Reducing Losses at a Power Utility

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Abstract *— This design project consists of a power utility and the complexity of handling losses that represent 12.4% of energy loss. The objective of this project was developed using the DMAIC methodology for a better understanding of the current structure of the process of handling and measuring losses in the utility. These are seen as technical and non-technical losses. In the US, a power utility has a combined 4.5% of losses, while this power utility has 7.9% of technical losses and a 4.5% of non-technical losses, representing a high priority for a loss reduction program. The program will help the utility develop long-term initiatives for handling and measuring losses with data-driven projects, improve employee skills with better training, and provide clarity about loss reduction goals to its workforce. The structure needed for completion will be based on standardizing the utility loss calculation methodology with a clear accountability organizational system in place.*

Key Terms *— metering, non-technical losses, technical losses, power utility*

INTRODUCTION

Loss assessment methods used by the utility lack data normalization and higher accuracy, making it difficult for the utility to undertake a fair investigation into its loss levels and to limit research into loss patterns and their root causes. The energy utility in this study project, like many others, has a systemic problem with the amount of technical and non-technical losses it incurs. Technical and non-technical losses are currently calculated by the utility as the difference between total annual invoiced energy and total energy generated in the transmission system. This results in an imprecise indicator of losses. Technical losses are inherent to energy transmission and are closely linked to the infrastructural features of power systems; this sort of loss is dependent on a number of interdependent parameters within the system architecture, such as power line voltage, loads, and so on. Non-technical losses are estimated amounts of energy that aren't billed to customers because of things like fraud, theft, and process problems, as well as metering, human, and system errors.

The utility must implement energy-balance capabilities in the system in order to do accurate loss estimations. Energy balancing refers to a utility company's ability to compare the amount of electricity delivered to a single feeder or group of feeders in its service zone to the amount of energy consumers have paid for in the same zone. Since any initiative for reducing losses is highly dependable on knowing the service point of the customer as the link with the distribution system by comparing the energy consumed by each customer in a zone with the energy that was given to the zone. For the utility to achieve the capability of knowing the high losses zones it needs to implement the use of modern technology as smart meter at all service points, tools that helps in the energy balance calculation, and standardizing business procedures that assures loss calculations effectiveness.

Because the utility lacks these specific limitations for calculating losses, it relies on a process that hasn't been updated in over 15 years. The process calculates an overall estimate loss of 12.4%, of which 7.9% represents technical losses, and subtracts the technical rate from the overall losses to leave a 4.5 %. This only takes in to account a high-level measurement of the overall utility losses. The process prevents the utility from performing a root-cause analysis to explain the losses since it is based on an estimate that does not account for the various variables that can affect both categories of losses. As a result, there is inefficiency in reviewing operations or forecasting future trends, as well as complexity in building future initiatives that measure the effectiveness of the loss reduction program. Also, not having a team overseeing the losses and accountable for the initiatives makes it even more complex to understand the company losses.

PROBLEM STATEMENT

The power utility currently needs to standardize its loss measurement methodology, as well as create a loss reduction program with a defined organizational system and align it with national quality standards for reducing the overall losses of 12.4% that represents technical losses (e.g., power line voltage, load, network lines, transformers, etc..) and non-technical(e.g., Mismanagement, un-metered supply, tampered meters, fraud, etc..) of energy. This losses represent $170 million annually to the utility. As a result, the power utility will be able to develop more specific and targeted initiatives and action plans as part of a loss reduction program to reduce overall losses to 4.5% or less over time.

RESEARCH DESCRIPTION

The research intends to assist the power utility in developing a loss reduction program based on data-driven strategies. Standardizing the organization's loss methodology and implementing a plan that quantifies the program's efficacy, so the utility may adjust investments and staff resources with better loss data and analytics management

RESEARCH OBJECTIVES

This research's primary objective is to develop a long-term loss reduction strategy in accordance with the fundamental concepts that guide the prioritization of power utility transformation projects, including operational significance, competitive strategy, economic effects, technological feasibility, and ease of deployment. The project aims to achieve the following objectives:

- Define internal responsibilities and frameworks for better loss management.
- Develop and train the employees of the power utility to better decrease losses.
- Develop procedures for determining the total loss that are reliable and accurate.
- Consistent method to calculate losses.
- Ensure that the proper revenue control and auditing processes are in place.
- To determine the location and kind of losses, conduct a complete energy balancing exercise.
- Create a long-term program and a loss-reduction strategy.

RESEARCH CONTRIBUTIONS

The power utility should gain the following benefits from implementing the seven deliverables stated in this research for reducing energy losses:

- A clearer, more detailed picture of the company's losses.
- Capability to establish strong action strategies.
- Creating a more accurate loss measurement.
- Understanding of the company's loss reduction program and results.
- A more precise approach to investing aimed at reducing potential losses.
- Internal and external openness on the success of loss reduction activities has improved.
- The ability to identify and implement effective loss-reduction initiatives.
- Capacity for energy balancing using quantitative methods to determine where losses are occurring and improve quality.
- A business culture that values and supports loss avoidance.

LITERATURE REVIEW

Utility companies require an extensive knowhow of risk management practices since aging, natural disasters and different situations might cause failures on the services or potential accidents that might decrease client satisfaction or even put people at risk. The article talks about how predictive analytics might help assess and detect risks to minimize non compliances and shorten corrective action when something does happen. Specifically, the article talks about a utility gas pipeline distribution company, these tools and techniques used to assess risk have application in all sorts of industries like financial services, insurance, life sciences and even pharmaceutical companies.

Predictive analytics serve the purpose of helping to improve the odds of identifying and correcting potentially dangerous conditions so that products can be better repaired or replaced in a timely manner. They work by creating predictive algorithms based on historical, internal, external, and synthetic data while using risk modeling, to rank risk levels across all jobs to be done so that they can focus on the parts that pose the greatest threat. The goal is to get ahead of the problems in the services/products proactively. New technologies can help operation and maintenance teams be more predictive in risk evaluation which will in turn improve planning around asset maintenance, repairs, or replacement [1]. One of the strengths of predictive analytic engines is their ability to draw on multiple information sources (current and historical) and use automation and statistical processing to create risk scoring and real-time alerts [1]. In turn, this information can be used to assimilate, aggregate, and standardize existing data. For utility companies, data sources can include geospatial infrastructure mapping, system performance, repair metrics, sectional age and service history, organizational business systems and applications, customer emails and voice mails, call center records and information from machine sensors [1]. Although the article talks about the advantages of the tools used in predictive analytics, it is important to note that predictive analytic solutions are not a replacement for people or their expertise, and that predictive results can and should be continuously evaluated against actual results to determine the power of the models and enhance the accuracy of outcomes [1]. Finally, the tools used in predictive analytics are more effective when they are added to an already existing body of intelligence and experience in existing engineers and other workers by giving them access to carefully prioritized set of data.

General Concepts

It has been a cornerstone of Six Sigma process improvement in American industry for decades: identify, measure, analyze, improve, and control. [2] DMAIC has been utilized by industries to help them improve their products and processes both at their facilities and in their organizational structures. In order to enhance a product or process, a business must first identify an issue, then monitor and evaluate the situation before making a final decision.

- **Define:** What issue do you wish to solve? The problem must be defined as the first stage in the Lean Six Sigma improvement process. Among the activities done in this phase are the creation of a Project Charter and a high-level process map. The process knowledge journey continues with Process Walks and interviews with process participants. Before moving on to the Measure Phase, the team ensures that the project emphasis is in accordance with the organizational leadership objectives. [3]
- **Measure:** What is the condition of the process at this point? To what extent is the problem? Measurement is essential throughout the project's life cycle since it gives crucial indications of process health as well as pointers to where process difficulties are occurring. As the team gathers data, they concentrate on the process's lead time or the quality of the product that clients get. The team develops its metrics and determines the current performance or baseline of the process before going on to the Analyze Phase. [3]
- **Analyze:** What is the source of the issue? One of the most difficult tasks for teams is to avoid the impulse to leap to a solution before determining the underlying root causes of process problems. Without thorough analysis, teams may execute solutions that do not address the problem, wasting time, resources, increasing variety, and perhaps introducing new issues. Have you ever seen a group do this? Yes, that occurs frequently. Instead of adopting non-solutions, teams should learn from their Process Walks, examine their charts and graphs, and utilize their observations to build and confirm

ideas about what's causing the problem they're attempting to address. This phase's main goal is to test theories before adopting solutions. The team should next go to the Improve Phase. [3]

- **Improve:** How will the team address the underlying causes of the problem? After the team has determined what is causing the problem, it is critical to implement strategies to address the underlying causes. The team refines its countermeasure ideas, evaluates process improvements, implements solutions, and collects data to validate meaningful success throughout the Improve Phase. A systematic improvement effort can result in innovative and elegant improvements that improve the baseline measure and, as a result, the customer experience. [3]
- **Control:** How can you keep the improvement going? Now that the changes have been implemented and the process problem has been fixed, the team must work hard to maintain the improvements and make it simple to update best practices. The team develops a Monitoring Plan to track the success of the improved process, as well as a Response Plan in the event of a reduction in performance during the Control Phase. Once in place, the Process Owner monitors and adapts the current ideal approach as appropriate. [3]

METHODOLOGY

For this project the DMAIC methodology was used to understand and improve the process of addressing the different types of losses in the power utility.

For the define phase a project charter was developed with the goal of understanding the types of losses and the need of the customer, as well as the scope of the project. Also, a process map was develop of the different types of losses the power utility has, the lack of standardized documents and information only a high-level process could be developed.

In the measure phase the goal was to identify the quantity of losses in monetary terms. With the help of a voice of the customer and the SIPOC. For calculating this losses, the company shared some information and permitted to analyze the data at the site, from that analysis of energy losses in the company system, as technical and non-technical losses it was identified that the company had data structure, sources, and parameters problem making it difficult to have an accurate quantity of losses. After identifying the issues, it was concluded that the energy losses are estimated to be $170 million annually.

Analyze phase objective changed from analyzing the data to analyzing the process gaps in the company that is affecting the process of handling losses. Developing and executing the gap analysis was challenging due to different factors (e.g., lack of standardization, lack of knowledge, lack of data structure). It was executed an interviewing process for understanding of each gap the company ha in the process of measuring and handling losses.

After the analyze phase, it was identified must of the gaps in the process and a set of initiatives were developed for the power utility to achieve is goal of effectively handling and measuring their losses in the improve phase. For the control phase it was suggested a timeline with the key milestones for executing and implementing the improvement phase. As KPI’s to measure the success of the project’s implementation.

RESULTS AND DISCUSSION

The major findings of the study in each of the five phases of the DMAIC methodology are discussed in this section.

Define

The objective of the Define phase is to define the problem as clearly and precisely as possible so that the procedures, problems, and people engaged in the process are better understood. A project charter (table 1) was developed in order to determine the business case, goal, and scope of the project.

Table 1
Project charter

Project Charter	
Business Case	Developing a long-term, data-driven loss reduction strategy and the internal infrastructure to support it will not only benefit the company by increasing revenues and reducing energy losses in its system, but it will also increase customer satisfaction by enhancing the power quality supplied to customers.
Goal	Development of a long-term loss-reduction strategy that is in line with company requirements.
Scope	Identify gaps in the process of limiting energy losses in the system and establish strategic plans to reach the desired state

After developing the Project Charter, a process map (figure #1) was developed to understand the losses in the power utility.

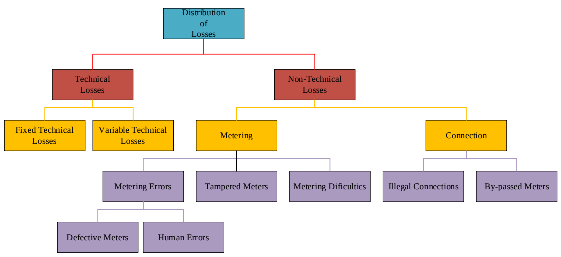

Figure 1
Process map

In the process map, the losses is divided in two categories [4]:

- Technical losses are inherent to energy transmission and are closely linked to the infrastructural features of power systems; this sort of loss is dependent on a number of interdependent parameters within the system architecture, such as power line voltage, loads, and so on.
- Non-technical losses are estimated amounts of energy that aren't billed to customers because of things like fraud, theft, and process problems, as well as metering, human, and system errors.

After completing the define phase, part of the necessity for project completion and the types of the power utility losses were identified.

Measure

The SIPOC and VOC tools were used in the Measure phase to gain a better understanding of the customer's requirements and preferences, as well as the process's inputs and outputs. From the SIPOC (figure 2) analysis it can be determined that the customer wants multiple accurate results for understanding losses and addressing them. Also, the customer wants to understand the current procedures in calculating losses. From the VOC (table 2) it can be identified that the customer doesn't have efficient variables related to losses or specific tools that help in the data analysis process. For measuring losses, the process calculates an overall estimate loss of 12.4% ($170 million), of which 7.9% ($110 million) represents technical losses, and subtracts the technical rate from the overall losses to leave a 4.5% ($55 million). Technical and non-technical losses for leading U.S. utilities total less than 4.5%.

Analyze

A Cause-and-Effect Diagram (figure 2) was conducted, followed by a gap analysis (tables 3 to 6) to identify the needs in the process for measuring and reducing losses. As part of the examination of the utility loss reduction technique and management process, interviews with the power utility's commercial, energy metering, operations, and utility divisions were done as part of the analyze phase. Also, a review of the power utility's present loss reduction targets was also conducted.

This study found limitations and possibilities in governance, operations, processes, employees, and systems.

Supliers	Inputs	Process	Outputs	Customers
Managers Supervisors Analysts Operators	Energy Measured Energy Consumption Energy Generated Energy Billed Non payment reports Estiamted clients reports Revenue	Energy Losses Calculation	Reports on losses. Baseline data measure and identified. Significant energy users identified, measured, stratified and prioritize. Identifed gaps in energy consumption situations Energy consumption anlyzed and causes identified. Objective, targerts and action plans developed. Control plan and procedures developed.	Business Owners CEO CFO Vice presidents Directors Utility Regulator

Figure 2

SIPOC

Table 2

VOC

Voice of the customer	Key Customer Issues	Critical Customer Requirements
What does the customer want?	Identify issues that prevents us from achieving customer goals.	Summarize key issues and translate them into specific and measurable requirements.
Custommer wants to identify the % of losses currently.	The customer doesn't have efficient variables related to losses calculation.	Development of standarize procedures for an overall loss calculation.
Custommer wants to identify if the personnel is aware of their role in the process of calculating losses	The customer doesn't understand if the current workstructure is efficient for calculating losses and have the skills needed.	Develop a structurize framework and training
How accurate are the revenue results	Customer wants to validate if there is an audit procedure in place to know the accuracy of the results.	Develop and introduce adequate procedures for revenue assurance and audits
How accurate is the data collected from the power measurement system	How accurate is the data collection that reflects losses	Develop a methodology for data collection

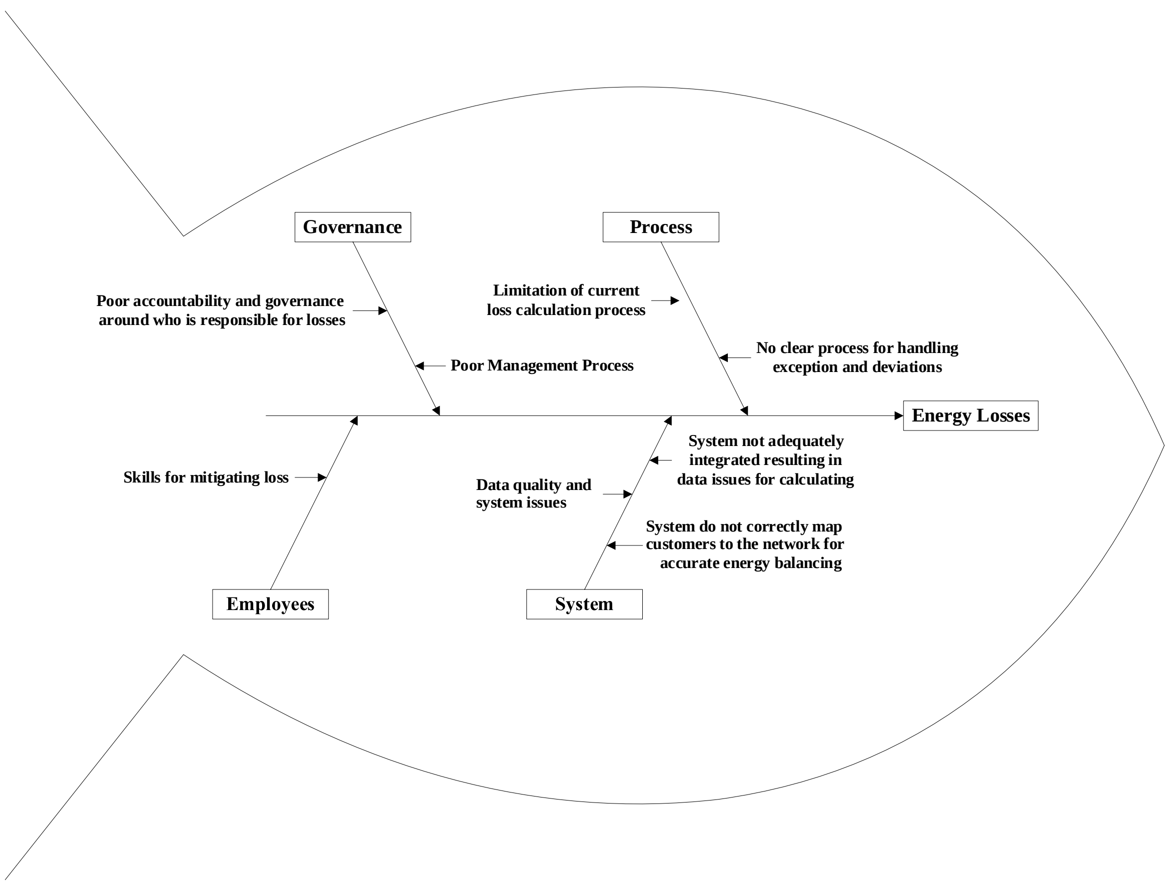

Figure 3

Cause and effect diagram

Table 3

Governance/strategy gap results

Governance: Problems

There is a lack of transparency and accountability on who is responsible for the losses.:
• There are a number of problems that arise when loss reduction efforts are not organized:
  ○ The inability to analyze losses and their causes.
  ○ The lack of information about what the team has already done and what the results have been.
  ○ Loss reduction efforts are being dispersed throughout the organization without adequate communication and coordination.
  ○ Ineffective strategies and policies are the result of poor process intelligence

Ineffective management procedures: • There appears to be no agreement on the best method for calculating the losses. • Indicator results in unreliable numbers. • Unreliable information about losses.

Table 4

Process gap results

Procedures: Problems
Constraints on how losses are currently calculated: • There is a lack of consistency in the loss computation process, such as equations and methods for gathering data. • Inability to calculate utility losses using established procedures. • Insufficient KPIs throughout the loss reduction procedure. • The distribution network lacks the meter control points required to provide the energy balancing capabilities required to understand losses in minute detail. • Absence of a method for identifying billing and collection errors that could result in revenue losses. • Inability to do a root cause analysis due to the absence of a data management or methodology.

There are no explicit procedures for addressing mistakes and incidents:
• Because of the poor quality of the data, departments come to the wrong conclusions about initiatives and actions.
• The utility has not specified discrete methods for resolving the two categories of problems that result in revenue losses in the meter-to-bill value chain. Common forms of issues include the ones listed below:
  ○ Meter readings that are inconsistent with historical trends, zero or low-value electricity purchases, and other issues that affect a large number of customers must be identified.
  ○ Problems connected with a small number of consumers, including as irregular usage, theft, meter bypasses and erroneous CT ratio settings that can only be recognized through advanced analytics and analysis.

Table 5

System gap results

System: Problems
There are problems with the quality of data and the systems that process it: • The use of incorrect information from the system. • To measure losses, the utility employs an incorrect methodology. • Root cause analysis is limited by poor data management. • To ensure more reliable data and avoid inaccurate analysis, databases need to be synchronized.
Customers cannot be effectively mapped to the infrastructure by the systems, resulting in inaccurate energy balancing: • The customer management system and the metering network do not communicate in real time. As a result, the utility is unable to carry out energy balancing at a finer level.

Data difficulties arise because the systems are not properly integrated:
• There is no standardization mechanism for loss calculations with technology.
• Since the billing and metering systems are not integrated, balancing at the transformer or feeder level is impossible. It is impossible to implement a number of loss-control measures, such as:
  ○ With more thorough customer analysis, locations can be targeted for inspections.
  ○ Gathering data on where losses are most widespread will help optimize the impact of inspections.
  ○ Loss measures at the transformer level are necessary since it is essential to link a customer with a transformer.

Table 6

Employee gap results

Employee: Problems
A lack of knowledge and abilities in preventing losses: • Lacking a distinct training approach. • When it comes to loss mitigation and control, the power utility staff lacks specialized expertise and skills. • The performance metrics of the field teams responsible for meter checks at the electric company must be improved.

Improve

The utility company should consider implementing the following improvements to build a more thorough and data-driven loss computation throughout the organization to solve the highlighted challenges and constraints that resulted from the gap analysis.

- Develop a method for gathering data that yields accurate information for calculating losses.
- Estimate the costs of implementing new, more targeted strategies.
- Improve the precision of key performance indicators by standardizing the loss calculation process.
- Calculate losses in a more precise manner by developing and implementing an appropriate technology.
- Make sure that all of your departments have clear roles and responsibilities when it comes to loss-reduction activities.
- Each job should have its own set of KPIs and responsibilities.
- For each field activity, determine the number of field employees needed to satisfy the inspection service demand.
- To repair damaged meters, define the infrastructure that is required.
- Determine if new tools, equipment, and technologies are required.
- Evaluate company knowledge gaps in order to design training programs.

A list of activities and initiatives tied to each of the project's objectives was prepared for the power utility.

One of the first initiative to be completed is to define the roles and responsibilities of loss management team members. For the utility to manage energy losses more effectively, it will need a clear accountability organizational system with the following:

- Organize the development of local action plans in the field:
  - Identify and implement localized solutions.
  - Incorporate loss prevention measures.
  - Report the results and make recommendations for further action.
  - Take use of cutting-edge technologies.
  - To avoid an increase in losses, make income protection a primary focus.
- Loss reduction activities must be centrally coordinated, and the following responsibilities must be fulfilled:
  - Develop a set of key performance indicators and related documentation.

- Set up an analytic approach for identifying the root causes of losses, the locations where they occur, and the patterns that may be used to reduce those losses.
- Measure the quality of the data and correct any errors.
- Ensure that all losses are calculated in the same method.
- Develop loss prevention strategies.
- Create a loss prevention program and system for the business.
- To assess losses, it is vital to understand what information is required, where it originates, and who is accountable for collecting it.

The second initiative is employee development. Long-term loss reduction strategies cannot begin without involving employees. In light of this, after the governance structure has been established, the utility should create loss reduction and community involvement training for its workers according to the steps outlined below. This will facilitate employee participation as the organization builds new procedures:

- All staff involved in loss reduction should get role-specific training.
- Assemble a working environment where loss prevention personnel may count on well-trained personnel and clearly defined procedures to accomplish their goals.
- Technical knowledge gaps should be evaluated and addressed through field employees in order to detect and reduce losses.

Developing mechanisms for calculating losses is the third initiative. Following activities are included in the extensive loss calculation approaches that standardize each stage in order to minimize losses:

- Determine on a method for estimating the growth in losses for each client group.
- A method for determining the location of non-technical losses should be developed.
- In order to locate areas where energy is being wasted, develop a method for balancing energy segment by segment.
- Determine how the action plan's outcomes will be measured.
- Establish an auditing procedure that covers the entire revenue cycle.
- Creating KPIs and reporting metrics for management.
- Develop a plan to detect the root causes of both technical and non-technical loss.
- Set criteria for instances in which meters cannot be read, have malfunctioned or are unavailable.
- Customers whose bills were put off by a month or more because of billing issues should have their unbilled energy calculated using specific criteria.
- Be specific about the information you need to compute the loss and who is responsible for collecting it.

Implementing a structured loss computation is the fourth initiative. It's time to standardize the company's loss calculation system by establishing the following:

- Based on an estimate of future market growth and predicted losses, perform the necessary computations.
- Loss data collection and distribution plan, requires recognizing the data source and the entity in charge of collecting and distributing it.
- Analysis of how indications of losses have altered throughout time.
- A formula-based approach that provides step-by-step guidance on how to calculate the results.

The fifth initiative is to improve the revenue auditing process. Develop controls for revenue:

- Do an audit that looks for flaws in the way business is being conducted and control system failures.
- Introduce modifications to the revenue cycle to avoid losing money due to inefficient or unnecessary procedures.
- Do audit procedures of the main parts of the company's revenue cycle, like the customer registration system, meter data process, and billing process deviations, to find and fix losses.

For the initiative number 6 is the development of strategies for energy balance. Run an energy balance scenario for the full-service area to improve and rank the mitigation initiatives:

- Do an energy balancing test for each feeder to identify where the most energy is being lost.
- Implement smart meters at feeder level.
- Set up procedures for gathering and evaluating data from the feeder level.

Final initiative is to develop a loss reduction program for the next 3 years after implementation using the data gathered during the implementation phase with the following:

- Over the next three years, a budget will be established for the initiatives and loss-reduction activities.
- According to their cost and potential loss reduction benefit, the utility will evaluate the various initiatives in the loss reduction program.
- In all of the loss-reduction activities, the functions and responsibilities of each team member have been clearly outlined.
- Predictions of future industry growth and their potential impact on loss reduction initiatives should be factored into the methodology used to calculate losses.
- As part of a comprehensive action plan that incorporates an indicator, dashboard, and post-initiative procedures, each loss reduction effort should have its own assessment strategy.
- An assessment plan should be developed for each loss reduction initiative as part of a full action plan that includes an indicator, dashboard, and post-initiative procedures.

This project provides a comprehensive cost analysis of the project execution, focusing on the quality of the business advantages. Because of the project's scope and the utility's lack of data, assumptions must be made. The cost-benefit analysis (table 7) takes into account the following factors: an estimate of the base cost of the designed components; It's important to show how the project contributes to an increase in revenue. The project's efficiency to reduce losses, as well as the numerous qualitative advantages of the solution, must be demonstrated.

The utility expects the project to cost $1,285,000 in total, broken down as follows by cost category, based on prior projects and national benchmarks: This takes into account the associated material resources, personnel resources, and technology support. In the end, the following operational cost was put together: An investment in vital physical assets, such as hardware, data storage devices and equipment. Personnel growth, training, and certification costs are all included in this category. Project management, process and system design, validation and deployment assurance are just some of the costs that go along with providing technical support to clients.

Table 7

Cost Analysis

Category	Description	Costs ($ 000s)	% allocated
Material Assets	Complete implementation of a software system for energy balancing.	375	29.18%
	Energy balancing: smart meters	350	27.24%
	Equipment for distribution and meters	45	3.50%
	Management software for losses.	45	3.50%
	System interface	45	3.50%
Employee Assets	Employee assistance and growth.	100	7.78%
Technical Support	Development of technical operating processes.	325	25.29%
Total		1285	100%

The gap and cost analysis provides the following qualitative advantages for the project's objectives:

- With in-depth knowledge of which strategies reduce losses and under what conditions each method is best suited to do so, the utility would be able to determine the zones with the most losses and assign resources according to their importance with an energy balance for each feeder, thereby avoiding wasteful spending that contributes to losses.
- Loss sources, locations, customer groups and how losses rise and change over time will be better understood.
- When calculating utility losses according to a defined approach, market expansion, a more precise loss forecast, and an evaluation of the resources required to achieve loss reduction objectives will be considered.
- On the basis of a comprehensive cost-benefit analysis, the utility will be able to assess the efficiency of loss reduction operations and plan

future loss reduction initiatives, resulting in a reduction in predicted investment costs.

- Corrective measures can be executed with more certainty and thoroughness thanks to the loss management program, which is based on a deeper understanding of the aspects that cause loss.

Control

Seven critical milestones must be met before the long-term loss-reduction program may be executed properly. To ensure the project's success, senior management must be involved at every phase of the process. It is estimated that this project will take a year and a half to complete. Here's an example of a project calendar (figure 3) that depicts the various stages of the project throughout that time range

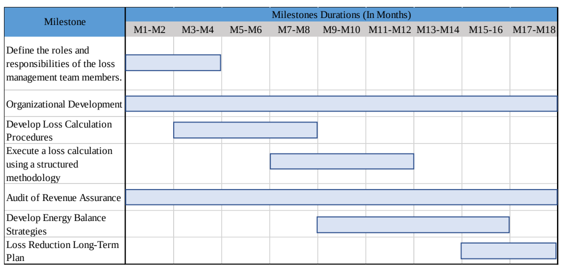

Figure 3
Execution Plan (Milestones)

Once the loss program is implemented and the quality of data gathering has improved, the utility will be able to develop root cause analysis and measuring the benefits of the program with the following:

- A better understanding of utility losses has resulted in customer-targeted programs.
- Inspections by field crews will be less expensive.
- Power quality for customers will enhance by ensuring that networks are suitably dimensioned for predicted loads, immediately following metering faults, and decreasing the number of direct connections to the distribution network.

Conclusion

Consequently, the company must standardize its loss calculation, create a long-term loss reduction strategy with a clearly defined ownership structure, and adhere to global best practices for determining loss levels. Due to the utility's current estimated 12.4% in overall losses and 7.9% in technical losses, leaving 4.5% in non-technical losses, the utility's annual non-technical losses are estimated to be $170 million, comprised of approximately $115 million in excess generation and $55 million in missed revenue. As part of a long-term effort to lower the company's total losses, the electricity provider will be able to establish more detailed, individualized action plans. To avoid economic losses surpassing $170 million, the utility must implement a planned and methodical strategy to standardize its continuous loss computation processes.

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