Salud, Ciencia y Tecnología. 2025; 5:2240
doi: 10.56294/saludcyt20252240

ORIGINAL

Integrated Digital-Flexible Work Performance Model: Evidence from Indonesia's Port Industry

Modelo Integrado de Desempeño Laboral Digital-Flexible: Evidencia de la Industria Portuaria en Indonesia

Riza Rosdiana[1], Nazaruddin[1], Harmein Nasution[1], Anizar Anizar[1]

[1]Universitas Sumatera Utara, Department of Industrial Engineering. Medan, Indonesia.

Cite as: Rosdiana R, Nazaruddin N, Nasution H, Anizar A. Integrated Digital-Flexible Work Performance Model: Evidence from Indonesia's Port Industry. Salud, Ciencia y Tecnología. 2025; 5:2240. https://doi.org/10.56294/saludcyt20252240

Submitted: 03-05-2025 **Revised:** 29-07-2025 **Accepted:** 17-09-2025 **Published:** 18-09-2025

Editor: Prof. Dr. William Castillo-González

Corresponding Author: Anizar Anizar

ABSTRACT

The maritime sector plays a pivotal role in global trade, yet Indonesian ports face infrastructure gaps, high logistics costs, and workforce adaptability challenges, making the alignment of digital transformation with flexible work arrangements crucial for improving employee performance and operational resilience. This study investigates the effects of work flexibility and digitalization on employee performance in Indonesia's port industry by examining the mediating roles of work engagement, job satisfaction, and work-life balance, as well as the moderating roles of technology readiness, organizational culture, and leadership style. A quantitative, cross-sectional survey was conducted with 671 employees from five major Indonesian ports, and data were analyzed using Covariance-Based Structural Equation Modeling (CB-SEM) via AMOS to test direct, indirect (mediation), and interaction (moderation) effects. Results indicate that work flexibility and digitalization significantly and positively influence employee performance both directly and indirectly through psychological well-being factors, with work engagement emerging as the strongest mediator, while technology readiness and transformational leadership strengthened these relationships; job characteristics and most organizational culture moderation effects were not significant. These findings demonstrate that integrating flexible work practices with digital technologies yields greater performance improvements than implementing each factor in isolation, offering theoretical contributions to workforce management literature and practical guidance for port authorities to design human-technology strategies that enhance operational efficiency and support employee well-being.

Keywords: Work Flexibility; Digitalization; Employee Performance; Work Engagement; Job Satisfaction; Port Industry.

RESUMEN

El sector marítimo desempeña un papel fundamental en el comercio mundial; sin embargo, los puertos indonesios enfrentan deficiencias de infraestructura, altos costos logísticos y desafíos de adaptabilidad de la fuerza laboral, lo que hace crucial alinear la transformación digital con modalidades de trabajo flexibles para mejorar el desempeño de los empleados y la resiliencia operativa. Este estudio investiga los efectos de la flexibilidad laboral y la digitalización sobre el desempeño de los empleados en la industria portuaria de Indonesia, examinando los roles mediadores del compromiso laboral, la satisfacción en el trabajo y el equilibrio entre la vida laboral y personal, así como los roles moderadores de la preparación tecnológica, la cultura organizacional y el estilo de liderazgo. Se realizó una encuesta cuantitativa de corte transversal con 671 empleados de cinco puertos principales de Indonesia, y los datos se analizaron mediante el enfoque de Modelado de Ecuaciones Estructurales Basado en Covarianzas (CB-SEM) utilizando AMOS para probar efectos

directos, indirectos (mediación) e interacciones (moderación). Los resultados indican que la flexibilidad laboral y la digitalización influyen de manera significativa y positiva en el desempeño de los empleados, tanto directa como indirectamente, a través de factores de bienestar psicológico, siendo el compromiso laboral el mediador más fuerte, mientras que la preparación tecnológica y el liderazgo transformacional fortalecieron estas relaciones; las características del puesto y la mayoría de los efectos de moderación de la cultura organizacional no fueron significativos. Estos hallazgos demuestran que la integración de prácticas de trabajo flexibles con tecnologías digitales produce mejoras de desempeño superiores a la implementación de cada factor de forma aislada, ofreciendo contribuciones teóricas a la literatura de gestión del talento y orientación práctica para que las autoridades portuarias diseñen estrategias humano-tecnológicas que mejoren la eficiencia operativa y el bienestar de los empleados.

Palabras clave: Flexibilidad Laboral; Digitalización; Desempeño de los Empleados; Compromiso Laboral; Satisfacción Laboral; Industria Portuaria.

INTRODUCTION

The maritime industry plays a critical role in facilitating global trade and economic integration, with ports acting as vital nodes in international logistics networks.[1] The rapid advancement of digital technologies—such as the Internet of Things (IoT), Artificial Intelligence (AI), blockchain, and big data analytics—has transformed operational processes in many leading ports worldwide, improving efficiency, safety, and sustainability.[2] At the same time, work flexibility has emerged as an important organizational practice, aimed at enhancing employee well-being, productivity, and adaptability in dynamic operational environments.[3] Studies have shown that aligning digital transformation with human-centered work design can create synergistic benefits for organizational performance and workforce engagement.[4] However, these advancements require careful integration to address the unique operational and cultural challenges present in the maritime sector.

Indonesia's ports hold a strategic position as gateways for global and domestic trade, connecting more than 17 000 islands and serving as key facilitators of the national supply chain.[5] Major ports such as Tanjung Priok, Tanjung Perak, Belawan, Makassar, and Batu Ampar handle millions of TEUs annually, underscoring their economic significance.[6] Despite this potential, Indonesian ports face structural challenges such as inadequate infrastructure, high logistics costs, and extended dwelling times compared to regional competitors.[7] These conditions are compounded by the need to modernize operations in line with global digitalization trends while ensuring workforce readiness and operational resilience.[8] The balance between implementing advanced technologies and maintaining workforce adaptability remains a pressing concern for port management.

Although research on port performance and digitalization is growing, most studies tend to address technological adoption or work design separately, without exploring their integrated impact on employee performance.[9] In the maritime context, scholarship often focuses on infrastructure efficiency, automation systems, and logistics optimization, while neglecting human resource aspects such as employee engagement, job satisfaction, and organizational culture.[10] Moreover, empirical research employing advanced statistical modeling to explore mediating and moderating mechanisms—such as technology readiness or leadership style—remains scarce.[11,12] These limitations highlight the need for comprehensive frameworks that capture the interplay between digitalization, flexible work practices, and performance outcomes in port environments.

The general objective of this study is to propose and empirically test the Integrated Digital-Flexible Work Performance Model (IDFWPM), which examines the effects of digitalization and work flexibility on employee performance, considering work engagement, job satisfaction, and work–life balance as mediating variables, and technology readiness, organizational culture, and leadership style as moderating variables. The framework draws upon Work Design Theory,[13] the Technology Acceptance Model,[14] and the Job Demands-Resources Theory,[15] offering a theoretically grounded yet contextually relevant approach to understanding performance in Indonesian ports. By combining these perspectives, the model aims to provide insights into how human and technological factors interact to shape operational outcomes in complex maritime settings.

This research holds significant relevance for Indonesia, where the maritime sector is a cornerstone of economic development and employment. Implementing a human-centered approach to digital transformation in ports can enhance operational efficiency, reduce costs, and improve workforce adaptability, thereby contributing to national competitiveness in global trade. The findings are expected to offer practical recommendations for policymakers, port authorities, and human resource managers to design strategies that balance technological innovation with employee well-being and engagement. Ultimately, the IDFWPM framework seeks to support the creation of resilient, high-performing port organizations capable of thriving in the era of Smart Port 4.0.

Theoretical Framework

Work Design Theory (WDT) highlights that job characteristics such as autonomy, task significance, feedback, and skill variety are essential drivers of motivation, satisfaction, and performance.[16] In the port sector, where cargo handling and documentation require precision and timeliness, integrating digital technologies—such as automation, real-time analytics, and communication platforms—enriches job content, increases decision-making autonomy, and provides immediate feedback.[17] Well-designed, technology-supported jobs are associated with higher engagement, satisfaction, and healthier work–life balance, ultimately enhancing performance.[18]

The Technology Acceptance Model (TAM) further explains that employees adopt technology when they perceive it as useful and easy to use.[14] In ports, successful adoption of port community systems, vessel tracking, and automated documentation depends on employees' recognition that these systems reduce workload, speed up operations, and improve coordination.[19,20] When adoption is successful, technology becomes a catalyst for higher engagement and performance.[21]

Complementing these perspectives, the Job Demands–Resources (JD-R) Theory emphasizes the importance of providing adequate resources—flexible scheduling, digital tools, and supportive work culture—to buffer heavy workloads, time pressure, and role ambiguity.[15] In digitalized port environments, work flexibility and technology act as critical resources that enable employees to manage stress, maintain balance, and sustain productivity even in high-pressure operational contexts.[22,23]

Building on these theories, this study proposes the Integrated Digital-Flexible Work Performance Model (IDFWPM), which conceptualizes digitalization and work flexibility as key antecedents of employee performance. Work engagement, job satisfaction, and work–life balance are considered as mediators explaining the psychological mechanisms through which these antecedents affect performance. Technology readiness, organizational culture, and leadership style act as moderators, acknowledging that employee competence and a supportive work environment are essential for translating digital and flexible work initiatives into sustained performance improvements.[24]

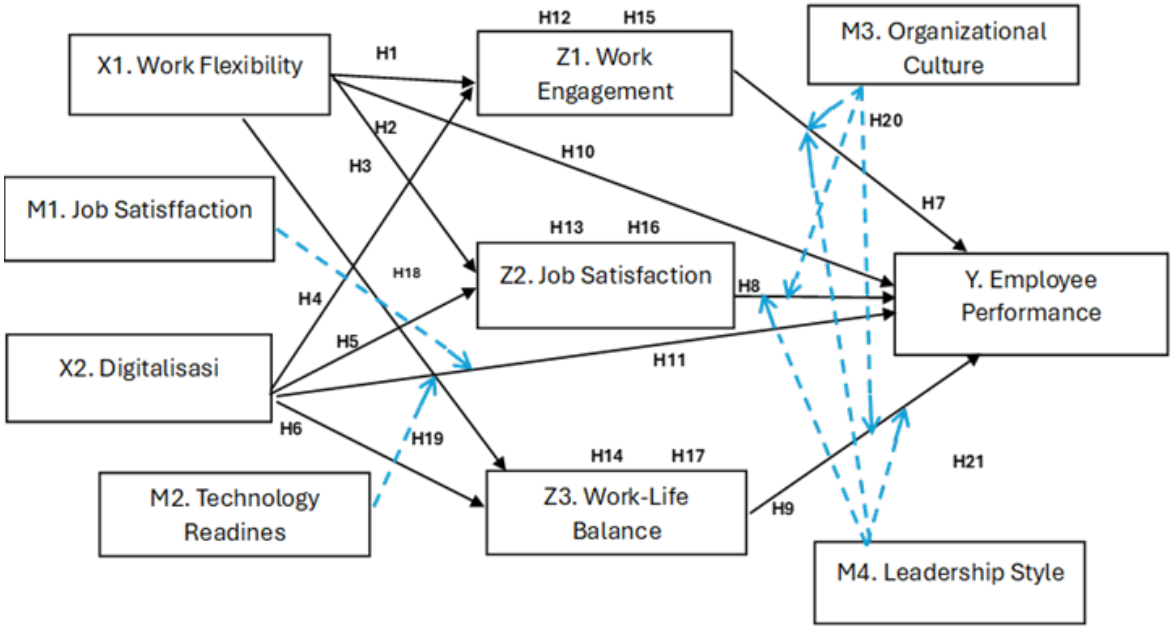

Figure 1. Proposed Integrated Digital-Flexible Work Performance Model (IDFWPM)

METHOD

A structured, multi-item survey instrument was designed for this study, comprising three main sections. The first section included an informed consent statement to ensure voluntary participation, clarification that responses should reflect actual conditions, and an assurance of confidentiality for all collected data, which were used solely for academic purposes. The second section captured socio-demographic details such as gender, age, educational attainment, tenure, and job position. The third section consisted of measurement items for all study variables, adapted from established international scales and contextualized for the operational and cultural characteristics of the Indonesian port sector. All variables were measured using a seven-point Likert scale, ranging from 1 ("strongly disagree") to 7 ("strongly agree"). Items related to work flexibility, digitalization, work engagement, job satisfaction, work-life balance, and employee performance were adopted from validated sources with minor modifications to ensure content validity in the maritime operational context.[5,9,14,19,27,28]

Sample and Procedure

This research followed a post-positivist paradigm, employing a quantitative, cross-sectional design. The population consisted of 675 employees from five strategic Indonesian ports—Tanjung Priok, Tanjung Perak, Belawan, Makassar, and Batu Ampar—covering both operational and administrative functions. Data were collected over a four-week period between June and July 2025. A stratified random sampling approach was applied to ensure proportional representation across job categories and port locations. The study analyzed work flexibility and digitalization as key predictors, work engagement, job satisfaction, and work–life balance as mediators, technology readiness, organizational culture, and leadership style as moderators, and employee performance as the primary outcome variable. A pilot test was conducted prior to the main survey to confirm the clarity, contextual relevance, and reliability of the instrument. Data collection was carried out through an online survey platform, with distribution facilitated by each port's HR department. From 675 questionnaires distributed, all were returned, although four responses were excluded due to inconsistencies in reverse-coded items, resulting in 671 valid responses (99,4 % effective response rate).

Common Method Bias

As all data were collected from a single source at one point in time, the potential for common method bias (CMB) was addressed using both procedural and statistical approaches following the recommendations of Podsakoff et al. Procedurally, the study ensured respondent anonymity, emphasized confidentiality to reduce evaluation apprehension, randomized the order of questionnaire items, and included reverse-coded items to identify inattentive responses.[32] The wording of all items was carefully adapted to the port industry context to avoid ambiguity and enhance clarity. Statistically, Harman's single factor test was conducted, and the results indicated that no single factor accounted for the majority of the variance, suggesting that CMB was not a serious concern in this study.

Data Analysis

Data were analyzed using Covariance-Based Structural Equation Modeling (CB-SEM) via AMOS, following a two-step analytical procedure. First, the measurement model was assessed through Confirmatory Factor Analysis (CFA) to evaluate convergent validity (average variance extracted (AVE) > 0,50) and internal consistency reliability (Cronbach's alpha and composite reliability > 0,70) as recommended by Hair et al. Second, the structural model was tested to examine all hypothesized relationships, including direct, indirect (mediation), and interaction (moderation) effects.[33] Significance testing was conducted using a bootstrapping procedure with 5000 resamples. Model fit was evaluated using multiple indices—Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and x^2/df ratio—based on the cut-off criteria established in SEM literature.[30]

Measurement Model and Validation

The measurement model exhibited strong psychometric properties, with complete results provided in table 1 and table 2. Standardized Loading Factor (SLF) values for first-order constructs ranged from 0,531 to 0,940, while second-order constructs ranged from 0,780 to 0,999, all surpassing the minimum threshold of 0,50, indicating substantial indicator contributions to their respective latent variables.[33] Most indicators exceeded the recommended loading value of 0,70, with only a few (e.g., X2.3.4 = 0,531; M1.1.2 = 0,600) slightly above the minimum acceptable level but retained for theoretical relevance. Constructs such as Work Flexibility, Work Engagement, and Work–Life Balance achieved particularly high second-order loadings (>0,97), with Schedule Flexibility (0,999), Stress Management (0,999), and Change Readiness (0,997) emerging as the most influential indicators.

The reliability and convergent validity of the constructs were confirmed through Composite Reliability (CR) and Average Variance Extracted (AVE) analysis. CR values ranged from 0,716 to 0,995, exceeding the minimum standard of 0,70, indicating satisfactory internal consistency.[33] AVE values fell between 0,457 and 0,985, with the majority above the recommended threshold of 0,50, supporting acceptable convergent validity.[33] These findings affirm that all measurement items reliably represent their latent constructs, thereby establishing a solid foundation for the subsequent structural model evaluation and hypothesis testing.

Table 1. Standardized Loading Factor (SLF) of All Constructs

Variable	Dimension	Indicator	SLF First Order	SLF Second Order
Work Flexibility (X1)	Schedule Flexibility	X1.1.1	0,858	0,999
		X1.1.2	0,867	
		X1.1.3	0,816	
		X1.1.4	0,861	

		X1.1.5	0,911	
	Location Flexibility	X1.2.1	0,894	0,986
		X1.2.2	0,883	
		X1.2.3	0,837	
		X1.2.4	0,853	
		X1.2.5	0,873	
	Task Flexibility	X1.3.1	0,846	0,992
		X1.3.2	0,862	
		X1.3.3	0,748	
		X1.3.4	0,720	
		X1.3.5	0,753	
Digitalization (X2)	Technology Adoption	X2.1.1	0,735	0,962
		X2.1.2	0,700	
		X2.1.3	0,747	
		X2.1.4	0,797	
	Digital Capability	X2.2.1	0,839	0,932
		X2.2.2	0,754	
		X2.2.3	0,772	
		X2.2.4	0,668	
	Digital Integration	X2.3.1	0,639	0.864
		X2.3.2	0,742	
		X2.3.3	0,855	
		X2.3.4	0,531	
Work Engagement (Z1)	Vigor	Z1.1.1	0,922	0,978
		Z1.1.2	0,901	
		Z1.1.3	0,897	
	Dedication	Z1.2.1	0,878	0,991
		Z1.2.2	0,756	
		Z1.2.3	0,917	
	Absorption	Z1.3.1	0,935	0,990
		Z1.3.2	0,939	
		Z1.3.3	0,715	
Job Satisfaction (Z2)	Satisfaction with the Job Itself	Z2.1.1	0,693	0,995
		Z2.1.2	0,828	
		Z2.1.3	0,881	
	Satisfaction with Supervision	Z2.2.1	0,889	0,993
		Z2.2.2	0,893	
		Z2.2.3	0,841	
	Satisfaction with Co-workers	Z2.3.1	0,826	0,920
		Z2.3.2	0,816	
		Z2.3.3	0,784	
	Satisfaction with Salary and Benefits	Z2.4.1	0,928	0,924
		Z2.4.2	0,918	
		Z2.4.3	0,920	
	Satisfaction with Working Conditions	Z2.5.1	0,927	0,883
		Z2.5.2	0,940	
		Z2.5.3	0,870	
Work–Life Balance (Z3)	Work-Life Integration	Z3.1.1	0,709	0,973
		Z3.1.2	0,802	

		Z3.1.3	0,866	
		Z3.1.4	0,880	
	Stress Management	Z3.2.1	0,853	0,999
		Z3.2.2	0,815	
		Z3.2.3	0,836	
		Z3.2.4	0,759	
	Life Satisfaction	Z3.3.1	0,764	0,946
		Z3.3.2	0,880	
		Z3.3.3	0,885	
		Z3.3.4	0,886	
Employee Performance (Y)	Task Performance	Y.1.1	0,786	0,956
		Y.1.2	0,794	
		Y.1.3	0,795	
		Y.1.4	0,819	
		Y.1.5	0,845	
		Y.1.6	0,863	
	Contextual Performance	Y.2.1	0,797	0,984
		Y.2.2	0,824	
		Y.2.3	0,788	
		Y.2.4	0,776	
		Y.2.5	0,792	
		Y.2.6	0,768	
	Adaptive Performance	Y.3.1	0,788	0,964
		Y.3.2	0,810	
		Y.3.3	0,847	
		Y.3.4	0,801	
		Y.3.5	0,830	
		Y.3.6	0,803	
Job Characteristics (M1)	Task Variety	M1.1.1	0,607	0,836
		M1.1.2	0,600	
		M1.1.3	0,841	
	Task Significance	M1.2.1	0,763	0,957
		M1.2.2	0,835	
		M1.2.3	0,808	
	Autonomy	M1.3.1	0,691	0,893
		M1.3.2	0,704	
		M1.3.3	0,630	
	Feedback	M1.4.1	0,632	0,876
		M1.4.2	0,845	
		M1.4.3	0,869	
Technology Readiness (M2)	Performance Optimism	M2.1.1	0,663	0,933
		M2.1.2	0,741	
		M2.1.3	0,789	
	Innovativeness	M2.2.1	0,744	0,994
		M2.2.2	0,800	
		M2.2.3	0,838	
	Discomfort	M2.3.1	0,843	0,972
		M2.3.2	0,806	
		M2.3.3	0,791	

		Insecurity	M2.4.1	0,863	0,780
			M2.4.2	0,868	
			M2.4.3	0,895	
Organizational (M3)	Culture	Innovation Orientation	M3.1.1	0,766	0,975
			M3.1.2	0,792	
			M3.1.3	0,867	
		Learning Culture	M3.2.1	0,867	0,976
			M3.2.2	0,855	
			M3.2.3	0,773	
		Change Readiness	M3.3.1	0,814	0,997
			M3.3.2	0,849	
			M3.3.3	0,792	
		Support Systems	M3.4.1	0,832	0,996
			M3.4.2	0,698	
			M3.4.3	0,674	
Leadership Style (M4)		Transformational	M4.1.1	0,869	0,975
			M4.1.2	0,872	
			M4.1.3	0,853	
			M4.1.4	0,811	
		Transactional	M4.2.1	0,811	0,994
			M4.2.2	0,656	
			M4.2.3	0,849	
		Laissez-Faire	M4.3.1	0,857	0,980
			M4.3.2	0,852	

Table 2. Composite Reliability (CR) and Average Variance Extracted (AVE) of All Constructs

Variable / Dimension	First Order		Second Order	
	CR	AVE	CR	AVE
Work Flexibility (X1)				
Schedule Flexibility	0,936	0,745	0,995	0,985
Location Flexibility	0,939	0,754		
Task Flexibility	0,891	0,621		
Digitalization (X2)				
Technology Adoption	0,833	0,556	0,943	0,847
Digital Capability	0,845	0,579		
Digital Integration	0,791	0,493		
Work Engagement (Z1)				
Vigor	0,933	0,822	0,963	0,896
Dedication	0,888	0,728		
Absorption	0,901	0,756		
Job Satisfaction (Z2)				
Satisfaction with the Job Itself	0,845	0,647	0,972	0,876
Satisfaction with Supervision	0,907	0,765		
Satisfaction with Co-workers	0,850	0,654		
Satisfaction with Salary and Benefits	0,944	0,850		
Satisfaction with Working Conditions	0,937	0,833		
Work-Life Balance (Z3)				
Work-Life Integration	0,889	0,668	0,982	0,947

Stress Management	0,889	0,667		
Life Satisfaction	0,916	0,732		
Employee Performance (Y)				
Task Performance	0,924	0,668	0,978	0,937
Contextual Performance	0,909	0,626		
Adaptive Performance	0,921	0,662		
Job Characteristic (M1)				
Task Variety	0,728	0,479	0,939	0,795
Task Significance	0,844	0,644		
Autonomy	0,716	0,457		
Feedback	0,829	0,623		
Technology Readiness (M2)				
Optimism	0,776	0,537	0,958	0,853
Innovativeness	0,837	0,632		
Discomfort	0,854	0,662		
Insecurity	0,908	0,766		
Organizational Culture (M3)				
Innovation Orientation	0,850	0,665	0,977	0,934
Learning Culture	0,871	0,693		
Change Readiness	0,859	0,670		
Support Systems	0,780	0,545		
Leadership Style (M4)				
Transformational	0,913	0,725	0,989	0,966
Transactional	0,818	0,603		
Laissez-Faire	0,844	0,730		

Ethical Considerations

Ethical approval for this study was obtained from the Research Ethics Committee of Universitas Sumatera Utara (No. 112/KEPK/USU/2025). Participation was voluntary, informed consent was obtained electronically, and anonymity and confidentiality of respondents' data were strictly guaranteed.

RESULTS

Sample characteristic

Table 3 presents the demographic characteristics of the study participants, showing that males constituted 67,0 % of the sample while females accounted for 33,0 %, reflecting the predominance of male employees in the port industry in line with global maritime and logistics trends. The majority were aged 31–40 years (42,7 %), followed by 21–30 years (28,1 %), indicating a workforce largely in early to mid-career stages. More than half of the respondents held a bachelor's degree (51,4 %), followed by diploma holders (27,0 %), demonstrating a relatively well-educated workforce. In terms of job position, operational staff formed the largest group (59,3 %), with supervisors (25,9 %) and managerial staff (14,8 %) comprising the remainder, consistent with the operationally intensive nature of port activities. Most participants had 6–10 years of work experience (32,3 %), followed by 1–5 years (25,5 %), indicating substantial industry exposure. Respondents were relatively evenly distributed across the five port locations, with Port B having the highest representation (20,7 %) and the others ranging from 19,3 % to 20,0 %, ensuring balanced coverage of operational contexts in the Indonesian port industry.

Table 3. Sample Characteristics

Variable	Category	n	%
Gender	Male	452	67,0
	Female	223	33,0
Age (years)	21–30	190	28,1
	31–40	288	42,7

	41–50	145	21,5
	>50	52	7,7
Education	High School	96	14,2
	Diploma	182	27,0
	Bachelor's Degree	347	51,4
	Postgraduate Degree	50	7,4
Job Position	Operational Staff	400	59,3
	Supervisor	175	25,9
	Managerial	100	14,8
Work Experience	1–5 years	172	25,5
	6–10 years	218	32,3
	11–15 years	156	23,1
	>15 years	129	19,1
Port Location	Port A	135	20,0
	Port B	140	20,7
	Port C	130	19,3
	Port D	135	20,0
	Port E	135	20,0

Structural Model and Hypotheses Testing

The structural model demonstrated a satisfactory level of fit, as indicated in table 4. Most indices met the recommended cut-off values, with GFI (0,921), RMSEA (0,063), SRMR (0,0359), NFI (0,968), TLI (0,971), CFI (0,976), IFI (0,976), RFI (0,961), and PNFI (0,785) all indicating a good fit, while AGFI (0,892) indicated a marginal fit and the Normed Chi-Square (3,701:1) slightly exceeded the ideal ratio. Hypotheses testing results (Table 5) confirmed that work flexibility significantly influences work engagement (H1: ß=0,988, p<0,001), job satisfaction (H2: ß=0,905, p<0,001), work–life balance (H3: ß=0,901, p<0,001), and employee performance (H10: ß=0,571, p<0,001). Similarly, digitalization significantly affects work engagement (H4: ß=0,597, p<0,001), job satisfaction (H5: ß=0,705, p<0,001), work–life balance (H6: ß=0,943, p<0,001), and employee performance (H11: ß=0,768, p<0,001). All mediating paths were significant, including work engagement (H12, H15), job satisfaction (H13, H16), and work–life balance (H14, H17), indicating strong psychological mechanisms linking work flexibility and digitalization to performance. For moderation effects, technology readiness significantly strengthened the digitalization–performance link (H19: ß=0,271, p=0,008), and leadership style moderated the job satisfaction–performance relationship (H21b: ß=0,347, p=0,035). However, job characteristics (H18) and most organizational culture and leadership style moderation paths (H20a, H20b, H20c, H21a, H21c) were not statistically significant. These results emphasize that employee performance in Indonesian port industries is strongly shaped by digital and flexible work practices through psychological pathways, with technology readiness and supportive leadership acting as important boundary conditions.

Table 4. Goodness-of-Fit (GoF) of the Structural Model

Category	Fit Index	Cut-off Criteria	Result	Interpretation
Absolute Fit	GFI	≥ 0,90	0,921	Good Fit
	RMSEA	≤ 0,08	0,063	Good Fit
	SRMR	≤ 0,08	0,0359	Good Fit
	Normed Chi-Square	≤ 3:1	3,701:1	Slightly Poor Fit
Incremental Fit	NFI	≥ 0,90	0,968	Good Fit
	TLI (NNFI)	≥ 0,92	0,971	Good Fit
	CFI	≥ 0,92	0,976	Good Fit
	IFI	≥ 0,90	0,976	Good Fit
	RFI	≥ 0,90	0,961	Good Fit
Parsimonious Fit	PNFI	≥ 0,50	0,785	Good Fit
	AGFI	≥ 0,90	0,892	Marginal Fit

Table 5. Hypotheses Testing Results

Hypothesis	Path	Estimate (β)	p-value	Supported?
Direct Effects				
H1	Work flexibility → Work engagement	0,988	<0,001	Yes
H2	Work flexibility → Job satisfaction	0,905	<0,001	Yes
H3	Work flexibility → Work-life balance	0,901	<0,001	Yes
H4	Digitalization → Work engagement	0,597	<0,001	Yes
H5	Digitalization → Job satisfaction	0,705	<0,001	Yes
H6	Digitalization → Work-life balance	0,943	<0,001	Yes
H7	Work engagement → Employee performance	0,166	<0,001	Yes
H8	Job satisfaction → Employee performance	0,227	0,002	Yes
H9	Work-life balance → Employee performance	0,263	<0,001	Yes
H10	Work flexibility → Employee performance	0,571	<0,001	Yes
H11	Digitalization → Employee performance	0,768	<0,001	Yes
Mediation Effects				
H12	Work flexibility → Work engagement → Employee performance	0,164	<0,001	Yes
H13	Work flexibility → Job satisfaction → Employee performance	0,695	<0,001	Yes
H14	Work flexibility → Work-life balance → Employee performance	0,237	0,001	Yes
H15	Digitalization → Work engagement → Employee performance	0,099	0,001	Yes
H16	Digitalization → Job satisfaction → Employee performance	0,541	<0,001	Yes
H17	Digitalization → Work-life balance → Employee performance	0,248	0,001	Yes
Moderation Effects				
H18	Digitalization × Job characteristics → Employee performance	0,034	0,550	No
H19	Digitalization × Technology readiness → Employee performance	0,271	0,008	Yes
H20a	Work engagement × Organizational culture → Employee performance	0,319	0,078	No
H20b	Job satisfaction × Organizational culture → Employee performance	-0,489	0,057	No
H20c	Work-life balance × Organizational culture → Employee performance	0,123	0,616	No
H21a	Work engagement × Leadership style → Employee performance	-0,295	0,054	No
H21b	Job satisfaction × Leadership style → Employee performance	0,347	0,035	Yes
H21c	Work-life balance × Leadership style → Employee performance	0,042	0,734	No

DISCUSSION

This study provides new empirical evidence on how work flexibility and digitalization jointly shape employee performance in the Indonesian port industry. The findings reveal that both factors exert significant direct and indirect effects on performance, with work engagement emerging as the most influential mediator, while technology readiness and leadership style strengthen these relationships, and job characteristics show limited moderating effects. The positive association between work flexibility and psychological well-being dimensions indicates that granting employees greater autonomy over schedules and tasks enhances intrinsic motivation, emotional stability, and work-life integration. This result is consistent with international studies reporting that flexible work arrangements drive engagement, retention, and productivity in high-intensity sectors such as logistics and healthcare.[3,22,28] In the Indonesian cultural context, where family obligations and collectivist norms are prominent, flexibility appears to amplify perceived work value and sustain performance over time.[27]

The significant effects of digitalization confirm the global consensus that technology adoption streamlines workflows, enhances autonomy, and reduces cognitive strain. Prior studies in the maritime and Industry 4.0 contexts have shown that technologies such as AI, IoT, and big data analytics improve efficiency, decision-making, and operational resilience.[2,8,9,17,24] By enabling real-time data visibility and facilitating interdepartmental collaboration, digital tools reduce role ambiguity and bottlenecks, which are crucial in port operations where timeliness is critical.[19,20,29] The mediation analysis highlights that work engagement is the strongest pathway linking managerial initiatives to performance, supporting evidence that engagement drives service quality, safety compliance, and customer satisfaction in logistics and manufacturing contexts.[11,21,23]

The moderation results add contextual insights that deepen understanding of the model. Technology readiness was found to strengthen the digitalization-performance link, suggesting that employees with higher

digital literacy benefit more from technological initiatives.[25] Leadership style amplified the job satisfaction-performance relationship, aligning with studies showing that transformational leaders inspire greater discretionary effort and innovative behaviors among satisfied employees.[12,30] The non-significant moderating effect of job characteristics may reflect the highly standardized and procedural nature of port operations, which limit variability in job design and thus reduce their potential moderating influence.[18]

Taken together, these results imply that a dual strategy combining human-centered flexibility with technology enablement, reinforced by digital skills development and supportive leadership, is essential for achieving sustainable performance improvements in the port sector.[10,13,15] Theoretically, this study contributes to Work Design Theory, TAM, and JD–R by demonstrating how flexibility and digitalization serve as complementary resources that jointly enhance performance. From a managerial perspective, the findings encourage port authorities and policymakers to adopt integrated approaches that promote flexible work arrangements and accelerate digital transformation while simultaneously investing in workforce digital competence and leadership capacity.

Despite these contributions, this study has limitations. Its cross-sectional design limits causal inference, and future longitudinal or experimental research is recommended to validate temporal relationships. The reliance on self-reported data may introduce bias, although procedural and statistical controls were applied. Moreover, the sample was restricted to five Indonesian ports, which may limit generalizability to other regions or port types. Future studies could include cross-national comparisons, multi-level data linking individual outcomes with organizational performance indicators, or qualitative insights from managers to capture strategic perspectives on human–technology integration. Overall, these findings underline the importance of aligning human-centered flexibility and digital transformation initiatives to build a resilient workforce and achieve long-term operational excellence, offering a strong foundation for future research and policy development.

CONCLUSIONS

This study elucidates the pivotal role of work flexibility and digitalization in enhancing employee performance within the Indonesian port industry. It highlights that these strategic resources not only exert direct positive effects on performance but also operate indirectly through key psychological well-being variables—namely, work engagement, job satisfaction, and work–life balance. The research further delineates the intricate mechanisms by which flexibility and digital transformation foster a high-performance workforce, emphasizing that these effects are significantly strengthened when supported by technology readiness and effective leadership styles. The moderating role of these contextual factors underscores their importance in translating organizational initiatives into tangible performance outcomes. By integrating human-centered flexibility with robust digital infrastructures, port authorities and policymakers can cultivate a resilient, adaptable, and high-performing workforce capable of meeting the operational demands and service quality expectations of modern port operations.

BIBLIOGRAPHIC REFERENCES

1. Kosowska-Stamirowska Z. Network effects govern the evolution of maritime trade. Proc Natl Acad Sci U S A. 2020;117(23):12719-28. https://doi.org/10.1073/pnas.1906670117

2. Su Z. Critical success factors for green port transformation. J Mar Sci Eng. 2024;12(12):2128. https://doi.org/10.3390/jmse12122128

3. Loh CW, Cheng ML. The role of flexible work arrangements in enhancing employee well-being and productivity: A study on SDG 8 implementation in tech companies. J Bus Soc Sci. 2024;2024(18):1-15. https://doi.org/10.61453/jobss.v2024no18

4. Rick VB, Stebner M, Dräger L, Franken A, Mertens A, Nitsch V. Effects of AI-based technologies on employees' work engagement: Implications for the human-centered design of digital work. Z Arbeitswiss. 2024;78(4):323-34. https://doi.org/10.1007/s41449-024-00438-1

5. Pulungan ED. From archipelago to maritime hub: Indonesia's quest to become the world's new maritime axis. J Ilm Ilmu Sos. 2024;10(2):106-17. https://doi.org/10.23887/jiis.v10i2.78631

6. IndoShipping Gazette. Tanjung Priok achieved a container throughput of approximately 7.6 million TEUs in 2024. IndoShipping Gazette / Ship4WD. 2025. https://indoshippinggazette.com/2025/priok-throughput-reaches-7-6-million-teus-marking-significant-growth-in-2024/

7. Haris E, Saidin OK, Sirait N, Kaban M. Strengthening national logistic ecosystem to increase Indonesia

competitiveness in international trade. Adv Soc Sci Educ Humanit Res. 2022;642:212-9. https://doi.org/10.2991/assehr.k.220204.038

8. He X, Hu W, Li W, Hu R. Digital transformation, technological innovation, and operational resilience of port firms in case of supply chain disruption. Mar Pollut Bull. 2023;190:114811. https://doi.org/10.1016/j.marpolbul.2023.114811

9. Li Y. Digital transformation and sustainable development in Tangshan Port: Evidence from a difference-in-differences analysis. Sustainability. 2025;17(15):6902. https://doi.org/10.3390/su17156902

10. Theotokas IN. Challenges of maritime human resource management for the digitalized environment: A systematic literature review. J Shipp Trade. 2024;9(1):1-19. https://doi.org/10.1186/s41072-024-00165-0

11. Sagbas M, Oktaysoy O, Topcuoglu E, Kaygin E, Erdogan FA. The mediating role of innovative behavior on the effect of digital leadership on intrapreneurship intention and job performance. Behav Sci. 2023;13(10):874. https://doi.org/10.3390/bs13100874

12. Montasser D, Prijadi R. The mediating effect of IT-enabled dynamic capabilities and organizational readiness on the relationship between transformational leadership and digital business model innovation: Evidence from Indonesian firms. SAGE Open. 2023;13(2):1-13. https://doi.org/10.1177/21582440231181588

13. Parker SK, Grote G. Automation, algorithms, and beyond: Why work design matters more than ever in a digital world. Appl Psychol. 2020;69(3):575-602. https://doi.org/10.1111/apps.12241

14. Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Q. 1989;13(3):319-40. https://doi.org/10.2307/249008

15. Bakker AB, Demerouti E. Job demands–resources theory: Taking stock and looking forward. J Occup Health Psychol. 2023;28(1):1-13. https://doi.org/10.1037/ocp0000305

16. Hackman JR, Oldham G. Motivation through the design of work: Test of a theory. Organ Behav Hum Perform. 1976;16(2):250-79. https://doi.org/10.1016/0030-5073(76)90016-7

17. Jović M, Tijan E, Aksentijević S, Pucihar A. Assessing the digital transformation in the maritime transport sector: A case study of Croatia. J Mar Sci Eng. 2024;12(4):634. https://doi.org/10.3390/jmse12040634

18. Senbursa N. Container port employees' organizational culture perception, job satisfaction & intention to stay at work. Mar Sci Technol Bull. 2023;12(1):12-26. https://doi.org/10.33714/masteb.1217277

19. Shahriar MS, Islam TM, Nahiduzzaman MT, Hossain RS. Digitalization in port operations: Prospects and challenges. Marit Transp Res. 2022;3:100054. https://doi.org/10.1016/j.martra.2022.100054

20. Heikkilä M, Saarni J, Saurama A. Innovation in smart ports: Future directions of digitalization in container ports. J Mar Sci Eng. 2022;10(12):1925. https://doi.org/10.3390/jmse10121925

21. Molino M, Cortese CG, Ghislieri C. The promotion of technology acceptance and work engagement in Industry 4.0: From personal resources to information and training. Int J Environ Res Public Health. 2020;17(7):2438. https://doi.org/10.3390/ijerph17072438

22. Çivilidağ A, Durmaz Ş. Examining the relationship between flexible working arrangements and employee performance: A mini review. Front Psychol. 2024;15:1398309. https://doi.org/10.3389/fpsyg.2024.1398309

23. Ngwenya B, Pelser T. Impact of psychological capital on employee engagement, job satisfaction and employee performance in the manufacturing sector in Zimbabwe. SA J Ind Psychol. 2020;46:a1781. https://doi.org/10.4102/sajip.v46i0.1781

24. Tijan E, Jović M, Aksentijević S, Pucihar A. Digital transformation in the maritime transport sector. Technol Forecast Soc Change. 2021;170:120879. https://doi.org/10.1016/j.techfore.2021.120879

25. Michelotto F, Joia R. Organizational digital transformation readiness. J Theor Appl Electron Commer Res. 2024;19(4):3283-304. https://doi.org/10.3390/jtaer19040159

26. Setayesh A, Greig MA, Grosse EH, Glock CH, Neumann WP. A generic approach to developing human factors-quality assessment tools exemplified by the warehouse error prevention tool. Ergonomics. 2024;68(7):1043-55. https://doi.org/10.1080/00140139.2024.2389287

27. Kalašová A, Paľo J, Černický Ľ, Čulík K. Research on the impact of flexible working hours on reducing traffic delays in the city. Appl Sci. 2024;14(17):7941. https://doi.org/10.3390/app14177941

28. Wang L, Xie T. Double-edged sword effect of flexible work arrangements on employee innovation performance: From the demands–resources–individual effects perspective. Sustainability. 2023;15(13):10159. https://doi.org/10.3390/su151310159

29. Sim S, Kim D, Park K, Bae H. Artificial intelligence-based smart port logistics metaverse for enhancing productivity, environment, and safety in port logistics: A case study of Busan Port. arXiv preprint. 2024. arXiv:2409.10519. https://doi.org/10.48550/arXiv.2409.10519

30. Qiao G, Li Y, Hong A. The strategic role of digital transformation: Leveraging digital leadership to enhance employee performance and organizational commitment in the digital era. Systems. 2024;12(11):457. https://doi.org/10.3390/systems12110457

31. Hu D, Lan Y. The dual path effect mechanism study of digital-HRM on employee innovative performance and cyberloafing. PLoS One. 2024;19(8):e0307195. https://doi.org/10.1371/journal.pone.0307195

32. Podsakoff PM, MacKenzie SB, Lee JY, Podsakoff NP. Common method biases in behavioral research: A critical review of the literature and recommended remedies. J Appl Psychol. 2003;88(5):879-903. https://doi.org/10.1037/0021-9010.88.5.879

33. Hair JF Jr, Hult GTM, Ringle CM, Sarstedt M. A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM). 3rd ed. Thousand Oaks: Sage; 2022.

FINANCING

The authors did not receive financing for the development of this research.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORSHIP CONTRIBUTION

Conceptualization: Riza Rosdiana, Anizar Anizar.
Data curation: Nazaruddin, Harmein Nasution.
Formal analysis: Riza Rosdiana, Nazaruddin.
Research: Nazaruddin, Harmein Nasution.
Methodology: Riza Rosdiana, Anizar Anizar.
Project management: Anizar Anizar.
Resources: Harmein Nasution, Nazaruddin.
Software: Riza Rosdiana.
Supervision: Anizar Anizar.
Validation: Riza Rosdiana, Nazaruddin.
Display: Riza Rosdiana.
Drafting – original draft: Riza Rosdiana.
Writing – proofreading and editing: Harmein Nasution, Anizar Anizar.