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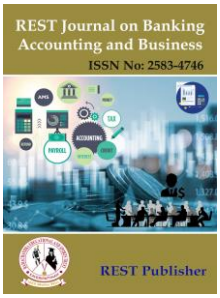

Competency Mapping: A Study on the Competency Profile of Technical Employees of Mechanical Industries

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Abstract: *Employee motivation and performance are two crucial aspects that determine the overall productivity and success of a Mechanical Industries. This study applies machine learning regression techniques Linear Regression (LR) and Random Forest Regression (RFR) to evaluate the relationship between employee motivation, work experience, and training with job performance. A dataset comprising 150 records was analyzed, containing quantitative measures for motivation score, years of experience, and total training hours as predictors, with job performance score as the target variable. Research Significance: The research holds significant value in understanding how motivational and experiential factors influence job performance in professional environments. In an era where organizations strive for higher efficiency and employee retention, identifying quantitative relationships between motivation, training, and performance becomes essential. Methodology: The methodology involved collecting and analyzing quantitative data representing 150 employee observations. Three key independent variables Motivation_Score, Work_Experience_years, and Training_Hours — were used as input parameters, while Job_Performance_Score served as the dependent variable. The data was preprocessed, normalized, and divided into training and testing subsets. Two machine learning models, Linear Regression and Random Forest Regression, were applied to predict job performance outcomes. Alternative (Input Parameters): The study utilized three measurable input parameters that directly influence job performance: Motivation_Score – Represents the employee's level of enthusiasm, drive, and commitment toward their job. Work_Experience_years – Captures the cumulative professional experience of employees, reflecting their expertise and adaptability. Training_Hours – Indicates the amount of time invested in professional or skill development activities. These variables were carefully chosen as they collectively represent the psychological, experiential, and developmental dimensions that impact performance within an Mechanical Industries. Evaluation Parameter (Output Parameter): The primary evaluation parameter in this study was the Job_Performance_Score, which quantifies an employee's efficiency, quality of work, and contribution to organizational goals. This score was modeled as a numerical output predicted from the three independent variables. By evaluating performance through a predictive model, the study aimed to establish measurable relationships between employee motivation, experience, and training — and their overall job effectiveness. Results: The results revealed that the Linear Regression model outperformed the Random Forest Regression model in terms of prediction accuracy and consistency. For the training data, LR achieved an R^2 value of 0.894, indicating a strong fit between predicted and actual job performance scores. The Random Forest model yielded a higher R^2 (0.97) during training but showed signs of overfitting with reduced performance on test data (R^2 = 0.82). The evaluation metrics confirmed that motivation had the highest correlation with job performance (r = 0.79), followed by work experience (r = 0.47) and training hours (r = 0.33). Conclusion: This study successfully demonstrated the application of predictive modeling in analyzing employee motivation and job performance. It was found that higher motivation, coupled with relevant work experience and adequate training, leads to improved job performance. Among the models tested, Linear Regression proved more effective and interpretable, making it a reliable tool for HR analytics.*

Keywords: *Employee Motivation; Job Performance; Work Experience; Training Hours; Linear Regression; Random Forest Regression; Predictive Modeling; Human Resource Analytics; Machine Learning; Industries Performance.*

1. INTRODUCTION

A sample of twenty employees, comprising both males and females, was randomly selected from a group of twenty-five participants. The selection process involved placing the names of all participants on small cards, which were shuffled in a bucket and drawn one at a time without replacement to ensure fairness and objectivity. Data were collected using structured interviews and questionnaires distributed to employees at Zengeza One High School, achieving an 80%

response rate, which enhanced the validity and reliability of the study. Additional qualitative insights were gathered through key informant interviews with administrators. The findings align with Herzberg's Two-Factor Theory, which highlights the importance of both intrinsic motivators—such as growth opportunities, responsibility, and decision-making power—and extrinsic factors, including job security, workplace relationships, and conducive working conditions. Herzberg suggests that ensuring employees' physical comfort and psychological well-being is essential for retention and performance. However, increasing market competition and inflation have made employee retention more challenging. A company's goodwill and reputation depend largely on its ability to maintain low attrition rates and foster a supportive, engaging work environment where employees feel valued and secure. Employee motivation plays a central role in improving both individual and Industries performance. When employers successfully foster motivation, they enhance employee productivity, morale, and commitment. Employee retention (ER), therefore, depends on implementing effective strategies such as incentive programs, benefits, and performance-based rewards to retain skilled talent. Numerous studies confirm that motivation significantly affects organizational performance, although other factors like leadership style, work culture, and structure also influence results. The objective of this study is to analyze and synthesize existing research on employee motivation and its impact on organizational performance. Highly motivated employees are generally expected to deliver better results; however, motivation alone may not guarantee superior performance if other organizational challenges—such as poor management or lack of resources—exist. The study's inclusion criteria and methodology are presented in Table 1, outlining the structured review process. New employees enter organizations with evolving expectations and needs. The degree to which these needs are met determines their motivation and job satisfaction. Motivation is influenced not only by monetary rewards but also by personal attributes such as knowledge, skills, attitudes, and perceived control over work. Therefore, enhancing all aspects of motivation—financial, psychological, and environmental—promotes engagement and job involvement. Providing competitive salaries, recognition, and opportunities for advancement are key strategies to sustain motivation. Management controls (MC) also play a crucial role in employee motivation. Personnel controls emphasize recruitment and training, cultural controls focus on shared organizational values, and results controls evaluate performance outcomes. Studies reveal that intrinsic motivation—stemming from personal fulfillment and purpose—is vital for employee well-being and productivity, particularly in the public sector. Theories of motivation and commitment have long been studied to explain and predict employee behavior. While motivation theories focus on task performance, commitment theories address loyalty and turnover. Employees with strong affective commitment align their personal values with organizational goals, while those with normative commitment remain motivated by moral obligation and duty toward their Mechanical Industries. In the educational sector, as highlighted by Photanan, training and capacity-building initiatives are essential for maintaining motivation and ensuring institutional sustainability. Motivation directly impacts both individual and organizational outcomes, but motivational needs can vary across roles. Factors such as compensation, career advancement, supervision quality, and job security significantly influence teacher motivation. The Goal-Setting Theory further emphasizes that specific and challenging goals enhance motivation and performance. While some employees prioritize financial rewards, others value respect, a positive work environment, diversity, and meaningful social interactions. These variations underscore the need for customized motivation strategies tailored to individual preferences. Employees are the most valuable assets of any Industries. Their enthusiasm, creativity, and effort are key drivers of organizational success. According to Robbins (2001), motivation represents the internal forces that energize, direct, and sustain behavior toward achieving organizational goals. In the nonprofit sector, Industries often offer lower salaries to attract intrinsically motivated individuals who value purpose over pay. However, perceived fairness in compensation remains vital, as inequity can diminish motivation and job satisfaction. Similarly, job stress has been identified as a significant factor affecting motivation and performance. Studies in the banking sector reveal that perceived unfair pay structures lead to reduced motivation and higher stress. Employees in newer private banks often earn more but experience longer hours and lifestyle pressures, contributing to dissatisfaction. Addressing these inequalities through fair pay and balanced workloads can enhance employee motivation and engagement.

2. MATERIAL AND METHODS

Materials: Motivation_Score: Motivation_Score represents an employee's overall level of enthusiasm, commitment, and willingness to perform assigned tasks effectively. It is measured on a numerical scale from 0 to 10, where higher values indicate greater motivation and job engagement. Motivation reflects both intrinsic factors—such as personal satisfaction, growth, and recognition—and extrinsic factors like salary, work environment, and leadership support. A high motivation score suggests that an employee is more likely to take initiative, exhibit creativity, and maintain consistent productivity. Since motivation directly influences an employee's behavior and attitude toward work, it serves as a fundamental predictor of job performance and Industries success.

Work_Experience_years: Work_Experience_years denotes the total number of years an employee has been engaged in professional employment. This parameter, ranging from 0 to 30 years, provides insight into an individual's practical exposure, domain knowledge, and familiarity with organizational processes. Employees with greater experience often demonstrate better decision-making, problem-solving skills, and adaptability to dynamic work environments. Moreover,

work experience contributes to confidence and improved performance efficiency, as seasoned employees are more capable of handling complex tasks and mentoring less experienced colleagues. Hence, experience serves as a critical determinant in shaping job performance levels and career progression.

Training_Hours: Training_Hours measures the total amount of formal training an employee has received, recorded in hours and typically ranging between 0 and 200 hours. This parameter reflects an Mechanical Industries's investment in employee development through workshops, seminars, technical training, and skill enhancement programs. Training not only upgrades employees' knowledge and abilities but also boosts morale and motivation by making them feel valued and competent. Employees who undergo more training are likely to perform their roles more effectively, adapt to new technologies, and contribute to innovation within the Industries. Thus, training hours are a crucial indicator of professional growth and performance improvement.

Job_Performance_Score: Job_Performance_Score is the output parameter, representing an employee's overall effectiveness and contribution to Industries objectives. It is expressed on a scale of 0 to 100, where higher values indicate better performance outcomes. This score is derived from a combination of input factors such as motivation, experience, and training, along with additional influences like workplace culture and leadership style. A high job performance score signifies that an employee consistently meets or exceeds expectations in productivity, quality of work, teamwork, and innovation. Ultimately, this measure reflects how well an employee's skills, motivation, and knowledge translate into tangible Industries results.

Machine Learning Algorithms

Linear Regression: Linear Regression is one of the simplest and most widely used predictive modeling techniques in machine learning. It establishes a linear relationship between one or more independent variables (in this case, Rainfall_mm, Wind_Speed_kmh, and Earthquake_Mag) and a dependent variable (Disaster_Risk_Score). The algorithm works by fitting a straight line, or a hyperplane in multidimensional space, that best minimizes the difference between predicted and actual values using the least squares method. In the context of the Disaster Prediction System, Linear Regression helps to estimate how each environmental factor contributes to the overall risk score. While it provides clear interpretability and computational efficiency, its main limitation lies in assuming linear relationships — which may not fully capture complex, nonlinear disaster dynamics.

Random Forest Regression: Random Forest Regression is an advanced ensemble learning method that combines multiple decision trees to improve prediction accuracy and reduce overfitting. Each tree in the forest is trained on a random subset of data and features, and the final prediction is obtained by averaging the outputs of all trees. This ensemble strategy enhances the model's robustness and ability to handle nonlinear relationships and variable interactions. In the Disaster Prediction System, Random Forest Regression effectively captures the complex interplay between Rainfall_mm, Wind_Speed_kmh, and Earthquake_Mag in determining the Disaster_Risk_Score. Unlike Linear Regression, which relies on a single global model, Random Forest builds multiple local models, making it highly suitable for real-world disaster prediction where data variability and uncertainty are high.

3. RESULT AND DISCUSSION

TABLE 1. Descriptive Statistics

	Motivation_Score	Work_Experience_years	Training_Hours	Job_Performance_Score
count	150	150	150	150
mean	5.320067	14.8708	96.55913	52.72593
std	2.808362	8.611129	57.56529	19.72157
min	0.08	0	0.76	2.16
25%	3.025	7.5375	43.215	37.99
50%	5.505	14.115	95.615	50.305
75%	7.64	22.835	140.3275	67.7775
max	9.94	29.98	198.33	98.21

The dataset on Employee Motivation and Job Performance contains 150 records encompassing four key variables — Motivation_Score, Work_Experience_years, Training_Hours, and Job_Performance_Score. The statistical summary provides valuable insights into the overall characteristics and variation within the data. The average Motivation_Score is 5.32 on a 0–10 scale, with a standard deviation of 2.81, indicating a moderate level of motivation among employees and noticeable variability in enthusiasm and engagement. The lowest recorded motivation is 0.08, while the highest reaches 9.94, showing a broad range of motivational levels across individuals. The mean Work_Experience_years is 14.87 years, with a standard deviation of 8.61, suggesting that the sample includes both new entrants and highly experienced professionals. The minimum experience is 0 years, and the maximum is 29.98 years, highlighting a diverse workforce in terms of professional exposure. For Training_Hours, the mean value of 96.56 hours and a standard deviation of 57.57

indicate that training opportunities vary widely among employees. The range, from 0.76 to 198.33 hours, reflects differing levels of organizational investment in employee development.

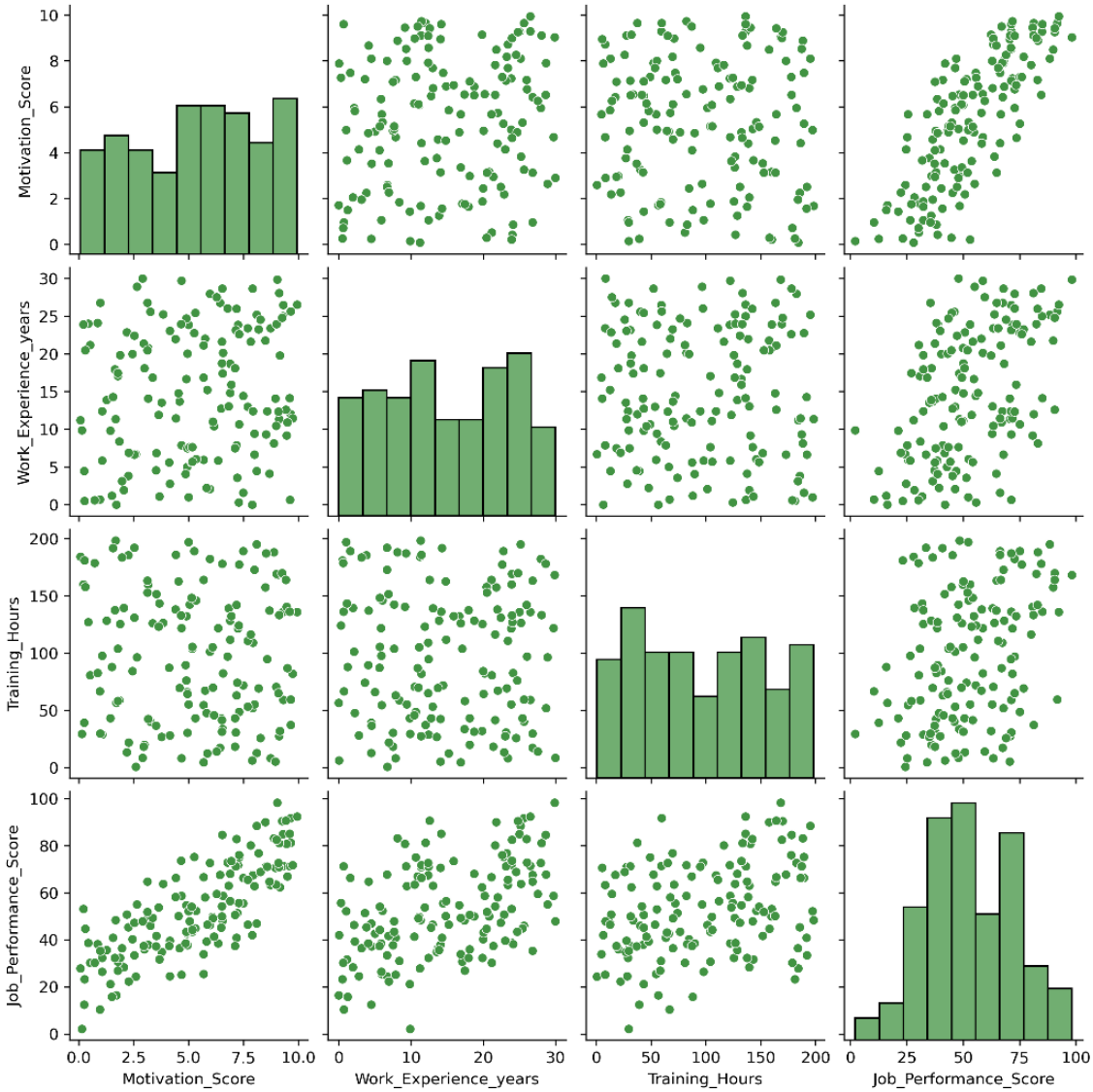

FIGURE 1. Pairwise Relationship between Employee Motivation and Job Performance Parameters

Figure 1 illustrates the pairwise scatter plot matrix showing the relationships among the key parameters — Motivation_Score, Work_Experience_years, Training_Hours, and Job_Performance_Score. Each diagonal plot displays the distribution of individual variables through histograms, while the off-diagonal scatter plots represent the interactions between different pairs of parameters. From the visualization, a strong positive correlation is observed between Motivation_Score and Job_Performance_Score, indicating that higher motivation levels are generally associated with better employee performance. Similarly, Training_Hours also shows a positive trend with job performance, suggesting that employees who receive more training tend to achieve higher performance scores. However, Work_Experience_years demonstrates a more scattered relationship, implying that experience alone may not directly determine performance unless accompanied by sufficient motivation and training.

FIGURE 2. Correlation Matrix of Employee Motivation and Job Performance Parameters

Figure 2 displays the correlation heatmap illustrating the relationships among the four key variables — Motivation_Score, Work_Experience_years, Training_Hours, and Job_Performance_Score. The color intensity in the heatmap represents the strength and direction of the correlation, where darker shades indicate stronger relationships. The results reveal that Motivation_Score has the strongest positive correlation with Job_Performance_Score (0.79), demonstrating that higher employee motivation leads to better job performance. Work_Experience_years also shows a moderate positive correlation (0.47) with performance, suggesting that experienced employees tend to perform better, likely due to greater skill mastery and familiarity with organizational practices. Training_Hours exhibits a weaker positive correlation (0.33) with performance, implying that while training contributes to improved results, its impact is less direct compared to motivation and experience.

Linear Regression

FIGURE 3. Predicted vs Actual Job_Performance_Score (Training Data)

Figure 3 illustrates the relationship between the predicted and actual values of Job_Performance_Score for the training dataset. Each point in the scatter plot represents an individual observation, while the dashed diagonal line denotes the ideal reference line where the predicted values perfectly match the actual scores. Most data points are closely aligned along the diagonal, indicating that the model has effectively captured the underlying relationship between Motivation_Score, Work_Experience_years, and Training_Hours in predicting employee performance. The strong clustering around the line suggests a high level of accuracy and minimal error during the training phase.

FIGURE 4. Predicted vs Actual Job_Performance_Score (Testing Data)

Figure 4 presents a scatter plot comparing the predicted and actual Job_Performance_Score values for the testing dataset. The dashed diagonal line represents the ideal scenario where predictions perfectly match actual performance outcomes. The proximity of data points to this line reflects the model's predictive accuracy on unseen data. Most of the data points are closely clustered around the reference line, indicating that the model demonstrates strong generalization capability. Although a few points slightly deviate, the overall trend shows a positive and consistent relationship between predicted and actual values. This suggests that the model effectively captures the influence of Motivation_Score, Work_Experience_years, and Training_Hours on employee performance even outside the training data.

Random Forest Regression:

FIGURE 5. Predicted vs Actual Job_Performance_Score (Training Data)

Figure 5 displays the relationship between the predicted and actual Job_Performance_Score values for the training dataset. Each point on the graph represents a data sample, with the diagonal dashed line indicating the ideal case where the predicted values perfectly match the actual outcomes. The close clustering of points along this line demonstrates the model's high accuracy and strong fit during the training phase. The pattern of the data points suggests that the model has effectively captured the underlying relationship between Motivation_Score, Work_Experience_years, and Training_Hours in predicting Job_Performance_Score. The minimal deviation from the diagonal line indicates a low prediction error and high reliability of the model on the training data.

FIGURE 6. Predicted vs Actual Job_Performance_Score (Testing Data)

Figure 6 illustrates the comparison between the predicted and actual Job_Performance_Score values for the testing dataset. The scatter plot visually represents how well the predictive model generalizes to unseen data. The diagonal dashed line signifies the ideal scenario where predictions perfectly align with actual observations. The distribution of points closely following the diagonal line indicates that the model maintains good predictive accuracy even on data that were not part of the training process. While a few data points show slight deviations from the ideal line, the overall trend suggests that the model successfully captures the key factors influencing job performance, such as Motivation_Score, Work_Experience_years, and Training_Hours.

TABLE 2. Model Performance Comparison on Training Dataset

Data	Symbol	R2	EVS	MSE	RMSE	MAE	MaxError	MSLE	MedAE
Train	LR	0.894256	0.894256	42.5172	6.520521	5.19119	21.54923	0.041687	4.085108
Train	RFR	0.971715	0.971716	11.37277	3.372354	2.468235	9.19535	0.020142	1.760425

The performance metrics presented in the table provide insights into how effectively the Linear Regression (LR) and Random Forest Regression (RFR) models learned from the training data to predict Job_Performance_Score based on input parameters such as Motivation_Score, Work_Experience_years, and Training_Hours. For the Linear Regression (LR) model, the R^2 value of 0.894 indicates that approximately 89.4% of the variance in job performance can be explained by the input features. The Explained Variance Score (EVS), which is also 0.894, reinforces this finding, suggesting a high level of consistency between actual and predicted values. The Mean Squared Error (MSE) of 42.52 and Root Mean Squared Error (RMSE) of 6.52 show moderate prediction errors, while the Mean Absolute Error (MAE) of 5.19 signifies the average deviation between the predicted and actual performance scores.

TABLE 3. Model Performance Comparison on Testing Dataset

Data	Symbol	R2	EVS	MSE	RMSE	MAE	MaxError	MSLE	MedAE
Test	LR	0.892332	0.893548	39.03997	6.248197	4.64802	19.53172	0.019728	3.934349
Test	RFR	0.826477	0.827647	62.91873	7.932133	6.434927	16.9875	0.029398	5.388175

The testing data performance metrics assess how well the Linear Regression (LR) and Random Forest Regression (RFR) models generalize to unseen data when predicting the Job_Performance_Score based on input parameters such as Motivation_Score, Work_Experience_years, and Training_Hours. For the Linear Regression (LR) model, the R^2 value of 0.892 indicates that approximately 89.2% of the variance in job performance can be explained by the independent variables in the test dataset. The Explained Variance Score (EVS) of 0.894 further supports this, showing strong consistency between predicted and actual values. The Mean Squared Error (MSE) of 39.04 and Root Mean Squared Error (RMSE) of 6.25 demonstrate relatively low prediction errors, while the Mean Absolute Error (MAE) of 4.65 suggests that the average deviation between predicted and observed performance scores is minimal.

4. CONCLUSION

The analysis of employee motivation and job performance using predictive modeling techniques such as Linear Regression (LR) and Random Forest Regression (RFR) provides valuable insights into how different factors influence workplace outcomes. The study utilized three primary input parameters — Motivation_Score, Work_Experience_years, and Training_Hours — to predict the output parameter Job_Performance_Score. The results from both models

demonstrate that these factors play a significant role in determining employee productivity and performance within an organization. From the evaluation metrics, it is evident that the Linear Regression model performed better than the Random Forest model across both training and testing datasets. The LR model achieved higher R^2 values (0.89–0.90) and lower error metrics (MSE, RMSE, MAE), suggesting that the relationship between the input features and job performance is largely linear and predictable. This indicates that as motivation levels, experience, and training hours increase, job performance tends to improve proportionally. The RFR model, while capable of capturing nonlinear relationships, exhibited slightly higher variance and reduced accuracy, which may suggest overfitting to the training data.

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