Emergency Callback Prioritize

Elisa P. Rodrigues[1], Gustavo M. de Almeida[1], Filiphe O. Louback[2]

[1]*Control and Automation Engineering Master Program, Instituto Federal do Espirito Santo*
Serra, Brazil
eliisapr@gmail.com, gmaia@ifes.edu.br
[2] *Electric Distribution Department, EDP Espírito Santo*
Vitória, Brazil
filiphe.louback@edp.com

Abstract. The need for performance evaluation of Electric Power Distributors by the National Electric Energy Agency (ANEEL), focusing on service quality, measured through the percentage of emergency occurrences with Power Interruption (PNIE). In response to the challenges faced by distributors in efficiently managing emergency complaints, with attention to reducing unproductive displacements, services without power interruption. The main objective is to develop an advanced system that optimizes service, establishes precise performance metrics, and reduces operational costs. We have a system that enables analysis, identification, prioritization, and forwarding of occurrences to the teams. Done through the mobile dispatch system, which streamlines communication between operations center operators and field teams. Once the service is completed, it becomes available for the next processing stage, where the data is analyzed and transformed into continuity indicators, providing a detailed view of service performance. Performance evaluation was conducted through meticulously selected metrics, allowing comprehensive analysis of Fuzzy logic, considering the diffuse and uncertain nature of the data. Among these metrics, calculation of the average degree of relevance, analysis of degree of relevance variation, and identification of minimum and maximum relevance stand out, providing a complete and detailed evaluation of model performance. After the initial tool implementation, it was observed that the percentage of unproductive displacement remained on average 40.64% over 12 months. Additionally, a significant increase of 10\% in the entry of emergency occurrences was noted, indicating satisfactory initial effectiveness of the tool. Although there is room for additional improvements, these results suggest that we are on the right track in our pursuit of service optimization and continuous process improvement. Finally, the first round of model testing and validation has already shown promising results, indicating significant potential to reduce the percentage of unproductive displacements in the company. Based on solid foundations and previous analyses, it is expected that the model will positively contribute to operational efficiency, being considered a strategy to optimize operations. We are committed to closely monitoring the results to make continuous adjustments and improvements to the system.

Keywords: Service quality, emergency occurrences, power interruption.

1 Introduction

This article aims to present and disseminate the results of the "Emergency Callback Prioritize" project, developed by the company EDP Espírito Santo. Power outages, as well as delays in restoring service, can cause significant problems for customers, especially in critical locations such as hospitals and factories, where intermediaries can severely disrupt operations. In addition to impacting customers, the concession of power is subject to the deliberations of the National Electric Energy Agency (ANEEL [1]), if the restoration time is not within the established parameters. For this reason, efficiency in responding to occurrences of problems in the power distribution must be a constant priority for the supply, which needs to seek continuous improvements in the quality of the services provided.

The objective of the project was to develop an intelligent service management system, incorporating cutting-edge technologies such as fuzzy control and modeling techniques (Silva et al. [2]). This system aims to allow technicians to access information about customers who have made contact by telephone. The tool will be used strategically to increase operational efficiency, optimizing communication between technicians and customers, and prioritizing the resolution of complaints, without the need for a technical visit. With this, we hope to provide quick and effective responses, allowing the technician, upon confirming the failure in the energy supply with the customer, to provide a satisfactory and more agile experience.

In addition to improving service, the project also aims to outline performance metrics that allow a systematic assessment of technicians' productivity. Defining these considerations will enable the delivery of regular and targeted feedback, promoting continuous improvements in the performance of the technical team and, consequently, in the quality of the service offered. Another important aspect that justifies the implementation of the “Prioritize” system is the financial impact that ineffective services and the busy allocation of resources generate for the company annually. Therefore, optimizing these processes is essential to find the balance between compliance with regulatory parameters and cost reduction, ensuring the most efficient use of resources.

ANEEL, the Brazilian electricity sector regulatory agency, assesses delivery performance using indexes such as the percentage of Emergency Occurrences with Power Outages (PNIE), which is calculated based on the ratio between the number of emergency occurrences with power outages (NIE) and the total number of emergency occurrences in the assessment period, as provided for in Module 8 of the Distribution Procedures (ANEEL [1]). The efficient management of emergency complaints related to inadequate technical problems with electrical energy is, therefore, a complex and vital challenge for the operations of EDP Espírito Santo.

The project is based on solid theoretical foundations in the areas of service management, customer service and information technology, seeking to fill a critical knowledge gap in the sector. One of its main objectives is to reduce the number of unproductive trips — that is, services in which there is no power outage — in the distributor's operations, improving the quality of service and optimizing the use of resources. In this way, the project not only aims to promote a more efficient service, but also to ensure compliance with regulatory standards, contributing to excellent service and a positive financial impact for the company.

2 Concept

ANEEL, the National Electric Energy Agency, is responsible for regulating and supervising the electricity sector in Brazil. Its functions range from formulating policies and guidelines for the sector to granting licenses, setting tariffs and ensuring the quality and safety of electricity services. The agency seeks to balance the interests of consumers, companies in the sector and the government.

Within the standards established by ANEEL, Module 8 of PRODIST (Distribution Procedures) regulates the operational and control procedures of the electricity distribution system. Specifically, Module 8 deals with issues related to energy quality, establishing standards to ensure reliability and safety in distribution, including parameters such as voltage, frequency and continuity of service. In some situations, occurrences reported by customers as defects in residential electrical installations may not be technical failures in the electrical grid. These services are classified as uninterrupted service, resulting in a loss of resources that could be directed to more urgent occurrences (ANEEL [1]).

Data collection is performed through the Power On application, which is responsible for recording field service for occurrences. This system allows for the efficient analysis, identification, prioritization, and dispatch of incidents to field teams. The mobile dispatch system facilitates communication between operators in the integrated operations center and field teams (Fortes and Muller [3]). After service, orders recorded in Power On are finalized and prepared for the next stage of processing, where they are transformed into continuity indicators.

SICOI (Occurrence and Indicator Control System) is an essential tool in the management and evaluation of service quality in the electricity sector. This system allows access to and modification of archived orders, enabling maintenance of information, data updates and calculations for indexes and compensations. The SICOI operational cycle, characterized by data consultation in the file database, adjustments, index calculations and monitoring of the results obtained, constitutes a daily verification process. This methodology provides continuous analysis of performance, with the aim of improving service quality (Pereira et al. [4]).

After analyzing and validating the data, the crucial step of extracting the indicators of continuity, service and monthly compensations stands out, and they are sent to ANEEL by the last business day of the month following the assessment. This flow of information not only meets regulatory requirements, but also allows for effective transparency in monitoring service quality (ANEEL [1]). It is worth noting that, with the consolidation of monthly data, SICOI automatically processes compensations to customers through the SAP system. This automated process contributes not only to operational efficiency, but also to agility in responding to customers affected by incidents (Magne et al. [5]). Thus, SICOI emerges as an integrated and strategic tool, combining control, analysis, and efficient communication functionalities, which are essential for the effective management of service quality in electricity distribution operations. By offering a comprehensive view of performance, this system not only meets regulatory requirements, but also promotes operational excellence and customer satisfaction. Fuzzy logic is an extension of classical logic that deals with uncertainty by allowing values that vary between completely true and false. It uses intermediate gradations, allowing the representation of inaccuracies in complex situations (Borges et al. [6]). This approach is valuable in areas such as systems control, decision making and artificial intelligence, where the boundaries between categories are not sharp, but gradual.

3 Methodology

In the Power On system, we receive complaints and emergency events related to power supply failures. It is necessary to log interruptions and the service times of these occurrences by field teams. This process is carried out through the FSA mobile dispatch system, which facilitates communication between operators in the integrated operations center and the field teams. After the service is completed, the orders in Power On, containing all recorded data, are finalized, and archived. These data are then available for the next processing stage, where the orders are converted into continuity indicators. The interaction between systems, databases, and service flows is illustrated in Figure 1. In parallel with Power On, the Callback team operates by contacting customers to identify the type of complaint. When it involves an internal failure within the customer's installation or if the requested service differs from a power supply failure, appropriate measures are taken without the need to dispatch a technical team.

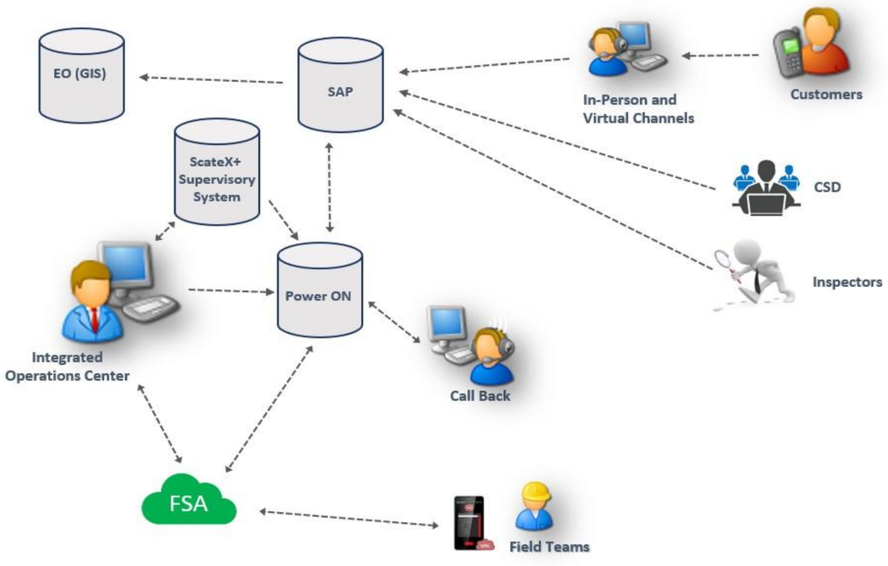


Figure 1 - Demand Flow

3.1 Data Collect

For the development of this study, various types of data were extracted from the Power ON database of EDP Espírito Santo, including historical records of non-productive occurrences, geoprocessing data of installations, short-duration interruption logs, ongoing occurrence information, complaint registration methods, and the type of installation responsible for the complaints. These data were processed using SQL and Python to perform the necessary extractions and transformations, generating the appropriate inputs for the developed model. Figures 2 and 3 below represent the initial screen and the occurrences screen of the Emergency Callback Prioritize system.

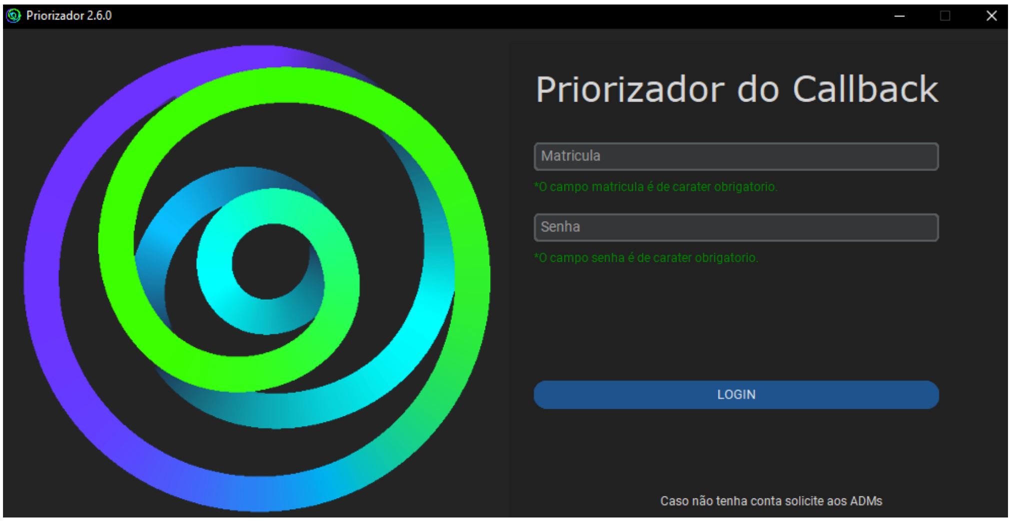


Figure 2 - Emergency Callback Prioritize Home Screen

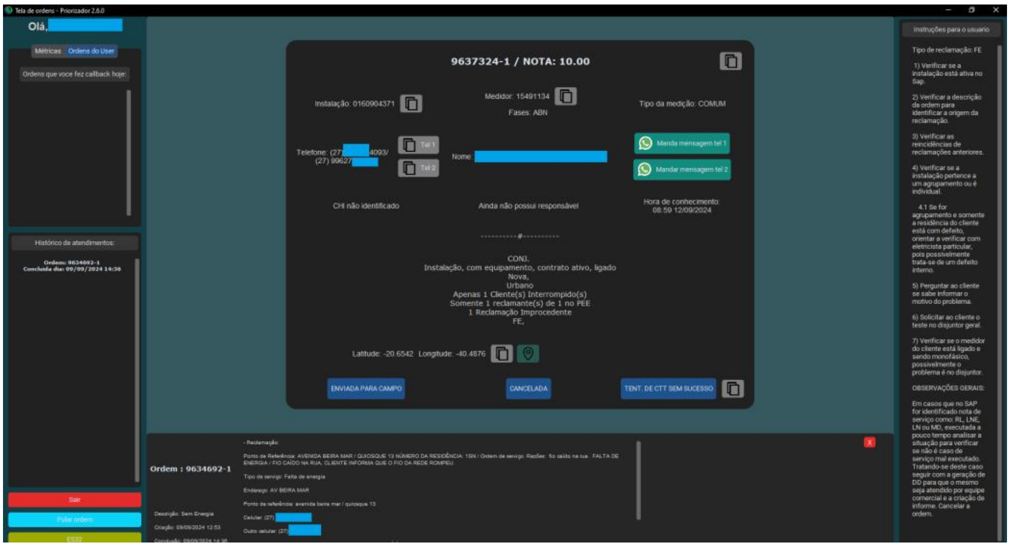


Figure 3 - Emergency Callback Prioritize Occurrences Screen

3.2 Data Pre-Processing

Definition of Unproductive Services: The data were processed to identify the number of non-interruption occurrences generated by customers over the past 12 months, where a team was dispatched to the service. However, upon arrival at the location, it was found that there was no defect, or that the defect was on the internal part of the customer's electrical installation. These services were classified as unproductive dispatches.

Customer Contract Status: This input checks the customer's contract status, extracted from the SAP database, distinguishing whether the complaint is related to a power suspension due to non-payment of the bill or a defect in the electrical network. It also identifies the type of customer installation, whether rural or urban.

Record: A georeferenced database analysis is conducted to locate automated equipment upstream of the installation, specifically line reclosers (RL) and distribution substations. This serves as a basis for verifying the occurrence inputs resulting from automatic reclosing operations of these devices following transient events, which cause short-duration interruptions of less than 3 minutes. These records are made in the Power ON database by the supervisory system (Scatex+).

3.3 Description of Test Settings

The tests were conducted in two distinct phases to evaluate the effectiveness of the prioritization model. Initially, historical data extracted from the Power ON database of EDP Espírito Santo was used. This phase focused on validating the model based on past occurrences, allowing for adjustments to parameters and necessary corrections to accurately reflect operational realities. The analysis of historical data helped calibrate the model and ensure it was aligned with actual operating conditions.

The second phase involved real-time testing using an application with an intuitive graphical interface, as illustrated in Figure 2. A technician from the Callback cell operated the application to record and prioritize emergency occurrences under real conditions. These tests allowed for observing the model's effectiveness in dynamic situations, collecting direct feedback on usability, and making final adjustments. The combination of these phases ensured comprehensive validation of the system and optimized its practical implementation.

3.4 Description of Metrics for Performance Assessment

The Fuzzy model performance evaluation was performed with analyses that analyze the imprecision and uncertainty of the data. The main analyses include Average Degree of Affiliation: Calculates the average of the degrees of affiliation of the input variables with the output (final score), providing an overview of the strength of the associations and consistency of the model.

Variation of Degree of Affiliation: Evaluates how the degrees of affiliation vary according to the inputs, allowing to understand the sensitivity of the model to different conditions and its robustness in different scenarios.

Minimum and Maximum Affiliation: Identifies the extremes of affiliation, highlighting the cases of weaker and stronger associations between inputs and outputs, providing insights into the range of variation of the system.

Convergence of Fuzzy Rules: Analyze the interaction and behavior of additional Fuzzy rules, such as those that prioritize high spikes and those that deal with erroneous inputs, to ensure that the model makes correct inferences. Accuracy in Predicting Unproductive Trips: Measures the effectiveness of the model in predicting and reducing unproductive trips, especially in scenarios with high untimely updates and low use of digital channels.

This evidence demonstrated that the model is effective in prioritizing emergencies and reducing unproductive trips, with a positive impact on operational efficiency and company indicators.

3.5 Description of the model's input and output variables

The rule bases of the fuzzy inference system were defined, along with the linguistic terms of the input and output variables (antecedents and consequences), and other parameters of the inference engine. Finally, the criteria for collecting the input data of the complaints were established, which are evaluated on a scale of 0 to 10 according to predefined criteria, as illustrated in Figure 2.

Dimensions	Discretion	Description	Scale
INPUT	digital_canal	Represents the form of filing the complaint	Low, Medium, High
	unproductive	Indicates the level of uninterrupted customer complaints.	Low, Medium, High
	type	Reflects the type of customer installation, rural or urban	Low, Medium, High
	pike	Indicates whether the client has suffered a short-term interruption in the last 24 hours.	Low, Medium, High
OUTINPUT	final grade	Defines the performance evaluation result based on input variables	Low, Medium, High

Figure 2 - Antecedent and Consequent

4 Results

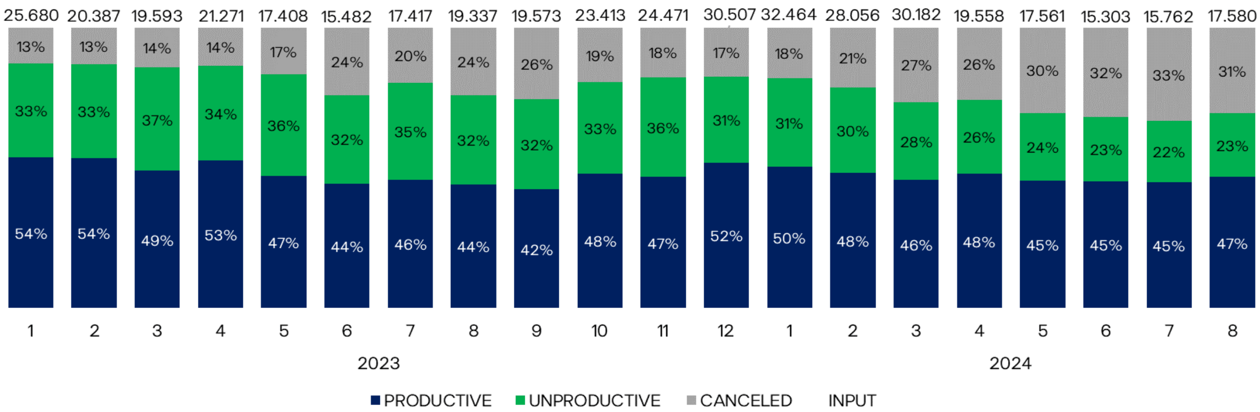
The implementation of the new model has enabled greater agility in the unification of information, resulting in more efficient and comprehensive contact with our customer base. This operational improvement has optimized the service process, allowing the team to respond more quickly to complaints, significantly reducing the response time for problem resolution. Effective data integration has allowed us to reach a greater number of customers in less time, improving the quality of the service provided.

With the system in operation, it was possible to develop an effective prioritization strategy for emergency occurrences. Using historical data and real-time analysis, the most critical cases were quickly identified, directing teams strategically. This approach has resulted in better resource management, ensuring that the most urgent problems were resolved more quickly and efficiently, increasing customer satisfaction and operational efficiency. In order to evaluate the performance of the "Emergency Prioritize Callback", we made a comparison over the last 3 years, shown in Table 1.

Year	Averted	Quantity Point of Service	Average per Service Point
2.022	2.698	11	238
2.023	3.627	14	264
2.024	4.876	17	287

Table 1 - Average number of technical visits avoided per service point.

Table 1 above shows that the average number of incidents per year has increased by an average of 34%. With the implementation of the system, we have increased the response capacity per service point by an average of 10% per year. Below, we have graph 1, which represents the percentage of productive, unproductive and canceled incidents in the last 2 years.



Graphic 1 - Total Number of Occurrences Entered.

Tests were conducted in June 2023, and the system was released for use by all Callback cell technicians in July of the same year. As illustrated in Chart 1, the percentage of avoided (canceled) visits exceeded 20% in months with fewer than 20,000 occurrences and remained close to this value when the number of occurrences was greater than 20,000 throughout 2023. In 2024, new service points were created, as highlighted in Table 1, especially in response to severe weather events that raised the number of occurrences beyond historical limits. With this expansion, it was possible to avoid an even greater number of unproductive occurrences, exceeding 30% of avoided visits in May 2024. Consequently, the percentage of unproductive trips was reduced to less than 25%.

The efficient unification of customer data, combined with a well-defined prioritization strategy, resulted in a significant improvement in operational efficiency. The ability to contact more customers quickly, combined with the prioritization of critical services, has increased the efficiency of daily operations. In addition, the increase of more than 10% in the identification of unproductive trips per technician demonstrates the effectiveness of the new system, providing a solid foundation for continuous improvements in the electric power distribution service.

5 Conclusions

Preliminary results suggest that the implementation of the model has the potential to significantly reduce trips without interruption in the company. Efficient data integration has improved contact with our customer base, streamlining the service process and reducing response times to resolve issues.

The new system has enabled an effective prioritization strategy for emergencies, quickly identifying critical cases and directing resources strategically. This has resulted in faster and more efficient resolution of the most urgent issues, increasing customer satisfaction and operational efficiency.

Since implementation, there has been an increase of more than 10% in the early identification of unproductive trips per technician, thanks to the optimization of processes and the use of Prioritize. This has reduced customer wait times and improved overall productivity, positively reflecting on the company's performance indicators.

While definitive results depend on an in-depth analysis of the testing and validation rounds, we are confident that this implementation is strategic for optimizing operations and resources. We are committed to closely monitoring the results to continually adjust and improve the model, ensuring a solid foundation for the continuous improvement of our electricity distribution service.

Acknowledgements: We would like to thank the EDP Espírito Santo team for their support and for providing essential data for this study. We would also like to thank the technicians from the Callback cell for their collaboration in real-time testing. We acknowledge the contribution of the developers of the Power On and Prioritize systems, whose expertise was fundamental in the initial phase of this project. We would also like to thank our consultants and researchers for their technical and academic support**.**

Authorship Statement: The authors confirm that they are solely responsible for the authorship of this work, including the research, data analysis and writing of the article. All content presented herein is the property of the authors and was included with the permission of the respective data owners.

References

[1] Aneel, Agência Nacional De Energia Elétrica "Distribution Rules And Procedures (Prodist)". Module 8 - Quality Of Electricity Supply, N. 1, Pp. 1–78, 2023.
[2] G. B. Silva, H. K. Morales-Paredes, J. C. Cebrian. "Study And Improvement Of The Priority Index For Consumers In Electricity Distribution Networks". Cba 2022, P. 8, 2022.
[3] B. J. Fortes, F. M. Muller. "Analysis And Modeling Of Fulfilling Emergency Service Orders In Electric Power Concessionaries". Master's Thesis From The University Of Santa Maria, Rio Grande Do Sul, P. 93, 2015.
[4] D. De S. Pereira, N. Kagan, C. F. M. Almeida. "Fault Locator In Distribution Networks In The Context Of Smart Electrical Networks Using Evolutionary Algorithms". Master's Thesis From The University Of São Paulo, P. 139, 2019.
[5] A. G. Magne, H. Gerald, A. Raja, H. George. "Detection Of Back-Fed Ground Faults Using Smart Grid Distribution Technology". Asu Electronic Theses And Dissertations, P. 62-68, 2014.
[6] P.H. P. Borges, H.K. D. Dos Santos, C.S. M. Bernardini, I. F. De O. Alencar, D.C. B. De Sousa, Y Jucá De Moraes Sales, R. "Interface Gráfica Sob A Utilização Da Lógica Fuzzy: A Qualidade De Água Em Reservatórios". Revista Aidis De Ingeniería Y Ciencias Ambientales: Investigación, Desarrollo Y Práctica. 13, 2020, 567–581.