PREDICTIVE MAINTENANCE
NTT DATA & IE SUSTAINABILITY

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Introduction

Gas pipeline leaks pose significant financial risks to the companies responsible for them due to lost revenue from leaked gas costs, major repair costs, compensations to affected communities, fines and penalties, and litigation costs. Besides that, we can see that they result in a significant reputational impact on the company, leading to a decrease in demand, customers churn and a drastic decrease in revenue. (PG&E, California, 2010)

Beyond the immediate business impacts, gas pipeline leaks also have significant environmental and sustainability implications. Gas emission into the environment contributes to the release of methane for example into the air, which harms people's health. According to a study by the Pipeline and Hazardous Materials Safety Administration, pipeline accidents resulted in $6.6 billion in damages between 2010 and 2019 in the United States.

As a consequence to the environmental impacts, the case of the SolGasCal leak in 2015 that released 500,000 metric tons of Methane for example led to a lawsuit by the California State that resulted in a $119.5 million law settlement. Thus, this shows huge regulatory and fine implications resulting from the environmental impacts that gas companies could risk.

According to a study by the Center for Climate and Energy Solutions found that companies with some sustainability efforts tend to outperform their peers in terms of financial performance, suggesting that addressing sustainability issues such as gas pipeline leaks can have a positive impact on the company's reputation.

Value Proposition

To address the challenge posed, we built a product exclusively designed to align with the company needs to predict gas pipe leaks, and provide an optimal inspection strategy by prioritising pipe leaks and by using optimal routes for inspection in terms of town proximity. In other terms, we used the power of machine learning models and decisional optimization algorithms to offer a product that optimises inspection routes by importance of gas pipe leaks.

Consequently, we minimise many costs that would potentially cause major financial, reputational, safety, regulatory, and environmental risks to the gas company. Our product will contribute to a guaranteed customer satisfaction and trust, minimal revenue losses and a great impact on the environment through reducing the carbon footprint and avoiding catastrophes.

Additionally, our product also contains a user friendly platform powered with a highly accurate predictive maintenance model that allows mechanical and operation engineers to have a look at potential pipe leaks with specific probabilities, but to most importantly utilise the tool for an optimised and effective scheduling of inspections that take into account geographical constraints and the size of the gas pipes. You can find our proposed platform here: nttbayesgenes.com

Comparison between the current inspection strategy of the company and the BayesGenes proposed strategy using predictive maintenance modelling

The Bayes Genes inspection strategy powered up with its pipe leakage detection model whose accuracy is reasonably high brings significant value in reducing gas leakage volume costs , and repairing costs. Along with the optimization decision model, the inspection strategy also reduces the costs in terms of logistic costs. Furthermore, the BG strategy has a positive impact on sustainability metrics, contributing to a reduction in our carbon footprint and minimising the risk of environmental catastrophes.

The performance of the BayesGenes inspection strategy is proved with the following KPIs:

Gas Leakage Volume Costs (in Million £)

As seen below, the Bayes Genes Strategy reduced the Volume Gas Leakage each year significantly. In fact between the years 2010-2020, the current strategy caused a loss of 64 Million Euros, while our strategy reduced that loss to 59 Millions euros , a significant decrease of 8%, and that is solely related to the volume of the gas leaked.

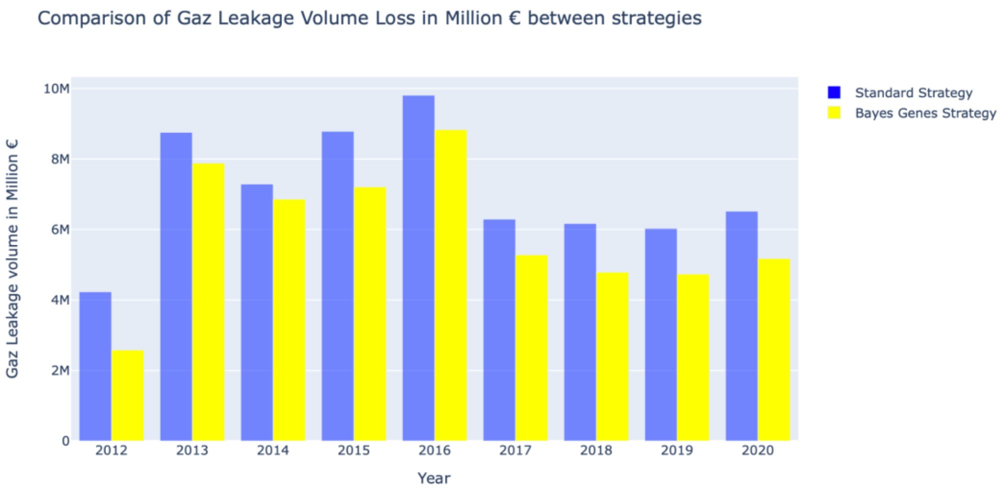

Figure (1) : Comparison of Gas Leakage Volume in Million Euros between the two strategies.

Additionally, in terms of environmental and sustainability implications, the Bayes Genes Strategy designed the inspection routes for the gas pipe leaks in a way that reduces the Carbon Footprint emitted in the air by 74 metric tons of CO2. As the EU regulations penalise exceeding certain limits of carbon footprints, and since our model provides insights in order to be able to make sure not to exceed those limits, the company would be able to get access to more allowances.

Leakage Pipe Repairing Costs

The longer the leakage persists, the more damage it has on the pipe. Additionally, the leak shape and size grows as long as the leak is happening, the material thickness worsens even more, and therefore repairing the pipe at an early stage reduces the repairing costs.

As seen below, the BG strategy reduces the pipe repair costs throughout the years significantly. In fact between the years 2010-2020, the standard strategy caused repairing costs estimated at 6.4 millions euros, while the BG strategy reduced it to 6 millions euros.

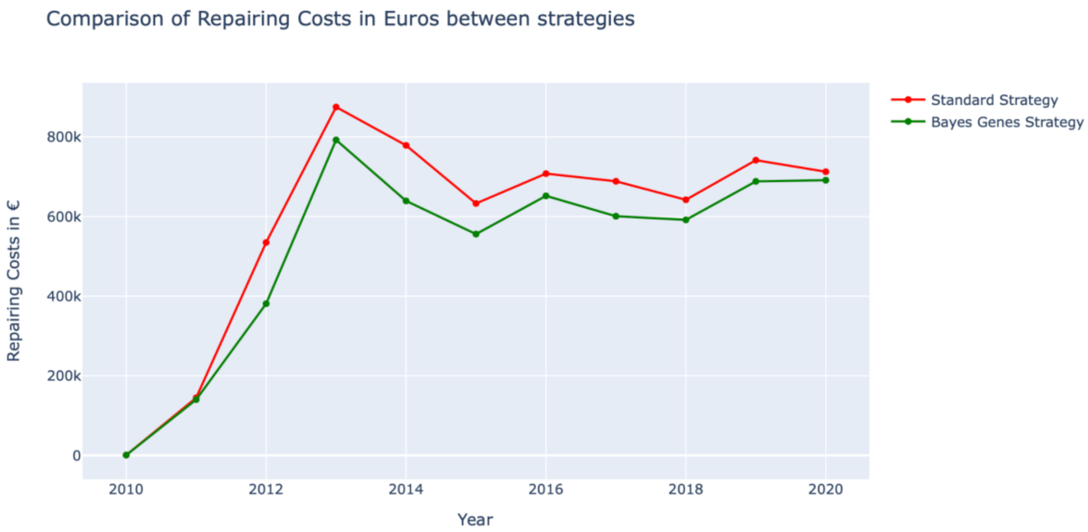

Figure (2): Comparison of Leakage Repairing costs in Euros between strategies.

Carbon Footprint Impact

The plot below shows a big decrease in the Carbon Footprint with our proposed BG inspection strategy, especially in years 2015-2016.

Figure (3): Comparison of Carbon Footprint in Euros between the two strategies

Note: The details on the inspection strategy and metrics can be found in the indexed file BGinspectionstrategy.ipynb.

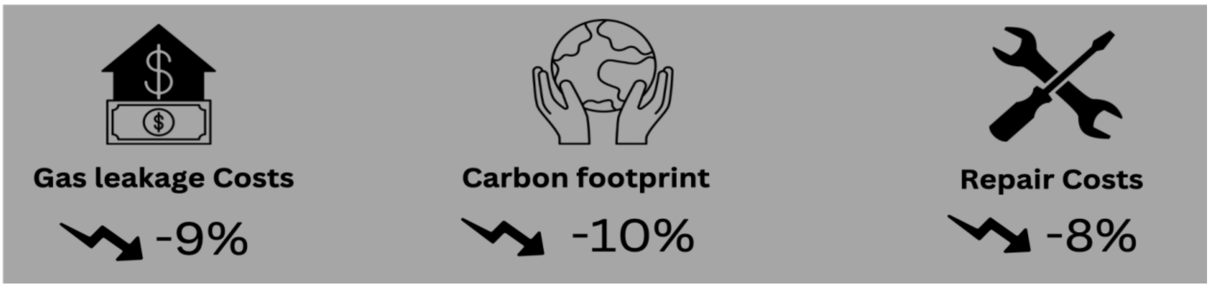

Figure (4): Overall BayesGenes Strategy Impact

Methodology:

To develop the BayesGenes inspection strategy, the use of a combination of machine learning models and decisional optimization algorithms was utilised. Specifically, we used historical data on gas pipeline leaks, including their location, size, and length to train our predictive maintenance model. We then used this model to predict the likelihood of future leaks and prioritise inspection routes based on the potential risk and impact of leaks.

To optimise the inspection routes, we used decisional optimization algorithms to find the most efficient and effective routes based on several factors, including the size and length of the gas pipes, the proximity of towns and communities, and logistical constraints such as road conditions and traffic.

To evaluate the performance of the BayesGenes inspection strategy, we compared it to the current inspection strategy of the gas company. We collected data on gas leakage volume costs and repairing costs for both strategies for the years 2010 to 2020, and compared the results. We also calculated the carbon footprint reduction achieved by the BayesGenes inspection strategy and its potential impact on the company's sustainability metrics.

Note that the inspection strategy presented in this report can be further optimised with more data and insights, and we encourage experts to review the information and metrics presented in the indexed file inspectionstrategy.ipynb.

Our product is highly scalable and designed to provide an optimal inspection strategy to gas companies of all sizes. The product is available through our platform, which can be accessed by gas companies using their credentials. The platform is user-friendly and provides a dashboard for close inspection of the data and the model's predictions in real time.

Our platform is designed to handle large amounts of data, which allows for accurate and efficient predictions. Additionally, the platform is designed to be flexible, allowing gas companies to adjust the inspection strategy as needed. This scalability ensures that our product can meet the needs of any gas company, regardless of their size or specific requirements.

Overall, the ease of scalability of our product is one of its key strengths, allowing gas companies to access the platform and obtain an optimal inspection strategy quickly and easily. This saves time and resources, ensuring that gas companies can focus on their core business activities while minimising the risks associated with gas pipeline leaks.

Conclusion:

In short, the gas pipeline leaks pose significant financial, reputational, regulatory, safety, and environmental risks associated with gas companies, to the people and to governments. The BayesGenes inspection strategy uses a hypertuned pipe leakage detection model and decisional optimization algorithms to offer an optimal inspection route which minimises costs associated with lost revenue from leaked gas, major repair costs, compensations to affected communities, fines and penalties, and litigation costs.

The BayesGenes inspection strategy has major positive environmental impacts, as it reduces the carbon footprint considerably and minimises the risk of catastrophes that could impact the safety of the people, the environment, and other creatures. By addressing sustainability issues such as gas pipeline leaks using the BayesGenes inspection strategy companies guarantee customer trust, avoid churn and differentiate themselves in the market. Providing such value in the marketplace creates an important competitive advantage especially with the rise of sustainability initiatives and regulatory sanctions in the space for the smallest mistakes in this sense.

However, there are many limitations associated with our model and strategy. The first one has to do with the quality of data provided and used to assess the risk of leakage of the pipes. Secondly, the investment cost needed for accurate data collection, like sensors and other infrastructure. Another aspect related to the optimization of inspection routes is practical, as some inspections may not be carried out as quickly. So we could recommend increasing the resources for inspections.