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Tailoring Human Resource Policy in a Government Bank: Machine Learning Insights into Job Rotation, Resilience, and Adaptability in Nueva Ecija

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Abstract. This quantitative, descriptive study leverages machine learning, specifically agglomerative hierarchical clustering, to generate actionable insights into job rotation, resilience, and adaptability among 70 employees in a government bank in Nueva Ecija, Philippines. Survey data from employees with job rotation experience across eleven branches were analyzed using standard descriptive statistics, t-tests, and Spearman correlations, with clustering techniques employed to segment the workforce. The clustering analysis tested various distance and linkage methods. While the Euclidean-average linkage combination achieved the highest cophenetic correlation coefficient, confirming its statistical validity, visual inspection favored the Euclidean-complete linkage method. This approach yielded five interpretable and diverse employee groups, supporting calls to balance quantitative cluster validity with qualitative interpretability. Key findings indicate that job rotation is generally associated with above-moderate resilience and adaptability. However, challenges related to geographic relocation were evident, with male employees reporting higher difficulty adjusting to new environments than females. Familial and contextual factors, specifically marital status, number of children, and residence-work location differences, positively correlated with both resilience and adaptability, highlighting their significant role in employee coping mechanisms. Furthermore, a strong positive relationship between resilience and adaptability was confirmed. Based from the cluster-specific insights, policy recommendations include developing structured job rotation programs, providing targeted commuter support, and implementing cluster-specific interventions to address group-specific needs, thereby optimizing organizational effectiveness and enhancing workforce well-being.

Keywords: Agglomerative hierarchical clustering; Human resource management; Job rotation; Machine learning;

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1. Introduction

Banks are increasingly pressured to develop adaptable and flexible workforces due to the swift transformations in the banking sector driven by evolving regulations and rapid technological advancements. Job rotation has emerged as a strategic human resource methodology that enhances employee resilience and adaptability by providing opportunities to engage in diverse tasks. This creates a workforce capable of managing business complexities, promotes skill enhancement, and fosters innovation. Research consistently indicates that job rotation can improve both individual and organizational growth potential, particularly in highly regulated environments such as government banking (Agustian & Rachmawati, 2021).

Nonetheless, there are certain challenges associated with implementing work rotation. Inadequately devised or insufficiently supported rotation programs can lead to significant stress, dissatisfaction, and increased employee turnover, particularly when alterations occur frequently or lack comprehensive training and communication. Such issues can diminish the efficacy of rotation and adversely impact both engagement and organizational outcomes. To address these issues, it is imperative to formulate policies grounded in empirical facts.

The emergence of advanced data analytics provided human resource practitioners with potent new tools. Machine learning can identify intricate patterns in worker data in unprecedented ways. This provides organizations with valuable insights into how strategies such as job rotation influence employees' adaptability and resilience (Patel et al., 2024). Utilizing these strategies, public sector organizations can transition from traditional policy compliance to a more precise, predictive, and data-driven understanding of employees leading to customized human resource approaches (Sharma & Sohal, 2024).

This study leverages machine learning to generate insights into job rotation, resilience, and adaptability among employees in a government bank in Nueva Ecija, Philippines and extract vital information from employee to inform tailored human resource policy initiatives. This approach addresses issues within the existing workforce while advancing public sector human resources management towards evidence-based practices.

2. Methodology

This research employed a quantitative descriptive method and specifically targeted the branch banking sector of a government Bank in Nueva Ecija in selected localities of the province, namely the cities of Cabanatuan, Palayan, Muñoz, San Jose, and the municipalities of Guimba, Rizal, San Isidro and Talavera. Samples were selected using purposive sampling technique as the respondents had to meet certain parameters, i.e., should have experienced job rotation at least once. Of the population of 126 employees, 70 or 56% responded to the survey. The respondents were comprised of junior, mid-level and senior employees. The research instrument used is a developed survey questionnaire made available through online and printed format. It consisted of five sections, namely the research overview, generally explaining the purpose of the research and seeking the consent from the respondents, the sociodemographic profile section which aimed to solicit sociodemographic data of the respondents, and the challenges, resilience, and adaptability sections, all composed of 4-point Likert scale statements, which aimed to elicit the

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respondents' level of agreement in challenges, resilience, and adaptability statement groups. The data collection process was conducted from June to July, 2025.

The researchers used Excel, Python and Jupyter Notebook as tools in data preparation, tabulation, statistical testing, and machine learning.

3. Results and Discussion

3.1. Challenges Affecting the Employees During Job Rotations

Table 1: Comparison of Responses to Challenges Statements by Sociodemographic Profile: Sex

Challenge Group	Statements	Overall Weighted Means		Mean Diff.	t-value	Critical Value at α=0.05	p-value
		Female	Male				
New Work Environment		2.172	2.500	0.327	-2.189	1.996	0.032*
Geographic Relocation		2.556	2.920	0.360	-2.174	1.996	0.033*
Overall Challenges		2.346	2.605	0.259	-2.126	1.996	0.037*

*. Correlation is significant at α=0.05 (2-tailed)
**. Correlation is significant at α=0.01 (2-tailed)

The male respondents regard the new work environment as more challenging than female respondents, evidenced by a computed t-value of -2.189, which is below the critical value of 1.996, and a p-value of 0.032. Geographic relocation also differs, where men perceive it to be more challenging as compared to women with t-value of -2.174 below the critical value of 1.996 and p-value of 0.033.Subsequently, male respondents perceive job rotations as typically more challenging than their female counterparts, with a computed t-value of -2.126, which is below the crucial limit of 1.996, and a p-value of 0.037. This data indicates that male respondents encounter greater challenges throughout job rotations. This may result from men encountering greater role ambiguity and routine (Martínez-Martínez et al., 2024). On the other hand, McKinsey (2024) reported that women see career-related transitions, such as role changes or new environment, as more formidable, though noting that women receive inadequate managerial support for overcoming work challenges and advancement, encountering a continuous setback in promotions. Further research is critical to better understand the variations in how men and women encounter challenges related to job rotation.

3.2. Resilience of Respondents during Job Rotations

The sociodemographic variables like sex, marital status, and residence and work location were analyzed in correlation with the resilience statements, but the statistical tests yielded no significant results.

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3.3. Adaptability of Respondents during Job Rotations

Table 2: Comparison of Responses to Adaptability Statements by Sociodemographic Profile: Marital Status

Adaptability Statements Group	Overall Weighted Means		Mean Diff.	t-value	Critical Value at α=0.05	p-value
	Married	Single				
Learning Work Tasks and Technologies	3.474	3.239	-0.235	1.999	1.996	0.050*
Overall Adaptability	3.219	3.031	-0.188	2.024	1.996	0.047*

*. Correlation is significant at α=0.05 (2-tailed)
**. Correlation is significant at α=0.01 (2-tailed)

Married employees exhibit significantly higher overall adaptability, and particularly in the domain of "Learning Work Tasks and Technologies", compared to their unmarried counterparts. This trend may be attributed to several factors. Married individuals, often older, likely possess greater professional experience and a history of job rotations, which may enhance their capacity to acquire new skills and adapt to technological changes. Furthermore, the life experiences associated with marriage, such as managing family responsibilities, may enhance adaptability skills not as prevalent among single employees. These findings suggest that marital status, intertwined with experiential and situational factors, positively influences adaptability in the context of job rotations.

Table 3: Comparison of Responses to Adaptability Statements by Sociodemographic Profile: Same Residence and Work Location

Adaptability Statements Group	Overall Weighted Means		Mean Diff.	t-value	Critical Value at α=0.05	p-value
	No	Yes				
Managing Unpredictability and Work Complexity	3.140	2.870	-0.269	2.587	1.996	0.013*
Physical and Cultural Adaptability	3.070	2.778	-0.292	2.602	1.996	0.011*

*. Correlation is significant at α=0.05 (2-tailed)
**. Correlation is significant at α=0.01 (2-tailed)

Employees residing outside the city or municipality of their workplace exhibit greater adaptability in the domains of "Managing Unpredictability and Work Complexity" and "Physical and Cultural Adaptability." This heightened adaptability may reflect a form of forced adaptability, whereby employees, distanced from their home environments, are necessitated to forge workplace relationships and navigate diverse organizational cultures to thrive in unfamiliar settings. However, this apparent positive adaptation may mask underlying challenges. Existing

literature (Hazwani Mohd Suadi Nata et al., 2024; Razzak et al., 2023; Tunguz, 2025) underscores the adverse effects of commuting, including increased transportation costs, reduced productivity, physiological stress, diminished work-life balance, and negative impacts on physical health. These factors suggest that while non-local employees demonstrate enhanced adaptability, such resilience may stem from necessity rather than preference, potentially carrying long-term costs for both employees and the organization.

3.4. Correlation of Sociodemographic Profile vs. Overall Level of Challenges, Resilience, and Adaptability

Table 4: Correlation of Sociodemographic Profile vs. Overall Level of Challenges, Resilience, and Adaptability

		Overall Challenges	Overall Resilience	Overall Adaptability
Age	Spearman Correlation	-0.139	0.037	0.107
	Sig. (2-tailed)	0.25	0.759	0.379
	N	70	70	70
Number of Children	Spearman Correlation	-0.01	0.276*	0.273*
	Sig. (2-tailed)	0.937	0.021	0.022
	N	70	70	70
Household Size	Spearman Correlation	0.014	0.066	0.004
	Sig. (2-tailed)	0.907	0.586	0.976
	N	70	70	70
Job Rank	Spearman Correlation	-0.163	0.174	0.16
	Sig. (2-tailed)	0.178	0.151	0.185
	N	70	70	70
Salary Grade	Spearman Correlation	-0.15	0.156	0.191
	Sig. (2-tailed)	0.216	0.198	0.112
	N	70	70	70
Total Experience - Current Organization	Spearman Correlation	-0.051	0.045	0.066
	Sig. (2-tailed)	0.676	0.712	0.587
	N	70	70	70

*. Correlation is significant at α=0.05 (2-tailed)

**. Correlation is significant at α=0.01 (2-tailed)

The Spearman correlation analysis for overall challenges showed no statistically significant correlations with age (r=-0.139, p=0.25), number of children (r=-0.01, p=0.937), household size (r=0.014, p=0.907), job rank (r=-0.163, p=0.178), salary grade (r=-0.15, p=0.216), or total experience (r=-0.051, p=0.676), indicating that these sociodemographic parameters do not significantly influence overall challenge scores. However, earlier t-test analyses revealed significant relationships for sex, with male respondents perceiving new work environment (t=-2.189, p=0.032), geographic relocation (t=-2.174, p=0.033), and overall challenges (t=-2.126, p=0.037) as more difficult than female respondents, leading to a partial rejection of the null hypothesis (H0) for sex in relation to challenges during job rotations.

In terms of overall resilience, the number of children exhibited a statistically significant moderate positive correlation (r=0.276, p=0.021, α=0.05), suggesting that respondents with

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more children tend to display greater resilience during job rotations. Other factors, including age (r=0.037, p=0.759), household size (r=0.066, p=0.586), job rank (r=0.174, p=0.151), salary grade (r=0.156, p=0.198), and total experience (r=0.045, p=0.712), showed no significant correlations. The significant finding for number of children led to the partial rejection of the null hypothesis (H0) for this variable.

For overall adaptability, the number of children showed a statistically significant moderate positive correlation (r=0.273, p=0.022, α=0.05), and t-test analyses indicated that married respondents exhibited higher adaptability in learning work tasks and technologies (t=1.999, p=0.050) and overall adaptability (t=2.024, p=0.047) compared to single respondents. Additionally, employees with different residence and work locations demonstrated significantly higher adaptability in managing unpredictability and work complexity (t=2.587, p=0.013) and physical and cultural adaptability (t=2.602, p=0.011) compared to those with the same residence and work location, leading to a partial rejection of the null hypothesis (H0) for marital status and residence-work location in relation to adaptability.

Overall, these findings highlight sex, marital status, and number of children as key sociodemographic factors influencing challenges, resilience, and adaptability during job rotations, necessitating targeted human resource interventions to address gender-specific challenges and leverage family-related strengths.

3.5. Correlation between Resilience and Adaptability

Table 5: Correlation between Resilience and Adaptability

		Overall resilience	Overall Adaptability
Overall resilience	Spearman Correlation	1	0.743**
	Sig. (2-tailed)		0
	N	70	70
Overall Adaptability	Spearman Correlation	0.743**	1
	Sig. (2-tailed)	0	
	N	70	70

*. Correlation is significant at α=0.05 (2-tailed)

**. Correlation is significant at α=0.01 (2-tailed)

The results revealed a strong positive correlation between overall resilience and overall adaptability, with a Spearman correlation coefficient of 0.743 (p=0.000, α=0.01, two-tailed). This highly significant correlation indicates a robust monotonic relationship, suggesting that as respondents' resilience increases, their adaptability tends to increase correspondingly. The strength of this correlation (r=0.743) is considered strong according to standard benchmarks for correlation coefficients, implying that resilience and adaptability are closely intertwined constructs in the context of job rotations. This finding may reflect that individuals who are better equipped to handle stress and recover from setbacks (resilience) are also more capable of adjusting to new roles, tasks, or environments (adaptability). The significant p-value ($p < 0.01$) underscores the reliability of this relationship, rejecting the null hypothesis (H0) that there is no statistically significant relationship between respondents' level of resilience and adaptability in favor of the alternative hypothesis (Ha).

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This insight suggests that interventions aimed at enhancing resilience, such as stress management training or support systems, could also foster greater adaptability during job rotations, potentially improving employees' ability to navigate organizational changes effectively. The strong correlation also highlights the potential for resilience and adaptability to share underlying psychological or behavioral mechanisms, such as emotional regulation or problem-solving skills, which could be explored in future research to better understand their interplay in dynamic work environments.

3.6. Agglomerative Hierarchical Clustering

Employing agglomerative hierarchical clustering, the researchers evaluated various combinations of distance metrics, including Euclidean, Chebyshev, Mahalanobis, and Cityblock, paired with linkage methods such as single, complete, average, weighted, centroid, and Ward. The analysis yielded the highest cophenetic correlation coefficient of 0.72 for the Euclidean distance metric combined with average linkage. Multiple studies support that average linkage method in conjunction with Euclidean distance metric trends to product higher cophenetic correlation coefficients in hierarchical clustering (Fadliana & Rozi, 2015; Rahayu & Mahdy, 2025; Rohmayanti & Hajarisman, 2025).

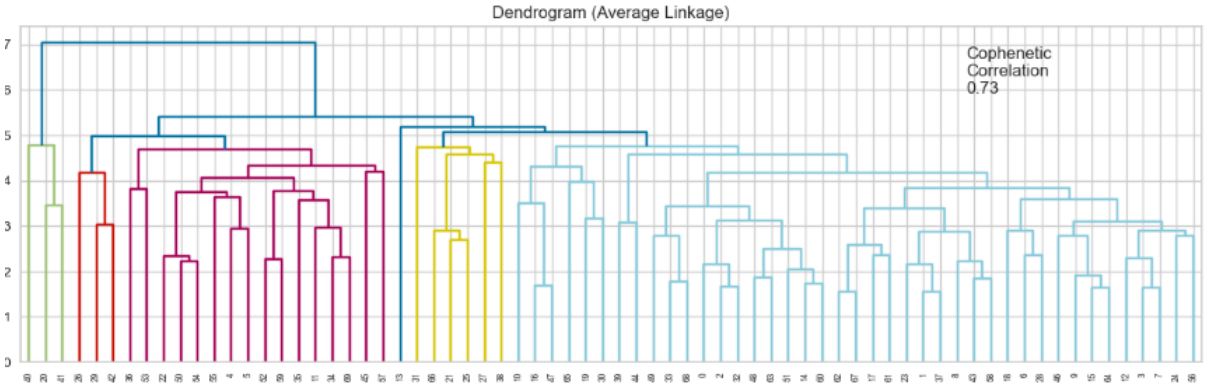

Figure 1 Dendogram with Cophenetic Correlation using Euclidean Distance and Average Linkage

However, visual inspection of the other dendrograms revealed that the Euclidean distance-complete linkage configuration produced more intuitive and diverse cluster structures, albeit lower cophenetic correlation of 0.63. Some scholars noted that more intuitive and diverse dendogram structures may emerge from other linkage and distance metric combinations and visual representations remain important (Carvalho et al., 2019; Gere, 2023).

The below figure shows the dendogram using the Euclidean distance-complete linkage combination.

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https://neust.journalintellect.com/quest

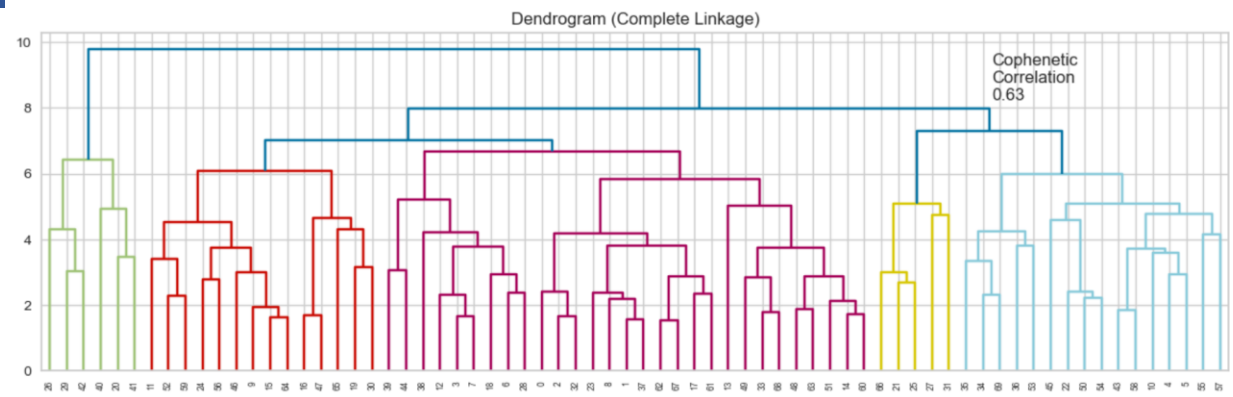

Figure 2 Dendogram with Cophenetic Correlation using Euclidean Distance and Complete Linkage

The Euclidean distance–complete linkage combination revealed the presence of five distinct clusters, leading to the adoption of a five-cluster configuration of the agglomerative hierarchical clustering algorithm.

The table presented below displays the computed average values of the demographic profiles of the respondents and their overall levels of challenges, resilience, and adaptability. These data were subsequently analyzed to develop and assign meaningful names to each identified cluster, as shown in the next table.

Table 6 Cluster Profile Based on Euclidean Distance–Complete Linkage Combination

Parameters	Cluster				
	0	1	2	3	4
Age	30.034	58.000	50.750	33.400	38.286
Sex	0.414	0.667	0.625	0.200	0.071
Marital Status	0.414	0.500	1.000	0.800	0.929
Number of Children	0.207	1.333	2.375	1.000	1.714
Household Size	3.759	5.333	4.250	3.600	6.214
Educational Attainment	1.172	1.667	1.313	1.800	1.214
Job Rank	1.310	4.167	2.563	1.800	1.500
Salary Grade	5.414	11.833	7.875	6.800	5.929
Total Experience – Current Organization	5.345	33.000	23.875	6.400	11.143
Same Residence and Work Location	0.517	0.333	0.188	0.400	0.357
Overall Challenges	2.574	2.283	2.431	1.960	2.461
Overall Resilience	2.962	3.342	3.041	3.620	3.157
Overall Adaptability	3.011	3.396	3.160	3.725	3.165
Count in each Cluster	29.000	6.000	16.000	5.000	14.000

String feature conversion: Sex (Female: 0, Male: 1), Marital Status (Single: 0, Married: 1), Educational Attainment (College: 1, Master's: 2, Doctorate: 3), Job Rank (Entry: 1, Mid: 2, Senior: 3, Managerial: 4, Executive/Senior Management: 5)

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Table 7 Cluster Profile Analysis

6	Cluster Name	Cluster Key Traits	Count
0	Junior	Young (avg. 30 yrs), predominantly female/single with minimal family (0.2 children, small households), entry-level roles (low salary/exp), moderate challenges, and lower resilience/adaptability scores, half commute from residence.	29
3	Intermediate	Young-mid (avg. 33 yrs), mostly male/highly married with small families (1 child), entry-mid roles with low experience/challenges but exceptional resilience/adaptability, moderate commuting.	5
4	Senior Intermediate	Mid-age (avg. 38 yrs), predominantly male/highly married with larger families (1.7 children, big households), entry-level despite moderate experience, moderate challenges/resilience/adaptability, low residence-work alignment.	14
2	Middle	Mid-age (avg. 51 yrs), mostly male/all married with families (2.4 children), mid-level roles with solid experience, balanced resilience/adaptability, and low residence-work overlap indicating frequent commutes.	16
1	Senior	Older (avg. 58 yrs), mostly male/married with moderate families (1.3 children, larger households), high-rank/experienced veterans, low challenges and strong resilience/adaptability, often separated from residence/work.	6

The table provided above delineates the assigned nomenclature for each cluster alongside their predominant characteristics.

Cluster 0, designated as "**Junior**," encompasses individuals who are relatively young (average age 30 years), predominantly female and single, with minimal familial responsibilities (0.2 children, small household sizes), occupying entry-level positions characterized by low salary and experience, exhibiting moderate challenges, and displaying lower scores in resilience and adaptability, with approximately half commuting from their residences.

Cluster 3, labelled "**Intermediate**," includes a young-to-mid-aged demographic (average age 33 years), predominantly male and mostly married, with small families (1 child), holding entry-to-mid-level roles marked by low experience and challenges, yet demonstrating exceptional resilience and adaptability, with a moderate proportion of employees commuting.

Cluster 4, termed "**Senior Intermediate**," comprises mid-aged individuals (average 38 years), predominantly male and highly married, with larger families (averaging 1.7 children and larger households), occupying entry-level roles despite moderate experience, facing moderate challenges and resilience/ adaptability levels, and exhibiting low alignment between residence and workplace.

Cluster 2, named as "**Middle**," consists of mid-aged individuals (average age 51 years), predominantly male and universally married, with families averaging 2.4 children, occupying mid-level roles supported by substantial experience, displaying balanced resilience and adaptability, and characterized by low residence-work overlap, suggesting frequent commuting.

Finally, Cluster 1, designated "**Senior**," represents an older cohort (average 58 years), predominantly male and married, with moderate family sizes (1.3 children, larger households), comprising high-ranking, experienced professionals facing minimal challenges, characterized by robust resilience and adaptability, and typically residing separately from their workplaces.

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https://neust.journalintellect.com/quest

4. Conclusions

The findings emphasize that job rotations in the government bank context cause moderate challenges, primarily from geographic relocation, yet foster moderate to high levels of resilience and adaptability among employees, particularly in self-effectiveness and technological learning. While correlation analyses showed no significant relationships between most sociodemographic profiles and overall challenges, t-test results revealed that male employees perceived new work, geographic relocation, and overall challenges as more significant than female employees, suggesting gender-specific sensitivities to logistical, environmental, and routine disruptions that warrant targeted interventions. Additionally, married employees demonstrated higher adaptability in learning work tasks and technologies and overall adaptability compared to single employees, indicating that marital status enhances adaptability, likely due to accumulated life experiences. Employees with different residence and work locations exhibited greater adaptability in managing unpredictability and work complexity and physical and cultural adaptability, suggesting that commuting necessitates adaptive behaviors, though potentially at the cost of increased stress or reduced work-life balance.

The positive influence of familial responsibilities, such as the number of children, on resilience and adaptability implies that personal life experiences enhance employees' capacity to cope with and thrive amid change, aligning with literature on how family demands cultivate transferable skills like emotional regulation and flexibility. Employees with different residence-work locations demonstrated necessity-driven adaptability, though this may incur hidden costs brought about by commuting. The robust interplay between resilience and adaptability highlights their synergistic role in navigating job rotations, suggesting that bolstering one construct may reinforce the other, thereby contributing to sustained employee performance and well-being.

The agglomerative hierarchical clustering applied various distance and linkage methods, identifying the Euclidean-average linkage combination as having the highest cophenetic correlation coefficient, in alignment with research demonstrating the statistical validity of average linkage for cluster formation in multi-attribute datasets. However, visual inspection highlighted that complete linkage with the Euclidean metric provided more interpretable and diverse clusters. The clustering analysis reveals heterogeneous employee subgroups, indicating that tailored human resource approaches could optimize rotational outcomes by addressing cluster-specific needs, such as mentoring for juniors or wellness support for seniors. The significant influence of sex, marital status, and residence-work location underscores the need for gender-specific support for male employees, family-centric policies for married employees, and commuter support programs to leverage locational adaptability while mitigating associated challenges.

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