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Do Generational Cohorts Matter? Moderating Effects of Generation X, Y, and Z on Job Satisfaction and Engagement in the Industrial Forest Plantation Sector

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ABSTRACT
The advancement of digital technology and shifts in workforce demographics influence various industrial sectors including Industrial Forest Plantation (Hutan Tanaman Industri) companies in Indonesia and impact numerous aspects, such as work systems, workplace culture, and employee behavior. This research aims to assess the effect of the Work Environment and Digital Literacy on Job Satisfaction and Employee Engagement, with Generations (X, Y, Z) serving as moderating variables in HTI companies in Indonesia. Data was gathered through an online survey involving 569 respondents who represent employees of HTI companies in Indonesia, data was analyized by Partial Least Square-Stuctural Equation Model (PLS-SEM) by SmartPLS and the results of the study revealed that Digital Literacy and Workplace Environment significantly influence both Job Satisfaction (R^2 = 0,573) and Employee Engagement (R^2 = 0,802) among Generations X, Y, and Z. Furthermore, Job Satisfaction was found to be the strongest predictor of Employee Engagement (path coefficient = 0.710, $p < 0.001$). The moderating effect of generational cohort was significant on the relationship between Workplace Environment and both Job Satisfaction and Employee Engagement, indicating that generational differences—especially among Generation Z—play a role in how workplace settings are perceived and responded to. However, no significant moderating effect was found between generational cohort and Digital Literacy, suggesting that technology adoption affects employees across generations more uniformly. The outcomes of this study offer strategic insights for plantation companies in Indonesia to develop human resource management strategies and improve employee engagement.

***Keywords**: Work Environment, Digital Literacy, Job Satisfaction, Employee Engagement, Generation X, Y, and Z, Industrial Plantations Forest .*

1. INTRODUCTION

Human resource (HR) management is a key element in the success of modern organizations, including Industrial Forest Plantation (HTI) companies. HR management is no longer viewed solely from an administrative perspective but has become a strategic component in achieving competitive advantage. In the digital era, organizations face challenges in managing employees across multiple generations—particularly Generations cohort X (1965-1980), Y (1981-1996), and Z (1997-2012)—who possess different values, preferences, and workplace expectations.

HTI companies in Indonesia play a vital role in supporting the national forestry industry. According to Statistik Perusahaan Pembudidaya Tanaman Kehutanan 2023 by BPS (2024), there are 388 registered forest plantation companies, managing a total concession area of approximately 7.89 million hectares. The workforce in this sector consists of both permanent and non-permanent employees, spread across administrative and field-based roles. Notably, 87.2% of permanent employees hold secondary, diploma, or undergraduate degrees.

Generational differences in the workplace demand adaptive HR strategies. Generation X tends to value stability and loyalty, Generation Y seeks work-life balance and technological advancement, while Generation Z has grown up in a fast-paced digital environment. These differences influence how each generation responds to the workplace and embraces technology.

The workplace environment plays a significant role in shaping job satisfaction and employee engagement. A supportive work environment includes physical comfort, social support, and access to sufficient resources to complete tasks (Schneider et al., 2018). Prior research (Erfeni et al., 2022; Kahn, 1990) has found that a conducive work environment positively impacts engagement, with job satisfaction often acting as a mediating variable.

At the same time, digital literacy has become a fundamental requirement across industries, including HTI. Digital literacy involves not only basic computer skills but also data comprehension, online communication, and the use of digital tools such as ERP systems, drones, and geospatial technologies (Shrestha et al., 2023; Wang et al., 2024). The Job Demands-Resources Model (Bakker & Demerouti, 2007) positions digital literacy as a job resource that enhances efficiency and engagement.

However, technology adoption and responses to workplace environments are not uniform across generations. Studies show that Generation Z adapts more quickly to technological changes, while Generation X may require more tailored support (Ng & Johnson, 2015). Jung & Yoon (2021) emphasized that workplace flexibility has a stronger effect on engagement for Generation Z than for previous cohorts.

Several prior studies have examined the impact of work environment and digital literacy on job satisfaction and employee engagement (Achmad et al., 2023; Putra & Darmastuti, 2021). Nevertheless, research that integrates generational differences as a moderating variable—particularly in the context of the industrial forest plantation sector—remains limited. Therefore, this study aims to fill that gap.

The objectives of this study are: (1) To analyze the influence of work environment and digital literacy on job satisfaction and employee engagement; and (2) To examine the moderating role of generational cohorts (Generations X, Y, and Z) in the relationship between work environment, digital literacy, job satisfaction, and employee engagement in Indonesia's industrial forest plantation sector.

2. METHODS

This study employed a quantitative approach with a cross-sectional survey design, utilizing self-administered questionnaires to collect primary data from employees in Indonesia's industrial forest plantation sector. The questionnaire was distributed online via Google Forms through WhatsApp and/or email to employees from companies registered with the Indonesian Forest Concessionaires Association (APHI). Based on BPS (2024) , the total population of permanent employees in the sector (both administrative and field workers) was 30,329 individuals. Using Slovin's formula with a 5% margin of error, the minimum required

sample size was 395 respondents. In total, 569 valid responses were collected and used for analysis.

The questionnaire consisted of multiple items across four key variables: work environment, digital literacy, job satisfaction, and employee engagement. Each construct was developed based on established dimensions and adapted from previously validated instruments in relevant literature. All items were measured using a five-point Likert scale (1 = strongly disagree to 5 = strongly agree).

Table 1 presents the details of the variables, their associated dimensions, the number of items used in the questionnaire, and the references from which the items were derived or adapted.).

Table 1. List of Research Variable , Dimension and Item

Variable	Dimension	Number of Items	Source(s)
Work Environment	Physical Facilities	9	Robbins & Judge (2013); Herzberg (2017); Oldham & Hackman (1981)
	Access to IT	2	Bakker & Demerouti (2008); Gallup (2013)
	Social Relationships	2	Kahn (1990); Gallup (2013)
	Safety and Security	3	Robbins & Judge ((2013))
	Accessibility	1	Herzberg et al. (1959); Oldham & Hackman (1981)
Digital Literacy	Digital Access	3	Bawden (2008)); Dobson & Willinsky (2009); Van Deursen & Van Dijk (2014)
	Information Competency	5	Bawden (2008); Eshet (2012); Dobson & Willinsky (2009)
	Digital Communication	2	Van Deursen & Van Dijk (2014); Dobson & Willinsky (2009)
	Data Management	4	Bawden (2008); Van Deursen & Van Dijk (2014); Eshet
	Adaptation to Technology	4	Van Deursen & Van Dijk (2014); Gallup (2013)

Variable	Dimension	Number of Items	Source(s)
Job Satisfaction	The Work Itself	4	Herzberg et al. (1959); Robbins & Judge (2013)
	Work Appreciation	4	Robbins & Judge ((2013); Deci & Ryan (2013)
	Development Opportunities	3	Robbins & Judge (2013); Herzberg et al. (1959)
	Work Conditions	5	Hackman & Oldham (1980); Robbins & Judge (2013)
Employee Engagement	Support, Recognition, Career Growth, Leadership Relationship	12	(Gallup, n.d.)

As shown in the table above, the total number of items used in the questionnaire across all variables and dimensions is 63, reflecting a comprehensive measurement of the constructs under investigation.

Table 2 outlines the hypotheses proposed in this study, which were derived from relevant theoretical frameworks and prior research findings.

Table 2. List of Hypotheses in study

No	Hypothesis	Explanation
1	H1: WE → JS	Work Environment (WE) influences Job Satisfaction (JS)
2	H2: WE → EE	Work Environment (WE) influences Employee Engagement (EE)
3	H3: DL → JS	Digital Literacy (DL) influences Job Satisfaction (JS)
4	H4: DL → EE	Digital Literacy (DL) influences Employee Engagement (EE)
5	H5: G × WE → JS	Generation (G) moderates the relationship between WE and JS
6	H6: G × WE → EE	Generation (G) moderates the relationship between WE and EE

No	Hypothesis	Explanation
7	H7: G × DL → JS	Generation (G) moderates the relationship between DL and JS
8	H8: G × DL → EE	Generation (G) moderates the relationship between DL and EE
9	H9: JS → EE	Job Satisfaction (JS) influences Employee Engagement (EE)
10	H10: G × JS → EE	Generation (G) moderates the relationship between JS and EE

Figure below illustrates the conceptual model of this study. It depicts the hypothesized relationships between work environment (X1), digital literacy (X2), job satisfaction (Z), and employee engagement (Y), with generational cohorts (Generation X, Y, Z) acting as a moderating variable on several direct paths.

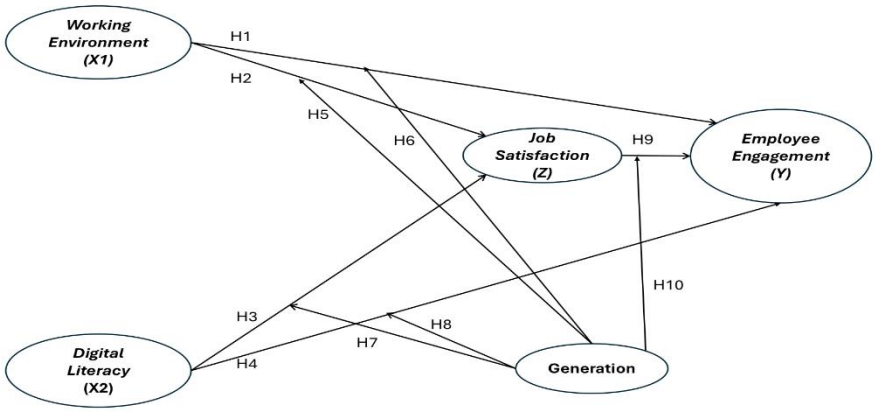

Figure 1. Framework of study

The data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) with the help of SmartPLS version 4.0. The analysis included evaluation of the measurement model (validity and reliability tests), followed by assessment of the structural model to test the proposed hypotheses, including direct effects, indirect (mediated) effects, and moderating effects of generational cohorts. The use of PLS-SEM was appropriate given the model's complexity and the presence of moderating constructs.

3. RESULTS AND DISCUSSIONS

3.1 Respondent Profile

The profile of respondents is described as follows:

Out of 569 total respondents, 514 were male (90.3%) and 55 were female (9.7%). Regarding educational background, 2.6% of respondents held an elementary or junior high

school degree (n = 15), 32.9% held a high school diploma (n = 187), 6.0% held a diploma (n = 34), 53.1% had a bachelor's degree (n = 302), 4.6% had a master's degree (n = 26), and 0.9% held a doctoral degree (n = 5).

In terms of employment status, 514 respondents (90.3%) were permanent employees, while 55 respondents (9.7%) were contractual employees. Regarding job function, 193 respondents (33.9%) worked primarily in office settings, 167 respondents (29.3%) split their time equally between office and fieldwork, and 209 respondents (36.7%) were primarily field-based.

Based on tenure, 61 respondents (10.7%) had worked for less than one year, 127 respondents (22.3%) had 1.1–3 years of experience, 56 respondents (9.8%) had worked for 3.1–5 years, 53 respondents (9.3%) had 5.1–7 years of experience, and the remaining 272 respondents (47.8%) had worked for more than 7 years.

Regarding position level, the majority held positions as technicians, administrative staff, or general staff (n = 265, 46.4%), followed by supervisors, researchers, or assistants (n = 214, 37.6%), department managers (n = 83, 14.6%), and division heads or general managers (n = 7, 1.2%).

Based on generational cohort classification, 0.7% of respondents (n = 4) were categorized as Baby Boomers, 17.4% (n = 99) as Generation X, 55.4% (n = 315) as Generation Y, and 26.5% (n = 151) as Generation Z.

3.2. Measurement Model

Before testing the structural relationships between constructs, it is essential to evaluate the measurement model to ensure the validity and reliability of the indicators used. The measurement model assessment in this study includes tests for convergent validity, internal consistency reliability, and discriminant validity. This step aims to confirm whether the indicators used adequately measure the latent variables they are intended to represent.

The assessment of the measurement model was conducted by examining the convergent validity, discriminant validity, multicollinearity, and internal consistency reliability, following the guidelines proposed by Hair Jr et al. (2021)) and Chin (1998).

Convergent validity was evaluated using the outer loading values of each indicator. All retained items exhibited outer loadings above 0.700, indicating that the constructs adequately capture the variance of their respective items (Hair Jr et al., 2021). Several items with loading values below 0.700 were excluded, resulting in a total of 49 items included in the final analysis.

Discriminant validity was tested through the Heterotrait–Monotrait (HTMT) ratio of correlations and the Fornell–Larcker criterion. The HTMT values for all construct pairs were below the conservative threshold of 0.85, and the Fornell–Larcker criterion confirmed that the square root of AVE for each construct was greater than its correlations with other constructs, thus supporting discriminant validity (Hair Jr et al., 2021).

Collinearity among indicators was assessed using the Variance Inflation Factor (VIF). All indicators had VIF values well below the threshold of 5.0, indicating no significant multicollinearity concerns (Chin, 1998).

Reliability was evaluated through Cronbach's Alpha, rho_A, and Composite Reliability (CR). All reliability coefficients exceeded the recommended cutoff of 0.700, and the Average Variance Extracted (AVE) for all constructs was above 0.500, supporting both reliability and convergent validity of the measurement model (Hair Jr et al., 2021)

3.3. Structural Model Result

The evaluation of the structural model was conducted to test the research hypotheses by examining the path coefficients, t-values, and p-values obtained through the bootstrapping procedure in SmartPLS. This approach assesses the significance and strength of the relationships between latent constructs, including both direct effects and interaction (moderating) effects. In this study, particular attention was given to the role of generational cohorts (X, Y, Z) in moderating the impact of working environment and digital literacy on job satisfaction and employee. engagement. The results of the path coefficient analysis are summarized in table below.

Table 3. Structural Model Path Coefficients and Significance Values

(Source: Ringle et al., 2022)

Hypothesis	Variable	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
H1	Workplace Environment -> Employee Engagament	0,130	0,128	0,034	3,825	**0,000**
H2	Workplace Environment ->Job Satisfaction	0,530	0,529	0,037	14,160	**0,000**
H3	Digital Literacy -> Employee Engagement	0,123	0,122	0,028	4,379	**0,000**
H4	Digital Literacy -> Job Satisfaction	0,306	0,308	0,036	8,543	**0,000**
H5	Generation x Workplace Environment -> Employee Engagament	0,065	0,063	0,031	2,107	**0,035**
H6	Generation x Workplace Environment ->Job Satisfaction	0,095	0,096	0,034	2,794	**0,005**
H7	Generation x Digital Literacy -> Employee Engagement	0,044	0,043	0,028	1,570	0,116
H8	Generation x Digital Literacy -> Job Satisfaction	-0,068	-0,069	0,035	1,918	0,055
H9	Job Satisfaction -> Employee Engagement	0,710	0,712	0,032	22,349	**0,000**
H10	Generation x Job Satisfaction -> Employee Engagement	-0,056	-0,054	0,038	1,463	0,144

As shown in Table 3.3, the hypothesis testing using path coefficients and *p-values* reveals that 7 out of 10 hypotheses are statistically supported ($p < 0.05$).

The variable Workplace Environment has a significant and positive effect on both Employee Engagement ($\beta = 0.130$, $p = 0.000$) and Job Satisfaction ($\beta = 0.530$, $p = 0.000$), supporting H1 and H2. Similarly, Digital Literacy significantly affects Employee Engagement ($\beta = 0.123$, $p = 0.000$) and Job Satisfaction ($\beta = 0.306$, $p = 0.000$), confirming H3 and H4.

The moderating role of generational cohorts (X, Y, Z) is partially confirmed. The interaction between Generation and Workplace Environment shows significant moderating effects on both Employee Engagement ($\beta = 0.065$, $p = 0.035$) and Job Satisfaction ($\beta = 0.095$, $p = 0.005$), which supports H5 and H6.

Furthermore, the path from Job Satisfaction to Employee Engagement shows the strongest effect (β = 0.710, *p* = 0.000), indicating that job satisfaction is a major driver of employee engagement (H7 supported).

However, three hypotheses are not supported. The direct effect of Generation on Employee Engagement (β = 0.038, *p* = 0.061) and Job Satisfaction (β = -0.018, *p* = 0.520) are both statistically insignificant, thus rejecting H8 and H9. In addition, the interaction effect of Generation × Job Satisfaction on Employee Engagement is also not significant (β = -0.056, *p* = 0.144), so H10 is not supported.

In summary, the findings highlight that both Workplace Environment and Digital Literacy significantly influence employees' Job Satisfaction and Employee Engagement, with Generational Cohort acting as a significant moderator only in the relationship involving Workplace Environment. The results also emphasize the critical role of Job Satisfaction in fostering Employee Engagement. Overall, these findings highlight that both Digital Literacy and Workplace Environment play significant roles in enhancing job satisfaction and engagement, while generational differences act as meaningful moderators—particularly in relation to the workplace environment.

Figure 2 presents the visual results of the structural model analysis using SmartPLS, showing the path relationships between constructs along with their corresponding p-values. Solid lines indicate significant paths ($p < 0.05$), while dashed lines represent non-significant effects. The model supports the majority of hypothesized relationships, particularly the direct influences of Workplace environment, Digital Literacy, and Job Satisfaction on Employee Engagement. Moderating effects of generational cohorts are partially confirmed.

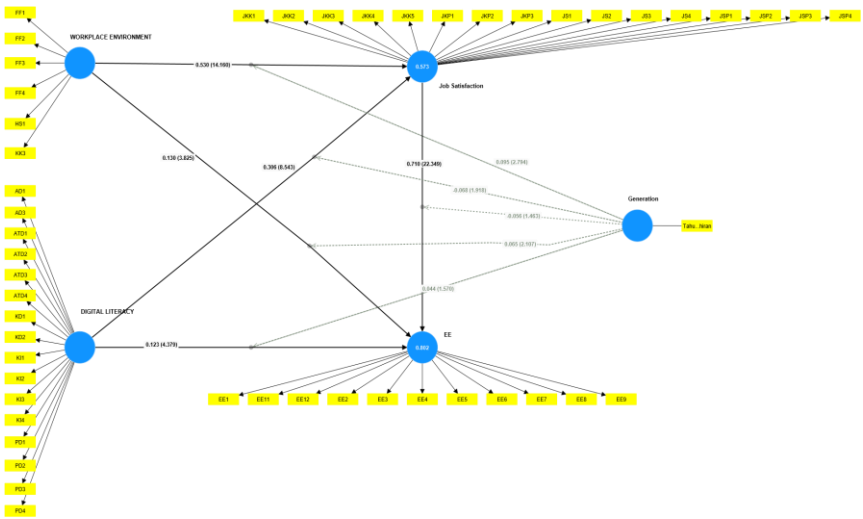

Figure 2. Structural Model Result Using SmartPLS (Bootstrapping Output)

To evaluate the explanatory power of the structural model, the coefficient of determination (R^2) and the adjusted R^2 were analyzed. As shown in Table 4 below :

Table 4. Coefficient of Determination (R^2) and Adjusted R^2 for Endogenous Variables

Constructs	R-Square	R-Square Adjusted
Employee Engagament	0.802	0.799
Job Satisfaction	0.573	0.570

From table above show the R^2 value for Employee Engagement is 0.802, and the adjusted R^2 is 0.799, indicating that 80.2% of the variance in employee engagement can be explained by the predictors in the model. This represents a substantial level of explanatory power, according to the thresholds proposed by Chin (1998) and Hair Jr. et al. (2021), where $R^2 > 0.75$ is considered substantial. A high R-square value (0.802) implies that the organization has significant leverage in influencing employee engagement by managing key variables such as work environment, digital literacy, and job satisfaction. Practically, this means that investments in improving physical facilities, enhancing digital competencies, and fostering a supportive work atmosphere can produce substantial gains in engagement levels, which in turn affect retention, productivity, and morale. Literature increasingly emphasizes that organizational digitalization influences engagement through both positive (challenge) and negative (stress) pathways. For example, Zhan & Xie (2025) and Dixit et al (2024) found that workplace digitalization significantly impacts engagement via challenge/threat appraisals, moderated by digital literacy (Chan et al., 2021). In addition to facilitating remote work, flexible scheduling, and more demanding and engaging jobs, contemporary technologies also bring with them a number of drawbacks, such as stress brought on by technology, an excessive dependence on technology, work-life conflict, and burnout syndrome are several items to consider of management (Nikolić, 2023). The findings of this study, which show that workplace and digital literacy promote good employee engagement, are also supported by a number of other studies (Rasool et al., 2021). The original approach to employee engagement, according to Surma et al. (2021) was primarily focused on the traditional workplace environment. Future considerations regarding various workplace types and their distribution concurrently with the growing moments and digitization of work were also taken into consideration.

Meanwhile, the R^2 value for Job Satisfaction is 0.573, with an adjusted R^2 of 0.570, indicating that 57.3% of its variance is explained by the independent and moderating variables. This value is considered moderate but still acceptable in social and organizational research contexts. These results confirm that the model has sufficient predictive relevance for both endogenous constructs. This also demonstrates a moderate to substantial level of explanatory power (Hair Jr et al., 2021). With 57.3% of job satisfaction variance explained, organizations can focus on workplace improvements and digital enablement to enhance employees' feelings of fulfillment. For example, equipping staff with up-to-date digital tools and ensuring ergonomic workspaces may lead to a more satisfied and motivated workforce, especially among digitally literate generations. Digital literacy has a good and large influence on employee performance and job satisfaction (Örgev & Demirci, 2024), however job stress (a bad work environment) will have a negative and significant impact on employee performance, according to research findings by Zuljanna & Sary (2024).

The influence of generation significantly moderates the Work Environment construct on Job satisfaction and Employee Engagement, while it does not significantly moderate the Digital Literacy construct. This is in line with a study by Mahmoud et al (2021) which found that there are differences in responses and work motivations in generations X, Y and Z towards the work environment. Since generational factors were considered, this suggests the organization should tailor engagement and satisfaction strategies based on generational needs—for instance, Gen Z may value digital tools and flexible work modes more, while Gen X may focus on job security and role clarity.

In the case of employees in the forestry sector, where the work environment is relatively in a remote area with various limitations such as accessibility, limited work infrastructure, the work environment is far from cities and homes, limited public facilities and infrastructure, work environment conditions that have high natural risks and other things are suspected to be factors causing interactions between the work environment and moderating generations, especially generations Y and Z who have different characteristics from previous generations. Age diversity in the workforce today is greater than ever before and occurs across sectors, according to Manongcarang & Guimba (2024) . These generational differences can cause problems and conflicts in the workplace because they differ in expectations, communication styles, work habits, and values that have been shaped by their individual experiences, upbringing, and historical events. Burnout has been found to be positively correlated with a work environment that does not support expectations regarding the physical work environment, workload, relationships within the organization, career progression, and policies. This will also affect job satisfaction and engagement, and it is closely related to perceptions across generations (Meechan & Wonglorsaichon, 2024). The findings of this study corroborate earlier research that found that determinants influencing job satisfaction include wage system conditions, freedom of expression, and the security of the work environment (Köse et al., 2020). According to the findings of a research conducted by C. Lee and Kim (2024) in the South Korean forestry industry, job satisfaction and intents to leave the company differed considerably depending on factors such as age, salary, education, kind of employment, working location, and working days. According to the findings of a study conducted on forestry research staff in Nigeria, work satisfaction levels among employees were substantially correlated with employee relations tools like letters and group meetings (Halidu et al., 2020).

These differences can result in different perspectives and approaches to work. In order to guarantee efficient communication and teamwork in the workplace, it is crucial to recognize and manage these generational disparities..

These findings encourage managers to adopt data-driven HR strategies, aligning organizational policies with measurable factors that demonstrably impact engagement and satisfaction, ensuring both productivity and well-being are simultaneously addressed.

To further assess the explanatory and predictive quality of the structural model, the effect size (f^2) and predictive relevance (Q^2) were evaluated. The effect size (f^2) helps determine the practical significance of each exogenous construct in explaining the endogenous variables. The analysis showed that Job Satisfaction had a substantial effect on Employee Engagement ($f^2 = 1.053$), indicating its central role in enhancing engagement. Similarly, Workplace Environment had a large effect on Job Satisfaction ($f^2 = 0.419$), and Digital Literacy had a moderate effect

(f^2 = 0.149), suggesting that workplace conditions and digital competencies significantly contribute to job satisfaction. On the other hand, interaction effects involving generational cohorts yielded negligible effect sizes ($f^2 < 0.02$), implying that generational differences did not meaningfully moderate the main relationships.

Regarding predictive relevance, the Q^2 values—derived from the blindfolding procedure—further confirmed the model's predictive capacity. Employee Engagement had a Q^2 value of 0.474 and Job Satisfaction had 0.355, both exceeding the 0.35 threshold recommended by Hair et al. (2017) indicating strong predictive relevance. These results underscore the practical importance of fostering job satisfaction and optimizing workplace environment and digital literacy initiatives to enhance employee engagement in multi-generational organizations.

4. CONCLUSION

This study investigated the influence of workplace environment and digital literacy on job satisfaction and employee engagement in the context of industrial plantation forestry, with generational cohorts (X, Y, Z) acting as moderating variables. The results show that workplace environment and digital literacy both significantly contribute to job satisfaction and employee engagement, with job satisfaction playing a strong predictor. The model explained 80,2% of variance of Employee Engagement and 50,7 variance of Job Satisfaction. However, the moderating effect of generational cohort differences was found to be limited, suggesting that environmental and digital factors may transcend generational boundaries in remote forestry settings.

Practically speaking, the results suggest that forestry firms should make investments in developing safe, encouraging, and technologically advanced work environments to increase staff retention and happiness, particularly in difficult distant locations. Regardless of generational identification, HR professionals are urged to give ongoing digital literacy training top priority and to match workplace design with the digital and physical needs of contemporary workforces.

Causal correlations cannot be established when a cross-sectional survey methodology is used. Furthermore, the information was self-reported, which increases the possibility of social desirability bias. Despite being sizable, the sample was restricted to Indonesian forestry enterprises, which could have limited the results' applicability to other industries or regions. Furthermore, the model's explanatory power could have been limited by the omission of relevant mediators such organizational culture, leadership style, or well-being metrics. To improve knowledge, future studies should look at longer-term strategies, more comprehensive sectoral comparisons, or the inclusion of more organizational and psychological characteristics.

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