CASE STUDY

Optimization of inspection and maintenance works for an important gas utility

PROJECT SUMMARY

Using advanced stochastic combinatorial modeling techniques, develop a risk-based inspection and maintenance schedule for the local natural gas distribution system to optimize work and reduce workload, while meeting regulatory requirements and maintaining risk at the desired level.

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- 1.4 million clients
- 3,259 km of local network
- 130,000 segments (pipes)

"The risk framework developed made it possible to establish an optimal risk-based inspection and maintenance schedule for the local natural gas distribution network that could be justified to the regulatory entities."

BACKGROUND

- Every year, significant amounts were spent to inspect, maintain and ensure the sustainability of the natural gas distribution network.
- The network was partly made of new generation polyethylene pipes with a long service life. However, the majority of the network still consisted of original steel and cast-iron pipes, which would have to be replaced in the medium term.
- Until recently, all elements of the network were inspected annually, regardless of their condition and level of risk.
- The regulator allows gas utilities to reduce the frequency of inspection of system components, provided they can demonstrate that the risk is under control. It is therefore possible for gas utilities to switch from a preventive management mode (time-based) to a predictive management mode (risk-based).
- First generation steel and cast-iron pipes had to continue to be inspected every year because of the risks involved. However, these new rules are applicable to second generation polyethylene pipes.

RESULTS

- Configuration of various network evolution scenarios and simulation of all network components over short-, medium- and long-term horizons, efficiently and without any line of code.
- Extraction of the list of pipes to be replaced which, according to the applicable constraints, have the highest probability of having the best return on investment, while maintaining the risk at the desired level.
- Better management of manpower needs through an annual inspection and maintenance plan and a medium- and long-term strategic vision.
- Demonstrate in a transparent manner the short, medium and long-term impacts on resources, risks and service levels.
- Justification to the regulator of the strategy that reduces the workload while adequately managing the risk and complying with all applicable rules.
- Consolidation of internal expertise by centralizing the knowledge base within a single platform and development of an easy-to-use, transparent and flexible solution that met the company's objective.

CHALLENGES

- Creating a framework to quantify the risk associated with each individual pipe.
- Adhering to and respecting all rules and regulations in place.
- Developing an asset-centric model, allowing the level of risk to evolve over time according to relevant factors (age, material, location, installation type, population density, etc.).
- Considering the replacement program in place, which consisted of replacing iron pipes with polyethylene pipes, in order to quantify the impact of changing old, risky materials to newer, safer materials.
- Prioritizing pipe replacement work optimally in order to strike a balance between reducing inspection work and managing the risk associated with the natural aging of the system.

KEY REQUIREMENTS

- This gas utility company needed help to develop a risk framework that complied with the highest industry standards and to maintain it adequately to ensure its sustainability.
- Because of the large number of pipes and the need to consider each pipe's full lifecycle in order to integrate the original iron pipe replacement program, the use of Excel was no longer sufficient.
- The use of advanced modeling tools such as MATLAB and Python would prevent the reliable operationalization of inspection recommendations, and the model would eventually prove difficult to maintain as requirements evolved, especially when considering the lack of documentation, the difficulty in modifying rules, and the risk of departure of key staff with knowledge of the source code.

OUR SOLUTION

- A complete segmentation of the network into asset classes was carried out and each asset class was modeled individually, without programming. The simple drag-and-drop functionalities ensured the maintenance and sustainability of the solution.
- A risk model based on ISO 55000 principles was developed to quantify the risk of each pipe according to various factors such as age, material, type of installation (underground, above ground), type of connection (distributor, manifold, etc.), population density, pressure, diameter, breakage history, etc..
- The frequency of inspections was determined according to risk and the rules in force, with a maximum interval of three years (low risk). The frequency of inspection for each pipe may increase more or less rapidly depending on the age of the pipe and other factors.
- Integrating the risk model within the solution allowed for the quantification of each asset's risk and the tracking of inspection frequency over time. Since the inspections were dynamic, it was possible to test the impact of various strategies over the short, medium and long term.
- All interdependencies between network components were modeled, making it possible to calculate risk dynamically while considering the impacts of replacement interventions carried out on the network. For example, the natural aging effect of the system (resulting in increased inspections) is offset by the replacement effect of existing pipes (resulting in decreased inspections).