Data Analytics

Assessing Risk of Extreme Weather on Facilities Maintenance

Explore how data analytics reveals the impact of climate change on Hamilton's buildings. This project uses machine learning to analyze climate factors like freeze-thaw cycles and precipitation, predicting their effect on maintenance costs. Dive into the findings to uncover strategies for resilient, climate-adaptive infrastructure.

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Project Objective

To evaluate the impact of climate change on building maintenance costs in Hamilton, Ontario, focusing on the Facility Condition Index (FCI).

Final Deliverable

A comprehensive poster summarizing findings, analysis, and methodology.

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Problem Statement

- **Climate Challenge**: Climate change is driving an increase in extreme weather events, posing risks to building safety, infrastructure integrity, and community well-being.
- **Current Shortcomings**: Existing building codes are based on historical climate data, which may no longer be adequate to ensure safety and resilience against future climate conditions.
- **Key Question**: How can Hamilton adapt its maintenance strategies to address the risks of extreme weather and ensure long-term infrastructure sustainability?

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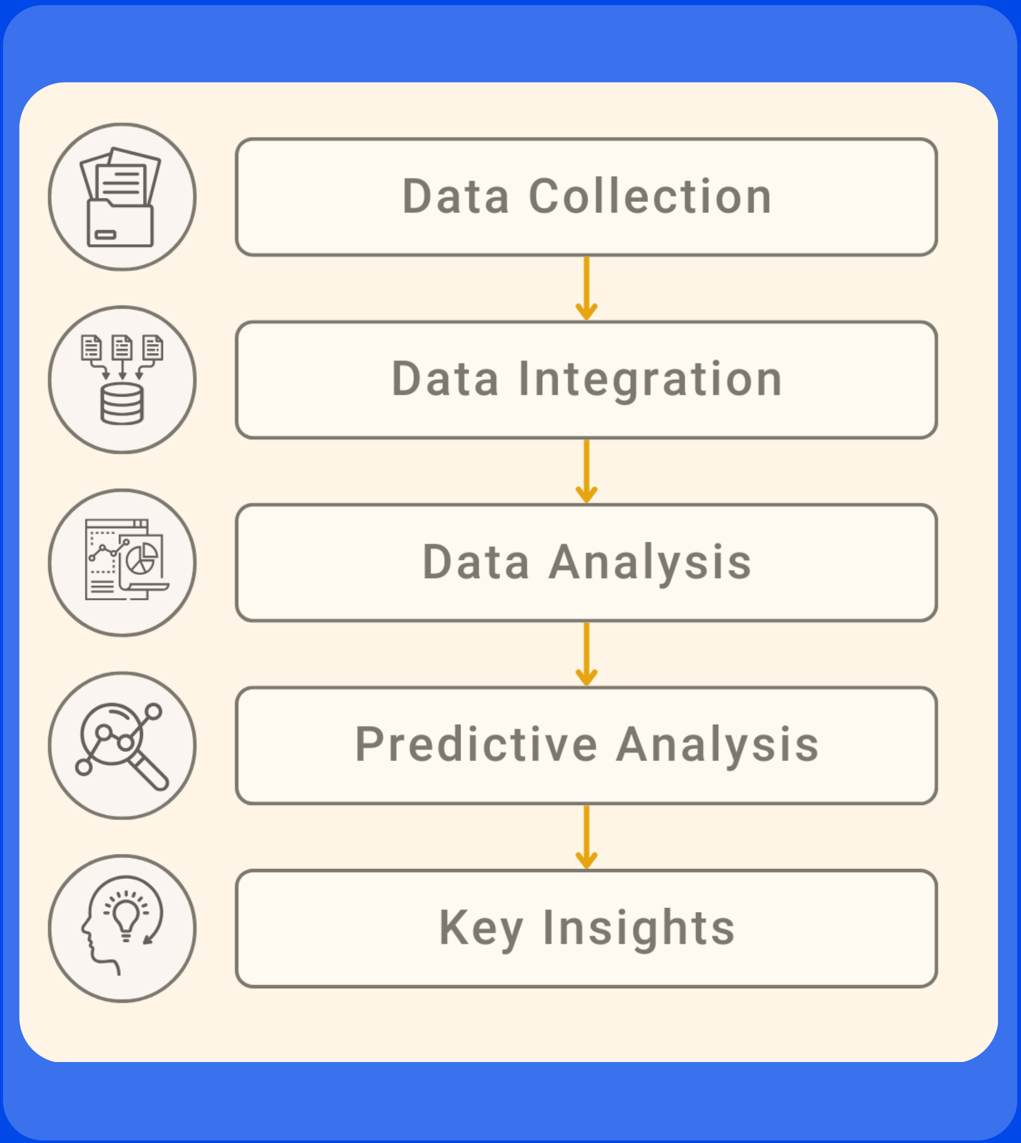

Methodology

- **Data Collection:**
  - **Climate Data:** Extracted from climate.ca, offering high-resolution historical and predictive weather data.
  - **Building Data:** Provided by the City of Hamilton, including facility information, FCI, and current replacement value (CRV).
- **Data Integration:**
  - Derived geospatial coordinates for buildings using Python libraries.
  - Merged climate data with building information based on geographic proximity.
- **Data Analysis Tools:**
  - Machine learning models (XGBoost) for predictive analysis.
  - SPSS for correlation studies.
- **Predictive Modeling:**
  - Assessed the impact of key climate variables (e.g., freeze-thaw cycles, precipitation, Humidex) on FCI trends over an 8-year horizon.

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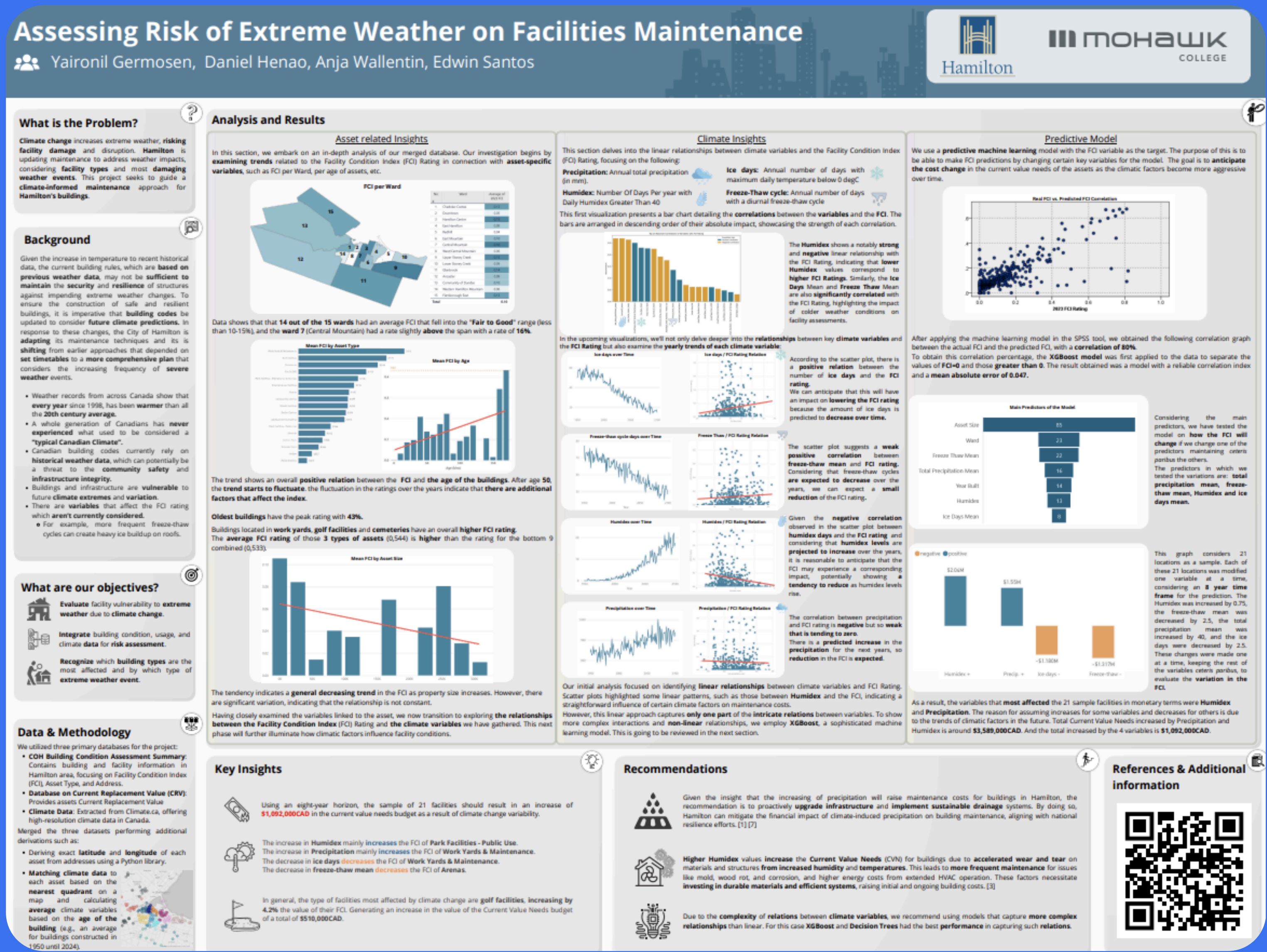
Final Result



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Conclusions

- **Integration of Diverse Data Sources:** Successfully merged building data, climate variables, and geospatial information to create a comprehensive dataset, enabling detailed analysis of the Facility Condition Index (FCI) across Hamilton’s facilities.
- **Key Climate Drivers Identified:** Analytics revealed that factors like freeze-thaw cycles, Humidex levels, and precipitation have measurable impacts on FCI ratings, with Humidex and precipitation emerging as the most significant predictors of increased maintenance costs.
- **Predictive Model Insights:** The XGBoost model demonstrated an 80% correlation between predicted and actual FCI values, providing reliable forecasts for future maintenance needs. This validates the use of machine learning in understanding complex relationships between climate variables and infrastructure deterioration.
- **Data-Driven Decision Support:** The predictive model quantified the financial impact of climate variability, projecting over $1M CAD in added maintenance costs for 21 sampled facilities over eight years. These insights offer valuable guidance for proactive budget planning and resource allocation.
- **Complex Relationships Unveiled:** Beyond linear correlations, the analysis captured non-linear interactions between variables, emphasizing the need for advanced modeling techniques to fully understand and predict climate impacts on infrastructure.

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