Journal of Information Systems Engineering and Management
2025, 10(41s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Two-Staged SEM-ANN Approach based Investigation of the Impact of Employee Turnover on Organizational Efficiency in Indian IT Companies

Devanshi Bareja[1], R.K. Ghai[2]
[1]*Research Scholar, Faculty of Management & Commerce, Swami Vivekanand Subharti University, Meerut, UP, India, Email: devanshiibareja@gmail.com (Primary Corresponding Author)*
[2]*Dean-FoMC & Director-AVGSCMC, Faculty of Management & Commerce, Swami Vivekanand Subharti University, Meerut, UP, India, Email: management@subharti.org*

ARTICLE INFO

Received: 29 Dec 2024

Revised: 15 Feb 2025

Accepted: 24 Feb 2025

ABSTRACT

Employee turnover is a critical challenge in the fast-paced and competitive Indian IT industry, significantly impacting organizational efficiency. This study employs an innovative Two-Staged Structural Equation Modeling-Artificial Neural Network (SEM-ANN) approach to explore the relationship between employee turnover and organizational efficiency, focusing on the mediating roles of employee engagement, retention policies, and management effectiveness, along with the moderating effect of organizational size. Data were collected from 556 employees in prominent IT companies using a stratified random sampling method and analyzed using both linear and non-linear modeling techniques. The findings reveal that employee turnover negatively impacts organizational efficiency (β = -0.391, $p < 0.05$), while employee engagement (β = 0.778), retention policies (β = 0.631), and management effectiveness (β = 0.877) positively influence it. Mediation analysis demonstrates that these variables mitigate turnover's adverse effects, with management effectiveness having the strongest mediating impact. Organizational size moderates the turnover-efficiency relationship, with larger organizations experiencing more pronounced negative effects. By integrating SEM and ANN, this study provides a comprehensive understanding of both direct and indirect relationships, offering actionable insights for practitioners to develop targeted HR strategies and enhance organizational performance.

Keywords: Employee Turnover; Organizational Efficiency; Employee Engagement; Retention Policies; Organizational Size.

1. INTRODUCTION

Employee turnover remains a pressing issue for organizations worldwide, particularly in the information technology (IT) sector, which operates in a highly dynamic and competitive environment (Hossain et al. 2024; Yadav and Yadav 2024). The challenges posed by high turnover rates extend beyond the immediate costs of recruitment and training, encompassing disruptions to team cohesion, loss of organizational knowledge, and reduced client satisfaction (Alhamad et al. 2024; Tomar 2019; Xuecheng, Iqbal, and Saina 2022). In the Indian IT industry, which contributes significantly to the nation's economy and global innovation landscape, addressing the impact of employee turnover is crucial for maintaining organizational stability and efficiency (Uraon 2018).

Organizational efficiency, defined as the optimal utilization of resources to achieve strategic objectives, is a key determinant of an organization's competitiveness and performance (Maan et al. 2020). In IT firms, efficiency is reflected through streamlined processes, effective project management, and the productive use of human capital (Dorta-Afonso et al. 2021). However, employee turnover can undermine these elements, causing project delays, reduced productivity, and decreased morale among remaining employees (Ghani et al. 2022). Given the critical importance of efficiency in the IT sector, understanding the mechanisms through which turnover affects efficiency is vital for formulating effective HR and organizational strategies.

Journal of Information Systems Engineering and Management
2025, 10(41s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

To address these challenges, this study adopts a Two-Staged Structural Equation Modeling-Artificial Neural Network (SEM-ANN) approach. SEM enables the analysis of complex linear relationships among variables, while ANN captures non-linear interactions, providing a robust methodological framework for exploring multifaceted organizational phenomena (Hair et al. 2019; Hanandeh, Ardah, and Abu-Farsakh 2020). This integration is particularly useful in contexts like employee turnover, where relationships between variables are seldom purely linear (Aboagye et al. 2016). By employing this hybrid approach, the study seeks to uncover deeper insights into the dynamics between employee turnover and organizational efficiency in the Indian IT sector.

Beyond turnover's direct impact, this research investigates mediating factors such as employee engagement, retention policies, and management effectiveness. These variables have been identified as critical levers for mitigating turnover's adverse effects and enhancing efficiency (Ghani et al. 2022). Employee engagement, characterized by employees' emotional commitment to their organization, has been consistently linked to improved organizational performance (Rahman 2017; Roshidi Hassan 2014; Saraf 2020). Retention policies, encompassing strategies like career development and flexible work arrangements, help reduce turnover and foster loyalty (Lazzari, Alvarez, and Ruggieri 2022). Similarly, effective management practices play a pivotal role in maintaining organizational stability and resilience during periods of high turnover (Al Balushi et al. 2022; Rubbab et al. 2022).

Additionally, the moderating role of organizational size is explored to capture the contextual nuances that influence the turnover-efficiency relationship. Larger organizations, with their complex structures and extensive interdependencies, may experience more pronounced impacts of turnover compared to smaller, more agile firms (Rahman and Karim 2022). By examining these mediators and moderators, this study provides a holistic understanding of the turnover-efficiency dynamic.

Based on this, this research makes theoretical and practical contributions by integrating mediating and moderating variables into a hybrid SEM-ANN framework. The findings aim to offer actionable insights for IT firms to develop targeted interventions, fostering organizational efficiency in the face of turnover challenges. Subsequent sections elaborate on the literature review, methodology, results, and implications, providing a comprehensive analysis of the studied phenomena.

2. LITERATURE REVIEW

Employee turnover is a unescapable challenge faced by organizations globally (Yan et al. 2022). In Indian IT industry, where retaining talent is critical to maintaining innovation and competitiveness, it is critical to understand how turnover affects organizational effectiveness.

2.1 Employee Turnover and Organizational Efficiency

Employee turnover is a widely recognized challenge with significant implications for organizational efficiency (Olusegun 2013; Roshidi Hassan 2014). While previous research has extensively documented the adverse effects of turnover such as increased recruitment costs, disruption of team dynamics, and reduced productivity (Halim et al. 2020; Kanchana and Jayathilaka 2023; Mossarah 2023), this study seeks to contribute to the field by examining these impacts in the context of the Indian IT industry, a sector characterized by high employee mobility and critical reliance on human capital (Olusegun 2013; Yang, Wan, and Fu 2012). Although the relationship between turnover and efficiency is well-trodden in organizational studies, this research addresses a gap by focusing on how the unique characteristics of the Indian IT sector shape these dynamics (Babajide 2010; Roshidi Hassan 2014). Thus, while acknowledging existing contributions, this study refines the research question to explore sector-specific nuances, hypothesizing that:

H1: Employee turnover negatively impacts organizational efficiency in IT companies in India.

2.2 Employee Engagement and Organizational Efficiency

The relationship between employee engagement and organizational efficiency is well-documented, with engaged employees demonstrating higher productivity, motivation, and commitment (Bangi and Mgeni 2022; Farooq et al. 2022). While this connection is not novel, the study advances the literature by investigating engagement as a mediator in the turnover-efficiency relationship (Halim et al. 2020; Lazzari et al. 2022). By integrating engagement

Journal of Information Systems Engineering and Management
2025, 10(41s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

into a holistic model, this research offers a nuanced understanding of how engagement moderates turnover's adverse effects, particularly in the Indian IT sector, where employee retention is critical to competitiveness (Ghani et al. 2022; Zhong, Zhang, and Wu 2022). Therefore:

H2: Employee engagement positively influences organizational efficiency in IT companies in India.

2.3 Retention Policies and Organizational Efficiency

Retention policies, including career development opportunities and flexible work arrangements, are well-known strategies for mitigating turnover (Chang et al. 2023; Xu et al. 2023). However, this study seeks to extend the existing literature by exploring retention policies as a mediating factor that buffers against turnover's negative impact on efficiency (Al-Taie and Khattak 2024; Joseph and Thomas 2024; Kersten et al. 2024). In doing so, it highlights the significance of tailored HR interventions in the Indian IT industry, where workforce dynamics demand innovative retention strategies (García-Arca, González-Portela Garrido, and Prado-Prado 2023; Rajashekar and Jain 2023). Consequently:

H3: Retention policies positively influence organizational efficiency in IT companies in India.

2.4 Management Effectiveness and Organizational Efficiency

While management effectiveness is a frequently studied determinant of organizational outcomes, this study contributes by situating it as both a direct influencer of efficiency and a mediator in the turnover-efficiency relationship (Kamel and Leithy 2023; Lee et al. 2023). This dual role underscores the importance of leadership practices that foster resilience and adaptability in the face of high turnover, particularly within large, complex organizations in the IT sector (Cachón-Rodríguez et al. 2022; Sinha, Likheshbhai Momaya, and Nidhi Kamleshkumar 2022; Zayed et al. 2022). Hence:

H4: Management effectiveness positively influences organizational efficiency in IT companies in India.

2.5 Theoretical Contribution: Mediating Role of Employee Engagement, Retention Policies, and Management Effectiveness

Although employee engagement, retention policies, and management effectiveness have been explored individually in prior studies, their combined mediating effects on the turnover-efficiency relationship remain underexplored (Basuvaraj and Jegadeeshwaran 2022; Xuecheng et al. 2022). This study offers a theoretical contribution by examining how these variables interact to buffer turnover's negative impact, providing a more comprehensive understanding of the mechanisms underlying organizational efficiency (Ghani et al. 2022; Shafaei, Nejati, and Mohd Yusoff 2020; Tej et al. 2021). Thus, the following hypotheses are proposed:

H5: Employee engagement mediates the relationship between employee turnover and organizational efficiency.

H6: Retention policies mediate the relationship between employee turnover and organizational efficiency.

H7: Management effectiveness mediates the relationship between employee turnover and organizational efficiency.

2.6 Theoretical Contribution: Moderating Role of Organizational Size

The moderating role of organizational size in the turnover-efficiency relationship remains underexplored, particularly in the context of the IT sector. This study addresses this gap by investigating how organizational size shapes the magnitude of turnover's impact, providing a contextual layer often overlooked in existing research (Lee and Chen 2018; Ramos 2019; Washington 2020). Larger organizations, with their intricate structures, may experience greater disruptions from turnover compared to smaller, more agile firms (AlKetbi and Rice 2024; Jia and Hou 2024; Papsiene 2024). Therefore:

H8: Organizational size moderates the relationship between employee turnover and organizational efficiency, with larger organizations experiencing greater negative impacts.

2.7 Research Gaps and Justification of Variables

Journal of Information Systems Engineering and Management
2025, 10(41s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

The mediating and moderating variables in this study—employee engagement, retention policies, management effectiveness, and organizational size—are frequently studied in organizational research. However, this paper contributes to the literature by examining these variables collectively within the Indian IT sector. The study provides a comprehensive framework to analyze their interdependencies and highlights their practical implications, bridging the gap between theoretical understanding and managerial application. This approach moves beyond isolated analyses, offering a more integrated perspective on organizational efficiency.

Additionally, the innovative use of a Two-Staged SEM-ANN approach distinguishes this study from prior research. While SEM effectively models linear relationships, ANN captures non-linear interactions, allowing a deeper exploration of the complex dynamics between turnover and efficiency (Hair et al. 2019; Yan et al. 2022). This methodological integration adds value by addressing limitations of traditional approaches, aligning theoretical contributions with methodological advancements (Aboagye et al. 2016; Henseler, Ringle, and Sarstedt 2015). By addressing these gaps, this research enriches the theoretical understanding of employee turnover and organizational efficiency, offering insights into their multifaceted relationships in a high-stakes industry. The conceptual model (Figure 1) encapsulates these relationships, providing a foundation for empirical investigation.

.

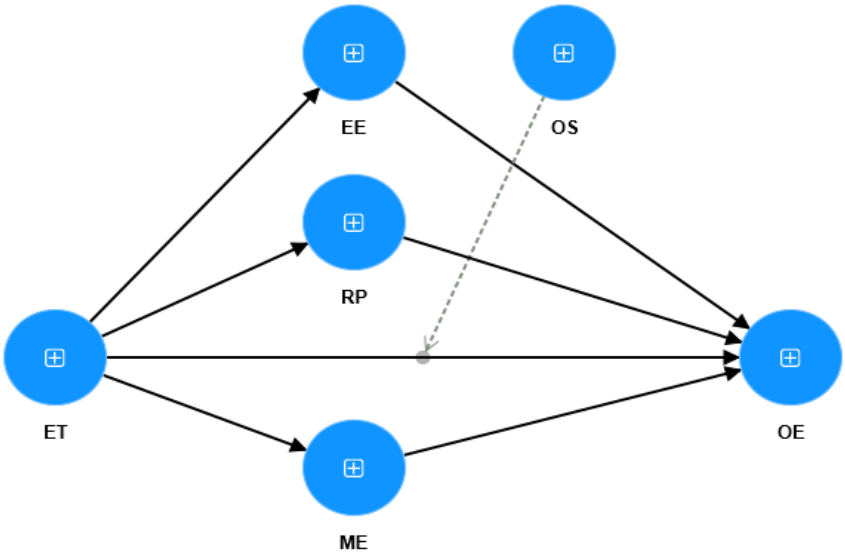

Figure 1. Conceptual Framework

3. SCALE DEVELOPMENT AND VALIDATION

The process of scale development and validation involved several critical steps to ensure reliability and validity of questionnaire (Aboagye et al. 2016). Initially, a comprehensive 52-item questionnaire was developed based on insights from literature review. Expert reviews were conducted to assess the relevance of each item, leading to the retention of 41 items deemed sufficiently relevant based on the Content Validity Ratio (CVR) analysis (Almanasreh, Moles, and Chen 2019). The CVR was calculated using Eq. (1):

$$CVR = \frac{N_e - \frac{N}{2}}{\frac{N}{2}} \quad (1)$$

Where: N_e denotes number of experts signifying "3" or "4" (items rated as highly relevant), and N denotes total number of experts. Items with CVR scores equal to or above predetermined 0.5 cut-off value were retained, indicating that at least half of the experts rated the items as highly relevant.

Subsequently, the exploratory factor analysis (EFA) aimed to uncover the latent factor structure and dimensions of retained items, resulting in a reduced set of 34 items. Confirmatory factor analysis (CFA) was then performed to validate factor structure identified through EFA, further refining the questionnaire to 31 items with robust covariance and factor loadings. Test-retest reliability was assessed through a survey conducted with a 40-day gap, demonstrating

Journal of Information Systems Engineering and Management
2025, 10(41s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

consistent responses over time. The final validated questionnaire, consisting of 31 items (Table 1), comprehensively covers the dimensions of Employee Turnover, Organizational Efficiency, Employee Engagement, Retention Policies & Management Effectiveness, and reflects both theoretical foundations and empirical evidence of construct validity, reliability, and discriminant validity.

Table 1 Variables and Measurement Items

Latent Variable	Symbol	Item
Employee Turnover (ET)	ET1	1. I am considering leaving my current organization due to job dissatisfaction.
	ET2	2. The turnover rate in my organization has increased over the past year.
	ET3	3. I have observed a significant number of colleagues leaving the organization recently.
	ET4	4. The turnover of key personnel has negatively impacted team morale.
	ET5	5. My organization struggles to retain talented employees.
	ET6	6. Management does not adequately address the reasons behind employee turnover.
Employee Engagement (EE)	EE1	1. I feel a strong sense of belonging to my organization.
	EE2	2. I am enthusiastic about my work and its impact on the organization.
	EE3	3. I actively seek opportunities to contribute beyond my job role.
	EE4	4. My organization values and recognizes my contributions.
	EE5	5. I am committed to the long-term success of my organization.
	EE6	6. My organization fosters a culture of collaboration and teamwork.
Retention Policies (RP)	RP1	1. My organization offers competitive salaries and benefits compared to industry standards.
	RP2	2. Opportunities for career advancement and professional growth are readily available in my organization.
	RP3	3. My organization provides flexible work arrangements to accommodate employees' needs.
	RP4	4. Employee training and development programs are well-established within my organization.
	RP5	5. My organization actively seeks feedback from employees to improve retention strategies.
	RP6	6. My organization offers attractive incentives to retain top-performing employees.
	RP7	7. Management demonstrates a genuine commitment to employee well-being and job satisfaction.
Management Effectiveness (ME)	ME1	1. My direct supervisor provides constructive feedback and guidance on a regular basis.
	ME2	2. Decision-making processes in my organization are transparent and inclusive.
	ME3	3. Managers in my organization lead by example and uphold ethical standards.
	ME4	4. There is effective communication between different levels of management.

Journal of Information Systems Engineering and Management
2025, 10(41s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

	ME5	5. Managers demonstrate a strong understanding of their team's strengths and weaknesses.
	ME6	6. Managers actively seek input from employees when making decisions that affect their work.
	ME7	7. Managers demonstrate flexibility and adaptability in response to changing circumstances.
Organizational Efficiency (OE)	OE1	1. Deadlines for projects and tasks are consistently met in my organization.
	OE2	2. My organization efficiently allocates resources to meet project requirements.
	OE3	3. Employees in my organization have access to the necessary tools and technology to perform their jobs effectively.
	OE4	4. Processes and workflows in my organization are regularly reviewed and optimized for efficiency.
	OE5	5. My organization encourages innovation and creativity to improve efficiency.

4. RESEARCH METHODOLOGY

4.1 Research Design

This study adopts a cross-sectional research design to investigate the relationships between employee turnover and organizational efficiency while examining the mediating roles of employee engagement, retention policies, and management effectiveness, along with the moderating role of organizational size. The choice of a cross-sectional design aligns with the objective of capturing current perceptions and behaviors across a diverse sample of employees in the Indian IT sector (Hair et al. 2019). The study employs a Two-Staged SEM-ANN approach, integrating SEM for hypothesis testing and ANN to capture non-linear relationships and interactions among variables (Hanandeh et al. 2020).

4.2 Sampling and Population

A stratified random sampling approach was utilized to ensure representation across key organizational and demographic segments. The population comprised employees from prominent Indian IT companies, including Tata Consultancy Services Limited, Tech Mahindra, Wipro Tech Limited, Infosys, C-DOT, ITI, Rail TEL, and MTNL. Stratification was based on organizational size (small, medium, and large firms), job roles, and hierarchical levels to capture diverse perspectives.

A total of 660 questionnaires were distributed via Google Forms, of which 556 valid responses were received, yielding an 84.24% response rate. The sample size meets the requirements for SEM analysis, as suggested by Hair et al. (2021), which recommends a range of 200 to 400 participants for complex models.

4.3 Data Collection

Data were collected between January 2024 and March 2024 using an online survey questionnaire. The questionnaire was developed based on validated scales from the literature and consisted of 31 items across five constructs: employee turnover, organizational efficiency, employee engagement, retention policies, and management effectiveness. Responses were recorded on a 5-point Likert scale ranging from "strongly disagree" to "strongly agree." Although online data collection offers efficiency and broad reach, potential biases, such as self-selection and response bias, were mitigated through clear instructions, anonymous responses, and quality checks (Evans and Mathur 2005).

4.5 Data Analysis

The collected data was analyzed using a two-staged approach. In first stage, SEM was employed to assess hypothesized relationships between employee turnover, engagement, retention policies, management effectiveness, and organizational efficiency. SEM allows for the investigation of intricate relationships between variables, providing

Journal of Information Systems Engineering and Management
2025, 10(41s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

a comprehensive understanding of data (Hair et al. 2019). In the second stage, ANN analysis was conducted to complement the SEM findings by capturing nonlinear relationships and interactions among variables. The ANN model was trained using the backpropagation algorithm, with multiple hidden layers to accommodate complex patterns in the data (Simon Haykin (McMaster University, Hamilton, Ontario 2005). Cross-validation techniques were employed to assess the robustness and generalizability of the ANN model, ensuring that the model's performance is not overly dependent on the training data (Yan et al. 2022). By combining SEM and ANN, the study effectively addresses potential methodological biases and leverages the strengths of both linear and non-linear analyses. This dual-method approach ensures robust and actionable insights, enhancing the study's relevance for IT firms seeking to mitigate the adverse effects of turnover and optimize organizational efficiency.

5. RESULTS AND DISCUSSION

5.1 General Information of Respondents

Table 2 provides a detailed breakdown of the demographic characteristics of the respondents involved in the study, which includes 556 employees from various IT organizations in India. The data reveals a fairly balanced gender distribution, with 49.28% male and 50.72% female respondents. In terms of age, the largest group is between 35-44 years (25.72%), followed by the 25-34 years age group (22.12%). The study includes a predominance of individuals with a bachelor's degree (76.08%), with smaller proportions holding a master's degree (18.88%) or a doctorate/professional degree (5.04%). The respondents' work experience is fairly distributed across different ranges, with 21.94% having 0-2 years, 18.17% with 2-4 years, and 21.58% with more than 8 years of experience. Regarding job roles, the survey includes various positions with no dominant role, though test managers (11.51%) and business analysts (8.81%) make up notable proportions. The size of the organizations represented varies, with medium-sized companies (50-500 employees) comprising the largest share (39.57%), followed by small (less than 50 employees) and large organizations (more than 500 employees), making up 34.53% and 25.90%, respectively. Department sizes were also diverse, with a significant number of respondents from small departments of less than 10 employees (26.44%) and larger departments of 10-50 employees (26.80%). Respondents came from a variety of prestigious IT companies, with Tata Consultancy Services (11.33%) and Tech Mahindra (12.05%) contributing to the largest proportions, followed closely by Infosys, Wipro, and other notable companies.

Table 2 General Information of Respondents

Demographic Variables	Category	Frequency	Percentage
1. Gender	Male	274	49.28%
	Female	282	50.72%
2. Age group	Under 25 years	101	18.17%
	25-34 years	123	22.12%
	35-44 years	143	25.72%
	45-54 years	114	20.50%
	55 years and above	75	13.49%
3. Education	Bachelor's Degree	423	76.08%
	Master's Degree	105	18.88%
	Doctorate or Professional Degree	28	5.04%
4. Work Experience	0-2 years	122	21.94%
	2-4 years	101	18.17%
	4-6 years	112	20.14%
	6-8 years	101	18.17%
	More than 8 years	120	21.58%
5. Role	Developer	54	9.71%
	Tester	49	8.81%
	Designer	53	9.53%

Journal of Information Systems Engineering and Management
2025, 10(41s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

	Test Manager	64	11.51%
	Project Manager	40	7.19%
	Software Engineer	43	7.73%
	Project Manager	48	8.63%
	Quality Assurance Analyst	54	9.71%
	Business Analyst	49	8.81%
	IT Support Specialist	51	9.17%
	Other	51	9.17%
6. Organization size	Small (less than 50 employees)	192	34.53%
	Medium (50-500 employees)	220	39.57%
	Large (more than 500 employees)	144	25.90%
7. Department Size	Less than 10 employees	147	26.44%
	10-50 employees	149	26.80%
	50-100 employees	148	26.62%
	More than 100 employees	112	20.14%
8. Name of Company	Tata Consultancy Services Limited	63	11.33%
	Tech Mahindra	67	12.05%
	Wipro Tech Limited	69	12.41%
	Infosys	69	12.41%
	C-DOT	71	12.77%
	ITI	74	13.31%
	Rail TEL	78	14.03%
	MTNL	65	11.69%

5.2 Descriptive Statistics and Common Method Bias (CMB)

The descriptive statistics provided in Table 3 reveal valuable insights into respondents' perceptions across the study's constructs. Mean scores ranged from 3.032 to 4.141, indicating a general tendency towards agreement with the survey questions. Standard deviation values, varying from approximately 0.928 to 1.196, suggest consistent variability within each construct. Skewness values, ranging from -1.465 to -0.021, imply slightly skewed but generally symmetrical distributions of responses, while kurtosis values, ranging from -1.282 to 2.381, suggest acceptable levels of peakedness or flatness compared to a normal distribution. These findings indicate that the empirical data exhibit characteristics of normality, bolstering the reliability of the analysis. Moreover, factor loadings ranging from 0.532 to 0.909 demonstrate the strength of association between each item and its underlying construct. All factor loadings exceed the commonly accepted threshold of 0.5, indicating satisfactory convergent validity. Additionally, variance inflation factor (VIF) values, representing multicollinearity, were observed for each factor loading (O'Brien 2007). With VIF values ranging from 1.886 to 5.684, all below the commonly accepted threshold of 10, there are no concerns regarding multicollinearity among the variables, ensuring the robustness of the regression analysis (O'Brien 2007). Moreover, Harman's single component test revealed that a single factor explains only 38.411 percent of the total variation, suggesting that common method bias is not a significant issue in this study (Yan et al. 2022).

Journal of Information Systems Engineering and Management
2025, 10(41s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Table 3 Descriptive Statistics

Variables	Items	Mean	Std. Deviation	Skewness	Kurtosis	Factor Loading	VIF
Employee Turnover (ET)	ET1	3.032	1.085	-1.375	1.399	0.532	1.982
	ET2	3.045	0.993	-1.022	0.516	0.821	4.053
	ET3	3.102	0.964	-1.405	2.244	0.808	3.592
	ET4	3.129	1.088	-1.465	1.650	0.673	1.886
	ET5	3.911	1.081	-0.960	0.592	0.672	2.896
	ET6	3.084	1.139	-1.511	1.679	0.723	2.902
Employee Engagement (EE)	EE1	3.542	0.984	-0.361	0.075	0.920	5.684
	EE2	3.708	1.100	-0.391	-0.831	0.704	2.189
	EE3	3.663	1.055	-0.021	-1.282	0.810	3.151
	EE4	3.507	1.102	-0.366	-0.325	0.866	3.473
	EE5	3.525	1.139	-0.299	-0.807	0.834	2.984
	EE6	3.946	1.137	-1.115	0.575	0.874	4.498
Retention Policies (RP)	RP1	3.663	1.196	-0.596	-0.570	0.804	3.219
	RP2	4.062	1.047	-1.377	1.842	0.819	3.021
	RP3	3.805	1.077	-0.945	0.579	0.803	3.509
	RP4	4.045	0.957	-1.454	2.381	0.864	4.087
	RP5	4.003	0.936	-1.027	0.983	0.887	4.535
	RP6	3.745	1.092	-0.859	0.298	0.853	3.708
	RP7	4.022	0.928	-0.944	0.858	0.746	2.731
Management Effectiveness (ME)	ME1	4.022	1.065	-1.334	1.559	0.909	5.323
	ME2	4.003	0.980	-1.023	0.667	0.769	2.665
	ME3	4.042	0.979	-0.977	0.565	0.773	3.158
	ME4	4.003	1.017	-1.028	0.453	0.864	3.765
	ME5	4.025	1.047	-1.301	1.245	0.817	2.952
	ME6	4.141	0.959	-1.234	1.274	0.871	4.393
	ME7	4.025	1.028	-0.932	0.192	0.888	5.222
Organizational Efficiency (OE)	OE1	4.037	1.033	-1.349	1.773	0.782	3.565
	OE2	4.025	0.955	-1.028	0.771	0.761	2.883
	OE3	4.069	0.948	-1.000	0.735	0.761	2.238
	OE4	4.015	0.991	-1.029	0.546	0.803	2.975
	OE5	4.037	1.021	-1.324	1.442	0.894	5.283

5.3 Assessment of Measurement Model

Table 4 presents the internal consistency, reliability, and convergent validity of the constructs in the study, drawing upon established measures. Cronbach's alpha values, ranging from 0.736 to 0.832, indicate good internal consistency for all constructs (Hair et al. 2021). Composite reliability values (rho_a and rho_c) exceeding 0.7 for each construct further affirm their reliability, with values ranging from 0.753 to 0.873 (Fornell and f. larcke 1981). Additionally, the average variance extracted (AVE), ranging from 0.562 to 0.743, demonstrates satisfactory convergent validity, surpassing the recommended threshold of 0.5 (Fornell and f. larcke 1981).

Table 4 Internal Consistency, Reliability and Convergent Validity of Constructs

Constructs	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Employee Turnover (ET)	0.784	0.823	0.791	0.724
Organizational Efficiency (OE)	0.832	0.844	0.777	0.588
Employee Engagement (EE)	0.811	0.753	0.715	0.642

Journal of Information Systems Engineering and Management
2025, 10(41s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Retention Policies (RP)	0.736	0.763	0.788	0.743
Management Effectiveness (ME)	0.792	0.873	0.899	0.562

Table 5 provides results of discriminant validity analysis using the Heterotrait-Monotrait (HTMT) ratio. All HTMT values are below the 0.85 threshold, demonstrating adequate discriminant validity between the constructs (Henseler et al. 2015). Specifically, the HTMT ratios range from 0.115 to 0.846, indicating that the constructs are satisfactorily distinct from each other. These findings suggest that the measures used to assess the constructs capture unique aspects of the underlying theoretical concepts.

Table 5 Discriminant Validity – HTMT Ratio

	EE	ET	ME	OE	RP
EE					
ET	0.115				
ME	0.795	0.173			
OE	0.846	0.199	0.693		
RP	0.683	0.265	0.828	0.677	

Table 6 displays results of Fornell-Larcker criterion for assessing discriminant validity. According to this criterion, the square root of the AVE for each construct must be greater than its correlations with all other constructs in the model. As shown in the Table 6, the square roots of AVEs (bolded on diagonal) are all greater than the correlations between the corresponding constructs and other constructs, indicating satisfactory discriminant validity (Fornell and f. larcke 1981).

Table 6 Discriminant Validity: F-L criterion

	EE	ET	ME	OE	RP
EE	0.851				
ET	0.018	0.416			
ME	0.741	0.043	0.801		
OE	0.778	0.086	0.678	0.862	
RP	0.636	0.098	0.73	0.631	0.75

5.4 Hypothesis Testing using PLS-SEM

The study's findings, summarized in Table 7, demonstrate critical relationships between employee turnover, organizational efficiency, and the mediating roles of engagement, retention, and management effectiveness. Hypothesis 1 confirms that employee turnover negatively impacts organizational efficiency, with a path coefficient of -0.391, a T-value of 6.942, and a significant P-value of 0.018, indicating that higher turnover reduces efficiency. Engagement plays a significant positive role, as shown in Hypothesis 2, where the path coefficient is 0.778, with a T-value of 8.302 and a P-value of 0.019, confirming that higher employee engagement leads to increased efficiency. Retention policies also positively influence efficiency (Hypothesis 3), with a path coefficient of 0.631, T-value of 5.214, and a P-value of 0.004. Management effectiveness has the strongest positive effect, as evidenced by Hypothesis 4, with a path coefficient of 0.877, T-value of 7.450, and a P-value of 0.001. The mediation analyses further reveal that engagement mediates the negative relationship between turnover and efficiency (Hypothesis 5), with a path coefficient of -0.211, T-value of 3.897, and P-value of 0.021, while retention policies (Hypothesis 6) and management effectiveness (Hypothesis 7) also mediate this relationship, with path coefficients of -0.187 (T-value 3.521, P-value 0.011) and -0.296 (T-value 5.23, P-value 0.022), respectively. Lastly, the moderating effect of organizational size (Hypothesis 8) is significant, with a path coefficient of -0.322, T-value of 4.105, and a P-value of 0.032, indicating that the negative impact of turnover on efficiency is more pronounced in larger organizations. These results highlight the importance of engagement, retention strategies, and management effectiveness in mitigating the negative effects of turnover and enhancing organizational efficiency, especially in larger firms.

Journal of Information Systems Engineering and Management
2025, 10(41s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Table 7 Hypotheses of the study

Hypothesis	Path	Path Coefficient (β)	T-value	R-square	P-value
Direct Hypotheses					
Hypothesis 1	Turnover → Efficiency	-0.391	6.942	0.612	0.018
Hypothesis 2	Engagement → Efficiency	0.778	8.302	0.612	0.019
Hypothesis 3	Retention → Efficiency	0.631	5.214	0.612	0.004
Hypothesis 4	Management → Efficiency	0.877	7.45	0.612	0.001
Mediation Hypotheses					
Hypothesis 5	Turnover → Engagement → Efficiency	-0.211	3.897	0.562	0.021
Hypothesis 6	Turnover → Retention → Efficiency	-0.187	3.521	0.534	0.011
Hypothesis 7	Turnover → Management → Efficiency	-0.296	5.23	0.561	0.022
Moderation Hypothesis					
Hypothesis 8	Turnover x Organizational Size → Efficiency	-0.322	4.105	0.59	0.032

The proposed structural model, as depicted in Figure 2, provides a comprehensive depiction of the intricate relationships among key variables relevant to OE, namely ET, EE, RP, ME and OS.

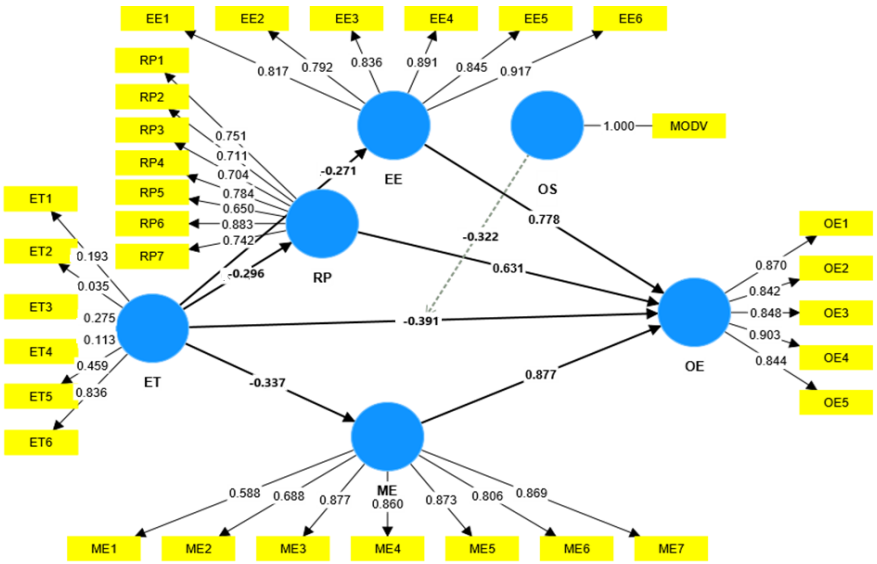

Figure 2. Proposed Structural Model

5.5 ANN Analysis

In this study, the combination of ANN modeling with SEM-PLS path analysis was employed. ANN was chosen to address non-normal distribution of data and non-linear relationships between dependent and independent variables (Hanandeh et al. 2020). Additionally, ANN analysis exhibits resilience against noise, outliers, and smaller sample sizes. The ANN model included five crucial independent factors—ME, EE, RP, and ET—identified from SEM-PLS path analysis. The output layer comprised the single outcome variable, termed here as OE.

The typical architecture of the ANN model involves multiple hierarchical levels, including an input layer, hidden layers, and an output layer. In this investigation, the input layer consisted of the aforementioned five independent factors, while the output layer contained the OE variable. By training the ANN model with the provided input data and known output values, the underlying patterns and relationships between independent and dependent variables were learned. IBM's SPSS neural network module facilitated the ANN analysis, capturing both linear and non-linear interactions among variables without requiring a normal distribution of data.

Journal of Information Systems Engineering and Management
2025, 10(41s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

To mitigate potential over-fitting, a tenfold cross-validation procedure was implemented, partitioning the data into 90% for training and 10% for testing. The results of root mean square error (RMSE) for both training and testing phases are detailed in Table 8. RMSE serves as a scale-dependent measure of prediction accuracy, assessing the reliability of the model by estimating errors in specific datasets (Yan et al. 2022). The mean RMSE values for training and testing were found to be 0.451 and 0.529, respectively, indicating accurate identification of both linear and nonlinear correlations. Minimal standard deviations observed in both testing and training phases further enhanced the credibility of the ANN model's predictive capabilities. The ANN model is depicted in Figure 3.

Table 8 Values of RMSEA for model A

Network	RMSE (Training)	RMSE (Testing)	Total Sample
ANN1	0.416	0.493	556
ANN2	0.423	0.506	556
ANN3	0.475	0.485	556
ANN4	0.507	0.645	556
ANN5	0.482	0.607	556
ANN6	0.462	0.516	556
ANN7	0.438	0.467	556
ANN8	0.494	0.576	556
ANN9	0.415	0.517	556
ANN10	0.407	0.487	556
Mean	0.451	0.529	
Standard Deviation	0.036	0.059	

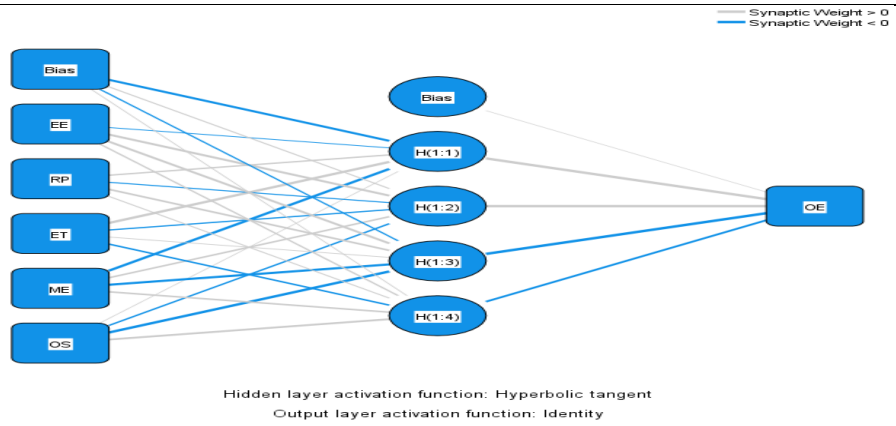

Figure 3 ANN Model

Table 9 illustrates the sensitivity analysis conducted in the study and ranking variables based on their normalized relative importance concerning the dependent variable. The sensitivity analysis revealed that ET emerged as the most crucial predictor of OE, followed by ME, EE, RP, and OS, providing valuable insights into their relative importance in influencing OE and informing strategic decision-making processes.

Table 9 Sensitivity Analysis

Variables	ANN1	ANN2	ANN3	ANN4	ANN5	ANN6	ANN7	ANN8	ANN9	ANN10	AI	NI (%)
OS	0.509	0.472	0.559	0.514	0.488	0.524	0.562	0.544	0.562	0.581	0.571	0.534
RP	0.521	0.478	0.512	0.571	0.501	0.588	0.671	0.561	0.511	0.599	0.601	0.799
EE	0.602	0.561	0.622	0.561	0.611	0.591	0.701	0.582	0.533	0.606	0.677	0.871
ME	0.606	0.565	0.626	0.565	0.614	0.596	0.705	0.586	0.537	0.610	0.681	0.879
ET	1.000	0.588	0.650	0.601	0.623	0.611	1.000	1.000	0.604	0.701	0.912	1.000

Journal of Information Systems Engineering and Management
2025, 10(41s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

5.6 Discussion

The study's findings provide critical insights into the interplay between employee turnover (ET) and organizational efficiency (OE), making both theoretical and practical contributions to organizational behavior literature. By employing a novel Two-Staged SEM-ANN approach, this research bridges gaps in traditional and machine learning methodologies, enabling a deeper understanding of the dynamic relationships among key variables.

Key Findings and Theoretical Contributions

The negative impact of employee turnover on organizational efficiency (Hypothesis 1), demonstrated by a significant path coefficient, aligns with prior studies that highlight turnover as a primary disruptor of productivity and organizational outcomes (Jagun 2015; Saraf 2020). This finding reinforces the urgency of implementing robust retention strategies to address turnover-induced inefficiencies.

Employee engagement (EE), retention policies (RP), and management effectiveness (ME) were identified as significant positive predictors of OE (Hypotheses 2, 3, and 4), corroborating earlier research that emphasizes the role of internal organizational factors in enhancing efficiency (Ghani et al. 2022; Rahman 2017). The mediating roles of EE, RP, and ME elucidate the mechanisms through which these factors mitigate the adverse effects of turnover, providing a theoretical contribution to the literature on employee management and organizational performance.

The moderating role of organizational size (OS) (Hypothesis 8) highlights the differential impacts of turnover on firms of varying sizes. Larger organizations experienced more pronounced negative effects, suggesting the need for size-specific retention and management strategies. This novel insight adds to existing literature by emphasizing the contextual nature of turnover's consequences (Kanchana and Jayathilaka 2023; Zhong et al. 2022).

Practical Implications

The findings carry significant managerial implications. IT firms, particularly larger organizations, should prioritize interventions to enhance employee engagement, strengthen retention policies, and ensure effective leadership. Strategies such as targeted training programs, flexible work arrangements, and transparent communication are essential to building a supportive work environment that mitigates turnover's negative effects (Bangi and Mgeni 2022; Chang et al. 2023). The ANN sensitivity analysis revealed ET and ME as the most influential factors impacting OE. These insights provide a data-driven basis for resource allocation, enabling managers to prioritize efforts on these critical areas. This approach not only ensures efficient use of resources but also enhances the likelihood of achieving organizational efficiency.

Methodological Contributions

The integration of SEM and ANN provides a methodological contribution by combining the explanatory strength of SEM with the predictive accuracy of ANN. This hybrid approach addresses limitations in traditional models, such as linear assumptions, by capturing non-linear interactions and ranking variable importance. This innovation aligns with recent calls for employing advanced analytical techniques to study complex organizational phenomena (Hanandeh et al. 2020; Yan et al. 2022). The use of cross-validation and low RMSE values in ANN analysis underscores the robustness and reliability of the model. By complementing SEM results with variable importance rankings, the ANN analysis enhances the interpretability of findings and their practical applicability, setting a methodological precedent for future research.

6. CONCLUSIONS

This study provides a comprehensive analysis of the complex relationship between employee turnover and organizational efficiency, emphasizing the mediating roles of employee engagement, retention policies, and management effectiveness, alongside the moderating influence of organizational size. The findings confirm that higher employee turnover significantly reduces organizational efficiency, particularly in larger organizations, highlighting the need for tailored strategies to address turnover challenges. By employing a Two-Staged SEM-ANN approach, the study captures both linear and non-linear interactions, offering an innovative methodological contribution that enhances the understanding of organizational dynamics.

The research demonstrates that mediating factors such as employee engagement, retention policies, and management effectiveness play a pivotal role in mitigating the adverse effects of turnover, underscoring their importance in organizational practices. The moderating effect of organizational size further reveals that larger firms are more susceptible to the negative impacts of turnover, necessitating size-specific interventions. Theoretical contributions of the study lie in its integration of traditional statistical methods with advanced machine learning techniques, offering a nuanced framework for exploring organizational challenges.

Practically, the findings provide actionable insights for IT firms, particularly in developing strategies that prioritize engagement, refine retention policies, and enhance management effectiveness to boost organizational efficiency. However, the study's cross-sectional design and focus on IT firms in India limit its generalizability. Future research could adopt longitudinal designs and explore diverse industries and regions to deepen the understanding of turnover's impact on organizational performance. Despite its limitations, this study makes a significant contribution by bridging methodological and practical gaps, offering a robust framework for addressing turnover challenges and enhancing efficiency in competitive business environments.

Ethical Approval

This study was conducted in accordance with the ethical guidelines for human subject research. Informed consent was obtained from all participants, ensuring that they were fully aware of the purpose, procedures, and voluntary nature of their participation. Participant confidentiality and anonymity were maintained throughout the study, and no personally identifiable information was collected or stored. Ethical approval for this research was obtained from the Institutional Review Board (IRB) of Swami Vivekanand Subharti University, Meerut, India, prior to data collection.

Consent to Participate

All participants provided informed consent before participating in the study. They were informed about the purpose of the research, their voluntary participation, anonymity, and confidentiality of responses. Participants had the right to withdraw at any stage without any consequences.

Funding

No funding was received to conduct this research.

Data Availability Statement

The authors declare that data associated with the outcomes of this study is available from the corresponding author upon reasonable request.

Disclosure Statement

The authors have no potential conflicts of interest to report concerning this research.

REFERENCES

[1] Aboagye, E., I. Jensen, G. Bergström, J. Hagberg, I. Axén, and M. Lohela-Karlsson. 2016. “Validity and Test-Retest Reliability of an at-Work Production Loss Instrument.” *Occupational Medicine* 66(5):377–82. doi: 10.1093/occmed/kqw021.

[2] Al-Taie, Moyassar, and Mohammad Nisar Khattak. 2024. “The Impact of Perceived Organizational Support and Human Resources Practices on Innovative Work Behavior: Does Gender Matter?” *Frontiers in Psychology* 15(June). doi: 10.3389/fpsyg.2024.1401916.

[3] Alhamad, Akram M., Ismail Mohamad Hilan, Ibrahim Seghaer, Mohamed Alghowl, and Mohamed Ibrahim. 2024. “Predicting Employee Turnover Through Advanced Hr Analytics : Implications For Engagement Strategies.” 30(5):964–72. doi: 10.53555/kuey.v30i5.2995.

[4] AlKetbi, Aisha, and John Rice. 2024. “The Impact of Green Human Resource Management Practices on Employees, Clients, and Organizational Performance: A Literature Review.” *Administrative Sciences* 14(4). doi: 10.3390/admsci14040078.

[5] Almanasreh, Enas, Rebekah Moles, and Timothy F. Chen. 2019. “Evaluation of Methods Used for Estimating

Content Validity." *Research in Social and Administrative Pharmacy* 15(2):214–21. doi: 10.1016/j.sapharm.2018.03.066.

[6] Babajide, Elsie Omolara. 2010. "The Influence Of Personal Factors On Workers Turnover Intention In Work Organizations In South-West Nigeria." *Journal of Diversity Management (JDM)* 5(4):1–10. doi: 10.19030/jdm.v5i4.338.

[7] Al Balushi, Adil Khamis, Venkat Ram Raj Thumiki, Nishad Nawaz, Ana Jurcic, and Vijayakumar Gajenderan. 2022. *Role of Organizational Commitment in Career Growth and Turnover Intention in Public Sector of Oman*. Vol. 17.

[8] Bangi, Yustin Ignas, and Prisca Levi Mgeni. 2022. "Factors Influencing Labour Turnover Intentions in Non-Governmental Organization: Insights from Christian Social Service Commission (CSSC) in Dar Es Salaam." *European Journal of Humanities and Social Sciences* 2(1):80–86. doi: 10.24018/ejsocial.2022.2.1.193.

[9] Basuvaraj, M., and M. Jegadeeshwaran. 2022. "An Empirical Study on Factors Affecting the Mobile Banking Services in Bangalore City." *Researchgate.Net* 11:2333–43.

[10] Cachón-Rodríguez, Gabriel, Alicia Blanco-González, Camilo Prado-Román, and Cristina Del-Castillo-Feito. 2022. "How Sustainable Human Resources Management Helps in the Evaluation and Planning of Employee Loyalty and Retention: Can Social Capital Make a Difference?" *Evaluation and Program Planning* 95(September). doi: 10.1016/j.evalprogplan.2022.102171.

[11] Chang, Victor, Yeqing Mou, Qianwen Ariel Xu, and Yue Xu. 2023. "Job Satisfaction and Turnover Decision of Employees in the Internet Sector in the US." *Enterprise Information Systems* 17(8). doi: 10.1080/17517575.2022.2130013.

[12] Dorta-Afonso, Daniel, Manuel González-de-la-Rosa, Francisco J. García-Rodríguez, and Laura Romero-Domínguez. 2021. "Effects of High-Performance Work Systems (HPWS) on Hospitality Employees' Outcomes through Their Organizational Commitment, Motivation, and Job Satisfaction." *Sustainability (Switzerland)* 13(6). doi: 10.3390/su13063226.

[13] Evans, Joel R., and Anil Mathur. 2005. "The Value of Online Surveys." *Internet Research* 15(2):195–219. doi: 10.1108/10662240510590360.

[14] Farooq, Hassan, Uzair Iqbal Janjua, Tahir Mustafa Madni, Abdul Waheed, Mahdi Zareei, and Faisal Alanazi. 2022. "Identification and Analysis of Factors Influencing Turnover Intention of Pakistan IT Professionals: An Empirical Study." *IEEE Access* 10:64234–56. doi: 10.1109/ACCESS.2022.3181753.

[15] Fornell, Claes, and David f. larcke. 1981. "Fornell, C., & Larcker, D. F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error." *Journal of Marketing Research* 18(1):39–50.

[16] García-Arca, Jesús, A. Trinidad González-Portela Garrido, and J. Carlos Prado-Prado. 2023. "Deploying Sustainability Through Employee Participation. An Action Research Proposal." *Systemic Practice and Action Research*. doi: 10.1007/s11213-023-09639-x.

[17] Ghani, Bilqees, Muhammad Zada, Khalid Rasheed Memon, Rezwan Ullah, Afraseyab Khattak, Heesup Han, Antonio Ariza-Montes, and Luis Araya-Castillo. 2022. "Challenges and Strategies for Employee Retention in the Hospitality Industry: A Review." *Sustainability (Switzerland)* 14(5):1–26. doi: 10.3390/su14052885.

[18] Hair, Joseph .. F., G. Tomas M. Hult, Christian M. Ringle, Marko Sarstedt, Nicholas P. Danks, and Soumya Ray. 2021. *Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R*. Vol. 21.

[19] Hair, Joseph F., Jeffrey J. Risher, Marko Sarstedt, and Christian M. Ringle. 2019. "When to Use and How to Report the Results of PLS-SEM." *European Business Review* 31(1):2–24. doi: 10.1108/EBR-11-2018-0203.

[20] Halim, Zahid, Maria, Muhammad Waqas, Cedric A. Edwin, and Ahsan Shah. 2020. "Identifying Factors for Employee Retention Using Computational Techniques: An Approach to Assist the Decision-Making Process." *SN Applied Sciences* 2(9):1–20. doi: 10.1007/s42452-020-03415-5.

[21] Hanandeh, Shadi, Allam Ardah, and Murad Abu-Farsakh. 2020. "Using Artificial Neural Network and Genetics Algorithm to Estimate the Resilient Modulus for Stabilized Subgrade and Propose New Empirical Formula." *Transportation Geotechnics* 24(February):100358. doi: 10.1016/j.trgeo.2020.100358.

[22] Henseler, Jörg, Christian M. Ringle, and Marko Sarstedt. 2015. "A New Criterion for Assessing Discriminant Validity in Variance-Based Structural Equation Modeling." *Journal of the Academy of Marketing Science* 43(1):115–35. doi: 10.1007/s11747-014-0403-8.

[23] Hossain, Md Ismail, Subrata Talapatra, Palash Saha, and H. M. Belal. 2024. "From Theory to Practice:

Leveraging Digital Twin Technologies and Supply Chain Disruption Mitigation Strategies for Enhanced Supply Chain Resilience with Strategic Fit in Focus." *Global Journal of Flexible Systems Management*. doi: 10.1007/s40171-024-00424-w.

[24] Jagun, Victoria. 2015. "An Investigation into the High Turnover of Employees within the Irish Hospitality Sector, Identifying What Methods of Retention Should Be Adopted." (September):1–73.

[25] Jia, Xiao, and Yanghong Hou. 2024. "Architecting the Future: Exploring the Synergy of AI-Driven Sustainable HRM, Conscientiousness, and Employee Engagement." *Discover Sustainability* 5(1). doi: 10.1007/s43621-024-00214-5.

[26] Joseph, Ashlin Maria, and Tessy Thomas. 2024. "From Capability to Commitment : Exploring the Evolving Dynamics of IT Workforce." 13(3).

[27] Kamel, Walid, and Aly El Leithy. 2023. "The Impact of Green Human Resource Management Practices on Employee Retention and Environmental Sustainability: A Conceptual Model." *Jour* 22(01):1005–34.

[28] Kanchana, Lakshmi, and Ruwan Jayathilaka. 2023. "Factors Impacting Employee Turnover Intentions among Professionals in Sri Lankan Startups." *PLoS ONE* 18(2 February):1–20. doi: 10.1371/journal.pone.0281729.

[29] Kersten, Amber, Marianne van Woerkom, Goedele A. Geuskens, and Roland W. B. Blonk. 2024. "The Relationship Between Strategic Human Resource Management Practices and the Employment of Vulnerable Workers: A Two-Wave Study Among Employers." *Journal of Occupational Rehabilitation* (0123456789). doi: 10.1007/s10926-024-10197-9.

[30] Lazzari, Matilde, Jose M. Alvarez, and Salvatore Ruggieri. 2022. "Predicting and Explaining Employee Turnover Intention." *International Journal of Data Science and Analytics* 14(3):279–92. doi: 10.1007/s41060-022-00329-w.

[31] Lee, C. Christopher, Joley L. Luppi, Tyler Simmons, Baotram Tran, and Ruoqing Zhang. 2023. "Examining the Impacts of ESG on Employee Retention: A Study of Generational Differences." *Journal of Business and Management* 29(1):1–22. doi: 10.6347/JBM.202307.

[32] Lee, Leemen, and Li Fei Chen. 2018. "Boosting Employee Retention through CSR: A Configurational Analysis." *Corporate Social Responsibility and Environmental Management* 25(5):948–60. doi: 10.1002/csr.1511.

[33] Maan, Annum Tariq, Ghulam Abid, Tahira Hassan Butt, Fouzia Ashfaq, and Saira Ahmed. 2020. "Perceived Organizational Support and Job Satisfaction: A Moderated Mediation Model of Proactive Personality and Psychological Empowerment." *Future Business Journal* 6(1):1–10. doi: 10.1186/s43093-020-00027-8.

[34] Mossarah, Ali. 2023. "Investigating Factors That Impact Employee Turnover in the Medical Device Industry in the United Arab Emirates." *Social Sciences and Humanities Open* 7(1):100492. doi: 10.1016/j.ssaho.2023.100492.

[35] O'Brien, Robert M. 2007. "A Caution Regarding Rules of Thumb for Variance Inflation Factors." *Quality and Quantity* 41(5):673–90. doi: 10.1007/s11135-006-9018-6.

[36] Olusegun, Solomon Oyetola. 2013. "Inflfluence of Job Satisfaction on Turnover Intentions of Library Personnel in Selected Univerisities in South West Nigeria." *Library Philosophy and Practice* 2013(April).

[37] Papsiene, Palmira. 2024. "Theoretical Modeling of Organizational Reflex in Human Resource Management from the Perspective of Organizational Biological Approach." *Humanities and Social Sciences Communications* 11(1):1–13. doi: 10.1057/s41599-024-02644-y.

[38] Rahman, Khadiza. 2017. "Analyzing the Factors Influencing Employee Turnover in Private Commercial Banks in Bangladesh." *SSRN Electronic Journal*. doi: 10.2139/ssrn.2952201.

[39] Rahman, Md H. Asibu., and Dewan Niamul Karim. 2022. "Organizational Justice and Organizational Citizenship Behavior: The Mediating Role of Work Engagement." *Heliyon* 8(5):e09450. doi: 10.1016/j.heliyon.2022.e09450.

[40] Rajashekar, S., and Alka Jain. 2023. "A Thematic Analysis on 'Employee Engagement in IT Companies from the Perspective of Holistic Well-Being Initiatives.'" *Employee Responsibilities and Rights Journal* (0123456789). doi: 10.1007/s10672-023-09440-x.

[41] Ramos, Polly Castro. 2019. "Employee Retention Strategies for Executive Operation Leaders in an Academic Nursing Environment." 1–147.

[42] Roshidi Hassan. 2014. "Factors Influencing Turnover Intention Among Technical Employees in Information Technology Organization : A Case of Xyz (M) Sdn . Bhd." *International Journal of Arts and Commerce* Vol. 3

No.(2008):120–37.

[43] Rubbab, Um E., Sana Aroos Khattak, Hina Shahab, and Naveed Akhter. 2022. "Impact of Organizational Dehumanization on Employee Knowledge Hiding." *Frontiers in Psychology* 13(February):1–11. doi: 10.3389/fpsyg.2022.803905.

[44] Saraf. 2020. "AN ANALYSIS ON EMPLOYEE-ATTRITION IN IT INDUSTRY Vinaya Saraf." *Mukt Shabd Journal* IX(Vii):2751–58.

[45] Shafaei, Azadeh, Mehran Nejati, and Yusmani Mohd Yusoff. 2020. "Green Human Resource Management: A Two-Study Investigation of Antecedents and Outcomes." *International Journal of Manpower* 41(7):1041–60. doi: 10.1108/IJM-08-2019-0406.

[46] Simon Haykin (McMaster University, Hamilton, Ontario, Canada). 2005. "Neural Networks - A Comprehensive Foundation - Simon Haykin.Pdf." 823.

[47] Sinha, Sugandha, Honey Likheshbhai Momaya, and Patel Nidhi Kamleshkumar. 2022. "Study on Employees Retention Strategies and It'S Impact Assessment for Selected Companies in Vadodara." *Www.Irjmets.Com @International Research Journal of Modernization in Engineering* 126(03):126–32.

[48] Tej, Juraj, Matúš Vagaš, Viktória Ali Taha, Veronika Škerháková, and Michaela Harničárová. 2021. "Examining Hrm Practices in Relation to the Retention and Commitment of Talented Employees." *Sustainability (Switzerland)* 13(24). doi: 10.3390/su132415563.

[49] Tomar, Jitendra Singh. 2019. *Employee Engagement in India*.

[50] Uraon, Ram Shankar. 2018. *Examining the Impact of HRD Practices on Organizational Commitment and Intention to Stay Within Selected Software Companies in India*. Vol. 20.

[51] Washington, F. T. 2020. "Employee Retention Strategies within Information Technology Small Businesses." *Walden Dissertations and Doctoral Studies Collection* 1–215.

[52] Xu, Hao, Jian Zheng, Renjing Liu, Xiangwen Zhang, and Ru Zhang. 2023. "Influencing Factors of Employee Turnover Based on the Random Forest and DEMATEL Method: Evidence from the Qinghai Electric Power Company in China." *Mathematical Problems in Engineering* 2023. doi: 10.1155/2023/7798674.

[53] Xuecheng, Wei, Qaisar Iqbal, and Bai Saina. 2022. "Factors Affecting Employee's Retention: Integration of Situational Leadership With Social Exchange Theory." *Frontiers in Psychology* 13(July):1–13. doi: 10.3389/fpsyg.2022.872105.

[54] Yadav, Vanita, and Neetu Yadav. 2024. "Beyond Sustainability, Toward Resilience, and Regeneration: An Integrative Framework for Archetypes of Regenerative Innovation." *Global Journal of Flexible Systems Management* 25(4):849–79. doi: 10.1007/s40171-024-00418-8.

[55] Yan, Chen, Abu Bakkar Siddik, Li Yong, Qianli Dong, Guang Wen Zheng, and Md Nafizur Rahman. 2022. "A Two-Staged SEM-Artificial Neural Network Approach to Analyze the Impact of FinTech Adoption on the Sustainability Performance of Banking Firms: The Mediating Effect of Green Finance and Innovation." *Systems* 10(5). doi: 10.3390/systems10050148.

[56] Yang, Jen Te, Chin Sheng Wan, and Yi Jui Fu. 2012. "Qualitative Examination of Employee Turnover and Retention Strategies in International Tourist Hotels in Taiwan." *International Journal of Hospitality Management* 31(3):837–48. doi: 10.1016/j.ijhm.2011.10.001.

[57] Zayed, Nurul Mohammad, Friday Ogbu Edeh, Khan Mohammad Anwarul Islam, Vitalii Nitsenko, Tetiana Dubovyk, and Hanna Doroshuk. 2022. "An Investigation into the Effect of Knowledge Management on Employee Retention in the Telecom Sector." *Administrative Sciences* 12(4):0–14. doi: 10.3390/admsci12040138.

[58] Zhong, Youwen, Huifang Zhang, and Xiaoling Wu. 2022. "Factor Analysis and Mental Health Prevention of Employee Turnover under the Profit-Centered Development of Modern Service Industry." *Occupational Therapy International* 2022. doi: 10.1155/2022/3375386.