

Predictive to Prescriptive Analytics for Employee Attrition in Complex Workplace Systems

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Abstract

Employee attrition is one of the most perilous threats for any organization since it affects the stability of the employee base. Even though research has been done comprehensively by applying Machine Learning (ML) algorithms for employee attrition prediction tasks, most of which have been centered on prediction for accuracy instead of contribution towards decision-making tasks for Human Resource departments, especially if the classes are imbalanced. This study proposes a predictive-prescriptive workplace analytics framework that reframes employee attrition as a decision-support problem rather than a purely classification task. Using the IBM HR Analytics Employee Attrition dataset, baseline ML models Logistic Regression (LR), Decision Tree (DT) and Random Forest (RF) are evaluated under imbalanced conditions and subsequently enhanced using the Synthetic Minority Oversampling Technique (SMOTE). Model evaluation prioritizes recall and false-negative reduction to reflect decision risk associated with missed attrition cases. Experimental results demonstrate that although baseline models achieve high accuracy, they fail to detect attrition cases arising from severe class imbalance class distribution. After applying SMOTE recall improves across all models that enhancing the identification of at-risk employees despite moderate predictive discrimination as reflected by ROC-AUC values near the random baseline. To enhance usability these probabilities are categorized as low risk, medium risk and high risk and these are aligned with human resource prescriptions. It has been indicated that value for an organization may be derived from a combination of imbalance awareness in prediction modeling with prescriptive analytics for human resource action in an environment that is uncertain in nature.

Extended Abstract

Motivation. Employee attrition [1] remains a major challenge to organizational bodies owing to its impact on organizational productivity and organizational knowledge retention. With enhanced organizational use of data analytics within human resource departments and machine learning-based methods of employee attrition analysis are increasingly being cited as an organizational tool of forecasting employee attrition [2]. Despite this complexity and advancement of the most research in this subject remains inclined to use employee attrition as a prediction task [3].

The motivation for this study arises from the mismatch between commonly used predictive evaluation metrics and real organizational decision priorities. This study addresses

this gap [4] by reframing employee attrition as a decision-support problem within complex workplace systems, rather than merely a classification task.

Such an integrated predictive–prescriptive approach aligns closely with the principles of computational social science and complex systems research.

Approach and Methodology. This proposed study aims to develop a Predictive-Prescriptive Workplace Analytics solution to re-formulate employee turnover analysis into a decision support problem. The framework explicitly handles class imbalance using SMOTE and evaluates models from a decision-oriented perspective that prioritizes recall. Instead of relying on binary outcomes that predicted attrition probabilities are used to segment employees into low, medium and high-risk categories are systematically associated with ordered HR initiatives. This study aims to improve practical usability of attrition analytics by integrating predictive outputs with managerial decision needs.

Results. This study confirms that the problem of analyzing Employee Attrition is a decision support problem as opposed to being purely a prediction problem. Baseline models approach the accurate results on this class imbalance problem, but the models are unable to identify instances of high false negative risk of attrition. Accurate results are approached by baseline models on this class imbalance problem. However, the models are not capable of identifying instances of high false negative risk of attrition [5]. When applying SMOTE recall improves all models that demonstrating better identification of at-risk employees despite only marginal changes in ROC–AUC. This highlights the trade-off between predictive accuracy and decision relevance where minimizing missed attrition cases is more critical for HR decision-making.

Conclusions and Outlook. In conclusion, this study introduces a predictive-prescriptive framework for workplace analytics that reframes employee attrition as a critical decision-support challenge in complex organizational systems. By applying machine learning models enhanced with SMOTE on the IBM HR Analytics dataset and prioritizing recall to minimize high-impact false negatives, the approach overcomes the limitations of accuracy-focused classification, which often fails to detect at-risk employees. This shift toward error-sensitive, actionable insights strengthens organizational resilience, enables proactive retention strategies, and highlights the value of complexity-aware analytics in addressing emergent social and human resource dynamics in modern workplaces.

References

- [1] Gamba, D., Yu, Y., Yuan, Y., Schoenebeck, G., & Romero, D. M. (2024, May). Exit ripple effects: Understanding the disruption of socialization networks following employee departures. In *Proceedings of the ACM Web Conference 2024* (pp. 211-222).
- [2] Hajra H, Jayalakshmi G (2025) Evaluating the Impact of Employee Attrition on Organizational Performance Through MIS Analytics. In: *Multidisciplinary Approaches to AI, Data, and Innovation for a Smarter World*. IGI Global Scientific Publishing, pp 87–110
- [3] Shukla S, Rishiraj A, Lucas Y (2023) Data: An Anchor for Decision-Making to Build the Future Workforce Management System. In: *Designing Workforce Management Systems for Industry 4.0*. CRC Press, pp 65–84
- [4] Younis, S., Ahsan, A., & Chatteur, F. M. (2023). An employee retention model using organizational network analysis for voluntary turnover. *Social Network Analysis and Mining*, 13(1), 28.
- [5] Li, Q., Lourie, B., Nekrasov, A., & Shevlin, T. (2022). Employee turnover and firm performance: Large-sample archival evidence. *Management Science*, 68(8), 5667-5683.