APS Failure and Operational Data for Scania Trucks Analysis

I ran several classifier models where each False Negative was penalized at $500 as it was a critical missed failure and for each False Positive, it was penalized at only $10 since it was considered an unnecessary inspection.

I used Logistic Regression, Random Forest and XGBoost utilizing class weighting and SMOTE oversampling to balance our classes.

These are the following results:

Logistic Regression (with weightings)

Metric	**Without SMOTE**	**With smote**
Validation Cost	12,610	11,020
Test Cost	21,590	21,110
Recall	0.91	0.92
ROC AUC	0.94	0.96

Despite being a simple linear model, Logistic Regression performed well seeing the SMOTE technique improve performance by reducing false positives and false negatives overall, reducing cost and preserving our recall.

Random Forest

Type	**Validation Cost**	**Test Cost**	**Recall**	**ROC AUC**
No weighting	29,150	59,670	0.71	0.99
With weighting	39, 650	82,660	0.60	0.99
With SMOTE	17,350	32,340	0.83	0.99

Interestingly, adding class weighting really hurt the performance of the RF model seeing an increase in false negatives thus reducing our recall. However, after applying SMOTE, I saw a significant increase in recall up to 0.83 while also reducing validation cost. SMOTE definitely helped the model better learn from critical failure cases.

XGBoost

Type	Validation Cost	Test Cost	Recall	ROC AUC
No weighting	22,710	40,150	0.78	0.99
With weighting	17,940	34,960	0.82	0.99
With SMOTE	17,030	31,120	0.83	0.99

All the XGBoost models performed well but again, the SMOTE model slightly outperformed class weighting in terms of total cost for validation and test. I also saw an increase in recall while maintaining precision and ROC AUC.

Conclusion

- SMOTE consistently improved the result across all models, especially Random Forest.
- XGBoost+SMOTE achieved the lowest test cost at $31,120 with an AUC of 0.99 and recall of 0.83.
- Random Forest+SMOTE also showed strong performance with a validation cost of $17,350 and a test cost of $32,340
- When I started, I thought class weighting would be sufficient enough but once I noticed it actually worsened performance with increases in recall and false negatives, I knew I had to try another technique like SMOTE to see if there was a significant difference.

Future Considerations

- Incorporate feature engineering and better feature selection with SMOTE and run cross validation to see if model performance improves.
- Also, for the tree based model, we could try adjusting the decision threshold to see if we can reduce false negatives.