that distribution utilities comply with standards while optimizing operational performance. Compliance with these regulations aligns technical efficiency with accountability and governance objectives, reinforcing the institutional framework for system loss reduction.

Recent developments in electric cooperatives further highlight the critical role of both technical and administrative factors in managing system losses. The South Cotabato II Electric Cooperative Inc. has been placed under a recovery plan supervised by the National Electrification Administration (NEA) due to persistently high system losses, which reportedly reached 12–15% between 2024 and 2025. These losses have been attributed to a combination of technical issues, such as overloaded substations, and non-technical factors, including electricity pilferage. The cooperative has experienced significant financial strain, with reported cumulative losses of approximately ₱2.2 billion, including monthly losses estimated at around ₱30 million and annual losses exceeding ₱600 million in 2025. In response, SOCOTECO II has initiated a "catch-up plan" and allocated substantial capital expenditures, estimated at approximately ₱919 million, to improve infrastructure and operational efficiency. The situation has also led to its downgrade from an AAA to a lower performance category and closer regulatory supervision. This case illustrates how deficiencies in both technical systems and governance mechanisms can lead to operational and financial deterioration, reinforcing the importance of integrating engineering interventions with strong administrative control, accountability, and regulatory compliance in sustaining electric cooperative performance.

Governance within the electric sector has evolved toward more collaborative, multi-stakeholder approaches. Wang (2018) highlighted that traditional top-down regulation is increasingly complemented by deliberative governance frameworks, enabling stakeholders with diverse interests to address both political and technical challenges in electricity transmission and renewable energy adoption. Such collaborative governance strengthens transparency and institutional coordination, enhancing non-technical management practices that mitigate losses and promote regulatory adherence.

Accountability mechanisms are equally critical in shaping system performance. Wu (2019) analyzed electricity market reforms in China, showing that dynamic accountability relations between central and provincial authorities influenced policy outcomes. The study demonstrated that clear lines of responsibility and monitoring procedures are necessary for effective utility management. In the context of electric cooperatives, mechanisms such as internal audits, regulatory compliance, and anti-pilferage programs ensure that both technical and non-technical interventions achieve measurable reductions in system loss.

Regulatory compliance further contributes to operational efficiency, risk reduction, and public trust. Kiteworks (n.d.) emphasized that organizations adhering to regulatory standards benefit from improved operational processes, reduced liabilities, enhanced public image, and resilience to changing regulations. For electric cooperatives, systematic compliance ensures continuity of service, protects resources, and strengthens stakeholder confidence while supporting efficiency, accountability, and governance objectives.

Electricity theft has direct implications for both operational performance and power quality. Arango (2016) demonstrated that unauthorized electricity connections increase transformer loads, create voltage imbalances, and reduce overall power quality. This results in financial losses and technical challenges for utilities. Programs targeting pilferage, combined with consumer behavior management, are therefore vital for reducing non-technical losses and enhancing the accountability and efficiency of cooperative operations.

Finally, preventive maintenance and technical interventions are essential for sustaining reliable service. da Motta (2002) studied the optimization of preventive maintenance schedules for protective relays in Brazil, finding that adjusting inspection intervals based on reliability assessments reduced workload by 62% while maintaining system integrity. Strategic line upgrades, transformer maintenance, and other proactive measures help minimize technical losses, reflecting prudent resource management and operational efficiency within electric cooperatives.

This review demonstrates that effective system loss management requires an integrated approach, combining technical precision, regulatory compliance, governance, and accountability. By linking technical and non-technical strategies to public administration outcomes, electric cooperatives can optimize operational performance while ensuring service reliability and stakeholder confidence.

The recommendations of this study are supported by existing literature emphasizing the importance of technical efficiency, governance, and modernization in electric utility operations. According to Gill (2016), systematic maintenance and continuous monitoring are essential in sustaining efficiency in electrical distribution systems. Chandel (2016) highlighted that anti-theft programs combined with monitoring systems significantly reduce non-technical losses in power distribution systems. Sultana (2016) further stressed that data-driven infrastructure management improves reliability and minimizes distribution losses in electric utilities. In terms of governance, Bovens (2007) emphasized that accountability is strengthened through monitoring, reporting systems, and clear responsibility structures, while Juiz (2014) noted that transparency, compliance, and stakeholder participation are critical components of good governance in public utilities. Moreover, Hood (1991) explained that New Public Management promotes efficiency through performance systems and modernization of public service operations. Douglas (2016) also emphasized that comparative and technology-integrated studies contribute significantly to the advancement of modern utility governance and operational effectiveness.

1.8.2. Related Studies

Several studies have examined system loss trends in electric cooperatives, both in the Philippines and internationally, highlighting the persistent challenges in rural electrification. In the Philippines, the rural electrification program has traditionally followed a grid-expansion approach, but the extension of lines to remote barangays has proven costly and technically inefficient. According to Yeneza (USAID/DOE, 2000), the cost of extending one kilometer of line averages PHP 468,000, and connecting sparsely populated areas often results in single-phase lines that compromise network performance. High system losses and fluctuating voltage along extended lines impose additional burdens on consumers, with over half of the electric cooperatives still exceeding the 14% system loss cap established under the Anti-Pilferage Law as of 2000. Internationally, projects such as the Japan International Cooperation Agency's System Loss Reduction Project for Philippine Electric Cooperatives (JICA, 2013) have emphasized skill-building, the use of distribution analysis software, voltage upgrades, and pilot projects with amorphous transformers to systematically reduce losses and inform policy and operational guidelines, demonstrating that targeted technical interventions combined with capacity-building and policy support effectively mitigate distribution losses.

Engineering interventions have been widely studied as methods to reduce technical losses in distribution systems. Research on Recovery Preventive Maintenance (RPM) at Pampanga I Electric Cooperative (David et al., 2025) revealed that structured maintenance of kWh meter connections could reduce system loss by 3,599 kWh annually, generating revenue savings of PHP 34,118.52 and achieving a return on investment within six years. The study emphasized that technical faults such as loose terminals, degraded wiring, and bypassed connections were major contributors to losses, and that proactive maintenance practices improved both reliability and operational efficiency. Similarly, studies in Bangladesh (Roy & Roy, 2015) demonstrated that rural distribution system losses could be minimized from double-digit to single-digit percentages using linear programming methods to optimize conductor sizing. These studies underscore the significance of line upgrades, transformer efficiency, and preventive maintenance in achieving measurable reductions in technical losses.

Non-technical factors, particularly pilferage and billing inefficiencies, have also been identified as key contributors to system loss. Electricity theft remains a persistent challenge in developing countries, accounting for a significant portion of aggregate technical and commercial (AT&C) losses. Sharma et al. (2022) analyzed trends in electricity theft in India and found a decreasing pattern in AT&C losses due to targeted mitigation measures. Similarly, Hu et al. (2021) employed a multi-source data approach in China, analyzing user behaviors in conjunction with regional and climatic factors, to enhance detection of electricity theft. Their framework successfully improved identification accuracy and allowed the State Grid of China to apprehend electricity thieves more efficiently. These studies highlight that addressing non-technical losses requires a combination of behavioral understanding and technological solutions to effectively reduce pilferage and revenue losses.

Governance, accountability, and administrative efficiency also play crucial roles in the performance of electric cooperatives. Newton (n.d.) found that board and executive engagement directly impact organizational outcomes, with role clarity and commitment correlating with effective decision-making and operational performance in cooperative organizations. In public administration contexts, the application of New Public Management principles has been linked to enhanced service performance, citizen satisfaction, and overall governance quality (Matei et al., 2016). Evaluations of administrative decision-making in healthcare facilities, such as the study by Al Flayyeh and Al-Harbi (2023), demonstrated that improvements in administrative decision-making significantly enhanced operational performance, suggesting a parallel importance of governance structures in utility performance. Collectively, these studies indicate that organizational capacity, decision-making processes, and institutional accountability are central to reducing losses and improving service delivery.

The use of quantitative and correlation-based analyses provides further insights into utility performance and loss management. Correlation studies in electrical distribution (Flygare et al., 2023) assessed consumers' contributions to grid peak loads, revealing behavioral patterns that inform demand management and load optimization. Trend analysis of power quality using advanced predictive models, such as deep belief networks combined with optimization algorithms (Yang et al., 2023), enables more accurate forecasting of distribution performance and supports preventive interventions. These analytical approaches allow utilities to make data-driven decisions to improve reliability, efficiency, and consumer satisfaction.

Finally, integrated frameworks combining technical and administrative factors have been proposed to enhance overall utility performance. Foster (1978) emphasized that effective municipal infrastructure management requires linking technical evaluations including system capacity, structural design, and maintenance with administrative considerations such as budgeting, organizational roles, and policy implementation. The study underscores that technical solutions must be administratively feasible and that governance decisions must be guided by engineering evidence. Together, these studies demonstrate that sustainable system loss reduction in electric cooperatives depends on a holistic approach, combining technical interventions, non-technical strategies, governance practices, and data-driven analyses to improve operational efficiency, accountability, and service quality.

2. Methodology

This study employed a descriptive quantitative research design with a correlational component to analyze system loss reduction trends in the Municipality under the First Laguna Electric Cooperative Inc. (FLECO) from 2021 to 2025. Descriptive quantitative research involved the collection and analysis of numerical data to describe characteristics, patterns, and trends within a population or phenomenon. Creswell (2014) explained that descriptive research aimed to document and summarize the characteristics of a population or phenomenon without establishing causal relationships, while Nassaji (2015) emphasized that it provided an accurate portrayal of events, persons, or situations that may be used for a broader understanding of observed patterns.

The descriptive component focused on the analysis of system loss trends from 2021 to 2025, including annual percentage system loss and variance from the Energy Regulatory Commission (ERC) allowable cap. Meanwhile, the correlational component examined the relationship between the independent variables of technical measures such as line upgrades, transformer efficiency improvements, and preventive maintenance, and non-technical measures such as anti-pilferage programs and administrative control measures, and the dependent variable, which was the public administration perspective in terms of efficiency, accountability, and governance.

This combined approach allowed the study to both describe system performance trends and determine the extent of relationships between operational interventions and governance-related outcomes.

2.1. Research Design

The study used a descriptive-correlational research design consisting of two complementary components. The descriptive component documented the respondents' demographic profile, including age, sex, educational attainment, department, position, and years in service, to provide a clear background of the study population. It also presented the annual system loss rates, regulatory variance, and related performance indicators using official FLECO records from 2021 to 2025. In addition, this component described the survey results on technical factors (line upgrades, transformer efficiency, preventive maintenance), non-technical factors (anti-pilferage programs and administrative control measures), and the public administration perspective in terms of efficiency, accountability, and governance.

The correlational component examined the relationship between the independent variables, which were technical factors such as line upgrades, transformer efficiency improvements, and preventive maintenance and non-technical factors such as anti-pilferage programs and administrative control measures, and the dependent variable, which referred to public administration outcomes measured in terms of efficiency, accountability, and governance.

Collected survey data were organized into tables and analyzed using descriptive statistics such as frequency, weighted mean, and standard deviation. The Pearson correlation coefficient was used to determine whether significant relationships existed between technical and non-technical measures and public administration outcomes.

2.2. Population and Sampling Technique

The respondents of this study consisted of key personnel of the First Laguna Electric Cooperative Inc. (FLECO) who were directly involved in system loss mitigation within the coverage municipalities. This included personnel from technical operations, metering, billing, substation operations, and institutional or administrative support services.

A total of 100 respondents were selected from the population of 192 FLECO employees. The sample size was considered adequate based on established sample size determination guidelines. Lenth (2021) supports the use of simplified sampling approaches for finite populations where precision requirements and field constraints are considered. In this study, the sample of 100 represented more than half of the total population, which strengthened the representativeness of the findings.

In addition, the selection of respondents considered operational realities within FLECO, including field personnel assigned across different municipalities and varying work schedules such as day and night shifts. Because of these conditions, complete enumeration was constrained by availability during the data collection period. Despite this, efforts were made to include qualified personnel across different operational units and schedules to ensure balanced representation of experiences in system loss reduction activities.

A purposive sampling technique was employed. The sample size and composition were determined based on the actual population of employees directly involved in system loss reduction-related functions within FLECO. Specifically, respondents were identified from key departments such as Technical Services, Finance, Audit, CorPlan & Infotech, Institutional Services, and administrative units, where participation in system loss reduction planning, implementation, monitoring, and evaluation is critical. All available and qualified personnel during the data collection period were included to ensure complete coverage of relevant respondents, resulting in a total enumeration of eligible participants rather than random selection. This strategy ensured that only information-rich respondents with direct involvement and relevant experience were included in the study (Palinkas et al., 2015).

Although the sampling technique employed in this study is non-probability in nature, it remains appropriate and useful for this research because it focuses on selecting respondents with direct knowledge and involvement in system loss reduction activities. Purposive sampling is widely used in applied and organizational studies where specific expertise and experience are required to generate meaningful and relevant data. In this context, the approach ensured that the information gathered reflects actual operational practices and administrative processes within FLECO. While the findings may have limited generalizability to other populations, the use of knowledgeable and qualified respondents enhances the validity and reliability of the insights derived from the study, particularly in examining the relationship between technical and non-technical measures and public administration outcomes.

2.3. Research Procedure

The research was conducted through a systematic series of steps to ensure a comprehensive analysis of system loss reduction trends within the First Laguna Electric Cooperative Inc. (FLECO) from 2021 to 2025. The study began with the identification of the research problem and the formulation of specific objectives. This was followed by a review of related literature, regulatory standards, and policies, including guidelines from the Energy Regulatory Commission (ERC).

Secondary data on system loss rates were collected from official FLECO records covering the study period. These records were validated through consultations with key personnel to ensure completeness and accuracy.

The collected data were carefully encoded, organized, and prepared for statistical analysis. Descriptive statistics such as frequency distribution, weighted mean, and trend analysis were used to present system loss patterns and survey responses. The Pearson correlation coefficient was applied to determine the significance of relationships between technical and non-technical measures and public administration outcomes. The results were then interpreted within the framework of public administration, with emphasis on efficiency, accountability, and governance.

2.4. Research Instruments

The research instrument for this study was a structured survey questionnaire designed to quantitatively measure FLECO employees' perceptions regarding system loss reduction initiatives and their impact on efficiency, accountability, and governance. The questionnaire was developed by the researcher and submitted for review, approval, and validation by a panel of experts in public administration and energy management to ensure its validity, reliability, and relevance to the study objectives.

The questionnaire consisted of two main parts. The first part gathered respondents' demographic and professional background, including position, years of experience, and involvement in system loss reduction programs. The second part included structured items measured using a 5-point Likert scale to assess technical and non-technical measures and public administration outcomes.

A 5-point Likert scale was used because it provides a balanced range of response options, including a neutral midpoint, while allowing respondents to express varying degrees of agreement. The inclusion of a neutral option is appropriate in perception-based studies, as it captures respondents who are neither in agreement nor disagreement or who may lack sufficient basis to evaluate an item. According to Joshi et al. (2015), a 5-point Likert scale is effective in measuring attitudes and perceptions because it offers clarity, simplicity, and balanced response distribution without overwhelming respondents. Similarly, Likert (1932) emphasized that Likert-type scales are useful tools for measuring attitudes, while Creswell (2014) noted that a 5-point scale provides sufficient variability while maintaining respondent ease and improving data reliability in social science research.

Table 1. The Five-Point Likert Scale to Measure the Respondents Response

Scale	Numerical Value	Verbal Interpretation
5	4.20 - 5.00	Strongly Agree
4	3.40 - 4.19	Agree
3	2.60 - 3.39	Neutral
2	1.80 - 2.59	Disagree
1	1.00 - 1.79	Strongly Disagree

Table 2. Interpretation of the Level of Perceived Effectiveness

Scale	Numerical Value	Verbal Interpretation
5	4.20 - 5.00	Highly Effective
4	3.40 - 4.19	Effective
3	2.60 - 3.39	Moderately Effective
2	1.80 - 2.59	Ineffective
1	1.00 - 1.79	Highly Ineffective

2.5. Statistical Treatment of Data

The data collected from both FLECO records and the administered questionnaires were systematically tabulated and analyzed to provide a comprehensive understanding of the study. Descriptive statistics were employed to summarize the data, the computation of means and standard deviations for questionnaire responses, annual system loss values, year-on-year comparisons, and frequency summaries of technical and non-technical interventions.

Trend analysis was conducted using line graphs to visualize the changes in system loss from 2021 to 2025, highlighting changes and linear regression indicators. These trends were also compared against the allowable loss caps set by the Energy Regulatory Commission (ERC) to evaluate compliance and performance.

Furthermore, the Pearson correlation coefficient was used to examine the strength and direction of the relationship between independent variables, and dependent variables. Interpretation of correlation results followed Guilford's (1973) guidelines for assessing the strength of relationships.

Table 3. Guildford's (1973) Rule of Thumb for Interpretation of Correlation Coefficient

Scale	Verbal Interpretation
0.00 – 0.20	Very Low Correlation, almost negligible relationship
0.21 – 0.40	Low Correlation, definite but small relationship
0.41 – 0.70	Moderate Correlation, substantial relationship
0.71 – 0.90	High Correlation, marked relationship
0.91-1.00	Very High Correlation, very dependable relationship

3. Results and Discussion

This chapter presents the results of the study on system loss reduction trends in the municipality under the First Laguna Electric Cooperative Inc. (FLECO) from 2021–2025 and their relationship to the public administration perspective in terms of efficiency, accountability, and governance. The analysis includes descriptive statistics on technical and non-technical factors, the level of public administration perspective, and correlation analyses exploring significant relationships among these variables.

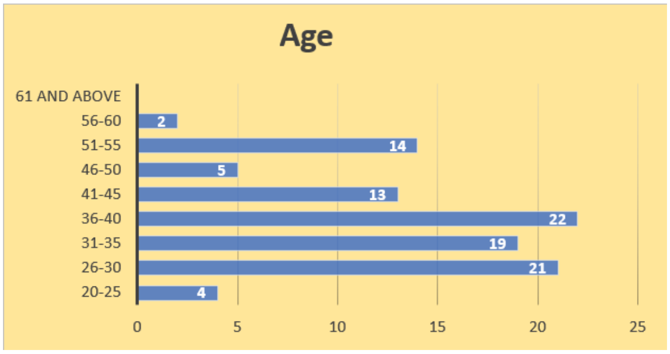

Figure 2. Frequency and Percentage Distribution of Respondents' Demographic Profile According to Age

Figure 2 presents the frequency and percentage distribution of respondents according to age. It can be observed that the largest proportion of respondents belongs to the 36–40 age group, with 22 respondents, followed closely by those aged 26–30 with 21 respondents, and 31–35 with 19 respondents. Meanwhile, respondents aged 51–55 and 41–45 comprise 14 and 13 respondents, respectively. On the other hand, the least represented age groups are 46–50 with 5 respondents, 20–25 with 4 respondents, and 56–60 with only 2 respondents.

The data indicate that the majority of respondents fall within the 26–40 age bracket, representing the prime working-age population. Studies suggest that individuals within this age group demonstrate high levels of task performance, adaptability, and engagement, making them highly effective in operational roles (Ng &

Feldman, 2010). This suggests that most participants are likely to be actively engaged in operational, technical, or administrative roles within the First Laguna Electric Cooperative Inc.(FLECO), thereby making them well-positioned to provide relevant insights regarding system loss reduction practices.

From an analytical perspective, the dominance of respondents within this age range implies a workforce that combines practical field experience with adaptability to modern systems and technologies, a balance shown to enhance organizational effectiveness (Kunze et al., 2013). This is particularly important in addressing both technical and non-technical factors influencing system loss, as studies highlight that skilled personnel play a crucial role in implementing infrastructure improvements and administrative controls in electric utilities

Figure 3 presents the frequency and percentage distribution of respondents according to sex. The data show that 76.76% of the respondents are male, while 24.24% are female, indicating a significant predominance of male participants in the study. This reflects broader trends in the energy sector, where technical and field-based roles remain largely male-dominated due to historical occupational patterns (Graf, 2009).

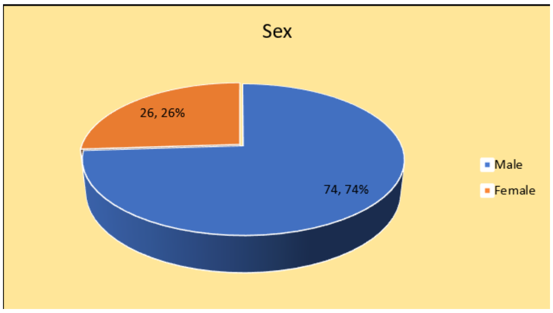

Figure 3. Frequency and Percentage Distribution of Respondents' Demographic Profile According to Sex

This distribution suggests that the workforce within the First Laguna Electric Cooperative Inc. (FLECO), particularly in areas related to system loss reduction, is largely composed of male personnel. This may be associated with the nature of many field-based and technical tasks such as line maintenance, installation, and troubleshooting—which have traditionally been performed by men in the electrical and infrastructure sectors (Thomas, 2018).

However, it is important to note that female respondents still comprise a meaningful portion of the sample. Their participation is often linked to administrative, monitoring, and managerial roles, which are essential in addressing non-technical system losses, including anti-pilferage implementation, documentation, and regulatory compliance. Studies emphasize that women play a significant role in strengthening accountability and governance mechanisms within public organizations (Dar, 2022). Moreover, gender diversity has been shown to enhance organizational effectiveness and decision-making processes (Eagly 2003).

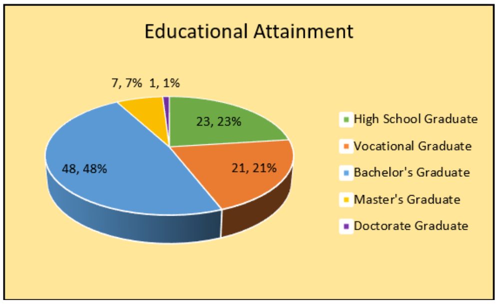

Figure 4. Frequency and Percentage Distribution of Respondents' Demographic Profile According to Educational Attainment

Figure 4 presents the distribution of respondents according to educational attainment. The data reveal that the largest proportion of respondents are bachelor's degree holders (48.48%), followed by high school graduates (23.23%) and vocational course graduates (21.21%). A smaller percentage of respondents have attained master's degrees (7.7%), while only 1.1% hold a doctorate degree.

The results indicate that the workforce of the First Laguna Electric Cooperative Inc.(FLECO) is largely composed of individuals with formal tertiary education, complemented by a substantial portion with technical-vocational and secondary education backgrounds. This composition reflects a diverse skills mix, where degree holders are likely engaged in engineering, administrative, and supervisory functions, while vocational and high school graduates may be involved in field operations and technical support roles. This aligns with human capital theory, which emphasizes that education and training enhance employee productivity and organizational performance (Becker, 1975).

From an analytical standpoint, this distribution suggests that system loss reduction efforts benefit from both theoretical knowledge and practical technical skills. Vocationally trained personnel play a crucial role in executing technical interventions such as line maintenance and system monitoring, as technical-vocational competencies are essential for operational efficiency (Barcucci, 2017). At the same time, the presence of degree holders supports planning and decision-making functions, reflecting a balanced workforce structure that has been shown to improve overall organizational effectiveness (Serban, 2007)

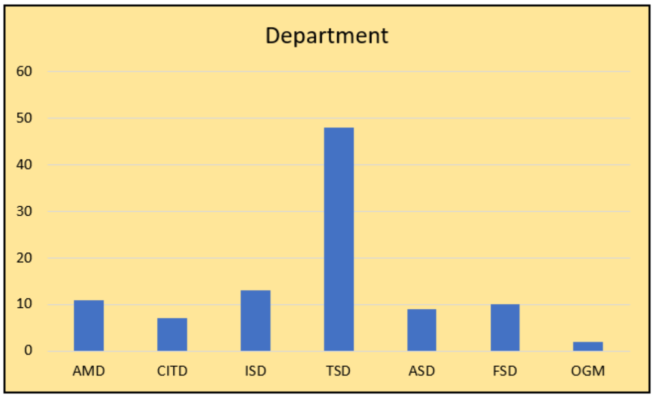

Figure 5. Frequency and Percentage Distribution of Respondents' Demographic Profile According to the Department They Belong

Figure 5 presents the distribution of respondents according to the department to which they belong. The data show that the majority of respondents come from the Technical Services Department, with 48 respondents, comprising the largest share of the sample. This is followed by the Institutional Services Department with 13 respondents, Area Management Department with 11, Finance Services Department with 10, and Audit Services Department with 9 respondents. Meanwhile, the CorPlan & InfoTech Department accounts for 7 respondents, and the Office of the General Manager has the least representation with only 2 respondents.

The dominance of respondents from the Technical Services Department indicates that the study heavily reflects insights from personnel directly involved in field operations, engineering works, system maintenance, and infrastructure management. This aligns with organizational structure theory, which emphasizes that the technical core of an organization is primarily responsible for operational outputs and service delivery (Mintzberg, 1989). This is particularly relevant, as these functions are closely associated with technical system loss factors, such as line upgrades, transformer efficiency, and preventive maintenance

On the other hand, the presence of respondents from Institutional, Finance, Audit, and CorPlan & InfoTech departments ensures that the study also captures perspectives related to non-technical system loss factors, including administrative controls, monitoring systems, financial accountability, and anti-pilferage enforcement. Studies on electric utility performance highlight that effective operations depend on the integration of technical functions with administrative and governance mechanisms (Sporn, 2007).

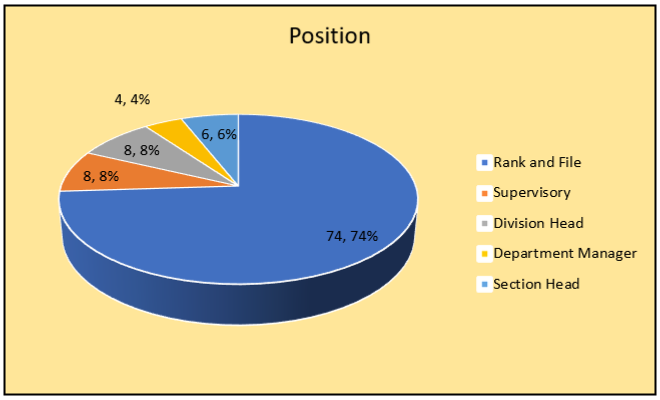

Figure 6. Frequency and Percentage Distribution of Respondents' Demographic Profile According to their Position

Figure 6 presents the distribution of respondents according to their position within the organization. Out of the total 100 respondents, the majority are classified as rank-and-file employees, comprising 74 respondents (74.74%). This is followed by those in supervisory positions and division heads, each with 9 respondents (8.8%). Meanwhile, section heads account for 7 respondents (6.6%), and the department managers represent the smallest group with 4 respondents (4.4%).

The data indicate that the study is largely informed by personnel who are directly engaged in the day-to-day operations of the First Laguna Electric Cooperative Inc. (FLECO). Rank-and-file employees are typically involved in fieldwork, system maintenance, meter reading, and operational support, making their insights particularly valuable in assessing both technical and non-technical system loss factors. This aligns with street-level bureaucracy theory, which emphasizes that frontline personnel play a critical role in the actual implementation of policies and operational procedures in public organizations (Lipsky, 1971).

The presence of respondents from supervisory to managerial levels, although smaller in proportion, ensures that the study also incorporates perspectives related to planning, decision-making, and policy implementation. This reflects organizational structure theory, which describes organizations as layered systems composed of operational, managerial, and strategic levels working together to achieve institutional objectives (Mintzberg, 1989).

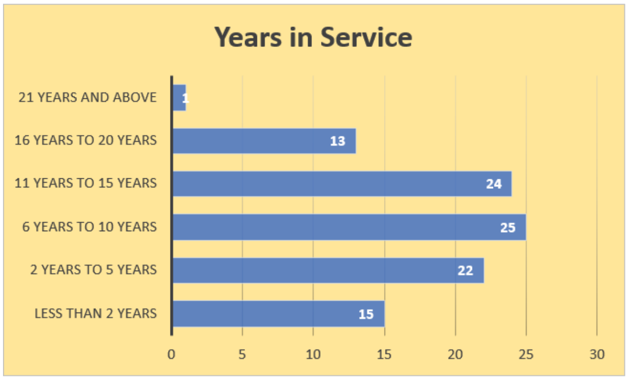

Figure 7. Frequency and Percentage Distribution of Respondents' Demographic Profile According to Years in Service

Figure 7 presents the distribution of respondents according to their years in service. Out of the total 100 respondents, the largest group consists of those with 6–10 years of service, accounting for 25 respondents (25%), followed closely by those with 11–15 years, with 24 respondents (24%). Respondents with 2–5 years of service comprise 22 respondents (22%), while those with less than 2 years account for 15 respondents (15%). Meanwhile, respondents with 16–20 years of service represent 13 respondents (13%), and only 1 respondent (1%) has 21 years or more of service.

The data indicate that the majority of respondents fall within the mid-level tenure range (6–15 years), suggesting that most participants have accumulated substantial experience within the First Laguna Electric Cooperative Inc. (FLECO). This level of experience is critical, as it reflects a workforce that is well-acquainted with operational procedures, system conditions, and organizational policies, particularly those related to system loss management. Research on expertise development emphasizes that sustained experience over time leads to higher levels of performance and decision-making capability in complex tasks (Ericsson, 2006).

From an analytical standpoint, respondents with 6–15 years of service are likely to have developed a high level of operational competence, enabling them to effectively handle both routine and complex tasks related to system loss reduction. Furthermore, organizational learning theory suggests that accumulated experience within institutions strengthens overall performance through knowledge retention and continuous improvement (Argote, 2011). This is further supported by studies on public sector capacity building, which highlight that longer tenure enhances institutional knowledge, operational efficiency, and governance effectiveness in public organizations (Blackman, 2012). At the same time, the presence of newer employees introduces perspectives aligned with recent training and updated systems, contributing to a balance between experience and innovation.

Table 4. ***Distribution Feeder Loss Cap for ECs***

Year	**Distribution Feeder Loss Cap (%)**		
	Cluster 1	**Cluster 2**	**Cluster 3**
2021	12.00%	10.25%	9.00%
2022 Onwards	12.00%	10.25%	8.25%

Table 3 presents the distribution feeder loss caps prescribed by the Energy Regulatory Commission (ERC) for electric cooperatives under different clusters. The First Laguna Electric Cooperative Inc.(FLECO), the cooperative is classified under Cluster 2 in accordance with the distribution system loss cap framework prescribed by the Energy Regulatory Commission. For Cluster 2, where FLECO is classified, the allowable system loss cap is set at 10.25% for both 2021 and the succeeding years. This benchmark serves as the basis for evaluating FLECO's compliance and operational efficiency in managing system loss.

The line graph in Figure 8 illustrates the trend of FLECO's system loss from 2021 to 2025. It shows a consistently decreasing pattern over the five-year period. Starting at 9.21% in 2021, the system loss slightly declined to 9.14% in 2022, followed by a more noticeable reduction to 8.72% in 2023. downward trend continued in 2024 at 8.64%, reaching its lowest point in 2025 at 8.33%.

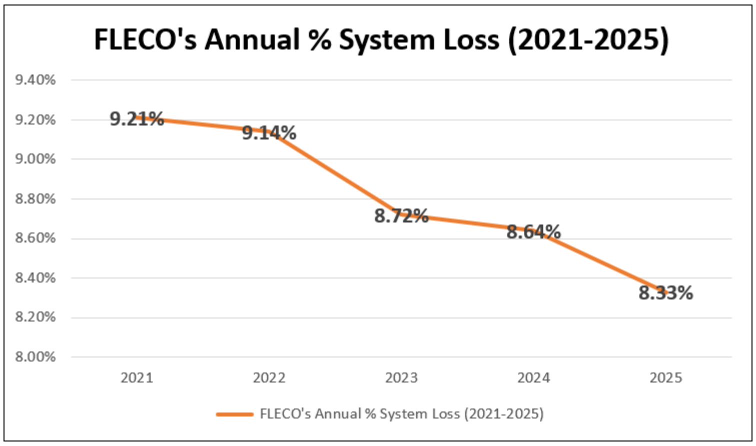

Figure 8. FLECO's Annual % System Loss (2021-2025)

Overall, the graph demonstrates a steady improvement in system loss performance, with no recorded increases during the period. The gradual decline indicates that FLECO has been consistently effective in implementing system loss reduction measures.

The bar graph of Figure 9 presents a comparison between the ERC allowable system loss cap and FLECO's actual system loss from 2021 to 2025. It shows that the ERC cap remains constant at 10.25% throughout the period, while FLECO's system loss consistently remains below this threshold each year.

Specifically, FLECO recorded 9.21% in 2021, slightly decreasing to 9.14% in 2022, followed by a more noticeable decline to 8.72% in 2023, 8.64% in 2024, and reaching 8.33% in 2025. The gap between the ERC cap and actual system loss gradually widens over time.

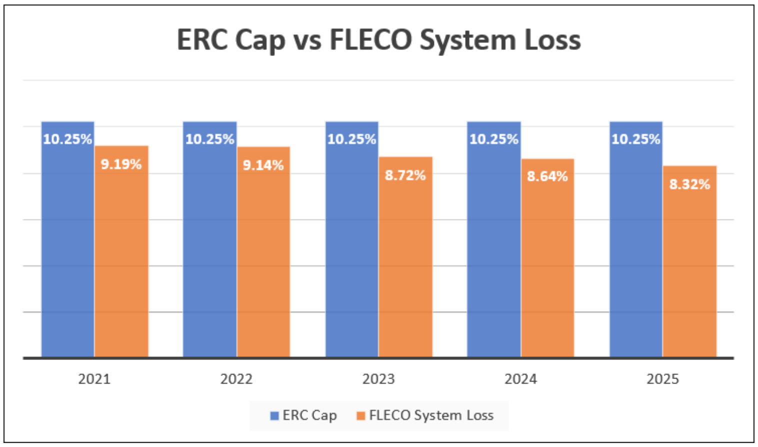

Figure 9. ERC Cap vs FLECO System Loss

Overall, the graph indicates that FLECO maintained system loss levels within the allowable limit across all years, with a consistent downward trend relative to the ERC benchmark.

Table 5. Variance from ERC Cap of FLECO System Loss (2021-2025)

YEAR	ERC Cap	FLECO System Loss	Variance
2021	10.25%	9.21%	-1.04%
2022	10.25%	9.14%	-1.11%
2023	10.25%	8.72%	-1.53%
2024	10.25%	8.64%	-1.61%
2025	10.25%	8.33%	-1.92%

Table 5 shows that system loss reduction trends of FLECO from 2021 to 2025, as measured by Annual Percentage System Loss and variance from the ERC allowable cap, show a consistent and gradual decline over the five-year period.

In terms of Annual Percentage System Loss, FLECO recorded 9.21% in 2021, which slightly decreased to 9.14% in 2022, followed by a more notable reduction to 8.72% in 2023, 8.64% in 2024, and reaching its lowest level at 8.33% in 2025. This indicates a steady downward trend with no recorded increases, reflecting continuous improvement in system loss management.

In terms of variance from the ERC allowable cap of 10.25%, all computed values are negative, ranging from -1.04% in 2021 to -1.92% in 2025. This signifies that FLECO consistently maintained system loss levels below the regulatory threshold throughout the study period. Furthermore, the increasing negative variance indicates that the gap between actual system loss and the allowable cap has widened over time.

These trends imply that FLECO has demonstrated consistent regulatory compliance with the standards set by the Energy Regulatory Commission. Moreover, the continuous reduction in system loss and the widening margin below the allowable cap suggest improving operational efficiency, likely resulting from effective implementation of both technical and non-technical loss reduction measures.

Information shown in Table 6 indicates a positive level of agreement regarding technical interventions related to line upgrades and their contribution to system loss reduction trends. Most indicators received scores within the "Agree" range, while one indicator reached the "Strongly Agree" level, reflecting generally favorable perceptions from the respondents.

Table 6. Level of Technical Factors Contributory to the Observed System Loss Trends as to Line Upgrades

Indicative Statement	Mean	SD	Verbal Interpretation	Remarks
Replacing old or damaged wires improved supply reliability.	4.08	0.76	Agree	Replacing old or damaged wires improved supply reliability was perceived to be effective.
Upgrading bare conductors to insulated ones improved line efficiency.	4.12	0.79	Agree	Upgrading bare conductors to insulated ones improved line efficiency was perceived to be effective.
Reconfiguring lines balanced electrical loads and maintained stable voltage.	4.21	0.78	Strongly Agree	Reconfiguring lines balanced electrical loads and maintained stable voltage was perceived to be highly effective.

Replacing weak poles and worn connectors in critical line sections reduced line faults and improved electricity delivery.	4.02	0.70	Agree	Replacing weak poles and worn connectors in critical line sections reduced line faults and improved electricity delivery was perceived to be effective.
Installing correctly sized fuses reduced outages and minimized energy losses.	4.01	0.76	Agree	Installing correctly sized fuses reduced outages and minimized energy losses was perceived to be effective.
Overall Mean and SD	*4.09*	*0.76*		Line Upgrades under Technical Factors for system loss reduction is perceived to be effective.
Overall Interpretation	*AGREE*			

Note. N=100. V.I.=Verbal interpretation. The mean is interpreted as follows: 4.20–5:00= Strongly Agree, 3.40–4.19= Agree, 2.60–3.39= Neutral, 1.80–2.59= Disagree, 1.00–1.79=Strongly Disagree)

Among the indicators, "Reconfiguring lines balanced electrical loads and maintained stable voltage" obtained the highest mean of 4.21, followed by "Upgrading bare conductors to insulated ones improved line efficiency" with a mean of 4.12. The remaining indicators, including replacing old or damaged wires, installing correctly sized fuses, and replacing weak poles and connectors, also yielded closely similar mean scores within the "Agree" range, indicating a consistent level of agreement across all aspects evaluated.

These findings are consistent with studies emphasizing that upgrading and modernizing distribution infrastructure such as reconductoring, insulation improvements, and system reconfiguration which significantly enhances system efficiency and reduces technical losses in electric utilities (Rafati, 2024). Similarly, evidence from energy system studies highlights that improvements in electrical network infrastructure contribute to voltage stability, load balancing, and overall reliability, thereby reducing energy losses in distribution systems (Sultana, 2016).

The results suggest that line upgrade interventions are perceived to be effective in improving system performance and reducing technical losses. Respondents agree that these measures contribute to enhanced electricity delivery and operational efficiency, demonstrating the importance of continuous technical improvements in sustaining reliable and efficient power distribution.

Information shown in Table 7 indicates a positive level of agreement regarding transformer efficiency measures and their contribution to system loss reduction trends from 2120 to 2025. All indicators received scores within the "Agree" range, with one indicator reaching the "Strongly Agree" level, reflecting favorable perceptions from the respondents.

Among the indicators, "Replacing overloaded units reduced losses in affected areas" obtained the highest mean of 4.20, followed by "Proper sizing improved voltage stability" with a mean of 4.12. The remaining indicators, including regular testing and inspection, upgrading to higher-efficiency units, and load balancing, also yielded closely similar mean scores within the "Agree" range, indicating a consistent level of agreement across all aspects evaluated.

Table 7. Level of Technical Factors Contributory to the Observed System Loss Trends as to Transformer Efficiency

Indicative Statement	Mean	SD	Verbal Interpretation	Remarks
Replacing overloaded units reduced losses in affected areas.	4.20	0.71	Strongly Agree	Replacing overloaded units reduced losses in affected areas was perceived to be highly effective.
Proper sizing improved voltage stability.	4.12	0.73	Agree	Proper sizing improved voltage stability was perceived to be effective.
Regular testing and inspection minimized energy losses.	4.09	0.77	Agree	Regular testing and inspection minimized energy losses was perceived to be effective.
Upgrading to higher-efficiency units improved overall performance.	4.05	0.74	Agree	Upgrading to higher-efficiency units improved overall performance was perceived to be effective.
Load balancing contributed significantly to loss reduction.	4.01	0.80	Agree	Load balancing contributed significantly to loss reduction was perceived to be effective.
Overall Mean and SD	*4.09*	*0.75*		Transformer Efficiency under Technical Factors for system loss reduction was perceived to be effective.
Overall Interpretation	*AGREE*			

Note. N=100. V.I.=Verbal interpretation. The mean is interpreted as follows: 4.20–5:00= Strongly Agree, 3.40–4.19= Agree, 2.60–3.39= Neutral, 1.80–2.59= Disagree, 1.00–1.79=Strongly Disagree)

These findings are consistent with studies emphasizing that proper transformer sizing, load management, and modernization significantly reduce technical losses and improve voltage stability in distribution systems (Aguero, 2017). Similarly, evidence from power distribution asset management highlights that regular maintenance, upgrading inefficient transformers, and load balancing enhance system reliability and reduce energy losses in electric utility operations (Sultana, 2016).

The results suggest that transformer efficiency measures in reducing system losses and improving reliability are perceived to effective. Respondents agree that interventions such as proper sizing, upgrading, and regular maintenance contribute to enhanced operational performance, highlighting the importance of sustained and well-managed transformer operations in achieving efficient power distribution.

Information shown in Table 8 indicates a positive level of agreement regarding preventive maintenance practices and their contribution to system loss reduction trends from 2021 to 2025. All indicators received scores within the "Agree" range, reflecting favorable perceptions from the respondents.

Among the indicators, "Vegetation clearing and right-of-way (ROW) maintenance reduced technical losses" obtained the highest mean of 4.13, followed by "Routine meter testing and calibration improved billing accuracy" with a mean of 4.10. The remaining indicators, including scheduled preventive maintenance, thermal scanning, and regular pole-line inspections, also yielded closely similar mean scores within the "Agree" range, indicating a consistent level of agreement across all aspects evaluated.

These findings are consistent with studies emphasizing that preventive maintenance activities such as vegetation management, line inspections, and equipment testing significantly reduce technical losses and improve service reliability in power distribution systems (Gill, 2016). Similarly, evidence from utility operations highlights that routine maintenance and system monitoring enhance operational reliability and contribute to improved efficiency in electric utilities (Schuelke-Leech, 2015).

Table 8. Level of Technical Factors Contributory to the Observed System Loss Trends as to Preventive Maintenance

Indicative Statement	Mean	SD	Verbal Interpretation	Remarks
Scheduled preventive maintenance prevented technical failures and losses.	4.08	0.73	Agree	Scheduled preventive maintenance prevented technical failures and losses was perceived to be effective.
Thermal scanning helped detect hotspots that contributed to losses	4.02	0.78	Agree	Thermal scanning helped detect hotspots that contributed to losses was perceived to be effective.
Regular pole-line inspections prevented system deterioration	3.99	0.80	Agree	Regular pole-line inspections prevented system deterioration was perceived to be effective.
Routine meter testing and calibration improved billing accuracy.	4.10	0.70	Agree	Routine meter testing and calibration improved billing accuracy was perceived to be effective.
Vegetation clearing and ROW maintenance reduced technical losses.	4.13	0.76	Agree	Vegetation clearing and ROW maintenance reduced technical losses was perceived to be effective.
Overall Mean and SD	*4.06*	*0.75*		Preventive Maintenance under Technical Factors for system loss reduction was perceived to be effective.
Overall Interpretation	*Agree*			

Note. N=100. V.I.=Verbal interpretation. The mean is interpreted as follows: 4.20–5:00= Strongly Agree, 3.40–4.19= Agree, 2.60–3.39= Neutral, 1.80–2.59= Disagree, 1.00–1.79=Strongly Disagree)

The results suggest that preventive maintenance practices in reducing system losses and maintaining service reliability are perceived to be effective. Respondents agree that regular inspections, maintenance activities, and monitoring mechanisms contribute to improved operational performance, highlighting the importance of sustained preventive measures in efficient power distribution management.

Information shown in Table 9 indicates a positive level of agreement regarding anti-pilferage programs and their contribution to reducing non-technical system losses from 2021 to 2025. All indicators received scores within the “Agree” range, reflecting favorable perceptions from the respondents.

Among the indicators, “Meter sealing and anti-tampering measures minimized pilferage” obtained the highest mean of 4.16, followed by “Consumer awareness campaigns improved compliance with billing policies" with a mean of 4.11. The remaining indicators, including anti-pilferage operations, community reporting mechanisms, and legal enforcement actions, also yielded closely similar mean scores within the "Agree" range, indicating a consistent level of agreement across all aspects evaluated.

These findings are consistent with studies emphasizing that non-technical losses such as electricity theft and meter tampering significantly reduce utility efficiency, and can be effectively addressed through strong monitoring systems, enforcement mechanisms, and community-based reporting strategies (Chandel, 2016). Similarly, evidence from power sector governance studies highlights that anti-pilferage interventions including meter sealing, inspection programs, and enforcement campaigns are essential in reducing non-technical losses and improving the financial and operational sustainability of electric utilities (Saeed, 2020).

Table 9. Level of Non-Technical Factors Contributory to the Observed System Loss Trends as to Anti-Pilferage Programs

Indicative Statement	Mean	SD	Verbal Interpretation	Remarks
Anti-pilferage operations effectively reduced non-technical losses.	4.03	0.78	Agree	Anti-pilferage operations effectively reduced non-technical losses was perceived to be effective.
Community reporting mechanisms helped identify illegal connections.	3.96	0.75	Agree	Community reporting mechanisms helped identify illegal connections was perceived to be effective.
Meter sealing and anti-tampering measures minimized pilferage.	4.16	0.76	Agree	Meter sealing and anti-tampering measures minimized pilferage was perceived to be effective.
Legal and enforcement actions discouraged electricity theft.	3.94	0.71	Agree	Legal and enforcement actions discouraged electricity theft was perceived to be effective.
Consumer awareness campaigns improved compliance with billing policies.	4.11	0.72	Agree	Consumer awareness campaigns improved compliance with billing policies was perceived to be effective.
Overall Mean and SD	*4.04*	*0.75*		Anti-Pilferage under Non-Technical Factors for system loss reduction was perceived to be effective.
Overall Interpretation	*Agree*			

Note. N=100. V.I.=Verbal interpretation. The mean is interpreted as follows: 4.20–5:00= Strongly Agree, 3.40–4.19= Agree, 2.60–3.39= Neutral, 1.80–2.59= Disagree, 1.00–1.79=Strongly Disagree)

The results suggest that anti-pilferage programs in reducing non-technical system losses are perceived to be effective. Respondents agree that enforcement measures, community engagement, and monitoring strategies contribute to improved system integrity and operational performance, highlighting the importance of sustained non-technical interventions in system loss management.

Information shown in Table 10 indicates a positive level of agreement regarding administrative control measures and their contribution to reducing non-technical system losses from 2021 to 2025. All indicators received scores within the "Agree" range, reflecting favorable perceptions from the respondents.

Among the indicators, "Administrative reporting procedures enhance transparency and accountability in system loss control." obtained the highest mean of 4.19, followed by "Interdepartmental coordination mechanisms are actively used to support system loss reduction" with a mean of 4.12. The remaining indicators, also yielded closely similar mean scores within the "Agree" range, indicating a consistent level of agreement across all aspects evaluated.

These findings are consistent with studies emphasizing that strong administrative systems and overall institutional performance in public organizations (Amalia, 2023). Similarly, evidence from governance studies highlights that effective internal control systems and interdepartmental coordination improve regulatory compliance and operational efficiency in public utilities and service delivery organizations (Boufounou, 2024).

Table 10. Level of Non-Technical Factors Contributory to the Observed System Loss Trends as to Administrative Control Measures and Regulatory Compliance

Indicative Statement	Mean	SD	Verbal Interpretation	Remarks
Regulatory compliance monitoring is consistently conducted for all system loss reduction activities.	4.07	0.70	Agree	Regulatory compliance monitoring is consistently conducted was perceived to be effective.
Corrective actions identified in system loss management are approved, documented, and implemented according to schedule.	4.10	0.73	Agree	Corrective actions identified in system loss management was perceived to be effective.
Internal audits of loss management activities are regularly conducted and recorded	4.07	0.74	Agree	Internal audits of loss management activities are regularly conducted and recorded was perceived to be effective.
Interdepartmental coordination mechanisms are actively used to support system loss reduction.	4.12	0.73	Agree	Interdepartmental coordination mechanisms were perceived to be effective.

Administrative reporting procedures enhance transparency and accountability in system loss control.	4.19	0.79	Agree	Administrative reporting procedures enhance transparency and accountability in system loss control was perceived to be effective.
Overall Mean and SD	*4.11*	*0.74*		Administrative Control Measures under Non-Technical Factors for system loss reduction was perceived to be effective.
Overall Interpretation	*Agree*			

Note. N=100. V.I.=Verbal interpretation. The mean is interpreted as follows: 4.20–5:00= Strongly Agree, 3.40–4.19= Agree, 2.60–3.39= Neutral, 1.80–2.59= Disagree, 1.00–1.79=Strongly Disagree)

The results suggest that administrative control measures and regulatory compliance in supporting system loss reduction is perceived to be effective. Respondents agree that structured reporting, coordination, and monitoring mechanisms contribute to improved operational performance and transparency, highlighting the importance of strong administrative practices in achieving efficient and accountable system loss management.

The Table 11 presents respondents' assessment of FLECO's system loss reduction programs from a public administration perspective, specifically in terms of efficiency. The overall mean of 4.10 (SD = 0.76) falls within the "Agree" category, indicating that respondents generally perceive the cooperative's initiatives as contributing positively to operational efficiency.

Among the specific indicators, "System loss reduction programs contributed to a measurable decrease in operational costs" received the highest mean score (Mean = 4.16, SD = 0.71), suggesting that interventions have tangible cost-saving effects.

The availability of resources (Mean = 4.14, SD = 0.78) demonstrates that operational planning ensures equipment and materials are provided when needed, supporting uninterrupted system loss management. Technical and administrative interventions (Mean = 4.06, SD = 0.80) were also recognized as effective in reducing power interruptions, while clearly communicated targets (Mean = 4.05, SD = 0.76) and improved processing times for technical and billing issues (Mean = 4.08, SD = 0.75) reflect structured operational efficiency.

Table 11. Level of Public Administration Perspective in Terms of Efficiency

Indicative Statement	Mean	SD	Verbal Interpretation	Remarks
System loss reduction programs contributed to a measurable decrease in operational costs.	4.16	0.71	Agree	System loss reduction programs contributed to a measurable decrease in operational costs was perceived to be effective.
Resources for system loss reduction (equipment, materials, tools) were available when needed.	4.14	0.78	Agree	Resources for system loss reduction were available when needed was perceived to be effective.

Technical and administrative interventions reduced power interruptions related to system losses.	4.06	0.80	Agree	Technical and administrative interventions reduced power interruptions related to system losses was perceived to be effective.
Targets for annual system loss reduction were clearly communicated to concerned departments.	4.05	0.76	Agree	Technical and administrative interventions reduced power interruptions related to system losses was perceived to be effective.
Implementation of loss reduction strategies improved processing time for technical and billing-related issues	4.08	0.75	Agree	Implementation of loss reduction strategies improved processing time for technical and billing-related issues was perceived to be effective.
Overall Mean and SD	*4.10*	*0.76*		The Public Administration Perspective in terms of Efficiency in system loss reduction was perceived to be effective.
Overall Interpretation	*Agree*			

Note. N=100. V.I.=Verbal interpretation. The mean is interpreted as follows: 4.20–5:00= Strongly Agree, 3.40–4.19= Agree, 2.60–3.39= Neutral, 1.80–2.59= Disagree, 1.00–1.79=Strongly Disagree)

These findings are consistent with New Public Management principles, which emphasize efficiency through cost control, performance measurement, and results-oriented management in public organizations (Hood, 1991). Similarly, studies on public sector performance highlight that efficient utilities are characterized by effective resource utilization, reduced operational costs, and improved service reliability achieved through structured operational systems (Marieta, 2010). From a public administration standpoint, these results illustrate that FLECO promotes efficiency through strategic planning, resource allocation, and systematic implementation of both technical and administrative measures. The findings indicate that operational processes are designed to optimize service delivery while minimizing system losses and associated costs.

The results suggest that FLECO's system loss reduction programs are perceived to be effective in improving efficiency, thereby enhancing organizational performance and service reliability.

Table 12 presents respondents' perceptions of FLECO's system loss reduction programs from the lens of accountability. The overall mean score of 4.24 (SD = 0.72) falls within the "Strongly Agree" category, indicating a high level of consensus that administrative practices effectively promote responsibility and answerability in system loss management.

The highest-rated indicators, such as "Sanctions or corrective actions were imposed when system loss targets were not achieved" and "Monitoring mechanisms ensured compliance with loss reduction policies" highlight that FLECO enforces structured oversight and accountability measures. Assigning specific departments or personnel to monitor system loss reflects clear responsibility delegation, ensuring that roles and duties are well-defined. Supervisory monitoring and regular reporting, review, and validation of system loss reports further demonstrate systematic accountability mechanisms embedded within organizational operations.

Table 12. Level of Public Administration Perspective in terms of Accountability

Indicative Statement	Mean	SD	Verbal Interpretation	Remarks
Specific departments or personnel were formally assigned responsibility for system loss monitoring.	4.40	0.67	Strongly Agree	Specific departments or personnel were formally assigned responsibility for system loss monitoring was perceived to be effective.
Supervisors monitored staff performance related to system loss reduction activities.	4.16	0.75	Agree	Supervisors monitored staff performance related to system loss reduction activities was perceived to be effective.
System loss reports were regularly submitted, reviewed, and validated by management.	4.16	0.73	Agree	System loss reports were regularly submitted, reviewed, and validated by management was perceived to be effective.
Monitoring mechanisms (e.g., audits, inspections) ensured compliance with loss reduction policies.	4.23	0.72	Strongly Agree	Monitoring mechanisms (e.g., audits, inspections) ensured compliance with loss reduction policies was perceived to be highly effective.
Sanctions or corrective actions were imposed when system loss targets were not achieved.	4.24	0.73	Strongly Agree	Sanctions or corrective actions were imposed when system loss targets were not achieved was perceived to be highly effective.
Overall Mean and SD	4.24	0.72		The Public Administration Perspective in terms of Accountability in system loss reduction was perceived to be highly effective.
Overall Interpretation	Strongly Agree			

Note. N=100. V.I.=Verbal interpretation. The mean is interpreted as follows: 4.20–5:00= Strongly Agree, 3.40–4.19= Agree, 2.60–3.39= Neutral, 1.80–2.59= Disagree, 1.00–1.79=Strongly Disagree)

These findings are consistent with public accountability theory, which emphasizes that effective accountability systems require clear assignment of responsibilities, continuous monitoring, and the enforcement of sanctions or corrective actions for performance outcomes (Bovens, 2007). Similarly, studies on public sector governance highlight that accountability is strengthened through structured mechanisms such as audits, performance monitoring, and reporting systems, which enhance transparency and improve organizational effectiveness (Sari, 2023).

The results indicate that FLECO's system loss reduction initiatives are strongly agreed upon, reflecting strong accountability measures that is perceived to be strongly effective organizational performance.

Information shown in Table 13 indicates a high level of agreement regarding FLECO's system loss reduction programs in terms of governance. All indicators received scores within the "Strongly Agree" range, reflecting strong positive perceptions from the respondents.

Among the indicators, "Stakeholders were informed about system loss performance" obtained the highest mean of 4.39, followed by "Compliance with regulatory requirements influenced planning and implementation of loss reduction programs" with a mean of 4.35. The remaining indicators, including adherence to cooperative policies and ERC guidelines, accessibility of documented policies, and governance practices enhancing institutional credibility, also yielded closely similar mean scores within the "Strongly Agree" range, indicating a consistent level of agreement across all aspects evaluated and assessed.

Table 13. Level of Public Administration Perspective in terms of Governance

Indicative Statement	Mean	SD	Verbal Interpretation	Remarks
Policies guiding system loss reduction were documented and accessible to concerned personnel.	4.31	0.71	Strongly Agree	Policies guiding system loss reduction were documented and accessible to concerned personnel was perceived to be highly effective.
Decisions regarding loss reduction strategies followed established cooperative policies and ERC guidelines.	4.31	0.72	Strongly Agree	Decisions regarding loss reduction strategies followed established cooperative policies and ERC guidelines was perceived to be highly effective.
Compliance with regulatory requirements influenced planning and implementation of loss reduction programs.	4.35	0.73	Strongly Agree	Compliance with regulatory requirements influenced planning and implementation of loss reduction programs was perceived to be highly effective.
Stakeholders (e.g., management, board, MCO's) were informed about system loss performance.	4.39	0.67	Strongly Agree	Stakeholders (e.g., management, board, MCO's) were informed about system loss performance was perceived to be highly effective.
Governance practices in system loss management enhanced institutional credibility and public trust.	4.22	0.73	Strongly Agree	Governance practices in system loss management enhanced institutional credibility and public trust was perceived to be highly effective.
Overall Mean and SD	*4.32*	*0.71*		The Public Administration Perspective in terms of Governance in system loss reduction was perceived to be highly effective.
Overall Interpretation	*Strongly Agree*			

Note. N=100. V.I.=Verbal interpretation. The mean is interpreted as follows: 4.20–5:00= Strongly Agree, 3.40–4.19= Agree, 2.60–3.39= Neutral, 1.80–2.59= Disagree, 1.00–1.79=Strongly Disagree)

These findings are consistent with the principles of good governance, which emphasize transparency, stakeholder participation, accountability, and adherence to established rules and policies in public organizations (Juiz, 2014). Similarly, studies on public sector governance highlight that effective utilities demonstrate strong performance through regulatory compliance, transparent decision-making, and active stakeholder engagement, which collectively enhance institutional credibility and operational effectiveness (Douglas, 2016).

The results suggest that FLECO's system loss reduction programs are perceived to be highly effective in promoting governance. Respondents strongly agree that transparency, regulatory compliance, and stakeholder engagement are well integrated into organizational practices, highlighting the cooperative's strong capability in maintaining ethical, accountable, and well-governed system loss management.

Table 14 presents the correlation between the technical and non-technical measures implemented by FLECO and the public administration perspective, particularly in terms of efficiency, accountability, and governance. Key measures such as line upgrades, transformer efficiency, preventive maintenance, anti-pilferage programs, and administrative control measures show moderate to high positive correlations with efficiency, indicating their strong contribution to improving operational performance. However, these same measures exhibit very small correlations with accountability and governance, suggesting limited direct influence on these administrative dimensions.

The table further indicates that all correlations with efficiency are statistically significant, particularly for line upgrades ($r = 0.736$, $p < 0.01$), transformer efficiency ($r = 0.592$, $p < 0.01$), preventive maintenance ($r = 0.651$, $p < 0.01$), anti-pilferage programs ($r = 0.621$, $p < 0.01$), and administrative control measures ($r = 0.621$, $p < 0.01$). This confirms that the relationships between these measures and operational efficiency are reliable and meaningful. In contrast, correlations with accountability and governance are not statistically significant ($p > 0.05$), indicating that these relationships are weak and may depend on other organizational or policy-driven factors.

Table 14. Significant Relationship between Technical, Non-Technical Measures and Public Administration Perspective

Factors contributory to the observed system loss trends	Public Administration Perspective		
	Efficiency	Accountability	Governance
Technical Measures			
Line Upgrades	r=0.736 High *p*<0.01	r=0.074ns Very Small *p*=0.486	r=0.086ns Very Small *p*=0.394
Transformer Efficiency	r=0.592** Moderate *p*<0.01	r=0.168ns Very Small *p*=0.094	r=0.113ns Very Small *p*=0.263
Preventive Maintenance	r=0.651** Moderate *p*<0.01	r=0.119ns Very Small *p*=0.237	r=0.175ns Very Small *p*=0.082
Non-Technical Measures			
Anti-Pilferage Programs	r=0.621** Moderate *p*<0.01	r=0.130ns Very Small *p*=0.196	r=0.158ns Very Small *p*=0.116
Administrative Control Measures	r=0.621** Moderate *p*<0.01	r=0.191ns Very Small *p*=0.056	r=0.091ns Very Small *p*=0.366
Correlation Value and Its Corresponding Interpretation 0.91 – 1.00 Very High 0.71 – 0.90 High 0.41 – 0.70 Moderate 0.21 – 0.40 Low 0.00 - 0.20 Very Low			

*** significant at 1% level* **significant at 5%* level

These findings are consistent with New Public Management theory, which emphasizes that operational and technical reforms primarily enhance efficiency in public organizations, but do not automatically translate into improved accountability and governance without structured institutional mechanisms (Hood, 1991). Similarly, studies on public sector performance highlight that while efficiency gains can be achieved through operational improvements, strengthening accountability and governance requires formal systems such as monitoring frameworks, policy enforcement, and stakeholder engagement processes (Thakkar, 2025).

In summary, both technical and non-technical measures are strongly linked to improvements in efficiency, highlighting their effectiveness in enhancing operational outcomes within FLECO. Measures such as line upgrades, preventive maintenance, and anti-pilferage programs play important roles in optimizing performance, while administrative control measures support process efficiency. However, the weak and non-significant relationships with accountability and governance suggest that these aspects require additional structured mechanisms such as formal monitoring, policy enforcement, and stakeholder engagement. Overall, the consistently positive and statistically significant correlations with efficiency indicate that these measures are essential in achieving effective system performance, while a more integrated administrative approach is needed to fully strengthen accountability and governance.

4. Summary, Conclusions, and Recommendations

4.1. Summary of Findings

This section presents the summary of the major findings of the study based on the analysis of data gathered on the demographic profile of respondents, system loss reduction trends, technical and non-technical contributory factors, and the public administration perspective, including the relationship between variables from 2021 to 2025.

1. Demographic Profile of Respondents
   - 1.1. The largest age group of respondents belongs to 36–40 years old (22%), followed by 26–30 years old (21%) and 31–35 years old (19%), indicating that most respondents are within the mid-career working age bracket. The least represented age groups are 56–60 years old (2%) and 20–25 years old (4%), showing minimal participation from the youngest and oldest workforce segments.
   - 1.2. The respondent population is predominantly male (76.76%), while female respondents comprise 24.24%, reflecting a male-dominated workforce consistent with the technical nature of the electric cooperative sector.
   - 1.3. In terms of educational attainment, most respondents are bachelor's degree holders (48.48%), followed by high school graduates (23.23%) and vocational graduates (21.21%), indicating a generally moderately educated workforce. A small proportion have attained master's degrees (7.7%) and doctoral degrees (1.1%), suggesting limited representation of advanced postgraduate education.
   - 1.4. Most respondents belong to the Technical Services Department (48%), indicating that technical personnel dominate the sample population. Other departments are less represented, with the Office of the General Manager having the lowest representation (2%), showing uneven departmental distribution.
   - 1.5. The majority of respondents are rank-and-file employees (74.74%), while only a small proportion occupy supervisory, section head, and managerial positions.
   - 1.6. In terms of years in service, most respondents have 6–10 years (25%) and 11–15 years (24%) of experience, indicating a relatively experienced workforce. Only a very small proportion (1%) have 21 years or more of service, suggesting limited long-tenured employees within the sample.
2. System Loss Reduction Trends and ERC Allowable Cap
   - 2.1. FLECO's annual system loss shows a consistent downward trend from 2021 to 2025, indicating steady improvement in operational performance.
   - 2.2. System loss decreased from 9.21% (2021) to 9.14% (2022), then further declined to 8.72% (2023), 8.64% (2024), and 8.33% (2025), with no recorded increase across the five-year period.
   - 2.3. FLECO is classified under ERC Cluster 2, with a fixed allowable system loss cap of 10.25% for the entire study period.

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2.4. Throughout 2021–2025, FLECO's actual system loss remained consistently below the ERC cap, indicating full regulatory compliance.
2.5. The variance from the ERC cap is consistently negative, ranging from approximately -1.04% (2021) to -1.92% (2025).
2.6. The findings indicate that FLECO has maintained strong compliance with ERC standards while demonstrating continuous improvement in system loss reduction efficiency over the five-year period.

3. Technical and Non-Technical Factors Contributory to System Loss Trends
    3.1. Line Upgrades (Technical Factors) are perceived as effective in reducing system loss, improving system reliability, efficiency, and overall power delivery performance.
    3.2. Transformer Efficiency (Technical Factors) is perceived as effective in minimizing technical losses, enhancing voltage stability and overall system reliability.
    3.3. Preventive Maintenance (Technical Factors) is perceived as effective, contributing to improved operational efficiency and service reliability through regular inspections and monitoring activities.
    3.4. Anti-Pilferage Programs (Non-Technical Factors) are perceived as effective in reducing non-technical losses, particularly electricity theft and meter tampering, thereby strengthening system integrity.
    3.5. Administrative Control Measures and Regulatory Compliance (Non-Technical Factors) are perceived as effective in enhancing accountability, transparency, coordination, and regulatory compliance within the organization.
4. Public Administration Perspective
    4.1. Efficiency: FLECO's system loss reduction programs are perceived as effective in improving efficiency, reflected in better resource utilization, reduced operational costs, and improved service reliability. Operational processes are viewed as well-structured and results-oriented, supporting effective performance management.
    4.2. Accountability: FLECO is perceived as very effective in ensuring accountability through monitoring systems, reporting mechanisms, and clear assignment of responsibilities. System loss initiatives are seen as strongly enforced and well-supervised, strengthening organizational accountability.
    4.3. Governance: FLECO's governance practices are perceived as very effective in promoting transparency, regulatory compliance, and stakeholder engagement. The organization is viewed as strongly governed, ethical, and compliant, reflecting sound public sector governance.
5. Relationship between Technical, Non-Technical Measures and Public Administration Perspective
    5.1. Technical and non-technical measures show a strong positive relationship with Efficiency, particularly line upgrades, transformer efficiency, preventive maintenance, anti-pilferage programs, and administrative control measures, with correlations ranging from moderate to high and statistically significant ($p < 0.01$).
    5.2. The strongest relationship is observed in line upgrades ($r = 0.736$), indicating a high contribution to operational efficiency.
    5.3. All other measures also show moderate positive and significant relationships with Efficiency, confirming their effectiveness in improving system performance. In contrast, relationships with Accountability and Governance are very weak (very small correlations) and not statistically significant ($p > 0.05$).
    5.4. This indicates that while technical and non-technical interventions improve operational efficiency, they have limited direct impact on strengthening accountability and governance.
    5.5. Overall, the findings suggest that system improvement measures are primarily efficiency-driven, and that accountability and governance require additional institutional and policy-based mechanisms.

4.2. Conclusions

The study concludes that FLECO's system loss performance from 2021 to 2025 demonstrates a consistent and sustained downward trend, indicating improved operational efficiency and strong compliance with the ERC allowable cap. This confirms that the cooperative has been effective in managing system losses within regulatory standards while continuously enhancing its operational performance.

The findings further establish that both technical measures (line upgrades, transformer efficiency, and preventive maintenance) and non-technical measures (anti-pilferage programs and administrative control systems) are perceived as effective contributors to system loss reduction. These interventions collectively strengthen system reliability, operational efficiency, and service delivery.

In terms of public administration perspective, FLECO is assessed as effective to very effective in efficiency, accountability, and governance. Efficiency is notably strengthened through improved operational systems, while accountability and governance are rated higher, reflecting strong monitoring, transparency, and compliance mechanisms.

However, the correlation results reveal that while technical and non-technical measures significantly influence efficiency, their relationship with accountability and governance is weak and not statistically significant. This indicates that improvements in accountability and governance are not solely dependent on operational interventions but require stronger institutional frameworks, policy enforcement, and organizational reforms.

Overall, the study concludes that FLECO's system loss reduction initiatives are primarily efficiency-driven, supported by effective technical and administrative strategies, while accountability and governance are sustained through institutional practices that extend beyond operational improvements.

The null hypothesis is partially rejected. The findings show that there is a significant relationship between the technical and non-technical measures and the public administration dimension of efficiency, indicating that these interventions meaningfully contribute to improved operational performance. However, there is no significant relationship between the said measures and accountability and governance, as the results are not statistically significant. This suggests that while FLECO's system loss reduction initiatives are effective in enhancing efficiency, their influence does not directly extend to accountability and governance, which are likely shaped by broader institutional, administrative, and policy-level factors.

4.3. Recommendations

Based on the findings of the study, several recommendations are proposed to guide FLECO and related stakeholders in sustaining and enhancing system loss reduction programs. These suggestions aim to maintain the positive trends observed, improve operational and administrative efficiency, and strengthen public administration outcomes in terms of efficiency, accountability, and governance.

1. For FLECO Management and Technical Operations: The cooperative should continue strengthening and sustaining technical interventions such as line upgrades, transformer efficiency improvements, and preventive maintenance across all operational areas, as these are proven to significantly enhance efficiency and reduce system losses. Specifically, FLECO should institutionalize scheduled preventive maintenance cycles, prioritization of high-loss feeders, and systematic replacement of aging distribution equipment to ensure continuous system reliability.
2. For FLECO Operations and Field Personnel: The cooperative is encouraged to further intensify non-technical loss reduction strategies, particularly anti-pilferage programs, through enhanced monitoring, stricter enforcement, and expanded community reporting mechanisms. Specifically, FLECO should strengthen routine inspection of service drops, installation of tamper-proof meters, and community-based reporting hotlines per municipality to detect and prevent electricity theft.
3. For FLECO Planning and Engineering Units: The cooperative should integrate a more data-driven asset management and maintenance system to ensure timely identification and resolution of technical

inefficiencies. Specifically, FLECO should develop a centralized system loss database per municipality, GIS-based mapping of loss hotspots, and predictive maintenance scheduling using historical outage and load data. Also, in coordination with System Operations and Metering Services, Planning and Engineering Units should prioritize the installation of feeder-level metering at substation and municipal levels to enhance the granularity of system loss monitoring and facilitate data-driven loss reduction strategies.

4. For FLECO Management and Administrative Offices: While accountability and governance were found to be strong, FLECO should establish more structured institutional mechanisms such as enhanced audit systems, performance dashboards, and clearer accountability frameworks to strengthen long-term institutional impact. Specifically, the cooperative should implement real-time performance monitoring dashboards, quarterly internal audits per department, and standardized reporting templates across municipalities to improve transparency and control.

5. For FLECO Top Management and Policy Committee: The cooperative should strengthen policy-based governance interventions, including stakeholder engagement programs and formalized transparency initiatives, to ensure that efficiency gains are complemented by stronger governance systems. Specifically, FLECO should conduct regular stakeholder consultations per municipality, publish system loss performance summaries, and institutionalize transparency reporting in annual reports.

6. For FLECO as an Organization: Future initiatives should adopt a balanced approach combining technical, operational, and administrative reforms to ensure that efficiency improvements are matched with stronger accountability and governance systems. Specifically, FLECO should pursue full integration of advanced metering infrastructure (AMI), cross-departmental coordination systems, and unified system loss monitoring across all municipalities to strengthen organizational performance.

7. For Future Researchers: It is recommended to conduct similar studies using a wider scope or comparative analysis across multiple electric cooperatives to further validate and expand the findings of this study. Specifically, future research may include comparative municipality-level analyses, integration of smart metering impact studies, and inclusion of consumer behavior and compliance factors to deepen understanding of system loss dynamics.

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