Application of ELECTRE II in Brazilian Liquefied Petroleum Gas Distributor

MARCOS FELIPE FALCAO SOBRAL
Departamento de Administracao
Federal Rural University of Pernambuco
Rua Dom Manuel de Medeiros, s/n – Dois Irmão – Recife - Pernambuco
BRAZIL
marcos_sobral@bol.com.br

Abstract: The objective of this study is to promote the use of multicriteria decision method ELECTRE II to support the customers ranking in liquefied petroleum gas distributer, located in the Northeast of Brazil. The company has difficulties to rank the customers their factory, causing various problems like the reduction of performance indicators and high costs with overtimes of employees. Finally, is presented a results comparison obtained by the method with the current results, performing a utilization viability analysis of method for this problem.

Key-Words: Multicriteria Decision Aid, Electre II, Liquefied Petroleum Gas, Logistics, Supply Chain Management

1 Introduction

The Liquefied Petroleum Gas (LPG) is an important product in the Brazilian energy matrix, in one hand because the environmental aspect, since it has a low emission burning of waste in the atmosphere, and in the other hand due to social context, with a low cost alternative energy [1]. The product became popular in Brazil in the 50s due to its distribution model, by transportable in cylinders. The product is marketed by wholesale distributors in order to effect the LPG filling process gas cylinders in portable and distributed to local dealers.

Each company has a share of monthly purchase that is set in advance based on the supply capacity of Petrobras. Thus, any substantial increase in sales translates into an inability to meet demand. Planning for the care of the dealers should be made so avoid or minimize such shortages. There are also issues related to competition in some areas, so there is a need to address properly the dealers as a way to send the loss of market share. The construction of an attendance order these dealers involves several criteria which are often conflicting, making the decision maker feels the difficulty of establishing a ranking to consider at the same time the main attributes of the customers. On the other hand dealers often do not know the best way to be prioritized in a ranking of day care, feeling wronged and often unsuccessful.

Before the problem is necessary to order the clients to be served to minimize shortages, loss of market share, customer dissatisfaction and profitability of the company. The use of a method decision support in this context is feasible and useful as it provides the decision maker with the help ranking in daily care of these clients. Because the characteristics of the decision problem was chosen and applied the method of decision support ELECTRE II between June and July 2007 in a wholesale distributor of LPG in order to solve the problem of customer service. Beyond this initial part of what makes a brief background on LPG and its problems are addressed in the main theoretical concepts of decision support methods, with the greater focus on the French school of over-and ELECTRE II. Next are explained the methodological procedures for collecting and analyzing data. Then, we present the results of the application.

2 The Context of Liquefied Petroleum Gas in Brazil

In Brazil the liquefied petroleum gas (LPG) was originally used as motor fuel in the German airship Graff Zeppelin, carrying passengers from Brazil to Europe in the early twentieth century [2]. After the suspension of these trips in the 30s, Brazil was left with large inventories of gas in Rio de Janeiro and Recife. LPG has been marketed for use in stoves, which so far worked with wood, Ethanol or kerosene. Even consumption is low at this time Brazil has to import gas from the United States. These imports were suspended during the second

World War and after the conflict, consumption in Brazil has grown so large emerging distributors of LPG and related businesses. One was Mangels Company, which developed in the 50's the design of transportable cylinders of 13 Kilograms, which became the Brazilian standard for marketing of LPG. In 1955 Petrobras Company starts producing LPG, although the dependence on foreign lasted until 2007, when Brazil reached self-sufficiency in the production of the product [2].

The Brazilian external dependence for decades made the LPG market went through several crises, one of the most severe during the Gulf War in 1991. With the cut in imports, the government began rationing measures, one of the reduction product of the cylinders 13 to 10 Kilograms. Were also set restrictions on its use in vehicles and boilers. After the end of the war in the quantities potted cylinders again be 13 pounds, however other prohibitions on the use of the product continues today. The LPG supply chain has several branches and levels depending on how to use the product. The higher sales volume in the gas is packaged in returnable and reusable containers of 13 pounds, which are packaged in bottling plants. Currently the wholesale market for LPG is operated by twenty-one distributors, they stand out among the outrages (Ultra Group), Minasgás (Dutch SHV Group), Butane (Grupo Edson Queiroz) and Liquigas (Petrobras Distribuidora). Government incentives for the use of natural gas have led to the use of LPG in the Brazilian energy corresponds to only 3.6% in 2006, indexes below the wood, diesel and electricity. Nevertheless, according to the Sindigás, GLP meets 100% of Brazilian cities, supplying more than 42 million households, generating about 350.000 jobs.

3 The Company

The subject company is a distributor of LPG, located in northeast of Brazil. Its area of operation covers three states, serving cities that lie within a radius of up to 500 km. In commercial terms it is among the second largest LPG distributor in Brazil, where it operates under a brand of containers packaged for resale.

Its distribution process is done through a range of sales representatives, who have the right to use and exploitation of the spot in a particular geographical area. In this market, competition is intense, and predominantly played by the four largest companies in the Northeast. The supply of dealer is accomplished by trucks adapted for handling LPG, and they may belong to a reseller or carrier hired by the distributor. The market is segmented into four major areas: north, south, interior and capital.

The service of the dealers at the factory during the day occurs randomly, creating moments of excess dealers awaiting loading (usually in the morning and late afternoon) and an idle output outside these times. This uneven distribution affects the rates of manufacturing productivity and efficiency. Moreover, as currently the service is provided based on the order of arrival, the dealers that are located closer to the Operating Center benefit at the expense of other customers who are more distant points, making these often remain shortages, impacting the market share of the distributor in a given region.

The lack of a specific method for deal this problem means that there are relationship problems between dealers who wish to prioritize your own loads. This process also generates interdepartmental conflicts between the managers of the segments (north, south, interior and capital), since they are paid according to a daily sales goal that often can not be met.

Despite the concession of the brand and product supply many retailers go without feed back their inventory or even competition with other underground deposits. It is necessary, given the situation, establish an order indicating which customers will be prioritized in the factory. Thus, it is possible to form an adequate distribution of service throughout each day of delivery. This process should take into account several factors of interest in the company so that the result is considered acceptable to managers and can minimize the waiting time for dealers.

4 Multicriteria Decision Support

The Decision Support, was used primarily as a means the mathematical expectation of support in decision making, such an approach because of its limitations is considered unacceptable to the present day. In the 50's, the emphasis on solving the problems turned to the source Operations Research (OR), caused initially by the Allied Forces in World War II. This approach has gained ground in the business world, the need to optimize costs, resources, expenses and profits. In the 60's, suggest the probabilistic methods aimed at decision methods have been replaced with less mathematical complexity. In the 70's there were the first methods aimed at the problems of discrete multicriteria decision or multiobjective environment. According to Almeida and Seixas (2003), multicriteria decision support principle is to seek the establishment of a list of preferences (subjective) between the alternatives being evaluated under the influence of

various criteria in the decision process. Thus, these methods are characterized by aggregating the preferences of decision-making criteria established to serve as an aid in decision making.

While not guaranteeing an optimal solution to the problem, using a consistent method will provide greater security in the decision-making. According Malczewki [3] multi-criteria problems involving six components: objectives, decision maker (s), a set of decision criteria, set of alternatives, a set of state of nature and consequence of decisions. Already a multicriteria decision problem for Vincke [4], the situation is being defined as a set of actions 'a' and a family of criteria 'f', you want to: determine a subset of actions considered in relation to the best F (a problem of choice), split A into subsets, according to some rules (classification problem), the actions of the order from best to worst (sorting problem). The same author points out that, in fact, that the real problems can be a mixture of choice, sorting and ordering.

There are several approaches that support a multicriteria decision problem, and this, as explained, the situation in which a decision maker must choose between alternatives in light of more than one criterion, seeking to accomplish several goals. Methods of Multicriteria Decision Support, can be classified in various ways, and one is on the leading theory on which they rely [5]. Some approaches add the criteria in a function-synthesis, intuitively establishing a tradeoff between them, as is the case of multiattribute utility theory, which is supported by a solid axiomatic structure.

Other approaches compare the alternative criterion to criterion, exploring concepts of dominance and efficiency, as is the case of over-classification methods [6, 7, 8]. The over-use of methods instead of multiattribute utility theory can be motivated by the fact sometimes be difficult to establish the utility function given all the assumptions of this theory, but in some cases because the decision maker cannot express their preferences so "rational." In this light becomes necessary to seek a deeper understanding of these methods [6, 7, 8].

Methods are based on building a relationship that incorporates over-the preferences established by the decision maker faced with problems and compared to available alternatives, evaluating them on a par. These methods consist in building a relationship and over-exploitation of the alternatives that were not sobreclassificadas, sending a recommendation to the decision maker, according to the problems presented. Among the best known over-classification methods can be related to the family

of ELECTRE methods, the PROMETHEE, segmentation and Trichotomy MELCHIOR [4].

The family methods ELECTRE (Elimination and Choice Translating Algorithm) was developed by Roy [9] and associates at the University of Paris Dauphine, being subdivided into ELECTRE I, II, III, IV and TRI. Belton [8] states that the family of ELECTRE methods differs according to the degree of complexity and richness of the information or according to the nature of the problem or issue. The methods of this family are referred to as over-classification methods, focusing on pairwise comparison, is usually applied in discrete choice problems [8]. Vincke [4] complements the methods of over-defining as a binary relation S defined on A, such that aSb defining the decision maker's preferences in this way 'a' is at least as good as 'b', unless there are compelling reasons in otherwise.

4.1 ELECTRE II

Intended for use in ordering problems, where there is a need to establish a ranking of the alternatives from best to worst, based on the preferences of the decision maker. In this method the decision maker's opinions are translated into an ordinal scale. Belton [8] suggests the use of five points: Very Low (MB), Low (B), Medium (M), High (A), Very High (MA). A high rating indicates a strong preference. Criteria are assigned weights that indicate the degree of importance of each one. The family Electre methods are based on the evaluation of two indices, referred to as agreement and disagreement, which are defined for each pair of alternatives. Belton [8] states that the agreement rate for the pair of alternatives a and b measures the strength of the hypothesis that is at least as good as b. In the Electre II the concordance index C (a, b) for each pair of alternative (a, b) is defined by:

$$C_{ik} = \frac{\sum_{j \in J_{ik}^+} \omega_j}{\sum_{j=1}^n \omega_j}.$$

The discordance index D (a, b) is the maximum value in that 'b' is better than 'a', being given by the equation:

$$D_{ik} = \frac{\max_{j \in J_{ik}^-} |\omega_j (r_{ij} - r_{kj})|}{\max_{j \in \{1,...,n\}} |\omega_j (r_{ij} - r_{kj})|}.$$

After the calculation of the indices of concordance and discordance for each pair of alternatives, two types of relationship will be over-built so that the comparison is made with two pairs of indices of thresholds: (C *, D *) and (C-, D -).

The indices calculated can be used to build a relationship over-classification. To this we must establish the thresholds of agreement and disagreement D * C *. It can be said that an alternative outrank other if the coefficient of concordance C (a, b) is greater than or equal to the threshold of agreement and coefficient C * discrepancy D (a, b) is less than or equal to the threshold of disagreement D *.

The ELECTRE II works with over-two levels: an over-strong and a weak, considering the two limits of agreement. The over-exploitation of relationships so happens that the alternatives that are not strongly outranking by any other form a subset B. In this subset to seek alternatives that are not weakly outrank by any other alternative in the subset.

All the best alternatives A1, subset of B, consists of the alternatives that satisfy both conditions and form the first class of ordering. The process is restarted with the alternatives that were left of the subset B, until it obtained a complete pre-order, this process gives the name of distillation.

The second pre-order is built using the same procedure, of which begins with a subset of alternatives that do not disqualify any other toward better alternatives [9] [4].

5 Proposed Model

Through an elicitation process with the decision maker, identified the most important criteria in assessing the sort of customer service, and based on this knowledge, some questions were formulated to identify the weight that each alternative would have in the process. We defined six criteria that received initial weights according to the level of importance assigned by the DM. One difficulty reported was related to the decision maker to establish the performance of each alternative against the criteria raised earlier. To solve this problem, we used a verbal scale with five levels: very low (MB), low (B), medium (M), high (A) and very high (MA) that was related to scores obtained by the alternative and converted according to the tables below:

Table 1 – Criteria Payment and Time of Trip

Criteria	Payment	Criteria	Time of trip
Weight	5	Weight	3
Original	Scale	Original	Scale
15 Days	MB	0-1 hour	MB
7 Days	B	1-2 hours	B
In Cash	M	2-3 hours	M
prepayment < 3 days	A	3-4 hours	A

prepayment > 2 days	MA	More than 4 hours	MA

Table 2 – Criteria Debits and Time of Trip

Criteria	Debits	Criteria	Seller by month
Weight	5	Weight	4
Original	Scale	Original	Scale
Debit> US$ 100 mil	MB	< 10 ton	MB
Debit> US$ R$ 100 mil	B	11 a 50 ton	B

Table 3 – Criteria Duration of Stocks and Achievements

Criteria	Duration of Stocks	Criteria	Achievements
Weight	5	Weight	3
Original	Scale	Original	Scale
> 4 days	MB	< 30 %	MB
3 a 4 days	B	30 a 40 %	B
2 a 3 days	M	50 a 80 %	M
1 a 2 days	A	80 a 100 %	A
Zero	MA	> 100 %	MA

Alternatives were defined as the set of retailers who issued supply order for the day stipulated. The use of ordination was converted into a positioning of clients to schedule the daily flow of supply from the Central Operation of the distributor.

As the ordering is daily, was defined as the volume that the scores / Month, Payment and travel time would be reviewed monthly while "payments on time" criteria, goals achieved and Customer Inventories should be updated daily. It was also defined as a form of support for the calculations and generation of the listings, the Microsoft Excel spreadsheet. This application allowed the decision maker analyzes the robustness and the adjustment of the rates of agreement and disagreement.

6 Results

Was collected data on the performance of customer service in the same period last year (2006), the application of the method as well as for the month previous to the application of the method.

The company uses three types of performance indicators: production / hour, waiting time for

loading, percentage of shortage of customers. These indices were used to make the comparison between the old application and ELECTRE.

To generate the lists were established thresholds C *= 0.85, D *= 0.01, C-and D-= 0.70 = 0.50. Both as compared to the previous year and the previous month there was an increase in hourly output. The average increase between 10 and 15%. It was identified that this increase was due to the reduction in idle production process.

The waiting time for loading, before the application of electricity has an average of 35 minutes was reduced to 15 minutes. The percentage of shortage did not show significant changes. The major difficulty encountered in the initial application was related to the routine schedule of supply. In the previous case the dealers were not used to pre-schedule your visit. The use of the ELECTRE required conducting two daily contacts, to inform the first and second load needed to be informed of the schedule that was provided by the method. As recommendation for further research, we recommend the use of ELECTRE TRI-NG [10, 11].

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