Predictive Analytics for Employee Attrition: Forecasting Employee Turnover with Machine

Learning

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Abstract

In today's highly competitive and dynamic business environment, employee retention has become a strategic priority for organizations. High attrition rates not only disrupt organizational performance but also lead to significant costs related to recruitment, training, and lost productivity. Predictive analytics, an emerging field within data-driven human resource management, offers a proactive approach to addressing employee turnover. This research explores the application of machine learning techniques to forecast employee attrition using historical and real-time HR data. The study utilizes a combination of logistic regression, decision trees, random forest, and neural networks to model attrition probability based on variables such as demographic profiles, job satisfaction, compensation, tenure, performance ratings, and employee engagement survey responses.

A comprehensive data preprocessing pipeline is implemented to clean, encode, and normalize features, followed by model training and evaluation using accuracy, precision, recall, and AUC-ROC as key performance metrics. The random forest model yielded the highest predictive performance, identifying key indicators like overtime hours, lack of promotion, and low job

satisfaction as strong predictors of attrition. Furthermore, the study highlights how predictive analytics can be integrated into HR decision-making through dashboards and risk profiling tools. The findings demonstrate that predictive models not only enhance the ability of organizations to retain top talent but also contribute to more equitable, data-informed HR strategies. The paper concludes with ethical considerations, emphasizing data privacy and algorithmic fairness in predictive HR analytic

Keywords: Predictive Analytics, Employee Attrition, Human Resource Analytics, Machine Learning, Logistic Regression, Random Forest

Literature Review

The growing importance of human capital in organizational success hasinterest in leveraging data analytics within Human Resource Management (HRM). A significant focus within this domain is on predicting employee attrition to develop proactive retention strategies. Various studies have employed machine learning and statistical methods to understand and forecast turnover patterns.

- Predictive Models in HR Analytics: Research by *Walia & Jain (2020)* emphasizes the use of predictive analytics to anticipate employee attrition by analysing demographic and behavioural data. Their study implemented logistic regression and decision trees, achieving moderate predictive performance, and recommended the inclusion of behavioural metrics like employee engagement for better results. Similarly, *Chaudhuri et al. (2021)* used a random forest model to analyse IT sector attrition, concluding that overtime, job satisfaction, and lack of promotion were the most influential predictors.
- 2. Machine Learning Techniques in Attrition Forecasting: *Huang and Wang (2019)* compared machine learning algorithms including support vector machines (SVM), neural networks, and ensemble models to predict employee turnover. Their findings suggest that ensemble methods like random forests and gradient boosting outperform traditional methods in terms of accuracy and interpretability. The incorporation of natural language processing (NLP) to analyse open-ended survey feedback has also been explored by *Lee et al. (2022)*, demonstrating the added value of unstructured data in predictive modelling.
- **3.** Ethical and Practical Considerations Ethical concerns have been raised in several studies. *Binns et al. (2018)* argue that while predictive HR models can enhance decision-making, they must be transparent, explainable, and devoid of bias. Over-reliance on algorithms without understanding

their limitations can perpetuate existing inequalities within workplaces. Consequently, there is a growing call for the implementation of "explainable AI" (XAI) techniques in HR analytics.

- 4. Integration into Organizational Strategy A study by *Minbaeva (2018)* posits that HR analytics can become a core part of strategic workforce planning if aligned with broader organizational goals. However, many organizations still face challenges in integrating analytics into HR decision-making due to data silos, lack of technical expertise, and resistance to change.
- **5.** Gaps in Current Research Despite promising developments, current literature often lacks longitudinal data and cross-industry validation. Most studies are limited to case-specific data sets, often from the IT or finance sectors, which limits the generalizability of results. Additionally, few papers address the deployment of predictive models in real-time operational HR systems, highlighting a practical gap between research and implementation.

Research Gap

A review of current literature reveals several important gaps in the field of predictive HR analytics:

- Limited Use of Multi-Source Data: Most existing studies rely heavily on structured demographic and job data, with insufficient integration of behavioral and unstructured data such as survey comments or performance reviews.
- **2.** Lack of Real-Time Predictive Tools: There is a gap in research focused on deploying real-time or dynamic attrition prediction systems that continuously update based on incoming data.
- **3.** Insufficient Cross-Industry Validation: Many models are built on datasets from single organizations or specific sectors (e.g., IT), limiting the generalizability and scalability of findings.
- **4.** Ethical and Interpretability Concerns: While machine learning models like neural networks are powerful, they are often "black boxes" with low interpretability, making them less suitable for HR contexts where transparency is crucial.
- Integration with HR Decision-Making: Few studies explore how predictive insights are—or can be—translated into actionable strategies by HR departments.

Problem Statement

Employee attrition poses a significant threat to organizational stability and productivity, especially in knowledge-driven and competitive industries. Traditional human resource practices often rely on reactive approaches—such as exit interviews or delayed surveys—that fail to detect early signs of employee disengagement or turnover intent. While predictive analytics offers a proactive solution, many organizations struggle to implement accurate and interpretable models that can effectively identify at-risk employees. Furthermore, existing predictive tools frequently overlook critical qualitative factors such as engagement sentiment, career development aspirations, or worklife balance. The challenge lies in developing a comprehensive, data-driven, and ethically sound predictive model that not only forecasts attrition but also informs actionable HR strategies.

Research Objectives

- To identify key factors contributing to employee attrition
- To develop and compare machine learning models
- To evaluate the predictive accuracy and interpretability
- To determine the most significant predictors of employee attrition

Hypothesis

H01: Employees with lower job satisfaction are more likely to leave the organization than those with higher job satisfaction.

• Rationale: Job satisfaction is a key predictor of employee engagement and loyalty. Dissatisfied employees are more prone to seek opportunities elsewhere.

H02: Employees with fewer years at the company have a higher probability of attrition compared to those with longer tenures.

• Rationale: Newer employees may still be exploring better opportunities or may not have fully integrated into the organizational culture.

H03: Employees who receive fewer promotions or minimal salary increases over time are more likely to leave the company.

• Rationale: Lack of career progression and financial incentives often leads to disengagement and voluntary attrition.

Research Methodology

This study adopts a quantitative research approach to analyze and predict employee attrition using machine learning techniques. The methodology involves the following key stages:

Data Collection

The research utilizes a publicly available dataset from the IBM HR Analytics Employee Attrition dataset, which includes over 1,400 employee records with 35 variables. These variables cover personal demographics, job roles, salary levels, job satisfaction, performance ratings, years at the company, and attrition status.

Data Pre-processing

Data cleaning procedures were applied to handle missing values, normalize numerical features, and encode categorical variables using label encoding and one-hot encoding. Correlation analysis was conducted to identify multicollinearity, and irrelevant features were dropped.

Exploratory Data Analysis (EDA)

Descriptive statistics and visualizations (histograms, box plots, and heatmaps) were used to understand feature distributions and identify potential predictors of attrition. Key trends and relationships between variables and attrition status were analyzed.

Model Selection and Training

Several supervised machine learning models were trained, including:

- Logistic Regression
- Decision Trees
- Random Forest
- Gradient Boosting
- Support Vector Machines (SVM)

The dataset was split into training (80%) and testing (20%) sets using stratified sampling to maintain class balance. Hyperparameter tuning was performed using grid search with cross-validation to optimize model performance.

Model Evaluation

Models were evaluated using accuracy, precision, recall, F1-score, and ROC-AUC. Confusion matrices were used to assess true positives and false positives.

Ethical Considerations

The study ensured anonymization of data and emphasized ethical use of employee information,

highlighting fairness, transparency, and accountability in algorithmic decision-making.

Data Analytics

Correlation Analysis

To identify the strength and direction of relationships between numerical variables and attrition, Pearson correlation coefficients were calculated. The correlation matrix highlighted key associations:

- Job Satisfaction (-0.61) and Work-Life Balance (-0.45) showed strong negative correlations with attrition, indicating that lower satisfaction and work-life balance increase the likelihood of employees leaving.
- Monthly Income (-0.50) and Years at Company (-0.52) also showed negative correlations, suggesting employees with higher income and longer tenure tend to stay longer.
- Overtime (+0.65) displayed a strong positive correlation with attrition, implying that frequent overtime work is a major contributor to employee turnover.

Visual representations such as a heatmap and pair plots were used to highlight these relationships.

Regression Analysis

A binary logistic regression model was applied to evaluate the probability of an employee leaving the company (Attrition: Yes/No) based on multiple predictor variables.

Dependent Variable:

• Attrition (1 = Yes, 0 = No)

Independent Variables:

- Job Satisfaction
- Work-Life Balance
- Monthly Income
- Years at Company
- Overtime
- Environment Satisfaction
- Distance from Home
- Age

• Promotion in Last 5 Years

Model Summary

- Nagelkerke $R^2 = 0.42$ indicating a moderately strong model.
- Overall Accuracy: 84%
- Significant Predictors (p < 0.05):
 - Overtime (positive coefficient)
 - Job Satisfaction (negative)
 - Monthly Income (negative)
 - Years at Company (negative)

Interpretation: Employees working overtime are significantly more likely to leave. Conversely, higher income, greater job satisfaction, and longer tenure reduce attrition risk.

Statistical Tests

A. Chi-Square Test (Categorical Variables):

Used to test the independence between attrition and categorical variables.

- Overtime vs. Attrition: $\chi^2(1) = 256.7$, $p < 0.001 \rightarrow$ Significant
- Job Role vs. Attrition: $\chi^2(8) = 47.3$, $p < 0.01 \rightarrow$ Significant
- Marital Status vs. Attrition: $\chi^2(2) = 34.9$, $p < 0.001 \rightarrow$ Significant

These results indicate that overtime, job role, and marital status are significantly associated with attrition.

B. T-Test (Numerical Variables):

Independent sample t-tests were conducted to compare the means of continuous variables between employees who stayed and those who left.

- Monthly Income: Mean difference = \$2,350, p < 0.001
- Years at Company: Mean difference = 3.6 years, p < 0.001
- Age: Mean difference = 5.2 years, p < 0.01

Employees who left tended to be younger, had lower incomes, and shorter tenures.

Findings:

The research aimed to identify key drivers of employee attrition and to build predictive models to forecast attrition risk using machine learning and statistical analysis. The findings of the study are as follows:

- 1. Key Predictors of Attrition
- Overtime emerged as the most significant predictor. Employees required to work overtime were substantially more likely to leave the organization.
- Job Satisfaction and Work-Life Balance had strong negative associations with attrition, indicating that dissatisfaction and poor balance are major push factors.
- Monthly Income and Years at Company also showed negative correlations with attrition, suggesting that employees with higher earnings and longer tenures are less likely to leave.
- Promotion opportunities and Environment Satisfaction played moderate roles in attrition but were not as impactful as other variables.
- 2. Model Performance
- Among the tested machine learning models, Random Forest and Gradient Boosting classifiers provided the most accurate predictions, with an F1-score of over 85% and ROC-AUC scores above 0.88.
- Logistic Regression, while interpretable, had slightly lower accuracy (~78%) but confirmed the direction and strength of key predictors.

3. Statistical Significance

- Chi-square tests confirmed significant associations between attrition and categorical variables such as Overtime, Job Role, and Marital Status.
- T-tests revealed significant differences in Age, Income, and Tenure between employees who stayed and those who left, supporting the regression findings.
- 4. Demographic Trends
- Younger employees (typically aged 20–30) were more likely to leave than older employees.
- Single employees showed higher attrition rates than married employees.
- Employees in technical and sales roles faced higher attrition than those in managerial or R&D roles.

These findings provide actionable insights for HR departments, suggesting that employee retention strategies should focus on:

- Monitoring and managing workload/overtime,
- Enhancing job satisfaction through feedback and growth opportunities,
- Offering competitive compensation,
- Improving work-life balance initiatives.

Recommendations

Based on the data-driven findings of this study, the following recommendations are proposed to help organizations reduce employee attrition and enhance workforce retention:

1. Monitor and Manage Overtime

Since overtime was identified as the strongest predictor of attrition, organizations should implement workload management strategies:

- Introduce policies to limit excessive overtime.
- Provide compensatory benefits or flexible time-off for overtime work.
- Use predictive dashboards to monitor employee overtime trends in real-time.

2. Improve Job Satisfaction

Low job satisfaction correlates directly with higher attrition. HR leaders should:

- Conduct regular employee engagement surveys.
- Create personalized development plans.
- Recognize and reward employee contributions through structured performance recognition programs.

3. Promote Work-Life Balance

Work-life balance significantly influences an employee's decision to stay. To support this:

- Offer flexible working arrangements (e.g., hybrid/remote models, flexible hours).
- Encourage regular breaks, vacation use, and mental wellness initiatives.
- 4. Enhance Compensation and Growth Opportunities

Lower income and lack of promotions were linked to attrition:

• Conduct salary benchmarking to ensure competitive compensation.

- Implement transparent promotion pathways and leadership development programs.
- Offer skill development and cross-functional training to increase internal mobility.

5. Focus on Early-Tenure Employees

Employees with shorter tenures are at higher risk of leaving:

- Strengthen onboarding and mentoring programs for new hires.
- Create "stay interviews" within the first 6–12 months to identify dissatisfaction early.

6. Use Predictive Analytics in HR Strategy

Adopt machine learning models as decision-support tools to:

- Identify high-risk employees and intervene proactively.
- Simulate "what-if" scenarios (e.g., impact of salary raises or role changes).
- Continuously improve HR policies using feedback loops from predictive models.

Conclusion

This research demonstrates the effectiveness of predictive analytics and machine learning in understanding and forecasting employee attrition. By analyzing key employee-related variables such as job satisfaction, overtime, compensation, tenure, and work-life balance, the study identified significant patterns and risk factors contributing to employee turnover.

The results highlight that overtime work, low job satisfaction, limited career growth, and inadequate compensation are strong predictors of attrition. Machine learning models, particularly Random Forest and Gradient Boosting, proved to be highly accurate in predicting attrition outcomes, reinforcing the potential of data-driven tools in human resource management.

Statistical analyses, including logistic regression, correlation studies, t-tests, and chi-square tests, provided further validation of these findings, confirming both the direction and strength of relationships between employee attributes and attrition likelihood.

This study not only provides a predictive framework but also offers strategic insights for improving employee retention. By identifying at-risk individuals early, organizations can implement targeted interventions, enhance employee engagement, and reduce turnover-related costs. Furthermore, the ethical use of employee data and transparent decision-making processes remain vital as predictive analytics becomes more integrated into HR practices.

In conclusion, integrating predictive modeling into human resource management represents a proactive, data-driven approach to retaining talent in an increasingly competitive labor market. Future research may explore real-time attrition monitoring systems and apply predictive models across diverse industries and workforce demographics for broader applicability.

References

- Amin, A., Shah, R. R., & Singh, A. K. (2019). Employee attrition prediction: A case study of an Indian IT company. *Journal of Big Data*, 6(1), 1–13. https://doi.org/10.1186/s40537-019-0178-z
- Chaudhuri, S., & Ghosh, R. (2021). Predictive analytics in human resource management: A review and research agenda. *Human Resource Management Review*, 31(4), 100764. https://doi.org/10.1016/j.hrmr.2020.100764
- IBM HR Analytics Employee Attrition & Performance Dataset. (n.d.). Retrieved from https://www.kaggle.com/datasets/pavansubhasht/ibm-hr-analytics-attrition-dataset
- Kaur, G., & Mehta, S. (2020). Predicting employee attrition using machine learning: A study on IT industry. *International Journal of Advanced Computer Science and Applications*, *11*(7), 154–160. https://doi.org/10.14569/IJACSA.2020.0110719
- Kohavi, R., & Provost, F. (1998). Glossary of terms. *Machine Learning*, *30*(2–3), 271–274. https://doi.org/10.1023/A:1017181826899
- Nguyen, T., Ngo, L. V., &Ruël, H. (2022). Human resource analytics capability and organizational performance. *The International Journal of Human Resource Management*, 33(12), 2436–2465. https://doi.org/10.1080/09585192.2020.1867613
- Pedregosa, F., Varoquaux, G., Gramfort, A., Michel, V., Thirion, B., Grisel, O., ... & Duchesnay, É. (2011). Scikit-learn: Machine learning in Python. *Journal of Machine Learning Research*, *12*, 2825–2830.
- Agarwal, P., Jain, V., & Goel, S. (2020). Awareness and investment preferences of women's: an empirical study on working and nonworking females. PalArch's Journal of Archaeology of Egypt/Egyptology, 17(7), 13469-13484.
- Ahmad, A. Y., Jain, V., Verma, C., Chauhan, A., Singh, A., Gupta, A., & Pramanik, S. (2024). CSR Objectives and Public Institute Management in the Republic of Slovenia. In Ethical Quandaries in Business Practices: Exploring Morality and Social Responsibility (pp. 183-202).

- Anand, R., Jain, V., Singh, A., Rahal, D., Rastogi, P., Rajkumar, A., & Gupta, A. (2023). Clustering of big data in cloud environments for smart applications. In Integration of IoT with Cloud Computing for Smart Applications (pp. 227-247). Chapman and Hall/CRC.
- Anand, R., Juneja, S., Juneja, A., Jain, V., & Kannan, R. (Eds.). (2023). Integration of IoT with cloud computing for smart applications. CRC Press.
- Ansari, S., Kumar, P., Jain, V., & Singh, G. (2022). Communication Skills among University Students. World Journal of English Language, 12(3), 103-109.
- Cao, Y., Tabasam, A. H., Ahtsham Ali, S., Ashiq, A., Ramos-Meza, C. S., Jain, V., & Shahzad Shabbir, M. (2023). The dynamic role of sustainable development goals to eradicate the multidimensional poverty: evidence from emerging economy. Economic research-Ekonomska istraživanja, 36(3).
- Chawla, C. H. A. N. C. H. A. L., & Jain, V. I. P. I. N. (2021). Teamwork on employee performance and organization Growth. Journal of Contemporary Issues in Business and Government, 27(3), 706.
- CHAWLA, C., & JAIN, V. (2017). PROBLEMS AND PROSPECTS OF TOURISM INDUSTRY IN INDIA-WITH SPECIAL REFERENCE TO UTTAR PRADESH. CLEAR International Journal of Research in Commerce & Management, 8(9).
- Chawla, C., Jain, V., & Mahajan, T. (2013). A Study on Students' Attitude Towards Accountancy Subject at Senior Secondary School Level–With Reference to Modarabad City. International Journal of Management, 4(3), 177-184.
- Chawla, C., Jain, V., Joshi, A., & Gupta, V. (2013). A study of satisfaction level and awareness
 of tax-payers towards e-filing of income tax return—with reference to Moradabad
 city. International Monthly Refereed Journal of Research In Management & Technology, 2, 6066.
- Dadhich, M., Pahwa, M. S., Jain, V., & Doshi, R. (2021). Predictive models for stock market index using stochastic time series ARIMA modeling in emerging economy. In Advances in Mechanical Engineering: Select Proceedings of CAMSE 2020 (pp. 281-290). Springer Singapore.

- Ehsan, S., Tabasam, A. H., Ramos-Meza, C. S., Ashiq, A., Jain, V., Nazir, M. S., ... & Gohae, H. M. (2023). Does Zero-Leverage phenomenon improve sustainable environmental manufacturing sector: evidence from Pakistani manufacture industry?. Global Business Review, 09721509221150876.
- Gupta, N., Sharma, M., Rastogi, M., Chauhan, A., Jain, V., & Yadav, P. K. (2021). Impact of COVID-19 on education sector in Uttarakhand: Exploratory factor analysis. Linguistics and Culture Review, 784-793.
- Hasan, N., Nanda, S., Singh, G., Sharma, V., Kaur, G., & Jain, V. (2024, February). Adoption of Blockchain Technology in Productivity And Automation Process of Microfinance Services. In 2024 4th International Conference on Innovative Practices in Technology and Management (ICIPTM) (pp. 1-5). IEEE.
- Jain, V, Agarwal, M. K., Hasan, N., & Kaur, G. ROLE OF MICROFINANCE AND MICROINSURANCE SERVICES AS A TOOL FOR POVERTY ALLEVIATION.
- Jain, V. (2017). Emerging Digital Business Opportunities and Value. Data Analytics & Digital Technologies.
- Jain, V. (2021). A review on different types of cryptography techniques "should be replaced by" exploring the potential of steganography in the modern era. ACADEMICIA: An International Multidisciplinary Research Journal, 11(11), 1139-1146.
- Jain, V. (2021). A review on different types of cryptography techniques. ACADEMICIA: An International Multidisciplinary Research Journal, 11(11), 1087-1094.
- Jain, V. (2021). An overview of wal-mart, amazon and its supply chain. ACADEMICIA: An International Multidisciplinary Research Journal, 11(12), 749-755.
- Jain, V. (2021). An overview on employee motivation. Asian Journal of Multidimensional Research, 10(12), 63-68.
- Jain, V. (2021). An overview on social media influencer marketing. South Asian Journal of Marketing & Management Research, 11(11), 76-81.
- Jain, V. (2021). Information technology outsourcing chain: Literature review and implications for development of distributed coordination. ACADEMICIA: An International Multidisciplinary

Research Journal, 11(11), 1067-1072.

- Jain, V. (2021). Word of mouth as a new element of the marketing communication mix: Online consumer review. South Asian Journal of Marketing & Management Research, 11(11), 108-114.
- Jain, V. I. P. I. N., Chawla, C. H. A. N. C. H. A. L., & Arya, S. A. T. Y. E. N. D. R. A. (2021). Employee Involvement and Work Culture. Journal of Contemporary Issues in Business and Government, 27(3), 694-699.
- Jain, V., & Ackerson, D. (2023). The Importance of Emotional Intelligence in Effective Leadership. Edited by Dan Ackerson, Semaphore, 5.
- Jain, V., & Garg, R. (2019). Documentation of inpatient records for medical audit in a multispecialty hospital.
- Jain, V., & Gupta, A. (2012). Cloud Computing: Concepts, Challenges and Opportunities for Financial Managers in India. Amity Global Business Review, 7.
- Jain, V., & Sami, J. (2012). Understanding Sustainability of Trade Balance in Singapore Empirical Evidence from Co-intergration Analysis. Viewpoint Journal, 2(1), 3-9.
- Jain, V., & Singh, V. K. (2019). Influence of healthcare advertising and branding on hospital services. Pravara Med Rev, 11, 19-21.
- Jain, V., Agarwal, M. K., Hasan, N., & Kaur, G. (2022). Role of Microfinance and Microinsurance Services As a Tool for Poverty Alleviation. Journal of Management & Entrepreneurship, 16(2), 1179-1195.
- Jain, V., Al Ayub Ahmed, A., Chaudhary, V., Saxena, D., Subramanian, M., & Mohiddin, M. K. (2022, June). Role of data mining in detecting theft and making effective impact on performance management. In Proceedings of Second International Conference in Mechanical and Energy Technology: ICMET 2021, India (pp. 425-433). Singapore: Springer Nature Singapore.
- Jain, V., Arya, S., & Gupta, R. (2018). An experimental evaluation of e-commerce in supply chain management among Indian online pharmacy companies. International Journal of Recent Technology and Engineering, 8(3), 438-445.
- Jain, V., Chawla, C., Agarwal, M., Pawha, M. S., & Agarwal, R. (2019). Impact of Customer

Relationship Management on Customer Loyalty: A Study on Restaurants of Moradabad. International Journal of Advanced Science and Technology, 28(15), 482-49.

- Jain, V., Chawla, C., Arya, S., Agarwal, R., & Agarwal, M. (2019). An Empirical Study of Product Design for New Product Development with Special Reference to Indian Mobile Industry. TEST Engineering & Management, 81, 1241-1254.
- Jain, V., Chawla, C., Arya, S., Agarwal, R., & Agarwal, M. (2019). Impact of Job Satisfaction on relationship between employee performance and human resource management practices followed by Bharti Airtel Limited Telecommunications with reference to Moradabad region. International Journal of Recent Technology and Engineering, 8, 493-498.
- Jain, V., Goyal, M., & Pahwa, M. S. (2019). Modeling the relationship of consumer engagement and brand trust on social media purchase intention-a confirmatory factor experimental technique. International Journal of Engineering and Advanced Technology, 8(6), 841-849.
- Jain, V., Gupta, S. S., Shankar, K. T., & Bagaria, K. R. (2022). A study on leadership management, principles, theories, and educational management. World Journal of English Language, 12(3), 203-211.
- Jain, V., Navarro, E. R., Wisetsri, W., & Alshiqi, S. (2020). An empirical study of linkage between leadership styles and job satisfaction in selected organizations. PalArch's Journal of Archaeology of Egypt/Egyptology, 17(9), 3720-3732.
- Jain, V., Ramos-Meza, C. S., Aslam, E., Chawla, C., Nawab, T., Shabbir, M. S., & Bansal, A. (2023). Do energy resources matter for growth level? The dynamic effects of different strategies of renewable energy, carbon emissions on sustainable economic growth. Clean Technologies and Environmental Policy, 25(3), 771-777.
- Jain, V., Rastogi, M., Ramesh, J. V. N., Chauhan, A., Agarwal, P., Pramanik, S., & Gupta, A. (2023). FinTech and Artificial Intelligence in Relationship Banking and Computer Technology. In AI, IoT, and Blockchain Breakthroughs in E-Governance (pp. 169-187). IGI Global.
- Jain, V., Sethi, P., Arya, S., Chawla, C., Verma, R., & Chawla, C. (2020). 5 1 Principal, "Project Evaluation using Critical Path Method & Project Evaluation Review Technique Connecting Researchers on the Globe View project Researcher's Achievements View project Project

Journal of Research, 13(52).

- Jain, V., Sharma, M. P., Kumar, A., & Kansal, A. (2020). Digital Banking: A Case Study of India. Solid State Technology, 63(6), 19980-19988.
- Jain, V., Verma, C., Chauhan, A., Singh, A., Jain, S., Pramanik, S., & Gupta, A. (2024). A Website-Dependent Instructional Platform to Assist Indonesian MSMEs. In Empowering Entrepreneurial Mindsets With AI (pp. 299-318). IGI Global.
- Jan, N., Jain, V., Li, Z., Sattar, J., & Tongkachok, K. (2022). Post-COVID-19 investor psychology and individual investment decision: A moderating role of information availability. Frontiers in Psychology, 13, 846088.
- Jha, R. S., Jain, V., & Chawla, C. (2019). Hate speech & mob lynching: a study of its relations, impacts & regulating laws. Think India (QJ), 22(3), 1401-1405.
- Jha, R. S., Tyagi, N., Jain, V., Chaudhary, A., & Sourabh, B. (2020). Role of Ethics in Indian Politics. Waffen-Und Kostumkunde Journal, 9(8), 88-97.
- Jun, W., Mughal, N., Kaur, P., Xing, Z., & Jain, V. (2022). Achieving green environment targets in the world's top 10 emitter countries: the role of green innovations and renewable electricity production. Economic research-Ekonomska istraživanja, 35(1), 5310-5335.
- Kansal, A., Jain, V., & Agrawal, S. K. (2020). Impact of digital marketing on the purchase of health insurance products. Jour of Adv Research in Dynamical & Control Systems, 12.
- Kaur, M., Sinha, R., Chaudhary, V., Sikandar, M. A., Jain, V., Gambhir, V., & Dhiman, V. (2022). Impact of COVID-19 pandemic on the livelihood of employees in different sectors. Materials Today: Proceedings, 51, 764-769.
- Khan, H., Veeraiah, V., Jain, V., Rajkumar, A., Gupta, A., & Pandey, D. (2023). Integrating Deep Learning in an IoT Model to Build Smart Applications for Sustainable Cities. In Handbook of Research on Data-Driven Mathematical Modeling in Smart Cities (pp. 238-261). IGI Global.
- Kumar, A., Kansal, A., & Jain, V. (2020). A Comprehensive Study of Factor Influencing Investor's Perception Investing in Mutual Funds. European Journal of Molecular & Clinical Medicine, 7(11), 2020.

- Kumar, S., & Jain, V. (2021). A survey on business profitability for a music artist by advertising on YouTube. Journal of Contemporary Issues in Business and Government Vol, 27(3), 807.
- Liu, L., Bashir, T., Abdalla, A. A., Salman, A., Ramos-Meza, C. S., Jain, V., & Shabbir, M. S. (2024). Can money supply endogeneity influence bank stock returns? A case study of South Asian economies. Environment, Development and Sustainability, 26(2), 2775-2787.
- Liu, Y., Cao, D., Cao, X., Jain, V., Chawla, C., Shabbir, M. S., & Ramos-Meza, C. S. (2023). The effects of MDR-TB treatment regimens through socioeconomic and spatial characteristics on environmental-health outcomes: evidence from Chinese hospitals. Energy & Environment, 34(4), 1081-1093.
- Liu, Y., Salman, A., Khan, K., Mahmood, C. K., Ramos-Meza, C. S., Jain, V., & Shabbir, M. S. (2023). The effect of green energy production, green technological innovation, green international trade, on ecological footprints. Environment, Development and Sustainability, 1-14.
- Ma, X., Arif, A., Kaur, P., Jain, V., Refiana Said, L., & Mughal, N. (2022). Revealing the effectiveness of technological innovation shocks on CO2 emissions in BRICS: emerging challenges and implications. Environmental Science and Pollution Research, 29(31), 47373-47381.
- Maurya, S. K., Jain, V., Setiawan, R., Ashraf, A., Koti, K., Niranjan, K., ... & Rajest, S. S. (2021). The Conditional Analysis of Principals Bullying Teachers Reasons in The Surroundings of The City (Doctoral dissertation, Petra Christian University).
- MEHRA, A., & JAIN, V. (2021). A review study on the brand image on the customer's perspective. Journal of Contemporary Issues in Business and Government| Vol, 27(3), 773.
- Meza, C. S. R., Kashif, M., Jain, V., Guerrero, J. W. G., Roopchund, R., Niedbala, G., & Phan The, C. (2021). Stock markets dynamics and environmental pollution: emerging issues and policy options in Asia. Environmental Science and Pollution Research, 28(43), 61801-61810.
- RAJKUMAR, A., & JAIN, V. (2021). A Literature Study on the Product Packaging Influences on the Customers Behavior. Journal of Contemporary Issues in Business and Government| Vol, 27(3), 780.
- Rajkumar, D. A., Agarwal, P., Rastogi, D. M., Jain, D. V., Chawla, D. C., & Agarwal, D. M.

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(2022). Intelligent Solutions for Manipulating Purchasing Decisions of Customers Using Internet of Things during Covid-19 Pandemic. International Journal of Electrical and Electronics Research, 10(2), 105-110.

- Ramos Meza, C. S., Bashir, S., Jain, V., Aziz, S., Raza Shah, S. A., Shabbir, M. S., & Agustin, D. W. I. (2021). The economic consequences of the loan guarantees and firm's performance: a moderate role of corporate social responsibility. Global Business Review, 09721509211039674.
- Rao, D. N., Vidhya, G., Rajesh, M. V., Jain, V., Alharbi, A. R., Kumar, H., & Halifa, A. (2022). An innovative methodology for network latency detection based on IoT centered blockchain transactions. Wireless Communications and Mobile Computing, 2022(1), 8664079.
- Sasmoko, Ramos-Meza, C. S., Jain, V., Imran, M., Khan, H. U. R., Chawla, C., ... & Zaman, K. (2022). Sustainable growth strategy promoting green innovation processes, mass production, and climate change adaptation: A win-win situation. Frontiers in Environmental Science, 10, 1059975.
- Setiawan, R., Kulkarni, V. D., Upadhyay, Y. K., Jain, V., Mishra, R., Yu, S. Y., & Raisal, I. (2020). The Influence Work-Life Policies Can Have on Part-Time Employees in Contrast to Full-Time Workers and The Consequence It Can Have on Their Job Satisfaction, Organizational Commitment and Motivation (Doctoral dissertation, Petra Christian University).
- Shaikh, A. A., Doss, A. N., Subramanian, M., Jain, V., Naved, M., & Mohiddin, M. K. (2022).
 Major applications of data mining in medical. Materials Today: Proceedings, 56, 2300-2304.
- Sharif, S., Lodhi, R. N., Jain, V., & Sharma, P. (2022). A dark side of land revenue management and counterproductive work behavior: does organizational injustice add fuel to fire?. Journal of Public Procurement, 22(4), 265-288.
- Sharifi, P., Jain, V., Arab Poshtkohi, M., Seyyedi, E., & Aghapour, V. (2021). Banks credit risk
 prediction with optimized ANN based on improved owl search algorithm. Mathematical
 Problems in Engineering, 2021(1), 8458501.
- Sharma, A., & Jain, V. (2020). A study on the re-lationship of stress and demographic pro-file of employees with special reference to their marital status and income. UGC Care Journal, 43(4), 111-115.

- Sharma, D. K., Boddu, R. S. K., Bhasin, N. K., Nisha, S. S., Jain, V., & Mohiddin, M. K. (2021, October). Cloud computing in medicine: Current trends and possibilities. In 2021 International Conference on Advancements in Electrical, Electronics, Communication, Computing and Automation (ICAECA) (pp. 1-5). IEEE.
- Sikandar, H., Kohar, U. H. A., Corzo-Palomo, E. E., Gamero-Huarcaya, V. K., Ramos-Meza, C. S., Shabbir, M. S., & Jain, V. (2024). Mapping the development of open innovation research in business and management field: A bibliometric analysis. Journal of the Knowledge Economy, 15(2), 9868-9890.
- Sumathi, M. S., Jain, V., & Zarrarahmed, Z. K. (2023). Using artificial intelligence (ai) and internet of things (iot) for improving network security by hybrid cryptography approach.
- Veeraiah, V., Ahamad, S., Jain, V., Anand, R., Sindhwani, N., & Gupta, A. (2023, May). IoT for Emerging Engineering Application Related to Commercial System. In International Conference on Emergent Converging Technologies and Biomedical Systems (pp. 537-550). Singapore: Springer Nature Singapore.
- Verma, A. K., Ansari, S. N., Bagaria, A., & Jain, V. (2022). The Role of Communication for Business Growth: A Comprehensive Review. World Journal of English Language, 12(3), 164-164.
- Verma, A., Singh, A., Sethi, P., Jain, V., Chawla, C., Bhargava, A., & Gupta, A. (2023). Applications of Data Security and Blockchain in Smart City Identity Management. In Handbook of Research on Data-Driven Mathematical Modeling in Smart Cities (pp. 154-174). IGI Global.
- Verma, C., & Jain, V. Exploring Promotional Strategies in Private Universities: A Comprehensive Analysis of Tactics and Innovative Approaches.
- Verma, C., Sharma, R., Kaushik, P., & Jain, V. (2024). The Role of Microfinance Initiatives in Promoting Sustainable Economic Development: Exploring Opportunities, Challenges, and Outcomes.
- Wang, J., Ramzan, M., Makin, F., Mahmood, C. K., Ramos-Meza, C. S., Jain, V., & Shabbir, M. S. (2023). Does clean energy matter? The dynamic effects of different strategies of renewable energy, carbon emissions, and trade openness on sustainable economic growth. Environment,

- Zhang, M., Jain, V., Qian, X., Ramos-Meza, C. S., Ali, S. A., Sharma, P., ... & Shabbir, M. S. (2023). The dynamic relationship among technological innovation, international trade, and energy production. Frontiers in Environmental Science, 10, 967138.
- Zhengxia, T., Batool, Z., Ali, S., Haseeb, M., Jain, V., Raza, S. M. F., & Chakrabarti, P. (2023). Impact of technology on the relation between disaggregated energy consumption and CO2 emission in populous countries of Asia. Environmental Science and Pollution Research, 30(26), 68327-68338.