MONITORING ELECTRICITY MARKETS TROUGH REGULATION USING IDEF0 LANGUAGE

Ms (c) Jorge A. FELIZZOLA CRUZ Ph.D. Gilberto CARRILLO CAICEDO Ph.D. Rubén D. CRUZ RODRIGUEZ
Universidad Industrial de Santander – Colombia
jfelizzo@uis.edu.co gilberto@uis.edu.co rdcruz@uis.edu.co

ABSTRACT

The considerations to develop a methodology for Power Market monitoring based on regulation are presented in this paper. Modelling methods such UML and IDEF facilitate to monitor process or activities. Such methods have been useful for establishing functional relationships and information in enterprises with different nature. Here a novel strategy is presented for the structured representation of the power market based on regulatory information (laws, resolutions and decrees) using IDEF0 which allows to identify variables and indicators to perform regulatory studies on the sector.

INTRODUCTION

The Power Markets have suffered continuous changes and a very fast evolution head by the regulations that govern them. They have gone from vertically integrated schemes to an opening or deregulation which have mainly introduced competition in generation and commercialization and regulated the operation of natural monopolies such as transmission and distribution.

The State was the only responsible for generation, transport, commercialization and distribution of the electric power. Now, those functions have been replaced by four business units (generation, transmission, distribution and commercialization) that are articulated by two units more which are the market operator and the system operator. The State continues being active part in the market, taking charge of to regulate and to supervise all the activities in the sector.

The restructuring and deregulation processes of the electric industry in other countries show that markets are still very immature; this is reflected in the great number of resolutions and decrees issued every year to regulate each one of the business of the sector. The market is in constant evolution. The power market can be modeled as a "great company", like the state-owned companies were it before the opening, made up by four big business units (generation, transmission, commercialization and distribution) which compete against each other, developing clearly defined functions through the regulation and which cause a different and only impact in the business.

MONITORING AND POWER MARKETS

A high automation level is been in the industry, but, in spite of that it is necessary monitoring and pursuit from expert eyes [1]. Continuous monitoring of processes or activities and the product or service evolution, will allow alerting about good or bad operation of the system, organization or company, and at the same time it allows to establish adjustment criteria and changes inside the system.

All power markets are susceptible of being monitored. However, markets based on bids in which generators compete with their bids instead of costs need special surveillance mechanisms that allow them to perform a constant control in the agent's behaviour so that, through the use of market power, avoid high non justified transfers of money from users to producers, which cause inefficiencies and competence limitation.

A detailed version of the monitoring scheme utilized in Pennsylvania-Jersey-Maryland (PJM) market is been in [2]. There, the main monitoring activities are related to rules and standards concordance, rate procedures, current or potential imperfections and market power exercises, among others. Similar elements at the previously mentioned are used by other schemes like the New York Independent System Operator (ISO).

According to the above-mentioned, in [3] are summarized certain "generic" monitoring elements that should be considered for a monitoring plan:

1. *Plan purpose*: a description about it is wanted to monitor should be made, i.e. risks, generators or load behavior or competence among other participants. Also, it includes identification and mitigation of anticompetitive behaviors, penalization of participants whose violate market rules, transparency assurance in market signs, identification of treats of structural, financial and operational type.
2. *Implementation procedures*: the next elements should be taken into account for monitoring process: current state of the laws, mitigation rules (action limits of the market legal/police control) and problems for obtaining information.

The power market monitoring based on regulation is supported on this last point and it is the spine of the present research.

BUSINESS PROCESS MODELLING

The business modelling is a group of activities or processes used to develop specific purpose models. To model it is necessary to have a deep knowledge about the environment, besides a clear and adaptive language that allows generating particular solutions for each agent of the market (generator, transporter, marketer and distributor).

The techniques for business modelling [4] are very important useful visual languages useful to achieve a global vision of the business. The present work adopts as

modelling technique the IDEF (Integration Definition For Function Modelling) which is a proven language and equipped with representation tools (software) used in diverse fields.

Before to reach a development level such software, it is necessary to establish the operative functionalities of the design, with their operation restrictions and information requirements with the objective of obtaining a "complete model".
This methodology is based on requirements engineering, which is necessary to determine and to specify the form of response of an entity because of stimuli presented into certain operational environment. For example, in requirements engineering, "entity" makes reference to a business object (primary stage of the design) and the same word is a software object in software engineering (later stage of the design). In order to do not waste resources as well as in time as in money, nowadays the software systems are modeled starting from organizational models.
The requirements engineering and the business modelling have been strengthened by the use of formal methods which contribute to obtain more precise and less ambiguous specifications [8].
Acoording to the above-mentioned, the biggest efforts should be aimed to the understanding of the environment as organization (the power market in this case) of the interactions among the different market agents and of the information requirements that will be necessary for the model development.
The following section is focused in the relationship between the power markets and the technique for business modelling IDEF0 used as support in the requirements engineering.

IDEF AND POWER MARKETS

IDEF is in fact a family of formal methods that had its origins in the 70's as part of a project of the United States Air Force [6]. Nowadays there are 16 versions of IDEF, each one with a different but complementary focus (object – oriented, relational databases, information processing). Nevertheless, almost in any project when the relationshiops or interactions are not clear, the first step should be taken with IDEF0.
IDEF0 consists on a series of rules for functions representation. The obtained models are a collection of hierarchical diagrams together with some texts and cross-references which are represented by means of rectangles or boxes and arrows. One of the most important aspects of IDEF0 is that, as modelling concept, it goes gradually introducing detail levels through the model structure. (See fig 1.)

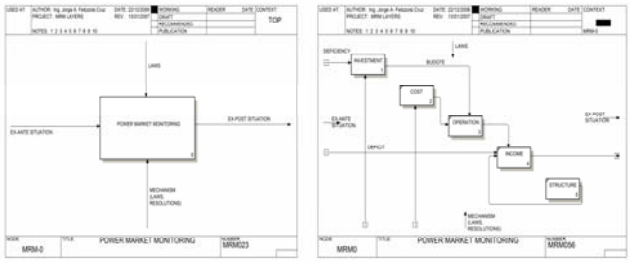

Fig. 1. TOP-DOWN decomposition of an IDEF0 model

From this perspective, the power market model is given by the relationships been in regulation and which are represented as inputs, outputs, mechanisms and controls (ICOM). Each ICOM block developed with IDEF0 for the monitoring methodology, is developed according to the thematic found into each one resolution, law or decree issued every year by the regulation entity and/or by anyone that affects the market operation.
A process of competitive intelligence [10] is used for selecting the methodology stages for market monitoring, with this, the basic resolutions that origin the model are included. *Ex ante* situations (market condition before the elaboration of the resolution) are the IDEF model inputs; the controls are restrictions imposed by the regulation entity, environmental conditions or similars; the outputs are considered as the impact produced by the mechanism (situation *ex post*) in the market's agent perception (generator, transporter, marketer and distributor) that is being modeled. The mechanisms are the resolutions under analysis. This way each ICOM block of the model is explicit.
The main advantages of representing the power market by means of IDEF are:

- It is a unified way of representing functions or processes.
- Its language is simple but rigorous and precise.
- It allows establishing limits of detail representation universally constituted.
- It can be represented with diverse computer packages.

In the macro project from which makes part the present work, the power markets monitoring[1] is being performed by means of a tripartite model that includes general monitoring of the markets through competitive intelligence and intelligent agents (MCGM), monitoring of the bid's behavior through clustering techniques (MCOM) and market monitoring based on regulation through IDEF0 (MRM).
One of the advantages of using IDEF for market monitoring based on regulation (MRM model) is that it can be used for a posterior development using intelligent agents. In [5],[7] a methodology oriented to agents is presented for business

1 The model is being developed by the research group GISEL as part of the COLCIENCIAS – ISA agreement.

modelling, which is a combination of object – oriented methodologies (OO-SE) and methodologies for business modelling (IDEF).

MRM METHODOLOGY

In MRM the rules of the market are perceived by market agents in a different way. A first problem confronted at the beginning of the modelling was to establish the limits of the market and therefore of the modelling. A first step is to establish the purpose and reach of the model through research questions; in addition the Structured Analysis Data Technique (SADT) methodology for structured analysis of dates was applied to the market using the IDEF0 language (see fig. 2). A market model seeks to extend the understanding of the same one through modelling its constituent parts, allowing to analyze the operation and interaction of the different processes.

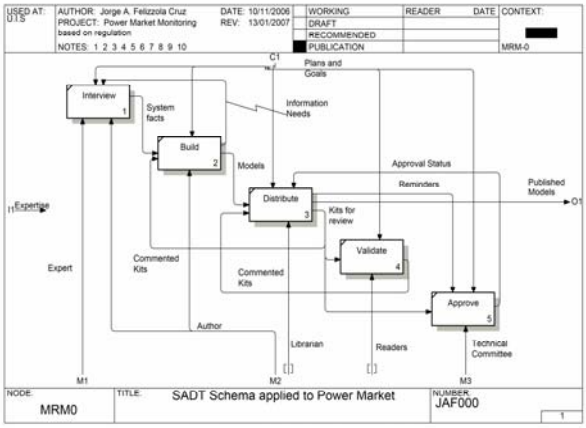

Fig. 2. SADT scheme applied to Power Market.

Selection of the Monitoring Elements

For develop the monitoring model using IDEF0, as primordial elements were selected the elements related to the system operation, the investment motivated by the regulation of each one of the business units, the costs recognized by the market in each one of their activities development and the market structure. The developed scheme was called PENSIMELEC (Pentagon for Monitoring the Power Market) (From its acronym in Spanish). See fig 3.

The crossed analysis of each PENSIMELEC edge allows to identify important signs of the market such as dynamics of the sector, concentration grade, prices stability, etc, according to regulatory signs of the market and which are captured as mechanisms in the model developed with IDEF0

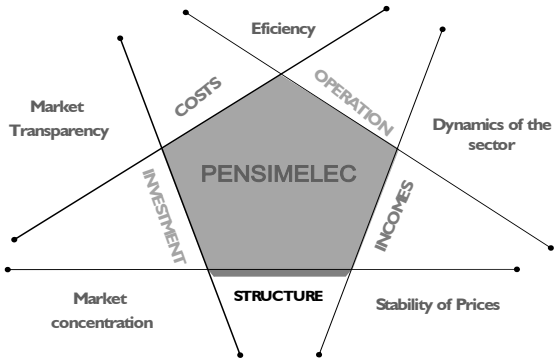

Fig. 3. PENSIMELEC. Pentagon for Monitoring the Power Market.

Simplified methodological structure of MRM

The methodological steps of the methodology are:

1. *Information search:* The methodology is based on regulatory information. Therefore, the regulation entity of the country is identified, as well as similar organisms.

2. *Storage:* The information found (resolutions, laws and decrees) is stored on a database or Excel ® book in order to apply discriminating criteria by means of filters or defined consultations.

3. *Classification:* Pertinent criteria for each agent are defined to achieve the classification. The application field of the resolution (general or particular) is determined by a simultaneous process, as well as those resolutions which are derogations, appeals or operation rules of the regulation entity (administratives). For an appropriate classification it is necessary to carry out surveys of regulatory impact (primary perception of the environment), as well as consultation to experts on power markets (secondary perception of the environment).

4. *Model development:* The first step for model development is to perceive the market as an organization and fraction it in business units that interact to each other. In the framework law that originated the market opening are described the units. As second step, a process of competitive intelligence (CI) should be applied for the identification of the relevant topics found in the previously classified resolutions and taking the PENSIMELEC as central axis. The third step is the identification of the ICOM elements for each developed unit.

5. *MRM Application:* The last stage is making decisions. The commissioned organization to perform the monitoring can generate indicators and periodical reports for the own company or for the rest of the agents (depending on the case).

CONCLUSIONS

The investigation proposal is pioneer in the introduction of the concept of business modelling for performing a monitoring scheme applied to power markets. The methodology is experimental and is still in a development stage.

The regulatory processes are complex and their reach is difficultly predictable; therefore every time new laws that affect the market conformation arise. In some cases is the market who "forces" to change the laws due to natural disasters or force majeure events. These changes are easy to represent with IDEF.

The methodology can be used for detecting contradictions or regulatory holes by making a scan through the different submodels of the expected ex post or current situation.

MRM is susceptible of being applied to any Latin American power market, at reduced costs, with simple desk tests. The necessary inputs for its application are gratuitous.

For the future, the integration of other models taking as base the MRM's main core (IDEF) is possible. Other models can be "called" to develop a complete and enough IT system (Information Technology) to carry out the necessary monitoring labors for an electricity market.

The models representation is conceptual. The development of a multi-agent intelligent system [9] for automating the task of searching variables into the resolutions that govern the market is more and more nearby whether it is counted with a global and structured understanding exists using formal notations of the power market.

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