Aggregating Value in Asset Management: An Approach for Electric Generation and Transmission Utility

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Abstract. An asset management platform is being the object of an R&D project conducted at the Cemig Generation and Transmission (GT) – a Brazilian electricity utility. The platform is being designed with the objective of providing information that supports decisions on a systematic basis, considering asset lifecycle integration and with the purpose of maximizing the value of such assets. The analytical approach is not only intended to support short-term operational actions, but also to provide scenarios that highlight the risks associated with the mature life of the assets most critical to the functions of generation and transmission of electricity. This paper presents an overview of such a project, pointing out the functional architecture and the methodology underlying the proposed solution.

Keywords: Asset Management, Life Cycle Cost, Decision Making, Asset Register, Data Quality.

1 Introduction

One of the major challenges facing capital-intensive companies, with operations in geographically dispersed locations and seeking to derive greater value from their industrial assets, lies in making effective use of data and making less risky decisions in order to better remunerate their business. In addition, the massive generation of decentralized data – collected from different sources and with different protocols – is increasing exponentially, causing insecurity and a certain kind of "paralysis" in decision-making processes. The industry in general already collects a large amount of data and realizes the value it contains; however, many organizations still extract little information from what this data can reveal (cf. [7]).

In the Brazilian electricity sector, companies are experiencing this situation and are not yet taking full advantage of data and information about their industrial assets to gain business insights, reduce risk and extract more value from such assets[1]. Data may be in different formats and stored in nonrelational databases, may be incomplete or have not the quality required for processing and analysis [10, 14], especially to feed models able to estimate future asset behavior and support strategic and operational issues.

An Asset Management system provides a favorable situation to address such issues and support more consistent and informed decisions (see, for example, [3, 11]. To be most efficient, an asset management system must implement a route and processes that ultimately make it possible to establish a close correspondence between the assets' records – the Asset Register – and the accounting records of the assets and their depreciation parameters.

To deploy this type of alignment, decision-makers need to be provided with information obtained from a combination of Asset Management methods, in such a way they have elements to respond the exigencies of relevant scenarios for the business (see, for example, [16]). These elements may provide analytical support to make more assertive decisions and are methodologically obtained from a set of data mining techniques, Artificial Intelligence algorithms, and dynamic tools for simulating scenarios and estimating KPIs (Key Performance Indicators).

An asset management platform is being the object of a project conducted at the Cemig Generation and Transmission (GT) – an electricity utility – within the scope of ANEEL (Brazilian Electricity Regulatory Agency) R&D projects. The central objective of this project (GT0651) is to develop a platform to support an Intelligent and Integrated Asset Management System (SIIGA) operating at Cemig GT, in order to enable assertive decision making about the utility's assets.

The platform is being designed to provide information that supports decisions on a systematic basis, considering asset lifecycle integration (cf. [6]) and with the purpose of maximizing the value of such assets. The analytical approach is not only intended to support short-term operational actions, circumscribed to the daily maintenance of assets, but also to provide scenarios that highlight the risks associated with the mature life of the assets most critical to the generation and transmission functions of an electricity utility. Importantly, the approach is not just about collecting and working on data, but it is mostly decision-oriented, aiming at providing relevant information for decision-makers.

Thus, it is possible to estimate key indicators and design business scenarios that help formulate new investment strategies and asset renewals. Moreover, the platform follows principles of flexibility, allowing to add/change its configuration, according to asset needs, the evolution of regulatory requirements and the utility's business rules.

This paper presents an overview of such a project, pointing out the functional architecture and the methodology underlying the proposed solution.

[1] In the electric power industry, utilities have been using models inefficiently [13]. Even when organizations recognize the need to use big data and analytics, they are reluctant in terms of implementing it [1], or there are situations in which data acquisition and integration process exist but are decoupled from the decision support application [12]. In a survey conducted by International Copper Association [8] with companies from the Latin American electric sector, only 56% consider maintenance costs to anticipate equipment replacement, and for Brazilian companies, the challenge for the coming years is to have more accurate information about the assets.

2 Methodological approach

The solution under development is designed to support the utility in data processing and analysis, aiming at overcoming the obstacles created by an overflow of disconnected data, by inconsistencies or missing data, and thus aligning operational activities with business strategy (line of sight) based on ISO 55000 recommendations. The analytical process is supported by consolidated scenarios and simulations to provide projections and analysis of short, medium and long-term trade-offs, in terms of risk, cost, Capex, Opex, Totex and other techno-economic indicators.

In this project, the guidelines for designing and developing lays on three methodological pillars that together add an innovative character to the solution:

- An integrated and business-oriented approach for Asset Management, going beyond the physical asset management and covering the asset life cycle [4]. In this sense, it is important to be clear that while maintaining the condition of an asset is operationally necessary, this factor differs from the task of extracting value from an asset over its life cycle (cf. [9]).
- The enhancement of models that represent asset behavior, considering failure occurrence probability and the respective impacts on costs. In this aspect, risk monetization associated with an asset plays a relevant role in supporting decision making, representing a more universal figure of merit for visualizing impacts. For example, the benefits of a decision can be assessed by people's willingness to pay for them (cf. [18]) or the severity of the risks may be better sized by the financial dimension arising from an event, providing a communication facility to quantitatively assess risks (cf. [5]). Since risks are monetized, it is possible not only to have a more precise notion about the total cost of a decision, but also ranking the alternatives involved in a decision, in order to concentrate more attention on what is most urgent (cf. [17]).
- The use of computational intelligence to improve the data quality of the asset information system. In such a case, artificial intelligence algorithms are primarily used to tackle inconsistent or incomplete database issues, as well as to estimate non-existent data that are required for analysis specified in the project methodology (see, for example, [2, 14, 15]).

It is important to keep in mind that data collection and transforming are activities related to other steps of the methodological approach to support decisions about assets in their life cycle. Value extraction from assets is a matter of processes and therefore is closer to the information than to the data itself. This is a central point of the analytical approach proposed in this project.

3 Functional architecture overview

Functional components of a preliminary architecture to overcome the challenges faced by Cemig GT concerning engineering Asset Management are depicted in Fig. 1 and described as follows.

The Asset Register has the function of receiving data from Cemig GT data sources, creating and maintaining the asset database. The basic elements of this module are:

- An integrator, that is connected with the Cemig GT systems and databases for data searching, making the necessary transformations for the standardized data model.
- The core, containing regulatory requirements and business rules for generation and transmission.
- Artificial intelligence Algorithms, devoted mainly to data integration and preparation, including estimation of possibly non-existent parameters and improving overall data quality.
- An Adapter to provide data on the specific interface of the Run-time simulation and analysis module.
- A Front-end for data access, maintenance and visualization operations of the Asset Register, by means of API (Application Programming Interface).

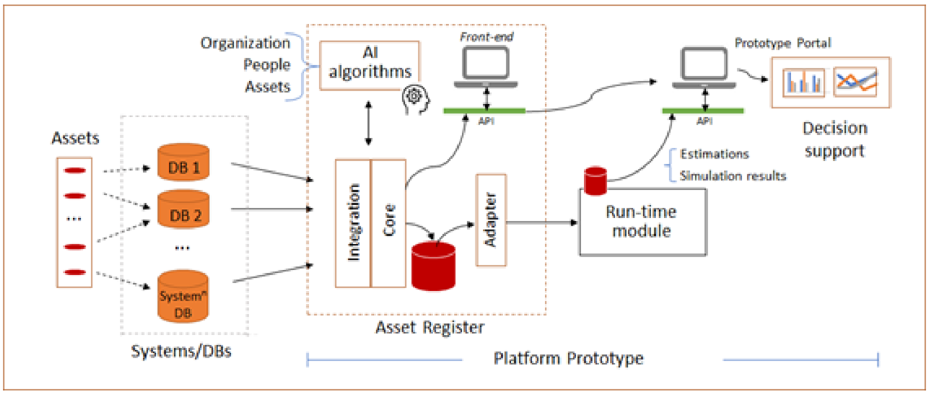

Fig. 1. Functional architecture of the platform.

In this prototype, the Run-time module consists of the AssetsValue® tool – a product by Assetsman – that receives the asset data from the Asset Register database and performs processing tasks to support the Asset Management processes. The results provided by this module are shown both visually and through data that is loaded into a repository.

Conceived as a web portal, the prototype Portal provides query features and a dashboard with results generated by the Run-time module as well as data and information stored in the Asset Register.

The dynamic relationship between these function blocks can be viewed as a Run-time module inserted into a toroid comprising the Asset Register the web portal, relating to the Cemig GT's legacy database that feed Asset Register with asset data (see Fig. 2). The toroidal metaphor is particularly adequate to illustrate the complex imbrications of multidimensionality needed to support more assertive decisions, including the utility's business rules and considering the life cycle cost of the assets.

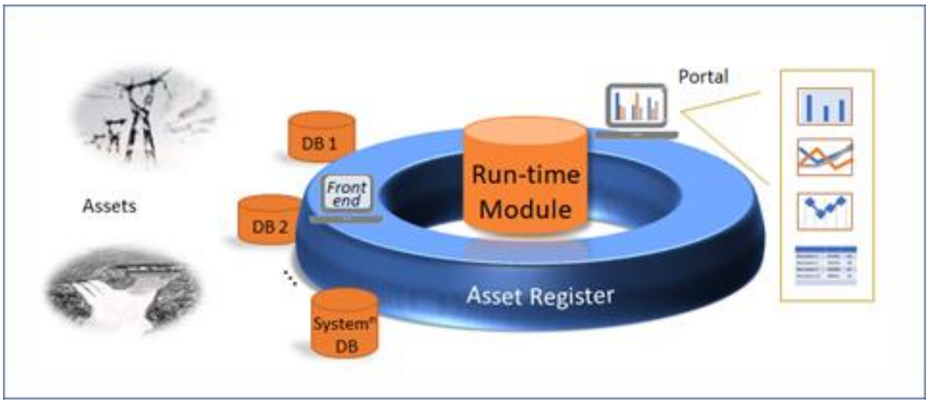

Fig. 2. Modules interrelation in prototype operation.

In short, the prototype will provide: a database in the Asset Register, containing the necessary data for the methodological proposal of Asset Management; modeling of the characteristics and regulatory requirements of the generation and transmission businesses; indicators and analytical models that support the evaluation of indicators and scenarios to support decision making; and visualization, by means of a web portal, of analytical results and asset data.

4 Analyses and result visualization

Based on simulations, multidimensional analysis and historical analysis, the methodology includes elements for assessing the performance, cost and risks associated with the assets, considering, among others, revenue indicators, Capex and Opex. This implies valuing and comparing the costs and risks of alternative solutions against the current solution, seeking to rationalize investment or renewal choices to maximize return on assets, based on Total Cost of Ownership (TCO).

The issue of multidimensionality that permeates the analytical approach is translated into the construction of knowledge about systems and equipment, analyzing different aspects for decision making, among them, asset lifespan, technological life, economic life and regulation. These aspects permeate the asset life cycle, being present in the daily operation of the company and with direct impacts on its businesses and financial performance.

Among the main functionalities, methods and analytical tools provided by the platform are:

- Risk assessment and monetization.
- Scenarios to support the decision-making process.
- Calculation Modules: life cycle oriented.
- Optimization of maintenance interval.
- Clustering: optimization of main stops.

- New investment and renewal strategies.
- Management of policies for parts replacement.
- Capex prioritization and organization of asset investment support.
- Decision-making heuristics based on the use of technological and methodological solutions designed for the project.
- Data elicitation, to fill in historical data gaps and create non-existent data needed to simulate some important decision-making scenarios. Some of these scenarios, by their very nature, are independent of the past, or projections based on similar data are inadequate for the purpose of the analysis. In such cases, the knowledge of experts may be raised based on specific methods, combining multiple experiences and feeding probabilistic models, for instance, in order to increase confidence in the data thus obtained.
- Tools to improve the operational and economic performance of the assets, based on the risk/cost ratio of assets throughout their life cycles.

In terms of aggregating value to the utility's Asset Management, these analytical capabilities enable more refined analysis, generating information for financial performance improvement and strategic alignment, as illustrated in Table 1.

Table 1. Stack of value aggregation.

+ value	*Description*
More alignment	Improvement of Strategic Alignment
Better results	Improvement of Opex and Capex in stages of operation
Eloquent approach	Introduction of simple qualitative methods: lifespan vs. mature life
New trade-offs	Ease of trade-off arbitration: risks vs. costs; Capex *X* Opex
Unfolding KPIs	AM KPI split, eg: Opex/RAV, Capex Sustaining/Opex

It is important to note that the adding value scale depicted in Table 1 starts by splitting indicators and its respective metrics into KPIs able to evaluate more appropriately the organization's businesses in function of possible decisions about the assets. Opex and Capex – standard financial indicators – can provide more business information when combined with other indicators, for example, Replacement Asset Value (RAV) that indicates the financial amount necessary to replace an asset, or Capex Sustaining related to Opex, that in turn support decision-makers to broaden their vision about risks and opportunities. The KPIs thus unfolded allow for more refined trade-offs, such as, maintenance costs vs. replacement investment or risks vs. costs, telling us a measure of the return-on-investment of a decision associated with an asset in its mature life. Continuing this scale of analytical elements, the introduction of qualitative methods adds other perspectives of trade-offs, supporting decisions to obtain better technical and operational results.

The projection of KPI behavior over time provides a dynamic visualization of the asset life cycle cost, in terms of Capex and Opex, including all relevant phases, from designing and deployment up to operation and disposal. Are equally significant some graphs relating maintenance cost, cost of failures and income loss (loss profit), among other analytical tools to input the dashboard of the Prototype Portal. Importantly, in the electricity sector, an asset failure can jeopardize performance or interrupt service provision, resulting in regulatory penalties, in addition to the loss of revenue.

Furthermore, the identification of points for continuous improvement of the operational processes covered by the platform is contemplated, based on tools for analyzing the effectiveness of actions taken by the “decision-making” system. It is important that the utilization of such tools as well as feedback of analysis results be done iteratively, as continued reevaluation. In this regard, the focus remains on improving service quality, in the asset lifecycle view and in extracting maximum return from assets.

5 Final remarks and next steps

In this paper, the objective was to present the design of a platform to support an Intelligent and Integrated Asset Management System (SIIGA) for Cemig GT, in order to enable assertive decision making about its assets, providing integrated information to maximize value extraction from assets in their life cycle.

The methodology includes information management models that allow capturing, retaining and delivering data with quality. The whole approach is oriented to improve Cemig GT Asset Management, going beyond physical asset maintenance management and extending the view throughout the asset lifecycle. Risks related to assets are monetized, featuring an aspect of innovation that homogenizes risk visions for decision-makers and adds value to the decision process. As one can note, even with R&D efforts to improve data quality, this methodology approach focuses substantially on analytical processes to extract value from assets, featuring more a decision-oriented approach than a data-oriented one.

The prototype is being designed following scalability and flexibility principles, with the intention of adapting to the company's growth and allowing the integration of new assets and emerging technologies (for example, electric mobility and photovoltaic distributed generation). Besides, it is aligned with the governance model of Cemig GT.

With this project presentation, even in its initial phase, it is expected to provide information about Asset Management solutions and contribute to other projects that share similar goals, in the electricity sector mainly, but not disregarding the possibility of applications in other sectors seeking to add value to their management processes.

The project’s kick-off took place in February 2019 and the R&D schedule is expected to last 24 months. Currently, it is in the development phase of the Asset Register, having gone through the early stages of an R&D methodology, as customer requirements survey, benchmarking and state of the art survey, knowledge of the company's existing legacy, gap identification and solution proposal. With the project moving forward, the results to be achieved – including proof of concept of technological and methodological innovation factors adopted – will be reported in future papers.

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