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Profit Maximizing from Energy Consumption with the Choquet-Based Cluster Analysis

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Abstract

New rules and laws for the electricity sector in Brazil aim to produce severe reductions to the cost of electricity in order to reduce the so-called 'Brazil Cost'. Taking into account those new rules and laws all electricity companies have an obligation to improve their processes. Among them the following actions are contemplated: intelligent use of resources; expansion of synergies; increase of the efficiency of internal procedures and processes; massive introduction of technological innovations; reduction of the amount of compensation paid in lawsuits; reduction of technical losses or losses by theft in the case of distribution of the generated energy. If the companies do not make plans and act quickly they will be bound to cause their shareholders very high losses of capital, leading to an expressive decrease of interest to invest in the sector. The absence of those plans and subsequent actions can also lead to investments in generation and distribution being returned to the state, which contributes to an increasing degree of state interference in the economy. In this paper the ordered groups of reading power consumption of clients that maximize the profits of a power plant are determined. The groups were determined by cluster analysis and their reading consumption groups ordered by making use of the Choquet integral.

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1. Introduction

Considering the new rules for the electricity sector (Law 12.783 / 2013), which aims large reductions in power tariffs in order to reduce the so-called 'Brazil Cost'. This term, is a generic term used to describe the set of structural, bureaucratic, economic difficulties and a set of factors that compromise the competitiveness and efficiency of the Brazilian domestic industry which decreases the investments in Brazil, power plants have an obligation to improve their processes. Among them it can be mentioned:

- use of smart features;
- enlargement of synergies;
- increase the efficiency of internal procedures and processes;
- technological innovations;
- reduction of the amount of compensation paid to legal proceedings;
- reduction of technical losses or theft (in the case of distribution);
- default combat (in case of distribution).

If it not occurs it will cause millionaire damage to its shareholders, making it with low interest to private capital business, and the generation and distribution will return to the state, causing increasing state interference in the economy. This paper aims to use the intelligent use of resources, technological innovations and increased efficiency of internal procedures to optimize the number of readings per location in a given power company. The cluster analysis was used to determine the groups by location and the Choquet integral was used to prioritize these groups, Sugeno [1], Grabisch [2].

The main idea is to determine optimal groups in the sense that the first group has the highest turnover among all groups maximizing cash flow and the operation in a power plant industry. The readings of power consumption take place monthly according to a schedule. All customers without exception are read. The reading is done by lists, each list comprises up to four hundred clients (limitation of the equipment). Lists of hundreds compose a town and dozens of villages make up a group. Considering the existence of twenty groups for financial reasons and cash flow the ideal is to receive the greatest amount as soon as possible, so it would be good if the first group has the largest volume revenue while the twentieth has the lowest volume of revenue.

As an example, when analyzing the median of total revenues per customer for the past eighteen months, all groups are "out of place" that is, they are not in their correct position in relation to their revenue. It can be seen in figure 1 that group 20 is the last reading and its revenue is received on the month turnover and the group 14 which revenue is lower is received within the same billing month, causing a loss of more than R$ 1 million.
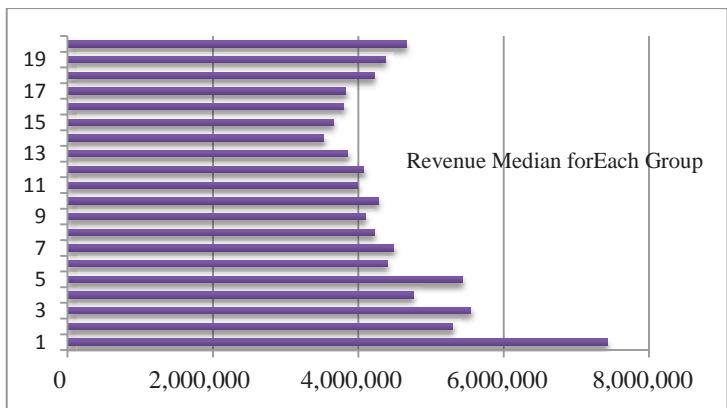

Fig.1. Actual Revenue Per Group