Swire Coca-Cola - Predictive Maintenance

Problem Statement

Swire Coca-Cola faces significant downtime in its production plants, leading to an annual loss of approximately $60 million. These downtimes are largely unplanned and occur due to unforeseen mechanical issues, wear and tear, or equipment failures. While the company tracks breakdowns via the Internal Warehouse Controller (IWC) system, many of these failures occur unpredictably, severely impacting productivity. The goal is to develop a predictive maintenance model that can anticipate failures, understand the underlying causes, and mitigate the downtime through advanced planning, timely parts procurement, and optimized production strategies. By proactively addressing these issues, Swire Coca-Cola aims to minimize downtime, reduce unplanned maintenance costs, and improve overall operational efficiency.

Objective

The primary objective of this project is to build a predictive maintenance system that can:

- Predict when a machine is likely to fail.
- Identify which machine parts are most frequently involved in breakdowns.
- Quantify the impact of these failures on production time and cost.
- Help optimize machine usage and maintenance schedules to prevent costly downtimes.

This predictive model will help Swire Coca-Cola anticipate equipment issues and plan accordingly, reducing unplanned maintenance and associated costs, while maximizing machine uptime and production capacity.

Success Metrics

The success of the project will be evaluated based on the following metrics:

- **Prediction Accuracy**: The model's ability to accurately predict when and why a machine will fail, based on historical IWC data.
- **Reduction in Downtime**: A measurable reduction in unplanned downtime due to better forecasting and proactive maintenance.
- **Cost Savings**: The ability to predict downtime early enough to reduce the opportunity cost by improving overall machine uptime.
- **Improved Efficiency**: Optimization of maintenance schedules, parts inventory, and production planning to minimize machine downtime.
- **User Adoption**: The ease with which plant supervisors and maintenance teams can adopt and use the predictive maintenance system for decision-making.

Analytical Approach

To tackle this problem, we will apply a combination of statistical analysis and machine learning techniques. Our approach will involve:

- **Data Exploration and Preprocessing**
  - Analyze IWC data for patterns in downtime occurrences, machine failure types, and frequency.
  - Cleanse the dataset, handling missing values, inconsistencies, and outliers.
- **Feature Engineering**
  - Extract features from machine descriptions, timestamps, maintenance activity types, and functional locations.
  - Identify key indicators that could predict breakdowns, such as wear and tear, machine age, and maintenance history.
- **Model Selection**
  - Experiment with various predictive modeling techniques such as classification models (e.g., Random Forest, SVM) and regression models (e.g., Linear Regression, Time Series Forecasting).
  - Use time-series analysis for identifying recurring failure patterns and machine life-cycle trends.
- **Model Training and Validation**
  - Train the model on historical data and validate its performance using cross-validation.
  - Measure the model's accuracy, precision, recall, and F1-score to assess prediction quality.
- **Predictive Maintenance Pipeline**
  - Develop a pipeline that integrates predictive models with existing systems to forecast failures and optimize maintenance schedules.
  - Provide actionable insights regarding inventory and parts management.
- **Dashboard Development**
  - Design an intuitive dashboard for plant supervisors and management, presenting predictive insights on machine health, upcoming failures, and cost savings.
  - Include visualizations for downtime impact, maintenance history, and the predicted time-to-failure for each machine

Scope

The project will focus on the following areas:

- **Data Integration:** Use the IWC data to build a comprehensive understanding of breakdowns, maintenance types, machine life cycles, and downtime impacts across Swire Coca-Cola plants.
- **Predictive Model Development:** Build models capable of forecasting failures, identifying patterns, and suggesting preventative actions.
- **Optimization:** Provide recommendations for inventory management (spare parts) and machine usage scheduling to minimize downtime.
- **User Interface:** Develop a dashboard to communicate key insights and predictions to the plant supervisors and production teams.

The scope of the project will exclude the direct implementation of the predictive system into operational workflows. The deliverables will focus on model development, insights, and user-friendly visualizations for decision-makers.

Team and Timeline

This project will be executed by **Anish Khairnar, Ankuramol Chitnis, Kritika Mahna, Sambit Pani and Sakshi Pandey**. The project is expected to be completed within **eleven weeks**. Key milestones include:

- **Business Problem Statement Delivery: September 15, 2024:** Deliver a clear problem statement and define the key business challenges to be addressed.
- **Data Cleaning and Exploratory Analysis: October 02, 2024:** Clean and preprocess the dataset, and conduct initial exploratory data analysis to identify patterns and insights.
- **Model Development and Validation: October 30, 2024:** Build, train, and validate the predictive model to forecast key customer indicators.
- **Final Presentation and Handover: November 20, 2024:** Present the final model and results, and hand over all deliverables to Swire Coca-Cola for implementation.