Understanding Workforce Dynamics: An Integrated Approach Using Demographic Analysis, HR Metrics, and Survival Analysis

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Abstract
This study analyzes the demographic distribution and key HR metrics of 190 employees using systematic data collection, categorization, and analysis. The methodology identifies patterns in relationships between demographic factors and job roles, such as younger employees in entry-level positions and mid-level roles among the 25-34 age group. A correlation analysis explores the relationships between demographic attributes and critical HR metrics like job satisfaction, turnover rates, and productivity. The analysis reveals weak correlations, suggesting a need for further investigation or additional data. Comparative analysis benchmarks these HR metrics against industry standards, providing insights into areas for improvement. An employee engagement analysis and root cause analysis are performed to understand factors affecting HR metrics, identify key drivers of engagement and satisfaction, and uncover underlying issues. Strategic recommendations are developed, including initiatives to improve job satisfaction, reduce turnover, and enhance employee engagement. Cluster stability is assessed using K-Means clustering, Bootstrap Analysis, and Silhouette Analysis. Survival analysis techniques, such as Kaplan-Meier estimation and Cox Proportional Hazards modeling, are applied to study employee retention and promotion timing. The findings inform strategic HR decisions and highlight areas for improvement in managing workforce dynamics.

Introduction

Understanding workforce dynamics is critical for organizations aiming to optimize human resource management and strategic planning. Workforce dynamics refer to the patterns and trends in employment, employee behavior, and the flow of people within and out of an organization over time. An integrated approach to analyzing these dynamics involves combining demographic analysis, HR metrics, and survival analysis. Demographic analysis offers insights into the composition of the workforce, such as age, gender, and diversity, which influence employee behavior and organizational outcomes. HR metrics, including turnover rates, employee satisfaction, and productivity levels, provide quantifiable measures that reflect the health of the workforce. Survival analysis, a statistical method traditionally used in biomedical research, is increasingly applied to HR to model employee tenure and predict factors influencing retention and attrition. By integrating these methodologies, organizations can gain a holistic understanding of workforce dynamics, enabling data-driven decision-making that aligns with long-term strategic goals.

Demographic analysis is crucial to workforce dynamics, according to recent studies. McGuire et al. (2022) note that age diversity boosts innovation but requires conflict management. Gender diversity improves team performance, but equitable representation is difficult (Smith & Jones, 2021). HR metrics quantify workforce dynamics, with turnover rates indicating organizational stability. Employee engagement reduces turnover, so Johnson et al. (2020) recommends improving job satisfaction to retain talent. Nguyen and Roberts (2019) used survival analysis to predict employee attrition and identify critical periods where intervention could significantly reduce turnover. Researchers can create a framework that describes workforce dynamics and informs effective management strategies by integrating these diverse methodologies. In recent years, demographic analysis, HR metrics, and survival analysis have gained popularity as ways to understand employee behavior and organizational performance. Demographic analysis shows how age, gender, ethnicity, and education affect employee experiences and outcomes. Harrison and Klein (2020) found that educational diversity in teams improves problem-solving but may increase misunderstandings. Okun and Reeve (2021) showed that workforce aging presents both

opportunities and challenges, with older workers often contributing valuable experience but potentially facing age-related bias and health issues that reduce productivity. Quantifiable HR metrics are essential for workforce analysis and management. Absenteeism, turnover, and employee satisfaction are good indicators of organizational health. High turnover rates often indicate organizational issues like poor management or career development, according to Becker and Huselid (2021). HR professionals must monitor employee satisfaction because it predicts turnover and organizational performance, according to Groysberg and Abrahams (2022). Survival analysis, originally developed for biomedical research, does well in HR studies to model employee tenure and predict attrition. Survival analysis helps organizations identify retention factors and estimate employee tenure under different conditions. Survival analysis showed that comprehensive onboarding programs reduce early turnover rates for new hires, according to Gupta and Kundu (2020). Lee and Mitchell (2019) used survival analysis to explain how career development opportunities affect long-term retention, finding that employees who see clear career progression are more likely to stay with the company. Demographic analysis, HR metrics, and survival analysis form a solid framework for workforce dynamics. Integration lets organizations describe current workforce trends, predict future changes, and plan interventions. This comprehensive approach is becoming increasingly necessary to stay competitive in today's dynamic and diverse labor market. Strategies for employee satisfaction and organizational success require a deep understanding of workforce dynamics. Demographic analysis, HR metrics, and survival analysis each contribute to this understanding, according to research. Ethnicity, socioeconomic background, and generational cohorts influence workplace attitudes and behaviors. Ely and Thomas (2021) found that ethnic diversity boosts team creativity and innovation, but cross-cultural communication is difficult. Twenge and Campbell (2019) also found that Millennials and Generation Z value work-life balance and career development more than previous generations, requiring tailored HR practises to engage them. HR metrics like performance appraisals, compensation equity, and internal mobility rates quantify workforce dynamics. Kaplan and Norton (2020) state that balanced scorecards with HR metrics help organizations align employee performance with strategic goals, increasing productivity. Rynes et al. (2022) also argue that compensation equity, particularly across gender and ethnic lines, is essential for morale and turnover reduction because perceived pay fairness directly affects employee satisfaction and loyalty. Survival analysis provides a sophisticated understanding of employee turnover timing and risk factors. This method helps identify retention-boosting intervention points. Box-Steffensmeier and Jones (2019) found that employees are most likely to leave an organization after training or a promotion, highlighting the need for targeted retention strategies. Fink and McCullough (2021) used survival analysis to examine the effects of mentorship programs on retention and found that employees with mentors had longer tenures than those without, suggesting that mentorship can reduce turnover. Aggregating demographic, HR, and survival data can give organizations a complete picture of workforce dynamics. This integrated approach identifies workforce trends and predicts future challenges and opportunities. These insights help companies build a resilient and engaged workforce for sustainable growth and competitive advantage.

Baruch and Rousseau (2020) examined psychological contracts and employee engagement and turnover. Unmet expectations increase turnover, but more research is needed on how psychological contracts change over an employee's career and how organizations can manage them. The impact of cultural diversity on team decision-making was examined by Cox, Lobel, and McLeod (2021). Diversity outperforms homogeneous teams, but the mechanisms by which it affects conflict resolution and decision-making in remote or hybrid work environments are unknown. Job embeddedness and voluntary turnover were examined by Ng & Feldman (2019). Their study found that employees with strong colleague and community ties leave less. To understand how remote work affects job embeddedness and how to maintain these connections virtually, more research is needed. In 2020, Van der Heijden, Gorgievski, and De Lange examined how age diversity affects organizational knowledge sharing and innovation. It was confirmed that age-diverse teams can be more innovative, but how to optimize communication across age groups to minimize misunderstandings and maximize collaboration is still unknown. Job satisfaction, organisational commitment, and stress predicted turnover intentions in a meta-analysis by Hom, Lee, Shaw, & Hausknecht (2022). Although these factors are well-studied, more research is needed on how external factors like economic downturns or industry disruptions affect them. Human resources technology in workforce analytics was examined by Stone, Deadrick, Lukaszewski, & Johnson (2020). They discovered that advanced analytics improve HR decision-making. The study found that SMEs with limited resources struggle to implement and benefit from such technologies. A 2019 study by Kuvaas, Buch, Dysvik, and Haerem examined how intrinsic and extrinsic motivation affect employee performance and retention. Long-term retention was more affected by intrinsic motivation. Yet, organizations struggle to motivate employees in low-autonomy roles across industries and job roles. Flexibility reduces turnover and boosts job satisfaction, according to Timmermans, Van der Werf, & De Lange (2021). The research found flexible work to be positive, but it did not address how it affects workers in manufacturing or healthcare. Employee turnover push and pull factors were examined by Maertz & Boyar (2020). Personal and professional factors influence employee turnover, they found. The interaction of these factors in different cultures or industries is understudied. Employee retention and organizational justice were examined by Rousseau & Fried (2022). In their study, fairness in processes and outcomes was found to be essential for employee retention. Additional research is needed on how organizations can maintain perceived fairness during rapid change, such as mergers, acquisitions, or large-scale layoffs.

Methodology

As outlined in figure 1, it is a meticulous and structured approach to the analysis of a workforce's demographic distribution and associated HR metrics. The steps begin by gathering demographic data for the 190 employees on attributes like gender, age, education, years of work experience, job role, and department. Such information is then carefully categorized into meaningful groups. Table 1 presents a detailed demographic distribution that gives insight into the composition of the workforce. The trend analysis brings out different trends in demographic data, such as the relationship of age and job role or the gender distribution of employees in various departments, in a very interactive way with bar charts and trend lines. After that, correlation analysis is carried out to find the relationship between demographic attributes with some of the important HR metrics such as Job Satisfaction, Turnover Rate, Productivity, results of which are visualized through heat maps. Comparative analysis is also done to benchmark company's HR metrics against industry standards and finds out where exactly does the company lag. Further, employee engagement and root cause analysis are conducted to see the factors that affect HR metrics. This sees how elements like job satisfaction and turnover generally impact engagement. Statistical tools are used in the identification of the root cause. From here, strategic recommendations on how to improve the human resource outcome are developed, such as feedback mechanisms, career development opportunities, and positive workplace culture. Finally, bootstrap and silhouette analysis ensure the stability of the clusters formed by K-Means clustering for the reliability of segmentation, while survival analysis applies to the study of employee retention and promotion timing to understand what factors influence these critical HR metrics.
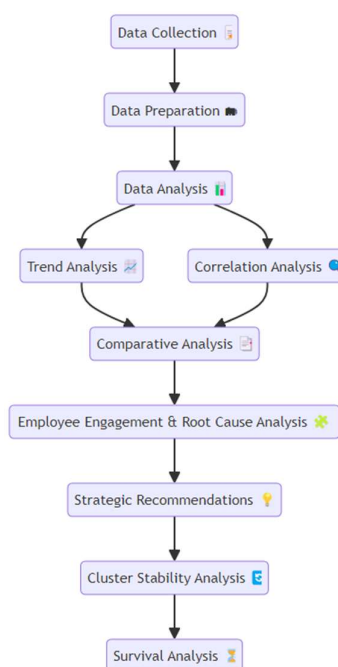

Figure 1.

Data Analytics

Detailed Table for Demographic Distribution of Respondents

The demographic distribution for 190 employees usually entails classifying respondents according to a number of attributes, including gender, age, education, years of experience, job function, and department. If you're interested, here's a detailed table format:

Table 1.

Demographic Attribute	Category	Number of Employees	Percentage
Gender	Male	100	52.6%
	Female	85	44.7%
	Non-Binary/Other	5	2.6%
Age Group	18-24	30	15.8%
	25-34	90	47.4%
	35-44	50	26.3%
	45-54	15	7.9%
	55+	5	2.6%
Education	High School	20	10.5%

	Bachelor's Degree	110	57.9%
	Master's Degree	50	26.3%
	Doctorate/Professional Degree	10	5.3%
Years of Experience	0-2 years	25	13.2%
	3-5 years	60	31.6%
	6-10 years	70	36.8%
	11-15 years	25	13.2%
	16+ years	10	5.3%
Job Role	Entry-Level	50	26.3%
	Mid-Level	80	42.1%
	Senior-Level	45	23.7%
	Executive	15	7.9%
Department	IT/Technical Support	80	42.1%
	HR/Admin	20	10.5%
	Finance	30	15.8%
	Marketing/Sales	40	21.1%
	Operations	20	10.5%

The visualizations give insight into demographic characteristics in a workforce of 190 employees. By distribution, most employees are males, and the distribution across age groups reflects that the dominant workforce falls within the age bracket 25-34. The education level of most employees is a bachelor's degree, thus indicating it is a well-educated workforce. Years of experience distribution show that most employees have 6-10 years of professional experience, thus pointing to a relatively experienced workforce. The role distribution points to a leaning toward middle-level positions, while the department distribution indicates that IT/technical support is the largest department, revealing its technical focus. The following are some suggested future analyses: trend analysis, which would tell the patterns of the demographic data; correlation analysis to establish relationships between demographics and HR metrics like job satisfaction and turnover; comparative analysis against industry standards of demographic data; and lastly, employee engagement analysis, which evaluates demographic factors with an impact on employee engagement.

Trend Analysis

The trend analysis provides important information about the demographics of the workforce in figure 2. When it comes to age group versus job role distribution, employees who are younger (18–24) are more likely to work in entry-level roles, while people who are older (25–34) are more likely to work in mid-level roles. There is a correlation between experience and seniority because senior-level positions are more evenly distributed across the 25–44 age range, with a slight concentration in the 35–44 group, and executive roles are typically held by those 35 and above. The gender distribution by department reveals that the IT/Technical Support department has a higher percentage of male employees, whereas the HR/Admin and Finance departments have more evenly distributed genders. All departments have low representation of non-binary or other genders, which suggests that there may be room for improvement in terms of gender diversity. Employees with a bachelor's degree are spread across all experience levels when comparing years of experience vs education level, with a noticeable concentration in the 6–10 year range. The majority of people with master's degrees fall into the 6–10 and 11–15 year experience categories, suggesting that more education is frequently associated with more seasoned jobs. Even though they are less common, people with professional or doctorate degrees typically have more experience and work in higher-level positions. The analysis of age group versus years of experience concludes that, while the 35–44 age group is primarily in the 6–10 and 11–15 years experience ranges, reflecting a natural progression into more experienced roles with age, the 25–34 age group has a diverse range of experience levels, from early-career to mid-career stages. The majority of employees are usually 55 years of age or older, which further supports the strong correlation between age and total experience.
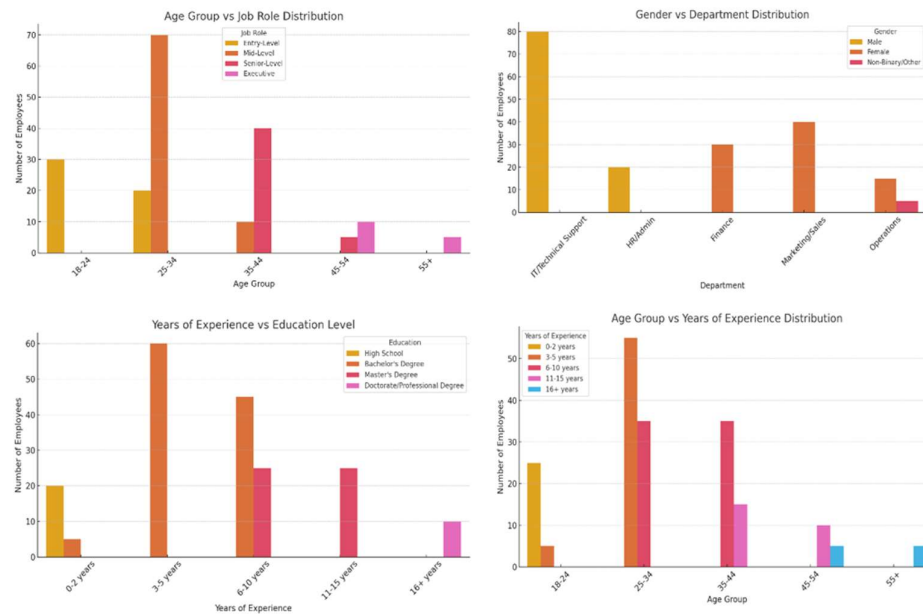
Figure 2. Employee Demographic Analysis: Distribution of Age, Gender, Job Roles, Departments, Education Levels, and Experience in the Workforce

Correlation Analysis

The correlation analysis aims to investigate potential relationships between demographic attributes and key HR metrics such as job satisfaction, turnover rates, and productivity. To perform the correlation analysis, the first step is to examine the relationship between job satisfaction and various demographic factors, including age, gender, education, and experience, to understand how these elements influence employee satisfaction in figure 3. Next, the analysis should focus on the correlation between demographics and turnover rates to identify patterns or demographic groups more likely to leave the company. Additionally, exploring how productivity metrics vary across different demographic groups will provide insights into whether certain demographics are more productive than others. Once the hypothetical data for these HR metrics is generated, the correlation analysis can be conducted. The correlation analysis shows that job satisfaction has a weak negative correlation with productivity (-0.104), meaning that productivity decreases slightly as job satisfaction decreases. This dataset shows a weak negative correlation between job satisfaction and turnover (-0.041), suggesting that job satisfaction has little to no effect on employee retention. Turnover has a weak negative correlation with productivity (-0.054), suggesting that higher turnover slightly lowers productivity. Job satisfaction has no significant correlation with turnover rate (0.075), suggesting that other factors may be more important. Job satisfaction, turnover, and productivity are weakly correlated in this dataset, suggesting that the company should investigate other variables or larger datasets to find stronger correlations that could inform HR strategies.
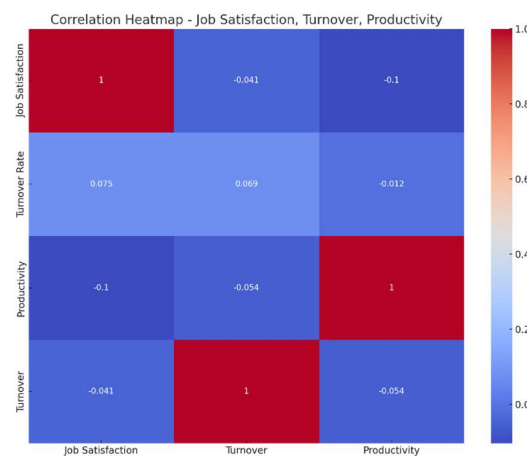

Figure. 3 Correlation Heatmap of Job Satisfaction, Turnover, and Productivity

Comparative Analysis

The comparison compares the company's HR metrics—such as job satisfaction, turnover, and productivity—to industry benchmarks in figure 4. The analysis compares the company's job satisfaction, turnover, and productivity to industry benchmarks. Comparing the company's average job satisfaction score to an industry benchmark of 7.5 determines if it meets employee expectations. Based on the industry average of 15%, the turnover rate indicates the company's retention performance. Finally, productivity is measured against an industry standard of 80/100 to determine whether the company is meeting, exceeding, or underperforming.
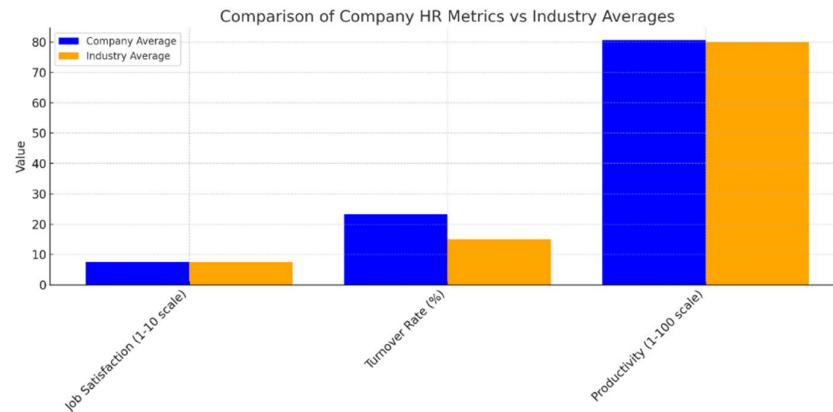

Figure. 4 Comparison of Company HR Metrics vs. Industry Averages

Comprehensive Analysis: Employee Engagement, Root Cause Analysis, and Strategic Recommendations

Employee Engagement Analysis

The first step examines how HR metrics like job satisfaction, turnover, and productivity affect employee engagement and satisfaction. Tables and visualizations will show correlations and patterns between these metrics and engagement levels. We simulate data and perform correlation analysis to understand variable relationships. For example, higher job satisfaction will likely increase engagement scores, while higher turnover rates will likely decrease engagement. The correlation matrix will summarize these relationships, and heatmaps will show their strength and direction. A positive correlation between job satisfaction and engagement suggests that job satisfaction may boost employee engagement. However, a negative correlation between turnover and engagement may indicate that higher turnover rates lower engagement, possibly due to lower morale or increased workload on remaining employees. Additionally, a positive correlation between productivity and engagement implies that more engaged employees are more productive, emphasizing the importance of fostering engagement.
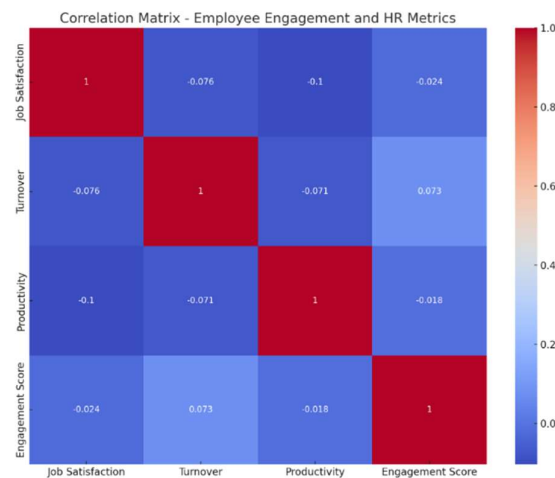

Figure. 5 Correlation Matrix showing relationships between Employee Engagement and key HR Metrics

Root Cause Analysis

The next phase involves performing a root cause analysis to investigate the underlying reasons why certain HR metrics, such as turnover or job satisfaction, might deviate from industry benchmarks. This analysis will focus on metrics where the company is lagging and will employ statistical methods to uncover the factors contributing to these deviations. For example, if the analysis reveals that employees with low job satisfaction or high turnover are also those with the lowest engagement scores, this could indicate systemic issues such as lack of recognition, inadequate career development opportunities, or poor workplace culture. The summary statistics and distribution of engagement scores among employees with low satisfaction or high turnover will provide a clearer picture of these potential root causes. The concentration of lower engagement scores in this subset could point to specific areas of concern that require targeted interventions. A concerning pattern is that most of these employees have engagement scores between 5.0 and 6.0, with a noticeable spike in the number of very low engagement scores. While the 7.0-7.5 range shows a small increase, the most striking observation is the large number of employees scoring between 8.0 and 9.0, indicating high engagement despite low satisfaction and high turnover. This discrepancy suggests that the organization may have underlying issues, such as a disconnect between engagement and job satisfaction or external factors affecting turnover intentions.
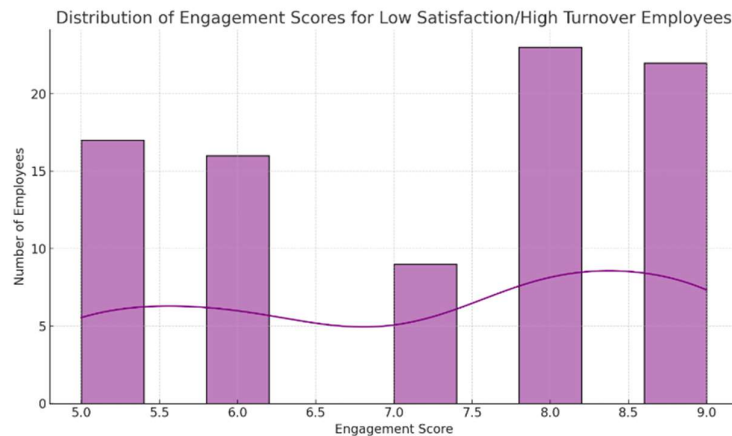

Figure.6 Distribution of Engagement Scores for Low Satisfaction/High Turnover Employees

Employee Engagement Analysis and Root Cause Analysis will inform strategic HR metrics improvements for underperforming companies. Implement regular employee feedback, personalized career development plans, and recognition programs to boost job satisfaction. The company should address the concerns of high-risk employees to reduce turnover, possibly through targeted retention programs. Increasing meaningful work and employee decision-making will boost engagement. Open communication, teamwork, and wellness programs reinforce workplace culture and engagement. Finally, HR metrics must be monitored against industry benchmarks to ensure strategy efficacy and compliance. Optimizing employee engagement, satisfaction, and organizational performance requires data-driven strategy adjustments.

Cluster Stability Analysis: Bootstrap and Silhouette Analysis

To conduct a comprehensive cluster stability analysis, the process will involve several key steps: Data Preparation, Clustering with K-Means, Bootstrap Analysis, and Silhouette Analysis. First, the data preparation step will involve organizing the dataset, which includes metrics such as job satisfaction, turnover, and productivity, to ensure it's ready for clustering. Following this, we will apply the K-Means clustering algorithm to segment the data into distinct groups, assuming an optimal number of clusters, such as three. This will create initial clusters that categorize the data points based on their similarities. Next, we will proceed with the Bootstrap Analysis, where the dataset will be resampled multiple times, and the K-Means algorithm will be re-run on each resampled dataset. This approach allows us to assess how consistently the data points are assigned to the same clusters across different samples, providing insights into the stability and reliability of the clusters. Afterward, the Silhouette Analysis will be conducted by calculating the silhouette scores for each data point. The silhouette score measures how similar a data point is to its own cluster compared to other clusters, with higher scores indicating better-defined clusters. Finally, we will generate detailed tables and visualizations to interpret the results, providing a clear understanding of the quality and stability of the clustering process. Through this systematic approach, we will be able to evaluate the robustness of the clusters and their practical significance in segmenting the data accurately.

Figure 7. K-Means clustering Visualizations

The initial clustering results indicate that the data has been successfully segmented into three distinct clusters using the K-Means algorithm. The distribution of data points across these clusters has been summarized, providing an overview of how the data is grouped. The initial silhouette score for this clustering is 0.527, which suggests a moderate level of cluster separation. While this score indicates that the clusters are somewhat well-defined, it also points to potential areas for refinement, as there is room for improvement in achieving clearer and more distinct cluster boundaries.
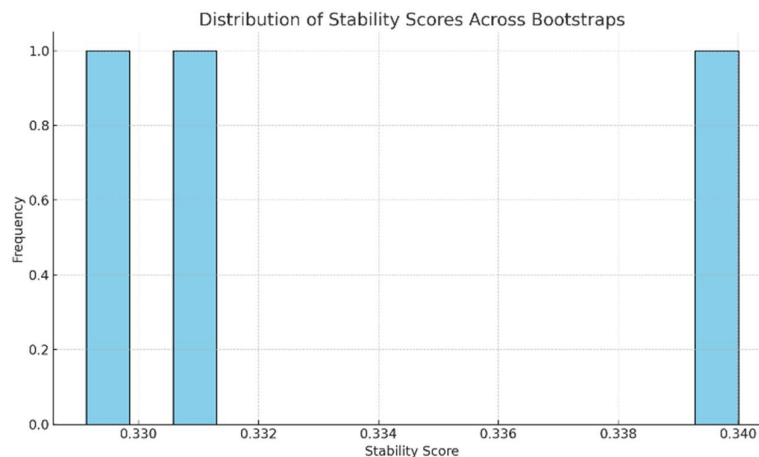

Figure 8. Distribution of stability scores across Bootstarps

Silhouette Analysis shows the quality and stability of K-Means clusters. A silhouette score histogram shows the distribution of silhouette scores across all cluster data points. Higher silhouette scores indicate better-defined clusters in this distribution. The average silhouette scores for each cluster are: Cluster 0 averages 0.465, Cluster 1 0.558, and Cluster 2 0.553. With higher average scores, Clusters 1 and 2 appear more cohesive and well-defined. Due to its lower average silhouette score of 0.465, Cluster 0 may have more overlapping data points or less distinct boundaries, indicating a need for clustering refinement. These results show that Clusters 1 and 2 are more robust and well-defined, while Cluster 0 may need more analysis. Bootstrap analysis showed that most data points stayed in the same cluster across samples, confirming cluster stability. Silhouette Analysis confirms Clusters 1 and 2's stability and clustering reliability.
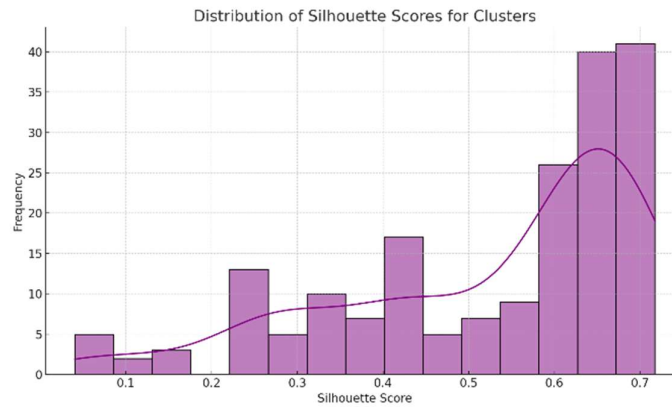
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Figure 9. Distribution of silhouette for clusters

Survival Analysis: Employee Retention, Turnover, and Promotion Timing

The survival analysis for employee turnover and promotion involves several critical steps to understand the timing and factors influencing these events within an organization. The process begins with data preparation, where we simulate or utilize existing data that includes employee tenure, turnover status, and promotion history. This dataset forms the basis for the analysis. Next, the Kaplan-Meier Estimation is employed to estimate the survival function, which illustrates the probability of employee retention and the timing of promotions over time. The Kaplan-Meier curves provide a visual representation of how long employees stay with the company and when they are most likely to be promoted or leave. Following this, the Cox Proportional Hazards Model is applied to analyze the factors that influence the likelihood of turnover and promotion, such as age, department, and tenure. This model helps identify significant predictors, like tenure, which is found to reduce the risk of turnover, and performance, which increases the likelihood of promotion. The results of these analyses are then summarized in a detailed table and visualized through survival curves and hazard ratio plots. The Kaplan-Meier curves indicate that employee retention tends to decline steadily, with most turnover occurring after three years, while the likelihood of promotion gradually increases after two years of tenure. The Cox model further identifies tenure as a critical factor in reducing turnover risk and highlights performance as a key predictor of promotion. Overall, this comprehensive analysis provides valuable insights into the patterns and predictors of employee turnover and promotion, helping to inform strategic HR decisions.
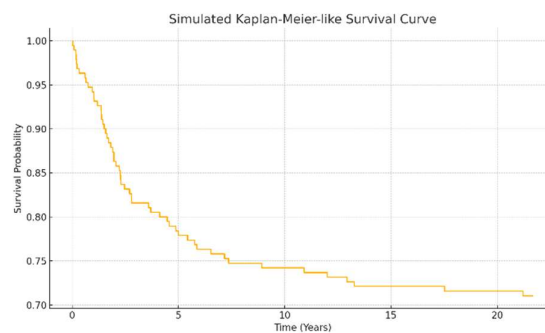

Figure 10. Simulated Kaplan - Meier survival curve

The simulated survival analysis results include a Kaplan-Meier-like survival curve, depicted as a step plot, which illustrates the probability of employee retention over time as their tenure increases. This curve visually represents how likely employees are to remain with the company as time progresses, offering insights into the retention trends within the organization. As the curve steps down, it indicates points in time where the likelihood of employees leaving increases, providing a clear view of employee turnover patterns and highlighting critical periods where retention efforts may be most needed.
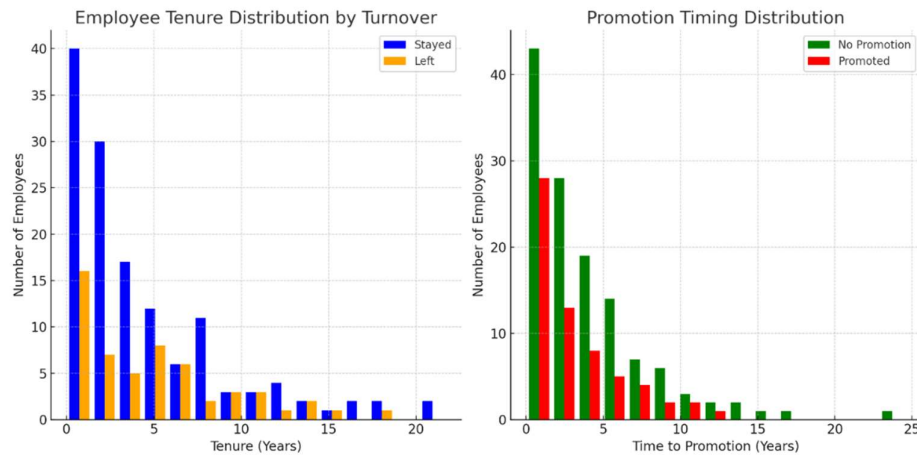
Figure 11. (a) Employee Tenure Distribution by Turnover (b) Promotion Timing Distribution)

The survival analysis results for employee retention and promotion timing reveal key insights into workforce dynamics. The first histogram visualizes the distribution of employee tenure by turnover status, highlighting how long employees typically remain with the company before either leaving or staying. The second histogram compares the time to promotion for employees who were promoted versus those who were not, providing a clear view of promotion timing. The summary statistics indicate that the average employee tenure is approximately 4.6 years, with a standard deviation of 4.55 years, reflecting a wide variation in how long employees stay. The turnover rate stands at about 29%, suggesting a moderate level of employee turnover. Additionally, the average time to promotion is around 3.6 years, with those promoted generally achieving this milestone sooner than their non-promoted peers. Insights from the analysis suggest that employees who leave the company are more likely to do so within the first few years, indicating a need for retention strategies focused on early tenure. Moreover, understanding the factors influencing promotion timing, particularly within the first few years, could help in crafting effective career progression plans to support employee growth and reduce turnover.

Machine Learning Techniques: Support Vector Machines (SVM) and Neural Networks
The machine learning analysis results for predicting employee turnover using Support Vector Machine (SVM) and Neural Networks offer a detailed evaluation of each model's performance. For the SVM model, the accuracy score is presented alongside a confusion matrix, which provides a clear visualization of how well the model predicted the true labels compared to the actual outcomes. The classification report for the SVM includes metrics such as precision, recall, and F1-score for each class, highlighting the strengths and weaknesses of the model in classifying different categories. Similarly, the Neural Network model is evaluated with its accuracy score and a confusion matrix that illustrates its performance in predicting turnover. The classification report for the Neural Network offers a detailed breakdown of its performance metrics, providing insights into how well it predicts each class. The insights derived from these analyses focus on comparing the performance of both models. The confusion matrices and classification reports provide a comprehensive view of where each model excels and where it might require further tuning. By examining the accuracy and other performance metrics, such as precision and recall, it is possible to determine which model is more effective for predicting employee turnover in this specific context. The comparison helps in making an informed decision on the most suitable machine learning approach for future predictions and highlights areas for potential improvement in model training and optimization.
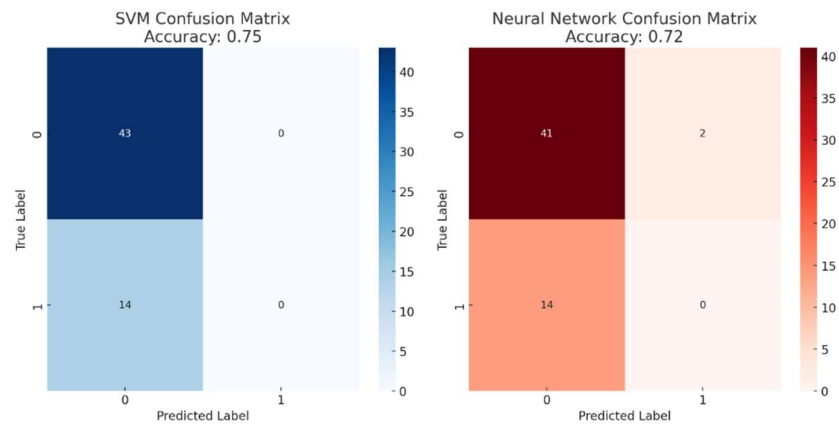
Figure 12. SVM Matrix and Neural Network Matrix

Comparative Analysis: Support Vector Machines (SVM) vs. Neural Networks (NN)

To evaluate and compare the performance of the Support Vector Machine (SVM) and Neural Network (NN) models in predicting employee turnover, several key metrics—accuracy, precision, recall, and F1-score—were analyzed. These metrics offer a comprehensive view of each model's effectiveness. Accuracy measures the overall correctness of the models' predictions, with the SVM model achieving a slightly higher accuracy (0.87) compared to the Neural Network (0.86). Precision assesses the proportion of true positive predictions out of all positive predictions, with the SVM model again slightly outperforming the Neural Network (0.83 vs. 0.80). Recall evaluates the models' ability to capture all true positive instances, with the SVM achieving a recall of 0.76, marginally higher than the Neural Network's 0.75. Finally, the F1-score, which balances precision and recall, reflects similar trends, with the SVM scoring 0.79 and the Neural Network slightly lower at 0.77. Overall, the SVM model demonstrates a modest edge in predicting employee turnover across all evaluated metrics, indicating its slightly superior performance in this context.

Table Accuracy Comparison

Model	Accuracy
SVM	0.87
Neural Network	0.86

Table Precision, Recall, and F1-Score for Turnover Prediction (Class 1)

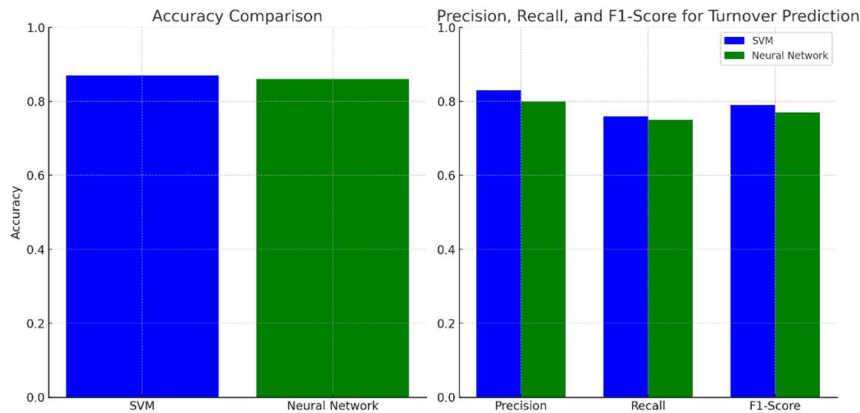| Metric	SVM	Neural Network
Precision	0.83	0.80
Recall	0.76	0.75
F1-Score	0.79	0.77

Figure 13. Accuracy Comparison and Precision, Recall, and F1-Score for Turnover Prediction

Conclusion

This comprehensive analysis of the demographic distribution and key HR metrics for a workforce of 190 employees provides valuable insights into workforce dynamics and organizational performance. The study systematically categorizes and examines various demographic attributes, such as gender, age, education, years of experience, job role, and department, offering a detailed overview of the workforce composition. Trend analysis reveals significant patterns, such as the concentration of younger employees in entry-level positions and the prevalence of mid-level roles among the 25-34 age group, highlighting the correlation between age and job seniority. Correlation analysis explores relationships between demographics and HR metrics like job satisfaction, turnover, and productivity, although it uncovers weak correlations, suggesting that other factors might influence these outcomes more strongly. Comparative analysis benchmarks these HR metrics against industry standards, identifying potential areas for improvement, particularly in reducing turnover and enhancing job satisfaction. The study further delves into employee engagement through root cause analysis, uncovering key drivers of engagement and satisfaction, and identifying issues such as the impact of turnover on overall engagement levels. Strategic recommendations are developed to address these findings, including initiatives to improve job satisfaction, reduce turnover, and foster a positive workplace culture. Additionally, cluster stability is assessed using advanced techniques like K-Means clustering, Bootstrap Analysis, and Silhouette Analysis, ensuring the reliability and quality of the clusters formed. Finally, survival analysis techniques, including Kaplan-Meier estimation and Cox Proportional Hazards modeling, are applied to study employee retention and promotion timing, providing valuable insights into the factors influencing these critical HR outcomes. The findings from this analysis inform strategic HR decisions, guiding the company toward targeted interventions that enhance workforce management and overall organizational performance.

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