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RESEARCH ARTICLE

Productivity equation: when digital literacy unlocks the true potential of human resource practices

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ABSTRACT

This study investigates how virtual performance management, utilization of digital collaboration tools, and clarity of hybrid work policies shape employee productivity within Pakistan's IT and technology sector. Drawing upon the Resource-Based View (RBV) and Socio-Technical Systems (STS) theories, it further investigates the moderating role of employee digital literacy as a critical contingent factor shaping these relationships. Employing a single-wave, cross-sectional quantitative research design, self-reported data was collected via a structured questionnaire administered to 380 professionals representing diverse roles, career stages, and genders across hybrid and remote work arrangements. Partial Least Squares Structural Equation Modeling (PLS-SEM) was applied to test the hypothesized relationships, with explicit consideration of potential common method bias. The results indicate that the direct associations of virtual performance management (β = 0.021, p = 0.684), utilization of digital collaboration tools (β = 0.055, p = 0.276), and clarity of hybrid work policies (β = 0.068, p = 0.191) with productivity are not statistically significant. While this pattern may reflect shared variance absorption by the moderator or intercorrelations among predictors, the moderation analysis suggests that digital literacy significantly interacts with the relationships between each HR practice and productivity (VPM × EDL: $\beta = 0.103, p = 0.032$; DCT × EDL: $\beta = 0.122, p = 0.025$; HWPC × EDL: $\beta = 0.126, p = 0.022$), explaining a substantial proportion of variance in the outcome ($R^2 = 0.525$).These findings suggest digital readiness is a critical capability enabling organizations to translate digital HR practices into tangible performance outcomes. The evidence suggests that implementing digital HR initiatives in isolation may fail to generate performance dividends. Instead, these findings suggest organizations should pair investments in developing employees' digital capabilities with technological infrastructure to unlock their full potential. Structured digital literacy programs, reinforced with clearly communicated hybrid work policies, appear as levers for optimizing workforce performance. By positioning digital literacy as a decisive moderator, this study advances understanding of how digital capabilities enhance the effectiveness of HR practices in a knowledge-intensive sector. The finding extends RBV and STS perspectives by suggesting how digital literacy functions as a strategic resource within the context of digital Human Resource Management (HRM) in a developing economy.

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1. Introduction

The post-COVID-19 era has triggered a major transformation in the way organizations operate with hybrid work models emerging as a cornerstone of modern work arrangements. In these newly popular hybrid setups, where employees alternate between remote and onsite work and the organizations can reap notable benefits including greater flexibility,

cost savings, and broader access to talent. Yet, these arrangements may also pose significant challenges for Human Resource Management (HRM), particularly in sustaining employee productivity and engagement across demographically and temporally distributed teams (Bloom et al., 2024; Ipsen et al., 2023). Effectively navigating these challenges requires a careful examination of HR practices that not only support performance but also foster fairness, cohesion, and a sense of shared purpose within hybrid teams.

This study is led by the following research question: What HR practices are most effective for sustaining employee productivity and engagement in hybrid work environments? To address this question, this research focuses virtual performance management practices, utilization of digital collaboration tools, and the clarity of hybrid work policies as key drivers of employee productivity. These factors reflect evolving HR strategies designed to manage both logistical and interpersonal challenges inherent in hybrid work arrangements (Narayan & Pillai, 2024; Choudhury et al., 2022).

Although organizations increasingly investing in these HR practices, existing literature often examines them in isolation or focuses narrowly on outcomes such as job satisfaction or remote readiness. There remains a notable theoretical and empirical gap in understanding how multiple HR mechanisms interact in hybrid contexts and how individual capabilities, particularly digital literacy, moderate their effects (Wang & Liu, 2023). Digital literacy, defined as employees' ability to effectively understand and utilize digital technologies, is predominantly critical in hybrid environments where communication, performance tracking, and collaboration are heavily digitized (Schulze et al., 2023). Employees with higher digital competence are more likely to leverage technological tools for productive work, indicating that the same HR practices may generate varied outcomes across different skill profiles.

Accordingly, this study develops a model to examine the direct effects of three independent variables, virtual performance management, digital collaboration tools utilization, and hybrid work policy clarity, on employee productivity - the dependent variable. Additionally, it further investigates employee digital literacy as a moderator, hypothesizing that it strengthens the effectiveness of these HR practices. Drawing on Resource-Based View (RBV) theory and Socio-Technical Systems (STS) theory, this research offers a comprehensive framework for understanding the effectiveness of HR strategy in hybrid environments. By addressing a pressing organizational need, this study provides evidence-based insights for practitioners and policymakers aiming to optimize hybrid work models and foster digitally inclusive, high-performance workplaces.

2. Underpinning theories

2.1 Resource-Based View (RBV) theory

The Resource-Based View (Barney, 1991) asserts that organizations achieve sustainable competitive advantage by strategically leveraging resources that are valuable, rare, inimitable, and non-substitutable. In hybrid work context, HR practices such as virtual performance management, utilization of digital tools, and clear communication of policies serve as strategic resources that can sustain or enhance employee productivity. When these practices are aligned with organizational objectives, they help streamline both remote and on-site workflows, enabling human capital to become efficient and adaptive to dynamic work environments.

2.2 Socio-Technical Systems (STS) theory

The Socio-Technical Systems Theory (Trist & Bamforth, 1951) highlights the interdependence between social system (people) and technical systems (technology). This perspective emphasizes the importance of integrating digital collaboration tools and performance management systems with employee behaviours, skills, and work processes. It also reinforces the moderating role of employee digital literacy, as an effective adoption of HR technologies depends on employees' ability to interact with and utilize them effectively. High digital literacy enables smoother adaptation to hybrid work, thereby enhancing productivity. Together, RBV and STS offer a comprehensive theoretical foundation for understanding how strategically implemented HR practices and employee capabilities drive higher productivity: RBV highlights the strategic value of HR resources, while STS emphasizes the interaction between technology and people in modern hybrid workplaces.

3. Literature review and hypothesis development

3.1 Virtual performance management practices

As hybrid work becomes increasingly common, organizations are adopting virtual performance management (VPM) systems to maintain employee productivity across geographically dispersed teams. These practices encompass digital goal setting, online performance tracking, and virtual feedback mechanisms. From the RBV perspective, such systems are strategic resources that are valuable, rare, inimitable, and non-substitutable (Barney, 1991). When implemented effectively, VPM can provide organizations with sustained competitive advantage by enhancing employee focus, accountability, and motivation (Tambe et al., 2019). For instance, Narayan and Pillai (2024) found that structured virtual appraisal systems improve both output quality and task efficiency, especially in knowledge-intensive roles. Simultaneously, the STS theory highlights that the effectiveness of technical tools depends on their alignment with social structures (Trist & Bamforth, 1951). Performance management technologies must meet employees' needs for clarity, autonomy, and interpersonal connection to produce meaningful results. Ipsen et al. (2023) reports that when digital performance management tools are paired with consistent feedback and trust-based leadership, productivity increases by up to 20%. Similarly, Wang and Liu (2023) suggest that virtual performance tools offer stronger goal alignment when complemented by clear communication protocols and employee training, reflecting the STS principle of joint optimization. Despite the widespread adoption of VPM tools, many organizations struggle to achieve productivity gains due to poor integration with social systems or lack of digital fluency among employees (Choudhury et al., 2022). Therefore, both RBV and STS theories indicate that the effectiveness of virtual performance management depends not only on the quality of tools but also on their embedding within organizational culture and workflows. Taken together, these insights and empirical evidence strongly support the formulation of the following hypothesis:

H1. *Virtual performance management practices positively influence employee productivity.*

3.2 Digital collaboration tools

As hybrid work becomes widespread, digital collaboration tools such as Microsoft Teams, Slack, Zoom, and Asana have become essential for sustaining and enhancing employee productivity. From RBV perspective, these tools are strategic, inimitable, and valuable assets that facilitate communication, coordination, and workflow transparency across dispersed teams (Barney, 1991). Supporting this view, Holubecki et al. (2024) found

that organizations investing in integrated collaboration platforms achieved up to 18% improvement in task completion times alongside stronger team coordination.

Likewise, STS theory emphasises that the effectiveness of technological interventions depends on their alignment with social structures, workflows, and organizational culture (Trist & Bamforth, 1951). Tools that enable shared context and seamless communication strengthen team cohesion, encourage informal knowledge sharing, and improve collective sense-making. Fernández, Lee, and Patel (2025) found that when collaboration tools were supported by clear norms and usage protocols, team productivity improved by 22%, reflecting mutual understanding and accountability.

Moreover, Zhou et al. (2023) reported that collaborative platforms with intuitive interfaces promote frequent and meaningful engagement, reducing misunderstandings and accelerating project delivery especially in knowledge-intensive sectors. However, productivity gains are reported to be limited without proper integration between tools and social workflows; sustained benefits require both effective tool design and supportive social processes (Kim & Choi, 2024).

Collectively, these findings effectively substantiate the formulation of our second hypothesis:

H2. *The effective use of digital collaboration tools positively influences employee productivity.*

3.3 Hybrid work policies

In hybrid work environments, establishing clear and well communicated hybrid work policies is crucial for sustaining employee productivity. Such policies reduce ambiguity and align individual efforts with organizational goals. From a RBV perspective, these policies are organizational capabilities that are valuable, difficult to replicate, and essential for effectively leveraging hybrid work arrangements. Solihah et al. (2025) found that structured hybrid policies enhance both productivity and employee satisfaction, particularly when supported by strong organizational culture and robust digital infrastructure, reinforcing their strategic value. Clear policies help mitigate miscommunication, workload imbalance, and disengagement by setting expectations for performance and collaboration (Pardosi et al., 2025).

The STS theory highlights that effectiveness of policy depends on their alignment with employees' social context and work processes. For instance, Mercer's survey revealed that unclear or absent formal hybrid guidelines caused confusion and productivity loss, with 73% of employees unsure on how to structure their work, adversely affecting morale and performance (Tsipursky, 2023). Similarly, PwC's study suggests that hybrid employees guided by purpose driven strategies rather than rigid mandates report higher productivity and sense of belonging, emphasizing the power of transparent, well communicated policies in fostering positive work environments (Business Insider, 2024).

Together, RBV and STS perspectives suggest that clear hybrid work policies function as strategic assets that, when aligned with social norms and workflow systems, enhance productivity by providing structure, reducing ambiguity, and enabling autonomy. This empirical evidence therefore supports and substantiates the formulation of the following hypothesis:

H3. *Clear and well-communicated hybrid work policies lead to higher employee productivity.*

3.4 Employee digital literacy

The moderating role of employee digital literacy in the relationship between HR practices such as virtual performance management, digital collaboration, and hybrid work policy clarity, and employee productivity is increasingly recognised as critical in the modern workplace. From an RBV perspective, digital literacy represents a unique and valuable capability that enhances the effectiveness of organizational resources. Employees with strong digital skills can better leverage performance management systems and collaboration platforms, enabling organizations to achieve higher productivity and competitive advantage (Barney, 1991; Ferreira & Fernandes, 2023).

Likewise, STS theory emphasizes the importance of aligning technical systems with human capabilities. In hybrid work environments, the success of digital HR practices depends on employees' ability to navigate and utilize digital platforms. Even well-designed HR systems may fail to deliver expected outcomes without sufficient digital literacy (Mumford, 2006; Syvänen et al., 2023). In a study of Finnish public sector organizations, Syvänen et al. (2023) reported that digital literacy significantly moderated the impact of digital workplace tools on employee engagement and perceived productivity.

Recent empirical studies further support this moderating role. Khorakian et al. (2023) found that digital literacy mitigated the negative effects of remote work challenges on employee performance during the COVID-19 pandemic. Employees with higher digital skills maintained greater job satisfaction and productivity despite disruptions. Similarly, Ameen et al. (2022) established that digital capabilities strengthened the effect of digital transformation initiatives on employee performance and resilience, particularly in knowledge-intensive sectors. Furthermore, Rahman et al. (2024) found that digital literacy amplifies the relationship between performance management practices and employee outcomes in hybrid work settings highlighting that it's not merely a supportive skill but a strategic moderator that shapes how effectively digital HR practices are internalized and applied.

In summary, employee digital literacy is a key enabler that enhances the effectiveness of HR practices in hybrid and digital environments. Grounded in RBV and STS theories, the literature affirms that organizations must pair investments in digital HR systems with parallel efforts to build digital literacy. This approach ensures that technology-driven HR initiatives translate into measurable productivity gain. Collectively, these findings effectively substantiate the formulation of our fourth set of hypotheses:

H4a. *Employee digital literacy positively moderates the relationship between virtual performance management practices and employee productivity.*

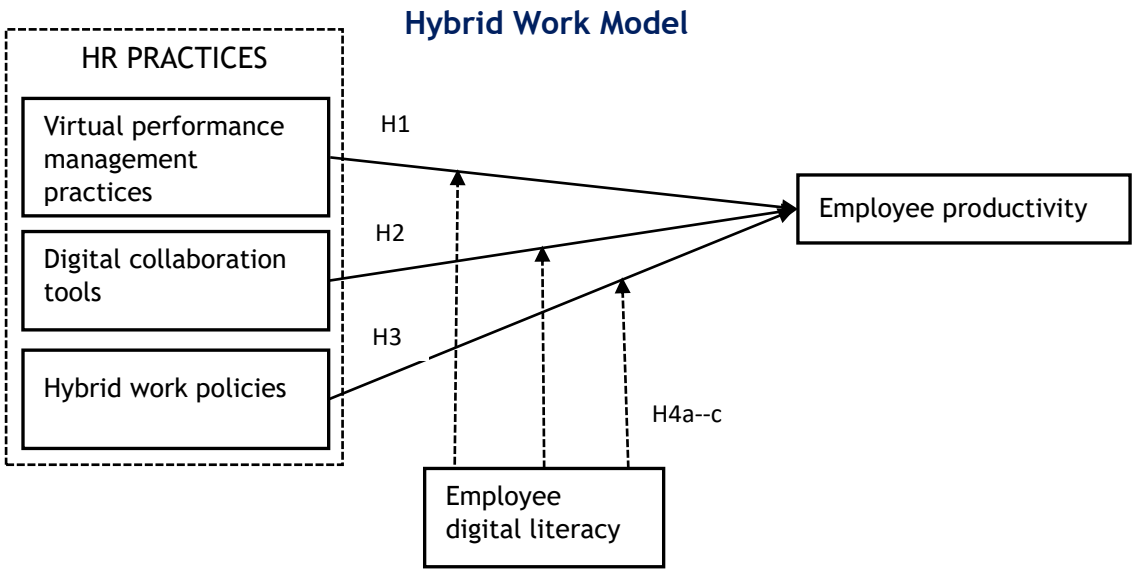
H4b. *Employee digital literacy positively moderates the relationship between the use of digital collaboration tools and employee productivity.*

H4c. *Employee digital literacy positively moderates the relationship between hybrid work policy clarity and employee productivity.*

4. Theoretical framework of study

The proposed model examines how key HRM practices influence employee productivity in hybrid work environments. Grounded RBV and STS theories, the model suggests that virtual performance management, digital collaboration tools utilization, and clear hybrid work policies (H1, H2, H3) serve as a strategic asset capable of enhancing productivity. Their impact, however, is significantly shaped by employee digital literacy (H4), which functions as a moderating factor. Employees with higher digital competence are better equipped to navigate virtual systems, utilize digital tools effectively, and adapt to hybrid work practices, thereby maximizing performance outcomes. This integrative framework underscores the dynamic interplay between digital HR practices and employee capabilities, offering a comprehensive perspective on productivity in digitally enabled, hybrid workplaces.

Figure1. Research model



5. Methodology

5.1 Questionnaire design

The study utilized a structured questionnaire to investigate the influence of HR practices on employee productivity in hybrid and digital work environments. All constructs were measured using a five-point Likert scale ranging from 1 (“Strongly Disagree”) to 5 (“Strongly Agree”), a widely accepted methods for capturing attitudes and perceptions in organizational research (Joshi et al., 2015). Virtual performance management practices were assessed using items adopted from Pulakos et al. (2019), focusing on online feedback, virtual goal-setting, and performance tracking mechanisms. Digital collaboration tools utilization was measured through perception of ease of use, usefulness, and frequency of usage with platforms such as Zoom, Microsoft Teams, and Slack (Taras et al., 2021). Hybrid work policy clarity was measured using items adapted from Gartner’s (2023) guidelines emphasizing transparency, communication, and flexibility. Employee digital literacy was

assessed via the scale developed by Eshet (2012) and refined by van Deursen and van Dijk (2021), capturing individual's capacity to navigate, understand, utilize digital tools effectively. Employee productivity was measured through efficiency, task completion, and quality of output, following Spreitzer et al. (2017). A pilot test with 30 employees confirmed clarity and reliability, with all constructs demonstrating strong internal consistency (Cronbach's alpha > 0.7) (Hair et al., 2019).

5.2 Sampling procedure

A stratified purposive sampling approach was employed to capture a diverse and representative sample of employees from Pakistan's IT and technology sector. Data was collected from 380 respondents based in Karachi, a major technology hub in Pakistan. The sample was stratified across key demographic and workplace dimensions: job functions (HR, technical [developers, engineers, analysts], and managerial roles), organizational levels (entry, mid, and senior levels), gender, and work arrangements (hybrid and remote setups) to ensure balanced representation across subgroups. This stratified purposive approach enabled targeted inclusion of relevant subgroups enhancing both the generalizability and contextual relevance of the findings (Etikan et al., 2016).

5.3 Data analytical techniques

The study used Partial Least Squares Structural Equation Modeling (PLS-SEM) for data analysis with SmartPLS version 4.0. This software was chosen for its suitability to analyse complex models with multiple constructs, non-normal data, and moderating effects (Hair et al., 2021). A two-staged approach was used for data analysis. First, the measurement model was assessed for reliability, convergent validity (using AVE), and discriminant validity (using Fornell–Larcker criteria). Second, the structural model was utilized to test the hypothesized relationships (H1 to H4), with path coefficients, t-values, and R^2 values analysed for significance. Moderation effects were tested through interaction terms, especially to assess the influence of employee digital literacy on the strength of the relationship between HR practices and employee productivity. This analytical approach enabled rigorous evaluation of both direct and moderated relationships within the conceptual model.

6. Data analysis

6.1 Model fitness

The structural model was evaluated for fitness using PLS-SEM criteria. With value of 0.058, the Standardized Root Mean Square Residual (SRMR) is lower than the recommended threshold of 0.08, indicating accepted fit (Henseler et al., 2014). The Normed Fit Index (NFI) was reported at 0.904, further supporting model quality and comparative fit. Moreover, the R^2 value for the endogenous construct Employee Productivity (EP) was 0.525, showing that 52.5% of the variance in EP is explained by the model's exogenous variables Virtual Performance Management (VPM), Digital Collaboration Tools (DCT), and Hybrid Work Policy Clarity (HWP), along with the moderating role of Employee Digital Literacy (EDL). Q^2 values, derived through blindfolding were all above zero (Q^2 for EP = 0.447), confirming strong predictive relevance. Collectively, these fit indices confirm that the model is robust, theoretically grounded, and suitable for hypothesis testing in the hybrid work context.

6.2 Construct validity and discriminant validity analysis

With composite reliability (CR) values ranging between 0.735 to 0.815, the measurement model surpassed the recommended threshold of 0.70 and confirming internal consistency and reliability (Nunnally & Bernstein, 1994; Kaufmann & Gaeckler, 2015). The average variance extracted (AVE) for all constructs was above 0.50, indicating that constructs explained more variance than error (Fornell & Larcker, 1981). Using the Fornell-Larcker criterion discriminant validity was confirmed, whereby the square root of each construct's AVE (diagonal values in Table 1) exceeded its correlations with other constructs (Fornell & Larcker, 1981). Furthermore, all construct pairs showed the Heterotrait-Monotrait ratio of correlations (HTMT) value below the threshold of 0.80 offering further evidence of discriminant validity (Henseler et al., 2015; Kaufmann & Gaeckler, 2015). Together, these results indicate that the measurement model exhibit strong convergent and discriminant validity, as summarized in Table 1.

Table 1. Discriminant validity (Fornell–Larcker criterion and HTMT)

	VPM	DCT	HWPC	EDL	EP
	Fornell-Larcker criterion				
VPM	***0.743***				
DCT	0.486	***0.784***			
HWPC	0.553	0.349	***0.689***		
EDL	0.596	0.395	0.434	***0.655***	
EP	0.524	0.386	0.382	0.413	**0.648**
	Heterotrait-Monotrait Ratio of Correlation				
VPM	—				
DCT	0.538				
HWPC	0.502	0.688			
EDL	0.510	0.657	0.602	0.442	
EP	0.618	0.552	0.588	0.482	

Note: n=380, Virtual Performance Management (VPM), Employee Productivity (EP), Digital Collaboration Tools (DCT), Hybrid Work Policy Clarity (HWPC), Employee Digital Literacy (EDL)

Source: Authors' compilation

6.3 Hypothesis Testing

H1. *Virtual Performance Management (VPM) practices positively influence employee productivity (EP)*

The standardized path coefficient from VPM to EP was 0.021 (p = 0.684), indicating a positive but statistically non-significant effect (see Table 2), thus rejecting H1. Although the relationship aligns well with the Resource-Based View, which underscores internal capabilities such as performance systems as strategic assets. This finding suggests that VPM practices alone may not yield meaningful productivity gains in hybrid environments. Several explanations are plausible; first, VPM systems may lack contextual adaptation, overlooking the motivational and autonomy needs of employees working remotely (Wang et al., 2021). Second, virtual performance feedback may lose relational nuance, reducing its motivational impact. This aligns with Socio-Technical Systems theory, which argues that technical tools must be integrated with social systems to be effective (Pasmore et al., 2018).

H2. *Use of Digital Collaboration Tools (DCT) positively influences employee productivity (EP)*

Surprisingly, the DCT → EP path was positive (0.055) and statistically non-significant (p = 0.276) (see Table 2), thereby rejecting H2 and contradicting most of the recent literature. This may stem from digital tool overload, ineffective adoption, or limited digital literacy all of which undermine the tools' efficacy (Yang et al., 2022). Although platforms like Slack, MS Teams, and Zoom are intended to enhance coordination, excessive or poorly integrated use can fragment attention and hinder deep work capacity, particularly in knowledge-intensive roles. From the STS perspective, digital tools enhance productivily only when supported by training, social support, and organizational norms. Without these enablers, they become technical disruptions rather than assets.

H3. *Hybrid Work Policy Clarity (HWPC) positively affects employee productivity (EP)*

The coefficient for HWPC was 0.068 ($p = 0.191$) (see Table 2), indicating a positive but statistically non-significant effect, hence rejecting H3. Although not significant, the findings align with the view that policy clarity reduces ambiguity, aligns expectations, and fosters psychological safety which are critical factors for productivity in hybrid environments (Gibbs et al., 2021). From a RBV perspective, clear policies function as structural capital, guiding efficient behaviour and decision-making. STS theory further reinforces that clearly communicated systems reduce socio-technical misalignments. In hybrid environments employees must clearly understand boundaries, expectations, and resources; ambiguous policies disrupt this alignment and hinder productivity.

H4a. *EDL × Virtual Performance Management (VPM) → EP*

The interaction between Employee Digital Literacy (EDL) and Virtual Performance Management (VPM) on Employee Productivity (EP) was positive and significant (β = 0.103, p = 0.032) supporting H4a (see Table 3). This indicates that employees with high digital literacy navigate digital performance systems effectively, interpret feedback with efficacy, and adapt behaviours quickly leading to improved productivity. From a Resource-Based View perspective, EDL represents a strategic intangible asset that enhances the utility of digital HR systems (Barney, 1991). Consistent with Socio-Technical Systems theory, digitally fluent employees integrate technical tools (e.g., dashboards, metrics) with social aspects (e.g., feedback, manager interaction), yielding superior outcomes (Trist & Bamforth, 1951).

H4b. *EDL × Digital Collaboration Tools (DCT) → EP*

The interaction between EDL and Digital Collaboration Tools (DCT) was also positive and significant (β = 0.122, p = 0.025), supporting H4b (see Table 3). Employees with higher digital skills optimize communication platforms such as Microsoft Teams or Slack, manage shared documents efficiently, and coordinate asynchronously, enabling smoother collaboration and higher productivity. This finding is consistent with RBV, which suggests that digital literacy enhances the value extracted from collaboration technologies. STS theory also reinforces that digital fluency enhances alignment between human interactions and digital systems, reducing friction and enhancing workflow efficiency.

H4c. *EDL × Hybrid Work Policy Clarity (HWP) → EP*

The moderation effect of EDL on the relationship between Hybrid Work Policy Clarity (HWP) and EP was positive and statistically significant (β = 0.126, p = 0.022), supporting H4c. Employees with higher EDL interpret policy guidelines more effectively, self-manage schedules, and adopt digital workflows, while those with lower EDL may struggle despite

clear policies. From the RBV perspective, digital literacy enables employees to drive strategic value from work policies. In line with STS theory, when technical competence is lacking, even well-designed hybrid policies may fail due to socio-technical misalignment.

Together, the moderation effects (H4a–H4c) (see Table 3) demonstrate that digital literacy significantly shapes employee productivity in hybrid workplaces. HR practices are not universally effective: their success is dependent on individual competencies. These findings support a person–technology fit framework and highlight the importance of investment in digital upskilling alongside deploying advanced HR systems. Integrating RBV and STS theory offers a robust theoretical foundation, showing how employee capabilities mediate the effectiveness of organizational digital transformation initiatives.

Table 2. Hypotheses testing – direct effect

Hypotheses	β	P-value	t-value	R^2	Results
H1. VPM →EP	0.021	0.684	0.408	4.014%	Not significant
H2. DCT →FP	0.055	0.276	1.090	3.122%	Not significant
H3. HWPC →EP	0.068	0.191	1.310	3.188%	Not significant

Virtual Performance Management (VPM), Employee Productivity (EP), Digital Collaboration Tools (DCT), Hybrid Work Policy Clarity (HWPC), Employee Digital Literacy (EDL)

Table 3. Hypotheses testing – moderation effect

Hypotheses	β	t-value	p-value	R^2	Results
H1. VPM →EP	0.021	0.408	0.684	6.116%	Not significant
H2. DCT →FP	0.055	1.09	0.276	8.227%	Not significant
H3. HWPC →EP	0.068	1.31	0.191	7.773%	Not significant
	0.103	5.044	0.032		
H4a. VPM x EDL →EP	0.122	7.004	0.025	27.18%	Accepted
H4b. DCT x EDL →EP	0.126	4.965	0.022	32.22%	Accepted
H4c. HWPC x EDL →EP	0.021	0.408	0.684	42.11%	Accepted

Note: $n = 380$; Overall model $R^2 = 0.525$ (52.5% variance explained in EP); $Q^2 = 0.447$. VPM = Virtual Performance Management; DCT = Digital Collaboration Tools; HWPC = Hybrid Work Policy Clarity; EDL = Employee Digital Literacy; EP = Employee Productivity.

7. Discussion

This study examined how virtual performance management practices, digital collaboration tools utilization, and hybrid work policy clarity influence employee productivity in Pakistani IT and tech firms, with digital literacy as a moderator. The results provide insights into the dynamics of remote and hybrid work environments.

The first hypothesis (H1) which predicted a positive effect of virtual performance management (VPM) on productivity, was not statistically significant, though the relationship was positive. This indicates that while VPM systems support remote performance tracking, feedback, and goal setting, their impact may depend on contextual and behavioural factors.

The STS theory suggests, productivity gains occur only when technical systems (e.g., VPM platforms) are aligned with social elements such as trust, communication norms, and managerial support (Pasmore & Sherwood, 2018). The RBV theory also highlights that unless these systems are embedded in organizational routines and culture, they deliver limited value (Barney, 1991).

The second hypothesis (H2), which examined the influence of digital collaboration tools utilization on productivity, showed a positive ($\beta = 0.055, p = 0.276$) yet statistically non-significant impact. Although this contradicts earlier findings (Yang et al., 2022), it reflects the possibility that the excessive or poorly integrated tools can overwhelm employees and hinder focus. Without proper training or coordination, such tools may create communication noise and overload rather than efficiency, reinforcing the STS view that technology must be socially integrated to be effective.

Likewise, the third hypothesis (H3), testing the effect of hybrid work policy clarity, yielded a positive but non-significant result. This suggests that clear and consistent policies may support conditions for productivity, though effect is statistically insignificant. Gibbs et al. (2021) reported that policy clarity reduces ambiguity and increases psychological safety, though its impact may only become significant when combined with high employee engagement and managerial support.

The strongest evidence supported our fourth hypothesis (H4), where digital literacy significantly moderated the relationship between HR practices and productivity. This evidence underscores the significance of digital literacy as a strategic resource aligning with RBV and STS perspectives. The findings aligned well with earlier research that digital literacy is an intangible resource that enhances the effectiveness of other organizational capabilities (van Laar et al., 2020). It also reflects that the virtual HR practices succeed only when employees can understand and navigate digital platforms effectively.

Overall, the findings from our research emphasize that achieving productivity in hybrid environment goes beyond merely adoption of technology. Building a digitally competent workforce and context-sensitive implementation of hybrid HR systems are critical to achieve sustained productivity gains.

8. Conclusion

This study explored how virtual performance management practices, digital collaboration tool utilization, and clarity in hybrid work policy influence employee productivity in Pakistan's IT and tech sector, with employee digital literacy as a moderating variable. The findings indicate that these HR practices generally support productivity with employees' digital literacy emerges as a strongest element. This evidence validates the importance of strategic digital HRM approaches in hybrid environments where digital literacy strengthens these relationships, reinforcing that technologically competent employees drive greater benefits from digital HR interventions. Grounded in the Resource-Based View and Socio-Technical Systems theories, the study emphasizes the importance of integrating both human and technological resources for a sustainable performance in hybrid work arrangements. While virtual performance practices and policy clarity consistently contribute to productivity, the utilization of collaboration tools showed nuanced effect largely dependent upon usability and training. Overall, the results suggest that the success of hybrid work arrangements depends not only on tools and clear policies but also on the employees' capability and readiness to understand and engage with them. These insights offer practical guidance for HR strategies in digitally transforming dynamic organizations.

9. Implications and future research directions

This study offers several theoretical and practical implications. Theoretically, it extends the Resource-Based View, and Socio-Technical Systems perspectives to hybrid work environments, demonstrating that HR practices, aligned with employees' digital capabilities, can significantly enhance productivity. The findings enrich the HRM literature by emphasizing the integrating digital tools and performance management frameworks, and employee-centric strategies.

Practically, the results offer valuable guidance for HR professionals, particularly in the IT and tech sectors. The study reinforces that organizations should implement clear and well-structured hybrid work policies, establish robust virtual performance management systems, and effective collaboration tools. Furthermore, digital literacy emerged as a key moderator, highlighting the value for ongoing employee training and digital upskilling programs. By fostering a digitally competent workforce, organizations can strengthen employee engagement, performance tracking, and goal alignment in remote or hybrid settings.

Future research could explore cross-industry variations in digital HR practices to enhance generalizability. Longitudinal studies may reveal deeper insights into how digital literacy evolves over time and its sustained impact on hybrid work arrangements. Furthermore, qualitative approaches, such as interviews or case studies, may uncover contextual factors like organizational culture or leadership style mediating or moderating these relationships. Additionally, studies may also investigate generational or gender differences in response to digital HR initiatives, offering further granularity for HRM strategies in hybrid workplaces.

As work environments continue to evolve, ongoing research into adaptive HR models remains critical for developing high-performance, digitally fluent organizations.

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Appendix 1. Questionnaire: The Productivity Equation

Dear Participant

We invite you to participate in a research study investigating how digital HR practices and digital literacy shape employee productivity in hybrid work environments within Pakistan's IT and technology sector. Your responses will remain strictly confidential and will be used solely for academic research purposes. Please read each statement carefully and select the option that best reflects your opinion.

Section A: Demographic Information

1. Gender:
   [ ] Male [ ] Female [ ] Prefer not to say

2. Job Function:
   [ ] HR [ ] Technical (Developer, Engineer, Analyst) [ ] Managerial [ ] Other

3. Career Level:
   [ ] Entry Level [ ] Mid-Level [ ] Senior Level

4. Current Work Arrangement:
   [ ] Fully Remote [ ] Hybrid (Mix of remote and onsite) [ ] Fully Onsite

Instructions: For the following sections, please indicate your level of agreement with each statement on a scale of 1 to 5, where:

1 = Strongly Disagree (SD)
2 = Disagree (D)
3 = Neutral (N)
4 = Agree (A)
5 = Strongly Agree (SA)

Section B: Virtual Performance Management (VPM)

VPM1: My organization uses effective digital tools for setting and tracking my work goals.
[1] [2] [3] [4] [5]

VPM2: The virtual performance feedback I receive is timely and constructive.
[1] [2] [3] [4] [5]

VPM3: The digital performance management system accurately reflects my contributions and productivity.
[1] [2] [3] [4] [5]

VPM4: I feel the online performance tracking mechanisms are fair and transparent.
[1] [2] [3] [4] [5]

Section C: Digital Collaboration Tools (DCT)

DCT1: The digital collaboration platforms provided (e.g., MS Teams, Zoom, Slack) are easy to use.
[1] [2] [3] [4] [5]

DCT2: I frequently use digital collaboration tools to coordinate effectively with my team.
[1] [2] [3] [4] [5]

DCT3: The digital tools provided by my organization significantly improve my daily workflow.
[1] [2] [3] [4] [5]

DCT4: The use of digital collaboration tools does not overwhelm me or fragment my attention.
[1] [2] [3] [4] [5]

Section D: Hybrid Work Policy Clarity (HWPC)

HWPC1: The hybrid work policies in my organization are clearly communicated.
[1] [2] [3] [4] [5]

HWPC2: I understand the expectations regarding my working hours and availability in a hybrid setup.
[1] [2] [3] [4] [5]

HWPC3: The policies provide sufficient flexibility for me to manage my tasks efficiently.
[1] [2] [3] [4] [5]

HWPC4: The guidelines for remote versus onsite work reduce ambiguity in my daily tasks.
[1] [2] [3] [4] [5]

Section E: Employee Digital Literacy (EDL)

EDL1: I am highly capable of navigating and using new digital tools required for my work.
[1] [2] [3] [4] [5]

EDL2: I can quickly troubleshoot and solve basic technical issues related to digital work platforms.
[1] [2] [3] [4] [5]

EDL3: I understand how to effectively manage, share, and protect digital information.
[1] [2] [3] [4] [5]

EDL4: I feel confident in my ability to adapt to future technological changes in the workplace.
[1] [2] [3] [4] [5]

Section F: Employee Productivity (EP)

EP1: I consistently meet my deadlines and complete my assigned tasks efficiently.
[1] [2] [3] [4] [5]

EP2: The quality of my work output remains high despite working in a hybrid/remote environment.
[1] [2] [3] [4] [5]

EP3: I can easily maintain my focus and momentum on critical tasks throughout the workday.
[1] [2] [3] [4] [5]

EP4: Overall, I feel highly productive in my current work arrangement.
[1] [2] [3] [4] [5]