1. INTRODUCTION

1.1. Context

Gaz de France, as an operator of distribution networks, has to provide gas in the best conditions of security, of continuity and of quality of services, in the frame of prescribed constraints and internal financial obligations. To assume this mission, Gaz de France has always made technical, economical and organisational choices, from the conception and the construction of the network, to its operation and maintenance.

Now evolving in the European gas market that is progressively deregulated and liberalised, Gaz de France adapts its mission of operator of distribution networks to this new context. In this frame, the stakes of the activities of operation and maintenance of the gas distribution system are big, and the mission of Gaz de France as an operator of networks involves more and more optimising these activities.

That means remaining competitive, as well as controlling networks performance and safety, and increasing customer’s satisfaction. In this logic, and as this new context presents a formidable challenge, Gaz de France has engaged, since 1999, works around optimising operation and maintenance of its distribution networks. Among them, Value Analysis, well known as a powerful and most frequently used method to undertake value management studies, has been adapted to its context of operator of networks.

1.2. Value analysis concept

Value analysis originated in the United States around 1947. It is now a standardised process [1-4], and is defined as “an organised and creative approach, using a functional and economic design process which aims at increasing the value of a value analysis subject”. In this approach, “the value may be described as the relationship between the satisfaction of need, and the resource used in achieving this satisfaction” [1]. As a consequence, increasing the value of a subject guarantees that it provides the services awaited by its user, as well as its resources are adjusted to the necessary and not more.

The Value analysis process implies different parties [4]:
- A decision maker, who takes decisions during the process, makes them known and applied. He can intervene each time it is necessary, but at least at the project definition phase, and at the choice of solutions phase;
- A Value Analysis animator, who masters the methods linked to Value Analysis,
- A project team who assures the interface between the animator and the company,
- A multidisciplinary working group

The multidisciplinary working group gathers together all the competences required, and brings together people with different educations and responsibilities. This allows a consensus on functions, performances, principles, solutions and costs, as well as it favours creativity, and enriches the available information. The team proposes orientations, but the decision remains submitted to the decision maker.

The general organisation of a Value Analysis action can be decomposed in several phases [3]:
- Definition of the project and of its scope
- Gathering data
- Functional analysis: it aims at formulating the subject in terms of functionalities rather than in terms of solutions, and then to compare the costs of each component of the subject with the functions associated
- Identification of solutions
- Evaluation of solutions
- Presentation of solutions to the decision maker
- Development and implementation of the solution selected by the decision maker

The process is based on a critical and global check-up of the existing situation, using research of data, and guiding the existing situation to an optimal one, based on a mutualisation of the acquired experiences [3].

2. APPLICATION TO GAZ DE FRANCE OPERATION AND MAINTENANCE OF DISTRIBUTION SYSTEM

2.1. Actors of the project

The Value Analysis process has been applied in Gaz de France on this subject of operation and maintenance of gas distribution systems since the end of 1999.

In this context:
- The national decision maker was the Gaz de France - Gas Engineering Department,
- The animator was an external specialist of Value Analysis,
- The project team was formed in Gaz de France R&D division,
- The multidisciplinary team brought together engineers and technicians of the Research and Development division, managers and technical experts of five Gaz de France operational entities implied in operation and maintenance of distribution networks, and internal technical consultants.

2.2. Definition of the scope and objectives of the project

The scope of the study was defined as the activities of operation and maintenance of the whole distribution system, which brings all together: the distribution network, its accessories (valves, seals, …), and its specific equipments (regulators, meters…), from the exit of last regulator from the transmission network to the downstream flange of the meter.

Because of the decision power kept by the operators located in regions, and of their local specificities, it was decided to conduct the four first stages of the value analysis progress in this project, and to provide the results to the operators. With a specific formation, this allows them to detect their own solutions to optimise the value of their activities.

The project was conducted in 2000 and 2001, and the results were provided to the operators in 2001 and 2002. They are still actualised and used today to optimise activities.

2.3. Gathering data

The collection of data was conducted all the project long. It consisted in gathering and analysing:
- The internal and external prescriptions defining the objectives of the activities of operation and maintenance of the distribution system
- The technical information on the components of the system
- The costs spent by the operators on their diverse activities
- The data linked to the characteristics of the operators’ networks (length of pipe, number of customers, number of regulators…)
- The data linked to operators’ quality of services (call of clients because of leaks, stop of providing gas…)

First of all, the data were statistically analysed to define a structural vision of the distribution system. Groups of operators that could be compared were identified, on the base of the characteristics of their systems: size of the operators and volume of their activities of operation and maintenance; area covered and expansion; density of supplying. Four groups emerged from this statistical analysis, and every Gaz de France local entities were classified in one of these four groups:
- Group 1: operators with low density, rural, with characteristics lower than the national average
- Group 2: both rural and urban operators, with characteristics closed to the national average
- Group 3: both rural and urban operators, with low density and high expansion
- Group 4: urban operators, with high density, few communes, and low expansion

This structural analysis of the distribution system was followed by its functional analysis described below.

2.4. Functional analysis

- Service functions
  The activities of operation and maintenance of the distribution system were formalised by the working group into service functions. Thirty-three service functions were identified and defined. The achievement of all these functions have an impact on the missions of Gaz de France as an operator of distribution network - the quality of providing and the security of people and goods - as well as on the brand image of the company.

  In order to estimate the costs of the service functions, a Function Cost Matrix was defined, to distribute the activities of operation and maintenance counted in their bookkeeping plan on the service functions.

  In all the local entities, the teams responsible of operation and maintenance assume sensibly the same activities, which are counted in the bookkeeping plan. On the other hand, the appreciation of their distribution on the service function can vary from an entity to another. It was decided at this stage that the entities could have the possibility to adjust this distribution to their own context, in order to have a better value analysis.

- Unit costs by domain
  The working group rapidly considered that the distribution of the costs on the thirty-three service functions was indispensable, but that their interpretation was complex. Then, it was decided to regroup these service functions in six domains: networks, service pipes, regulators of networks, regulators of customers, supervision, and customers. The first three domains were decomposed between preventive and corrective maintenance. The costs of these domains were deducted from those of the associated service functions.

  In parallel, unit costs have been established (reported to the length of network, the number of service pipes, the number of regulators...), to compare the costs of different operators by taking into account their specificities.

- Definition of service criteria
  The realisation of each function has an impact on the missions of Gaz de France as operator of distribution network. Furthermore the cost of a service function can only be judged as good or excessive in comparison with a given level of service, corresponding to the level assuring the missions of the operators.

  In order to optimise the activities of operation and maintenance, a service criterion was defined for each domain.

2.5. Identification of solutions

Once the functional analysis done, it was decided to build a software application to allow each operator of distribution system to make its own value analysis and to identify solutions to optimise its activities.

3. A SOFTWARE APPLICATION TO ANALYSE THE VALUE OF THE ACTIVITIES OF OPERATION AND MAINTENANCE OF GAS DISTRIBUTION SYSTEMS

3.1 General presentation of the software

The decision was made to provide the results of the functional analysis to all the operators, so that it can be shared and that each operator can lead its own analysis and take the best decision on how to optimise the value of its activities. This decision led in particular to the development of a specific software application, named ADVGAZ (“Analyse De la Valeur Gaz” in French, that means “Value Analysis of Gas”).

A model was built using an Excel Program, and distributed during years 2000 and 2001 to the operators. Because of the interest of the operators for this first program, it was then decided to develop a specific intranet application, more dynamic and convivial. This application was implemented during year 2002 and is described below.
3.2. Objectives of the device ADVGAZ

Built on the basis of the Value Analysis, the intranet application ADVGAZ enables operators to detect over-quality or under-quality in the operation and maintenance of the distribution system that is under their responsibilities.

This analysis is based on the relation between the costs and the performance of the systems, and on a comparison between operators.

The device enables:
- To estimate the costs of service functions, regardless of the activities reported in the book keeping plan,
- To extract unit costs related to each domain of operation and maintenance among the networks, the service pipes, the regulators, the supervision of operation, and the operation at customers’ installation,
- To automatically recover from other data bases the financial and technical data necessary to the analysis,
- To compare the costs of the service functions with the quality of the services
- To compare the unit costs by domain of activities with the median of the group of operators which have the same specificities,
- To have a vision of the evolution of the costs and the levels of services by domain, for 3 to 10 years,
- To simulate different hypotheses of volumes of expenses by domain in order to appreciate their impacts on the costs of the functions of services.

All these functionalities are available via the intranet, and the use of many different graphical representations makes the system very convivial and easy to interpret.

3.3. Functionalities and structure of the device ADVGAZ

All the operators of Gaz de France distribution networks can have an access to the intranet ADVGAZ. This access is specific to the data of the region covered by this operator.

Once the user is connected, he arrives to the welcome navigation page (figure 1).

This page gives to him the access to all the other pages and functionalities of the system which contains the information of the year before, and of all the years up to 10 years before.
3.3.1. The breakdown of the expenses

In this page, and at the beginning of each year, the annual expenses of the operator are automatically recovered from the bookkeeping plan of the previous year. During the beginning of the year, the breakdown of these expenses according to the thirty-three service functions can be adjusted by the operator in function of its activities of the previous year. This distribution will build the updated Function Cost Matrix of the operator.

3.3.2. The data

In this page, and at the beginning of each year, the data related to the stock list of the operator's system, and the data related to the level of services of the operator's system are automatically recovered from other databases. These data were chosen for this application in relation with the definition of service criteria of the functional analysis, and for the six domains of activities studied. For example, for the domain “Networks”, the data related to the stock list is the total length of network, and the data related to the level of services is the number of calls from third party due to an incident on the network. Others specific data are recovered for the domains “Service pipes”, “Regulators of networks”, “Regulators of customers”, “Supervision”, and “Customers”. They are available on this page.

3.3.3. The graphs

This page is the heart of the software application and of the Value Analysis. At the beginning of the year, it provides, once all the data have been actualised and the breakdown adjusted by all the operators, a large number of graphical representations of the value analysis adapted to the connected operator.

A simple click builds a sound base that enables operators to make their own value analysis and:
- To point out activities that show a gap of cost or quality with similar operators,
- To diagnostic the weak points or the over dimensioned points of their activities, and to detect possible gains of productivity,
- To compare their performances to those of other operators which have similar configurations of networks (length, density of customers, level of development…)

These comparisons, based on operation and maintenance costs, and quality of services to customers, can be analysed on several years.

Many graphs are available, and described in the paragraph 3.4.

3.3.4. The simulation

In this module of ADVGAZ, the operator can propose target costs for each of its domains of activities. These costs are automatically distributed on the service functions, and a graph is generated to compare the costs expended the year before on the service functions, and the costs that would be expended with the fixed targets. This aims at adjusting the prevision of budget for the current and the following year.

3.3.5. The administration

This menu enables national administrators to give a specific access to the operators in function of their region, to activate the interfaces to recover the data from other databases, to activate the calculations to generate new graphs, and to adjust parameters of the application.

For local administrators, this menu enables to give an access to everybody in the same structure who can have interest in making the value analysis of its system.

3.4. Graphic restitutions

Several graphs are proposed for the operator to analyse its costs and level of services. They are classified in four categories of graphs:
- The repartition of costs by domain,
- The comparison of unit costs to the national median, and to the median of the group of operators with similar specificities,
- The comparison of the costs to the provided levels of services,
- The evolution of the costs and levels of services on several years.
Some of these graphs are described below. These examples are built on non-real data but have the advantage to show the diversity of the available analysis.

3.4.1. The repartition of costs by domain

Pie charts aim at comprehending:
- The relative level of costs by domains (Graph 1)

![Graph 1](attachment://image1.png)

- The repartition of the costs of service functions for a chosen domain (Graph 2)

![Graph 2](attachment://image2.png)
3.4.2. **The comparison of unit costs to the national median and to the median of the group of operators with the similar specificities**

The comparison of the unit costs is established, from one hand with the national median, from the other hand with the median of the group of operators that have the same specificities as the operator connected, and that was identified within the phase of structural analysis of the system.

The corresponding restitutions are provided in the form of bar charts. An example is given in Graph 3.

![Graph 3](image)

All the costs of the domains and service functions are reported to the data related to the stock list recorded for this domain.

A more detailed analysis is possible for each domain, in the graph 4. This bar chart represents the unit costs compared to the median of the similar operators, for each service function of the selected domain.
Thanks to these comparative bar charts, the gaps can be highlighted. Here, the objective is to identify for each service function, and from local specificities, the possible origin of the gaps of cost between comparable operators.

Then, it consists in distinguishing, among the gaps identified with the median, those which can be explained by the specificities of the operator, and those for which there is no explanation, and that could be optimised.

Graph 4

Year 2002: Comparison of unit costs by service functions of the domain “Networks” of the operator X, with the median of the group

<table>
<thead>
<tr>
<th>Service Function</th>
<th>Unit Cost (k€/Unit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>To follow the third party calls</td>
<td></td>
</tr>
<tr>
<td>To ensure on-call services</td>
<td></td>
</tr>
<tr>
<td>To survey the network by detecting leaks</td>
<td></td>
</tr>
<tr>
<td>To measure cathodic protection</td>
<td></td>
</tr>
<tr>
<td>To protect network during third party works</td>
<td></td>
</tr>
<tr>
<td>To maintain accessories for cathodic protection</td>
<td></td>
</tr>
<tr>
<td>To maintain accessories of the network (pipes, valves, siphons...)</td>
<td></td>
</tr>
<tr>
<td>To locate leaks</td>
<td></td>
</tr>
<tr>
<td>To put the network out of danger and make temporary repair</td>
<td></td>
</tr>
<tr>
<td>To repair the network</td>
<td></td>
</tr>
</tbody>
</table>
3.4.3. The comparison of the costs with the provided levels of services

These graphs enable to visualise, by domain, the level of services measured, in function of the unit cost of the domain. They enable to situate one operator in comparison with the others, as in graph 5.

Once gaps between the levels of services and the associated costs are identified, specific points of improvement can be found.
3.4.4. The evolution of the costs and level of services on several years

ADVGAZ enables to build a history of data for three to ten years and to analyse the evolution of costs on several years. These evolutions concern:

- The costs by domain (Graph 6)

Graph 6

[Diagram showing costs by domain from 2000 to 2002]

- The costs by service function (Graph 7)

Graph 7

[Diagram showing costs by service function from 2000 to 2002]
The level of services (Graph 8)

Graph 8

These last graphs enable to describe the evolution of the quality of services in function of the costs expended on the domain, and to see the effect of the expenditures on several years.

4. CONCLUSION

Now used in Gaz de France as a base of discussion between the different operators, and as a base a choice to arbitrate between maintenance and investments, this device is one method used by the operators of networks to analyse their systems. Its conviviality, associated with the reliability of the value analysis method, enables operators to easily and efficiently compare their performances to those of other operators that have similar configurations of networks, and to point out solutions to improve their system.

This auto-emulation is a sign of the operators’ concern of quality, a guarantee of their perfect command of the techniques, and a way of improving security and availability of gas.

REFERENCES