

Implementation and operation of the RI_HANA project – Revenue Intelligence in the EPM Group to fight non-technical losses in Energy, Water and Gas Utilities - a successful experience

Authors: Carlos Mario Galeano, Director of the non-technical losses management program for the EPM Business Group
Norela Quintero Montoya, Systems Engineer, EPM Group
Katherine Avendaño, Project Manager, Choice Technologies Colombia
Rui Mano, VP, Choice Technologies Holding

Summary

The article describes the project implemented for reduction and control of non-technical losses, supported by the Revenue Intelligence software on top of HANA in-memory database. This analytics software, with artificial intelligence and machine learning technologies, operates on EPM Group's electricity, water and gas network data. The results, in the first months of operation of the solution, already show an increase of 98% in energy recovery from fraud and the total benefits of the project in the year 2017 exceed 6 million US dollars.

1 - Background

EPM Group is the second largest economic group in Colombia, only below the oil group Ecopetrol. EPM is a Group of 48 companies owned by the Municipality of Medellin and spreads in six countries - Colombia, Chile, Mexico, Guatemala, El Salvador and Panama. EPM Group serves more than 20 million consumers in the supply and distribution of energy, water and natural gas.

EPM Group has been building its vision to the achievement of operational excellence and business sustainability with competitive rates, in supplying the services that are its strategic objectives. To achieve these objectives, EPM created a program for the reduction and control of electricity losses with the participation of the following companies at the national level: EPM energy, CHEC, EDEQ, CENS, ESSA, EPM Aguas, EPM Gas as well as ENSA Panama, internationally. This program seeks to reduce and control the non-technical losses indicators from 9.25% to 8.00%, recovering 183 GWh in no more than five years in the National Energy Companies, through four fundamental pillars:

- Culture and Legality,
- Access services and purchase capacity,
- Technology excellence and an
- Advanced Computer solution, with state-of-the-art analytical technology to support the program.

EPM proceeded its search for the desired technological solution, first via literature research and consultation with market research institutes. The selected technological solution, found as the most advanced and with consistent, proven experience, was with the Choice Technologies supplier, originally from Brazil. The Revenue Intelligence software from Choice uses analytical technologies based on artificial intelligence and machine learning and operates on a HANA in-memory database provided by SAP. HANA provides the processing speed necessary to give agility to Revenue Intelligence algorithms.

The market research process revealed the Revenue Intelligence system – that was operating with successful results in Electricity distributors of the size of Light Company in Rio de Janeiro, Brazil, supervising more than 4 million consumers. Likewise, a proof of concept coordinated by SAP and CHOICE was implemented, which yielded excellent results, propitiating a great vision of the situations causing the commercial losses and demonstrated practical results greater than the previous ones.

Subsequently, the group contracting process with CHOICE Technologies and SAP firms was initiated under the non-binding offer modality, by EPM contracting guidelines. The implementation of the Revenue Intelligence solution by CHOICE on SAP HANA started in May 2015.

2 - Implementation

The firm CHOICE was in charge of the implementation of the solution. The project implementation was organized in several stages, and the planning brought an important benefit as the implementation was carried out simultaneously in all the companies. The production environments went live subsequently, with a difference of weeks, in EPM energy, CHEC, EDEQ, CENS, ESSA; ENSA Panama, EPM Aguas, and EPM Gas:

- Blue Print
- Conceptual Design
- Implementation (ETL from exchange area to HANA, configurations, component and report development) distributed in three business milestones: Addressing, Verification, Balances.
- End-user testing
- Solution Training, Operational training and knowledge transfer following the methodology of learning by doing
- Deployment to the production environment
- Follow up to optimize the implemented models
- Solution and Project Acceptance.

SAP was in charge of the certification of the appliances, consulting services for deployments to QA and production environments, sizing of HANA and Business Object, and HANA tuning.

3 - Learning Process of the Artificial Intelligence System

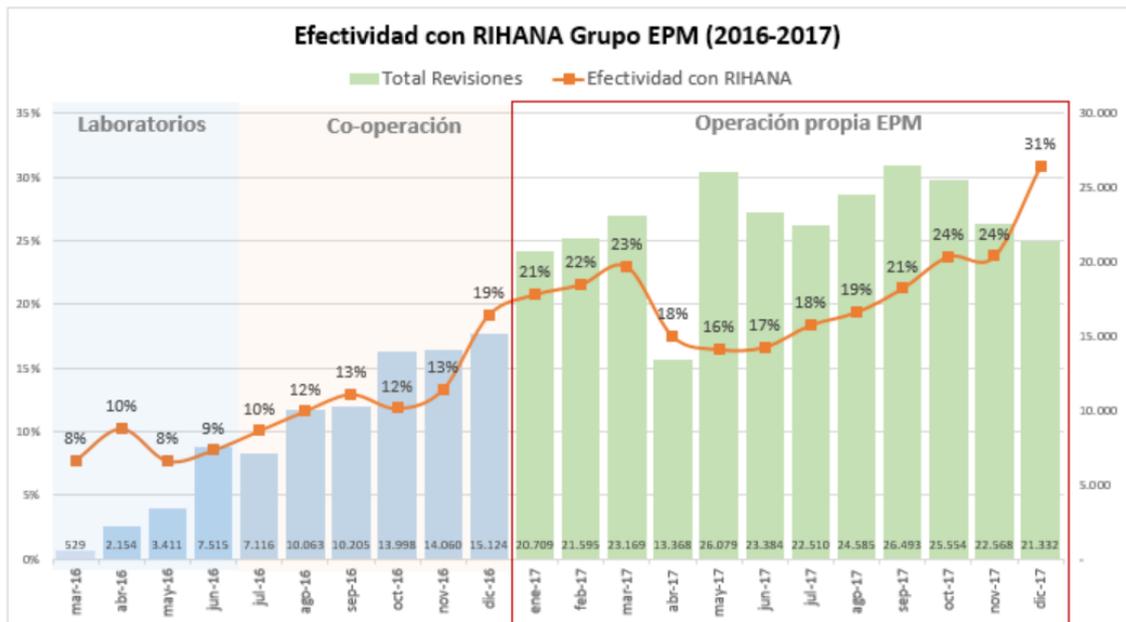
The learning process of the intelligent system is achieved through the training of the algorithms and the mechanisms of artificial intelligence and machine learning. That included the generation by the system of a process of extraction, transformation and data loading, carried out carefully and with high-quality standards, to guarantee a successful learning start.

4 – Results of the Commercial Operation

Operation begins in EPM Energy with two phases of selection and sending of field revisions: as a first step, an initial tuning phase, nicknamed Laboratories phase, which allowed to start training the algorithms via the machine learning process, through a few operations directly addressed by Revenue Intelligence (RI). In this initial process, the processes that support the routing through RI were evaluated. This phase had a duration of 4 months. Subsequently, the co-operation phase started. A joint working group was formed with Choice team and EPM business experts and initiated the formal process of addressing inspections using the software.

An important KPI for the selection process is the Effectiveness index, which represents how effectively the detection process finds real issues (frauds and irregularities) and is defined as the relation between the number of effective revisions (with fraud or irregularity) and the total number of executed inspections. The historical effectiveness of the EPM Group before implementation was 16%.

During the initial stage of Laboratories, an average effectiveness of 9% was obtained, which was similar to the indexes immediately before RI_HANA project. The second phase, Co-operation, was developed between July 2016 and December 2016, with addressing all done through the Revenue Intelligence Solution and, in December, the effectiveness reached 19%.



Graph 1: Effectiveness with Revenue Intelligence since implementation
Source: Reports obtained via Business Objects HANA

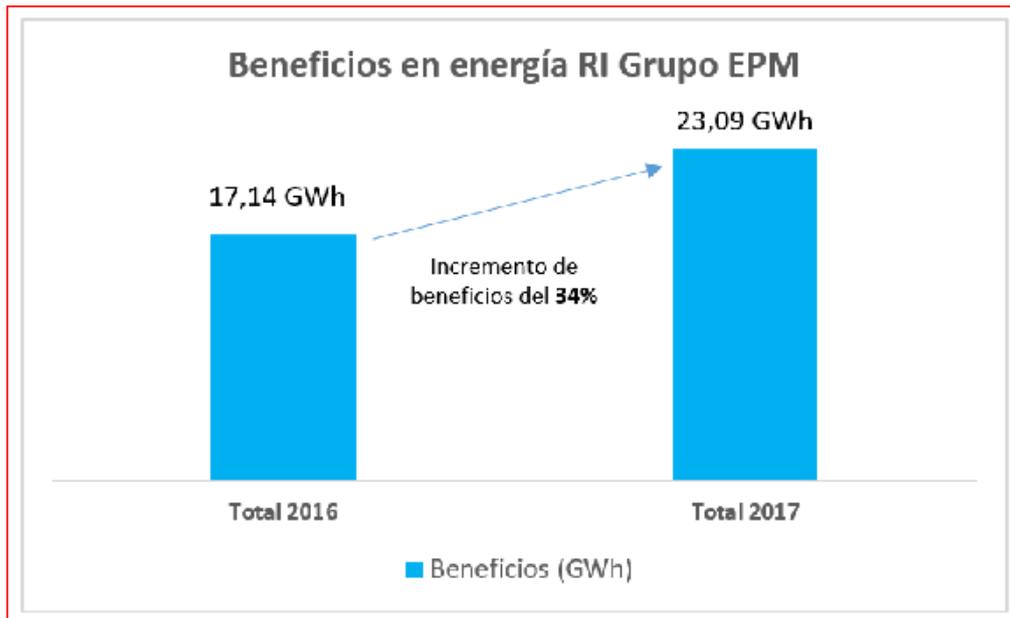
The next stage and having started Revenue Intelligence its machine learning process, EPM Group started its operation independently, achieving the highest effectiveness obtained in 2017 with 31%. These results demonstrate the successful incorporation of Revenue Intelligence use in the losses combat processes and the adequate alignment of the actors in the non-technical loss detection production chain. **These results show an increase of 194% in the effectiveness indicator, compared with EPM historical results** before the implementation of the RI_HANA project.

Regarding the number of inspections carried out, EPM Group made gradual increases on the number of revisions addressed through RI. For 2016, an average of 31% of the inspections for non-technical loss detection (84,175 revisions) were addressed via RI. In 2017, 271,316 revisions were executed and all were addressed under this concept.

The Productivity indicator represents how effective is the detection in uncovering significant amounts of non-registered energy. This is another key indicator to determine the value of the process and the software tool in the detection of installations with irregularities. This is calculated as the monthly average of the amount of energy recovered (kWh) divided by the total of frauds or irregularities registered in the period. For this indicator, the **EPM Group evolved from an average of 701 kWh / fraud (historical data before RI) to an average of 1,184 kWh / fraud obtained through Revenue Intelligence during 2016, an increase of 98%.**

5 – Quantifiable Benefits

The quantification of committed energy in cases detected with irregularity is performed for the estimation of benefits. There are two components in the measurement of economic benefits: the first is recovered energy, defined as the energy consumed but not registered (measured in kWh). On the other hand, the incorporated energy is calculated as the consumption increases presented by facilities after the normalization, which is, once the causes of energy under-registration is fixed.



Graph 2: Economic Benefits - RI Group EPM 2016-2017

Source: Reports obtained via Business Objects HANA

In 2016, with the execution of a limited number of inspections directed by RI_HANA, 17,15 GWh were already recovered, bringing an increase in revenues over previous years. For 2017, with a majority share of the inspections directed by RI, higher revenues were generated corresponding to 23.09 GWh, which **represents an increase of 34% in the measurement of economic benefits** over the previous year.

Another important identified benefit, on the operational side, corresponds to the OPEX savings by the execution of fewer inspections. In 2017, the EPM strategy was focused mainly on increasing effectiveness. With the higher effectiveness in detecting irregularities, with an increase of 34% over 2016 (as seen above), it became possible to reduce the number of revisions while maintaining the planned recovery objectives. Before the implementation of Revenue Intelligence in the EPM Group, 14% of the EPM Group energy consumers were inspected each year, and in 2017 this proportion decreased to 10%, which represents a **significant cost savings of approximately 30% on the field inspections operational costs (OPEX)**.

Adding both, there is a total benefit for the EPM Group of USD 6.1 million in 2017.

6 – Soft Benefits

At the level of processes, other benefits obtained by the EPM Group through the implementation of Revenue Intelligence, are the **increase in the opportunity to improve non-technical losses internal processes and the achievement of loss reduction objectives at each Company and Group level**. On the other hand, the benefit of a **greater rapport between the energy companies within the EPM Group was obtained, and it opened scenarios for teamwork to share strategies, experiences and thus achieve a permanent benchmarking within the Group in the energy segment**. Additionally, **strategies for continuous improvement of the loss detection and combat process were implemented, as well as synergies with the teams in the field**.

It is evident the substantial change in the analysis of data to detect irregularities, obtaining information management advantages at the Big Data level, sharing information among the public services provided (energy, gas and water), and providing the opportunity to standardize processes to obtain higher business efficiencies.

7 – Conclusions

The RI_HANA solution allows EPM Group **to make supported decisions based on data and user behavior, eliminating the subjectivities** of the teams in charge of detecting losses and the wear and tear of strategies established by the experience in the business. Thus, professional experts in non-technical loss detection can focus on the development of business rules and optimization of strategies to increase the productivity of energy recovery activities and reduction of non-technical losses.

Revenue Intelligence's machine learning machine, in its models of fraud probability of fraud and financial impact estimation, is a self-adaptive inference machine using fuzzy logic. These are sets of intelligent algorithms that were developed to interpret business rules in a dynamic and easily adjusted knowledge base to achieve effective non-technical loss reduction strategies.

Data quality plays an essential role in the detection of non-technical losses strategy to achieve effective results, as well as the permanent refinement of the models are a critical success factor, facilitating the business processes knowledge discovery and also provides an efficient framework for the development of irregularity detection rules. Likewise, the joint work with the operation (field inspections, compliance with the PDCA cycle), and the strengthening of the analytical capacity of analysts using Revenue Intelligence are of great importance for the achievement of business objectives.

For EPM Group project, good results have been realized to date since the effectiveness is over 30% and **its revenues in 2017 increased by a 34%** compared to the benefits of 2016.

A quote from the Vice-President of Business of EPM Group:

“CHOICE Revenue Intelligence solution uses predictive analytics with mathematical and statistical modeling, artificial intelligence, neural networks, and other unique technologies to detect fraudulent users from historical information. This timely identification of fraudulent users will allow us to optimize our existing resources to reduce and control energy losses, resulting in an increase in revenue assurance and a decrease in operating costs.”

And a quote from Juan Carlos Duque – Manager of Energy Transmission and Distribution EPM Group

“The results we are achieving with the use of Revenue Intelligence in EPM Group exceeded our expectations and are even more successful than we considered in the business case. The influence of the system and the project is not only beneficial for the increase of the recovery results, but also in the optimization of the processes to combat losses, as well as the consolidation of a methodology and processes that were developed from the experience of Choice and in conjunction with them.”

	Carlos Mario Galeano, Electrical Engineer and Executive MBA. Director of the non-technical losses management program for the EPM Business Group. He is head of the Control Unit of energy losses for EPM
	Norela Quintero Montoya, systems engineer, specialist in systems and technology management. EPM IT Professional
	Katherine Avendaño, M.Sc in Economics, with extensive experience and knowledge in the fight against non-technical losses of energy, water and gas. Specialist in utilities and Smart meters. She is a project manager at Choice Technologies Colombia and an expert consultant in the application of big data techniques for the detection of non-technical energy losses and analysis of regulatory policies for utilities.
	Rui Mano, Electronic Engineer, experienced in Smart Grids, automation, IoT / SCADA / EMS / DMS systems and analytics for the detection of fraud/theft. Author of articles and lecturer at conferences in LATAM, USA, and EMEA. VP at Choice Technologies. Previously was Managing Director and Principal Consultant of KEMA Brazil and Professor of the Pontifical Catholic University, PUC Rio de Janeiro. Senior Member of IEEE PES, CS and CIS and Member of CIGRE B5.