

# Perception of Quality in Electricity Services: A Study of Brazilian Companies

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**Abstract.** The supply of electrical energy is essential for the socioeconomic development of Brazil, affecting several sectors and the population's quality of life. This study analyzes the results of measuring the quality perceived by consumers in the services provided by electricity distributors in the country, using a scale constructed using Item Response Theory (IRT). The objective is to identify consumer perception of service quality of electrical energy in different regions and offer insights to improve the services provided by distributors. The methodology included the analysis of data collected using the perceived quality scale, allowing an assessment of consumer perception. The results revealed that 0.28% of consumers expressed dissatisfaction with the services provided, while 15.31% were indifferent, 67.88% were satisfied and 16.53% were very satisfied. It is noteworthy that in the South region, consumers were more satisfied, with RGE Sul Distribuidora de Energia S.A. recognized as the concessionaire with the best perceived quality. Among all regions, CPFL Santa Cruz stood out among the concessionaires with more than 400 thousand consumer units, while Mux Energia stood out among the concessionaires with up to 400 thousand consumer units. The assessment of consumer perception plays a fundamental role in the sector's development, highlighting the importance of prioritizing perceived quality to meet market expectations and drive advancements in the field.

**Keywords:** Perceived Quality. ANEEL Consumer Satisfaction Index. Item Response Theory.

## 1 Introduction

The assurance of reliable and high-quality electricity supply is fundamental for the socio-economic progress and development of Brazil [1]. Across all sectors of the economy, from industry to basic services, the availability of energy plays an essential role in driving economic growth and enhancing productivity [2, 3]. Furthermore, the quality of electricity services transcends the economic aspect. It plays a vital role in improving the quality of life for the Brazilian population, ensuring access to essential resources for well-being and social development. Access to electricity is fundamental to ensuring the functioning of basic services such as lighting, refrigeration, and communication, both in urban and rural areas, promoting social inclusion and human development [4, 5].

In the context of the electricity sector, distribution companies play a fundamental role as facilitators of access to electricity nationwide. Operating at the forefront of the system, distributors act as an essential component between supply and demand, ensuring a reliable and efficient supply of energy to consumers in different regions. The quality of services provided by these companies has a direct impact on the reliability of the entire electrical system, as well as its ability to meet the needs of the population in all regions of the country [6].

Despite the strategic importance of the electric power distribution sector, the perception of quality in electricity services by consumers remains an area that requires attention. Consumer satisfaction reflects the effectiveness of distribution companies but also influences the trust and stability of the national electrical system. In an increasingly competitive and dynamic market where consumer expectations are constantly evolving, it is essential for companies in the sector to be attentive to market demands and continuously seek to improve the quality of their services [7].

In this context, the article aims to analyze the results obtained through a measurement instrument developed to assess consumer perception regarding the quality of electric power services. This analysis seeks to understand the perception of service quality, identifying areas that offer opportunities for improvement. Based on these findings, insights are provided for the development of continuous quality improvement strategies aimed at promoting consumer satisfaction and loyalty.

### **1.1 Theoretical framework**

### **1.2 Perceived Quality and Consumer Satisfaction**

In recent years, the Brazilian electric power sector has undergone significant transformations, with an increasing focus on the consumer [8]. Previously seen merely as recipients of services, consumers and their needs now play a central role in sector operations. This shift is driven by both regulatory initiatives, such as the standards set by the National Electric Energy Agency (ANEEL) and its oversight actions, as well as efforts from the private sector, exemplified by the Abradee Award and the IASC Award.

The Abradee Award, promoted by the Brazilian Association of Electric Energy Distributors, aims to recognize distributors that excel in various aspects, including service quality, operational efficiency, sustainability, innovation, and social responsibility [9]. Distributors are evaluated in different categories, according to their size and area of operation, based on criteria established by Abradee.

On the other hand, the IASC Award (Consumer Satisfaction Index - Índice Aneel de Satisfação do Consumidor) is an initiative of ANEEL that assesses consumer satisfaction regarding the services provided by electric power distributors. This index is calculated from opinion surveys conducted with consumers, addressing aspects such as energy supply quality, customer service, problem resolution, among others [10]. Distributors that achieve the highest consumer satisfaction indices in their respective concession areas are recognized with the IASC Award.

These awards play a fundamental role in evaluating the quality of services provided by electric power distributors. While the Abradee Award recognizes distributors based

on various performance criteria, encouraging excellence and innovation in the sector, the IASC Award specifically focuses on consumer satisfaction, providing an indicator of how distributors are meeting consumer expectations. Both awards aim to promote continuous improvement in the quality of electric services in Brazil. However, it is essential to emphasize that the basis of this research lies in the ANEEL Consumer Satisfaction Index.

### **1.3 Measurement Instruments of Perceived Quality and Consumer Satisfaction**

Several methods have been developed to measure perceived in the context of electric power services. Among these methods, the use of Classical Test Theory (CTT), Structural Equation Modeling (SEM), and Item Response Theory (IRT) stand out, offering consistent and contemporary approaches to measuring these constructs [11].

IRT is based on mathematical and statistical models that allow the analysis of individual items on a measurement scale, taking into account respondents' characteristics [12]. This provides an enhanced assessment of perceived quality, enabling the identification of perception patterns among different segments of the population.

Additionally, IRT has been widely used in various research fields such as education, marketing, environmental management, among others, due to its ability to improve evaluation instruments and provide insights into individuals' behavior [13, 14].

In the context of electric power services, the application of IRT offers an opportunity to interpret consumer perceptions and identify areas for improvement in the services provided by distributors. This statistical approach enables a detailed analysis of collected data, providing information for the development of strategies aimed at promoting consumer satisfaction and loyalty.

### **1.4 ANEEL Consumer Satisfaction Index**

The ANEEL Consumer Satisfaction Index is a tool developed by ANEEL to assess consumers' satisfaction with electric power services [15]. This index covers various aspects of services provided by distributors, including supply quality, customer service, communication, and billing processes [16].

The analysis of the ANEEL Consumer Satisfaction Index provides insight into the performance of electric power distributors concerning consumer satisfaction, offering insights for service improvement and the development of strategies aimed at consumer satisfaction and loyalty. This index also plays a prominent role in supervising and regulating the electric power sector by providing data on the performance of concessionaires [16, 17].

Furthermore, by evaluating consumer satisfaction, the index contributes to sector transparency, allowing consumers access to relevant information about company performance. This transparency fosters healthy competition among distributors, encouraging the pursuit of excellence in customer service and service provision.

Therefore, continuous analysis of consumer satisfaction is crucial for monitoring the quality of electric power services in Brazil, as well as for establishing a regulatory environment conducive to sector development. By providing an objective and comprehensive assessment of consumer satisfaction, it plays an essential role in promoting user well-being and ensuring quality service for the entire population.

## 2 Methodology

This research analyzes the results of an instrument composed of 18 items, each with four response categories: (0) dissatisfied, (1) indifferent, (2) satisfied, and (3) very satisfied. Responses labeled (NA) were defined as "do not know how to assess" or "did not respond." The instrument was constructed using the Graded Response Model (GRM) of Item Response Theory (IRT) to evaluate consumers' perception of the quality of electricity services provided by electricity distributors in Brazil. The data were obtained through secondary sources available at [18].

The sample consisted of 21,927 responses from residential consumers, covering 618 municipalities and the concession areas of 53 electricity distribution companies nationwide. The distribution of these distributors by state is presented in Table 1, highlighting the geographic diversity, sample representativeness, distributor abbreviations, number of consumer units, and population served.

**Table 1.** Distributor Data by States – Concessionaires.

Concessionaires by States				
State	Number of Distributors	Distributor Abbreviations	Number of Consumer Units	Served Population
SP	7	CPFL PAULISTA; CPFL PIRATININGA; CPFL SANTA CRUZ; EDP SP; ELEKTRO; ENEL SP; ESS	20.762.172	45.896.080
MG	3	CEMIG-D; DMED; EMG	10.405.834	20.866.188
RJ	3	ENEL RJ; ENF; LIGHT	7.370.715	17.104.595
BA	1	COELBA	6.359.992	14.761.448
PR	3	COCEL; COPEL-DIS; FORCEL	5.285.865	11.133.196
RS	7	CEEE-D; DEMEI; ELETROCAR; HIDROPAN; MUXENERGIA; RGE; UHENPAL	4.875.579	10.793.744
PE	1	CELPE	4.037.670	9.514.822
CE	1	ENEL CE	3.669.240	9.075.649
PA	1	EQUATORIAL PA	2.364.639	8.513.497
MA	1	CEMAR	2.365.546	7.035.055
GO	2	CHESP; ENEL GO	3.167.894	6.921.161
SC	5	CELESC-DIS; COOPERALIANÇA; DCELT; EFLJC; EFLUL	3.130.341	6.660.101
AM	1	AME	1.065.509	4.074.837
PB	2	EBO, EPB	1.708.741	3.977.967
ES	2	EDP ES; ELFSM	1.755.057	3.972.388
RN	1	COSERN	1.584.315	3.479.010
MT	1	EMT	1.557.764	3.441.781

AL	1	EQUATORIAL AL	1.119.021	3.322.820
PI	1	EQUATORIAL PI	1.304.073	3.264.531
DF	1	CEB-DIS	1.113.922	2.974.703
MS	1	EMS	1.146.357	2.593.358
SE	2	ESE; SULGIPE	968.177	2.314.451
RO	1	ERO	831.107	1.759.640
TO	1	ETO	643.502	1.555.229
AC	1	EAC	313.752	873.206
AP	1	CEA	222.982	829.494
RR	1	RORAIMA ENERGIA	175.609	576.568
Total	53		89.305.375	207.285.519

Source: Adapted from [19].

The evaluated instrument incorporated four dimensions: Perceived Quality, Satisfaction, Trust in the Provider, and Loyalty. Each dimension was investigated through a set of questions directed at consumers, as presented in Table 2, which describes the indicators and items of the ANEEL Energy Consumer Satisfaction Index questionnaire.

**Table 2.** Description of Indicators and Items of the IASC Questionnaire.

Dimension	Indicators	Item	Description of Items Used in the Study
Perceived Quality	Customer Information	V16	Accuracy and safety in electricity bill charges
		V24	Ease of understanding all information presented on the electricity bill
		V90	Effective dissemination of important information by the distributor through different channels such as radio, internet, television, or on the electricity bill
	Access to the company	V10	Compliance with established deadlines for service provision
		V11	Ease of contact with the company's service channels
		V12	Courtesy and politeness of company employees during customer service
		V14	Efficiency in resolving customer problems and requests
	Reliability in services	V17	Accessibility to electricity bill payment points
		V8	Continuous supply of electricity, without power outages
		V9	Stability in the voltage of supplied electricity, without harmful fluctuations
V18		Prompt restoration of electricity supply after interruptions	
V20		Advance communication about scheduled interruptions in electricity supply	
Satisfaction	Evaluates consumer perception	V7	Assessment of satisfaction considering the quality of services offered by the distributor, with options ranging from dissatisfied to very satisfied

	regarding supply quality and customer service	V32	Perception of the quality of services offered by the distributor compared to the ideal, with options ranging from far from ideal to very close to ideal
<b>Trust</b>	Assessment of Suppliers	V37	Confidence in the distributor
		V38	Conviction about the distributor's commitment to customer interests
<b>Fidelity</b>	Evaluate the possibility of Supplier Change	V33	Probability of changing electricity supplier if there are options available for choice among several supplier companies in the region
		V94	Likelihood of recommending the company to family and friends

Note: The database is available at the link [19].

To assess the factorial structure of the Perceived Quality scale, Exploratory Factor Analysis [20] was employed, ensuring the existence of a dominant dimension. Additionally, the Graded Response Model (GRM) was used to estimate item parameters and respondent parameters (latent trace of consumer perception of service quality), assessing the discrimination and difficulty of the items. The R software and the MIRT package were utilized in these analyses, considering the individual characteristics of each item and its relationship with consumer perception.

This methodology provided an understanding of consumers' perception regarding the quality of electricity services in Brazil, enabling the identification of areas for improvement in the services provided by distributors.

### 3 Results and discussions

The application of the IRT resulted in a perceived quality score for each consumer, interpreted at four levels, as shown in Table 3.

**Table 3.** Interpretation of Levels of Perception of Service Quality by Consumers of Brazilian Electricity Distributors.

Perception of Quality Level	Number and Percentage of Consumers	Interpretation of Level
Level I score $\leq 70$ points	61 0.3%	At this level of the scale, consumers express indifference regarding access to electricity bill payment points (V17), and dissatisfaction with all other services observed in the instrument.
Level II $70 < \text{score} \leq 80$ points	517 2.4%	Consumers demonstrate indifference regarding the reliability of electrical energy services: Uninterrupted energy supply, without the occurrence of power outages (V8); Stability in the voltage of the energy supplied, without harmful fluctuations (V9), as well as in relation to the kindness and politeness of the employees in the service (V12). They are satisfied with the accessibility of payment points (V17). Regarding other services, they remain dissatisfied.

Level III 80 < score ≤ 105 points	14.759 67.2%	Consumers at this level go from being indifferent to being satisfied in various aspects, such as access to the company (V10, V11, V12), customer information (V16, V24, V90), reliability of services (V8, V9, V18 and V20), trust in the distributor (V37), the distributor's commitment to consumers' interests (V38) and general satisfaction (V7, V32).
Level IV score > 105 points	6.590 30.1%	Consumers at this level are very satisfied with the perceived quality in indicators of customer information, access to the company and reliability of services. Many are also satisfied with their trust in the distributor and its commitment to the interests of consumers. At this level, the items in the general satisfaction dimension (V7 and V32) are evaluated from satisfied to very satisfied. They are also likely to indicate that the utility is close to ideal (V94) and that the chance of switching is very low when considering the possibility of switching to another electric utility in the city (V33). These indicators emphasize the high quality perceived by consumers at this level of satisfaction.

After analyzing the collected data, it became evident the importance of understanding the different levels of consumers' perception regarding the quality of services offered by distributors. This interpretation of the results allows identifying areas for improvement and leveraging the sector companies' strengths, thus contributing to the continuous improvement of the quality of services offered and to the overall satisfaction of consumers. Table 4 presents the percentage of perceived quality by consumers for each evaluated item.

**Table 4.** Percentage of Consumer Perception on the Quality of Service Offered by Distributors in Each Item.

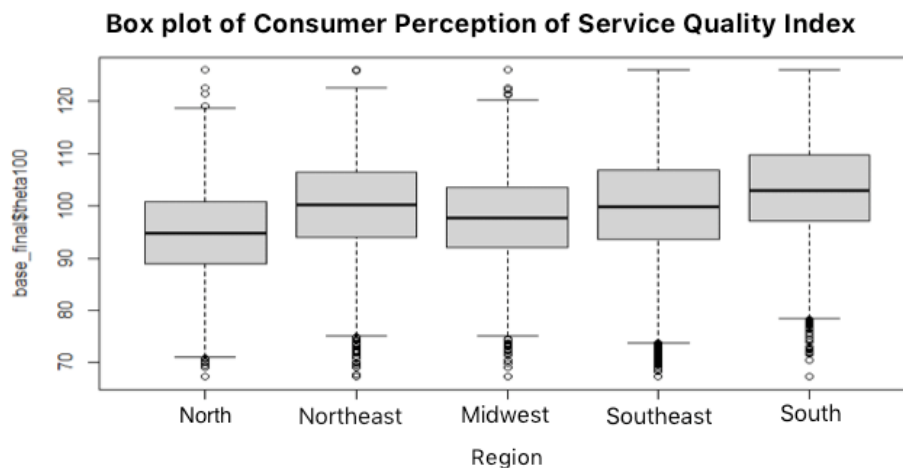
Items	0 Dissatisfied	1 Indifferent	2 Satisfied	3 Very Satisfied	NA
V7	15%	17%	60%	8%	0%
V8	4%	11%	39%	46%	0%
V9	4%	12%	36%	47%	1%
V10	10%	16%	30%	32%	12%
V11	11%	16%	29%	38%	6%
V12	4%	7%	22%	62%	5%
V14	10%	16%	31%	35%	7%
V16	16%	20%	29%	31%	3%
V17	3%	6%	18%	73%	1%
V18	11%	19%	36%	33%	1%
V20	12%	15%	29%	35%	9%
V24	10%	16%	32%	40%	3%
V32	25%	23%	41%	8%	2%
V33	18%	44%	33%	3%	1%
V37	9%	15%	36%	39%	2%
V38	13%	18%	33%	33%	3%
V90	8%	14%	31%	41%	6%
V94	12%	19%	31%	34%	3%

It is noteworthy that regarding access to the company, in items V12 and V17, consumers expressed significant levels of satisfaction, with 62% and 73% of consumers respectively, attributing the highest category to these items. These results indicate specific areas well evaluated by consumers and thus demand immediate attention from electricity distributors, such as the courtesy and education of employees during service (V12) and the accessibility to payment points for the electricity bill (V17).

On the other hand, a percentage of consumers expressed dissatisfaction with items V32 and V33, with 25% and 18% respectively, attributing the lowest category to these items. Although the percentage of satisfied and very satisfied with these items reached 49% and 36% respectively, these results suggest that distributors prioritize attention to consumers' perception of the quality of services offered in relation to the ideal (V32), which includes aspects such as providing energy without voltage variation and maintaining constant and steady lighting, as well as the ease of understanding all information present in the electricity bill, which directly influences the likelihood of switching electricity companies (V33) if there are choices among several supplier companies in the region. These data emphasize the importance of a strategic and focused approach to improving perceived quality by consumers, identifying and addressing areas of dissatisfaction while strengthening aspects that contribute to consumer satisfaction.

The analysis of consumers' perception on the quality of services offered by distributors revealed important insights into satisfaction levels across different regions of the country. As shown in Figure 1, the Southern Region stood out as a leader in terms of service quality (mean = 103.2; median = 102.9; standard deviation = 9.4), with consumers expressing significant levels of satisfaction, predominantly positioned at the satisfied and very satisfied levels on the perceived quality scale. This highlight of the Southern Region is followed by a close performance in the Northeast Region (mean = 100.2; median = 100.1; standard deviation = 9.7), followed by the Southeast Region (mean = 100.0; median = 99.8; standard deviation = 10.2), and subsequently by the Midwest Region (mean = 97.7; median = 97.7; standard deviation = 9.3) and North Region (mean = 95.0; median = 94.8; standard deviation = 9.3). These results demonstrate the variation in perceived quality among different regions, highlighting the importance of specific regional strategies to ensure consumer satisfaction.





**Fig. 1.** Consumer Perception index on Service Quality in the regions of Brazil.

In the South region, with more than 400 thousand consumer units, the concessionaires Celesc-Dis, Copel-Dis, and RGE Sul Distribuidora de Energia S.A. stood out, with RGE Sul Distribuidora de Energia S.A. being recognized as the concessionaire with the best perceived quality by consumers.

In the Southeast region, also with more than 400 thousand consumer units, the concessionaires CPFL Paulista, CPFL Santa Cruz, and Energisa stood out, with CPFL Santa Cruz – Companhia Jaguari de Energia being recognized as having the best perceived quality in this region.

Among the concessionaires that serve 30 thousand to 400 thousand consumer units in the South and Southeast regions, Cooperaliança, DMED and Santa Maria stood out, with Cooperativa Aliança – Cooperaliança being the best evaluated.

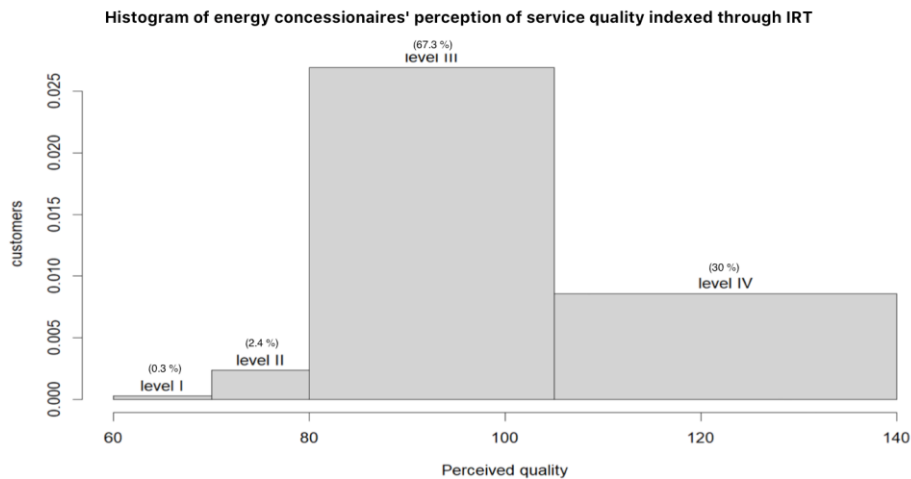
In the South, Southeast and Center-West regions with up to 30 thousand consumer units, the concessionaires Forcel, Hidropan and Mux Energia stood out, with Muxfeldt Marin & Cia. Ltda. – Mux Energia being recognized for the best perceived quality.

In the Northeast, Energisa Borborema, Energisa Paraíba and Sulgipe were the concessionaires best rated by consumers, with Companhia Sul Sergipana de Eletricidade (Sulgipe) being recognized as having the best assessment.

In the North Region, the concessionaires CEA Equatorial, Energisa Rondônia, and Energisa Tocantins stood out, with Energisa Tocantins – Distribuidora de Energia S.A. being the best evaluated.

In all regions, CPFL Santa Cruz stood out as the concessionaire with the best perceived quality among consumers of concessionaires with more than 400 thousand consumer units, while Mux Energia stood out among concessionaires with up to 400 thousand consumer units. The perception of consumers on the quality of services is an essential indicator for monitoring and guaranteeing the adequate provision of services to electricity consumers, highlighting the fundamental role of the consumer as a monitoring agent.

The results emphasize that consumers are satisfied with the services offered by energy companies in Brazil, as shown in Figure 2.



**Fig. 2.** Consumer Perception of Service Quality Index

This satisfaction reflects the quality of services provided by the concessionaires but also mirrors the strategies adopted to meet the specific needs of each region. This analysis reinforces the importance of delivering quality service to the customer and recognizing consumer needs as an essential element in the continuous improvement of the electricity sector in Brazil.

## 4 Conclusion

The result of the analysis of consumer perception regarding the quality of electricity services provided by distribution companies has provided valuable insights into the consumer experience. These insights allow for the identification of areas of excellence and gaps, contributing to a better understanding of consumer needs and expectations.

While a significant percentage of consumers have expressed satisfaction with the services received, indicating that many distribution companies are meeting their customers' expectations, it is essential to address the concerns of the small portion of consumers who have expressed dissatisfaction. These concerns, such as courtesy in service (4%) and ease of access to electricity bill payment points (3%), require immediate attention to improve overall customer satisfaction.

Regional analysis revealed differences in the perception of service quality among different regions, especially highlighting the effectiveness of strategies adopted by distribution companies in the southern region. This suggests the potential replicability of these approaches in other regions, emphasizing the importance of adapting such strategies to the unique characteristics of each market.

Additionally, analyzing the performance of concessionaires based on criteria like the number of consumer units and population served allows for the identification of companies excelling in various contexts. This emphasizes the absence of a universal solution, emphasizing instead the necessity for adapting and customizing strategies to suit the specific characteristics of each market. Such insight into context-specific strategies further highlights the critical role of quality perception as a fundamental pillar for the success of electricity distribution companies.

Looking ahead, prioritizing actions to address areas in need of improvement and investing in initiatives aimed at personalizing services will enable distribution companies to strengthen relationships with existing customers, attract new consumers, promote loyalty, and ensure the sustainable growth of the sector. Additionally, future research could explore international comparative studies to gain insights into global best practices and specific areas for improvement in the Brazilian context, further enhancing the sector's continuous improvement.

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