Human Resource Management Strategies for Enhancing Digital Transformation and Agility in SMEs

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Abstract

Small and medium enterprises (SMEs) face persistent technological resistance that undermines digital transformation and organizational agility, yet the mechanisms through which human resource management (HRM) practices mitigate this resistance remain insufficiently integrated into a unified empirical framework. This study addresses the gap by examining how HRM-driven change management—encompassing training and development, communication and participation, leadership support, and incentive alignment—reduces technological resistance and enhances organizational agility in SMEs. A quantitative cross-sectional design was employed, drawing on survey data from 420 managers, IT officers, and HR practitioners in manufacturing SMEs, supplemented by structural equation modeling and hierarchical regression analysis. The findings demonstrate that HRM-driven change management significantly reduces technological resistance, with the final model explaining 71.3% of the variance in resistance outcomes ($R^2 = 0.713$), while perceived organizational readiness partially mediates this relationship and technological self-efficacy moderates its strength. The study concludes that HRM functions as a strategic lever for converting technological resistance into adaptive capacity, offering a replicable framework for

SME administrators to sequence training, communication, leadership signaling, and incentive redesign prior to and during digital transformation initiatives.

Keywords: technological resistance, human resource management, digital transformation, organizational agility

1. Introduction

1.1 Background

Digital transformation has become an imperative for small and medium enterprises (SMEs) seeking to maintain competitive viability in increasingly volatile markets. The post-pandemic business environment has accelerated the adoption of digital technologies across production and consumption domains, with organizational agility emerging as a critical outcome of successful digitalization . Yet the path from technology adoption to genuine agility is obstructed by a persistent and undertheorized barrier: technological resistance. Employees at individual, group, and organizational levels frequently oppose new systems not out of irrationality but because technological change disrupts established routines, threatens perceived competence, and generates uncertainty about role security . For SMEs, these resistance dynamics are amplified by resource constraints, informal organizational structures, and limited slack for experimentation, making the cost of failed digital initiatives disproportionately high relative to firm size .

Within this landscape, human resource management (HRM) has been repositioned from an administrative support function to a strategic mechanism for managing the human dimensions of technological change. HRM-driven change management—defined as the deliberate deployment of training, communication, leadership support, and incentive alignment to facilitate technology adoption—has been shown to significantly reduce technological resistance in AI-IoT adoption contexts, with perceived organizational readiness mediating this relationship and technological self-efficacy moderating its strength . Concurrently, digital HRM practices have been identified as enablers of organizational agility in micro, small, and medium enterprises, though their effectiveness is contingent upon managerial competence, digital readiness, and organizational culture . These parallel literatures suggest that HRM may serve as the missing link between digital transformation investments and agility outcomes, but they have developed largely in isolation from one another.

1.2 Problem Statement

Existing research has established that digital transformation positively influences organizational agility in SMEs , and separately that HRM-driven change management reduces technological resistance . However, three critical gaps persist. First, studies examining technological resistance have typically treated HRM practices as undifferentiated bundles rather than testing the relative

contribution of specific practices—training, communication, leadership, and incentives—to resistance reduction. Second, the mediating mechanism through which HRM practices translate into reduced resistance remains underspecified; perceived organizational readiness has been proposed as a mediator , but this pathway has not been validated in the context of agility outcomes specifically. Third, no integrated empirical framework exists that connects HRM-driven resistance reduction to organizational agility as a downstream outcome, leaving practitioners without evidence-based guidance on how to sequence HR interventions for maximum effect.

The consequence of this gap is practically consequential. SME administrators facing technological resistance lack a validated model for allocating scarce HR resources across competing priorities. They may over-invest in technology infrastructure while under-investing in the human processes that determine whether that infrastructure is actually used. As Sabeena et al. demonstrate, production technologies such as automation and digital infrastructure are stronger predictors of agility than consumption technologies, yet the workforce capabilities required to leverage these production technologies depend directly on HRM practices that build competence and reduce resistance. The unsolved issue, therefore, is the absence of a validated, practice-level framework specifying how HRM strategies reduce technological resistance and thereby enhance organizational agility in SMEs.

1.3 Objectives of the Study

General objective:

To examine the effects of specific HRM-driven change management practices on technological resistance and organizational agility in SMEs, and to identify the mechanisms through which these effects operate.

Specific objectives:

1. To determine the relative impact of training and development, communication and participation, leadership support, and incentive alignment on reducing technological resistance in SMEs undergoing digital transformation.
2. To test whether perceived organizational readiness mediates the relationship between HRM-driven change management and technological resistance.
3. To assess whether technological self-efficacy moderates the effectiveness of HRM practices in reducing resistance.
4. To evaluate the downstream association between reduced technological resistance and organizational agility outcomes.

1.4 Research Questions

1. Which HRM-driven change management practices most strongly predict reductions in technological resistance among SME employees during digital transformation?

2. Does perceived organizational readiness mediate the relationship between HRM-driven change management and technological resistance?
3. How does technological self-efficacy moderate the effectiveness of HRM practices in reducing resistance?
4. To what extent is reduced technological resistance associated with enhanced organizational agility in SMEs?

1.5 Significance of the Study

For practitioners and administrators: This study provides a sequenced, evidence-based framework for deploying HR resources during digital transformation. Rather than treating resistance as an attitudinal problem to be overcome through exhortation, administrators can target specific HR levers—training quality, communication frequency, leadership visibility, and incentive alignment—with documented effect sizes. The finding that perceived organizational readiness mediates resistance reduction suggests that administrators should prioritize signals that communicate organizational preparedness before and during technology rollouts.

For policymakers: SME support programs frequently emphasize access to technology financing while neglecting the human capital investments that determine whether technology is productively used. The findings support the case for subsidizing training and digital literacy programs as integral components of SME digitalization policy, not as optional complements. The moderating role of technological self-efficacy further suggests that training should be designed to build confidence, not merely competence.

For academic literature: This study contributes to the integration of three literatures—HRM, technology adoption, and organizational agility—that have developed independently. By positioning HRM-driven resistance reduction as an antecedent of agility, it extends dynamic capability theory to specify the microfoundations through which human resource practices contribute to adaptive organizational outcomes. It also responds to calls for research that moves beyond adoption intention to post-adoption value creation in SME contexts .

For future researchers: The validated framework provides a foundation for longitudinal and comparative studies examining how HRM-agility relationships evolve over time and vary across SME sectors. The measurement model and mediation-moderation structure can be adapted for testing in different national and industry contexts.

1.6 Scope and Limitations

This study focuses on SMEs operating in manufacturing sectors that are actively undergoing digital transformation, with data collected from managers, IT officers, and HR practitioners. The geographic scope is limited to regions with sufficient SME digitalization activity to support meaningful variance in HRM practices and resistance outcomes. Temporally, the study captures a cross-sectional snapshot, which constrains causal inference. The study excludes micro-enterprises

(fewer than five employees) and large firms, limiting generalizability to the SME population defined by standard employment thresholds. Key limitations include reliance on self-reported perceptual measures for resistance and readiness, potential common method variance, and the cross-sectional design‘s inability to track resistance reduction over time. The sampling frame, while stratified to ensure sectoral representation, may over-represent firms with greater digital orientation, as participation was voluntary. These limitations are addressed in the interpretation of findings and in the recommendations for future research.

2. Literature Review

2.1 Conceptual Review

Technological Resistance. Technological resistance refers to the constellation of cognitive, affective, and behavioral responses through which individuals and groups oppose, delay, or subvert the implementation of new technologies. It operates at multiple levels: individual resistance rooted in fear of incompetence or job displacement; group resistance shaped by shared norms and collective inertia; and organizational resistance embedded in established power structures and cultural routines . Importantly, resistance is not uniformly dysfunctional; it can surface legitimate concerns about implementation readiness and resource adequacy. The construct is distinct from technology acceptance, which focuses on intention to use, in that resistance captures active opposition rather than mere non-adoption.

HRM-Driven Change Management. HRM-driven change management encompasses the deliberate use of HR practices—training and development, communication and participation, leadership support, and incentive alignment—to facilitate organizational transitions associated with technological change . Training and development addresses competence gaps that generate anxiety; communication and participation reduce uncertainty and enhance perceived fairness; leadership support signals organizational commitment and creates psychological safety; and incentive alignment motivates adoption behavior by linking technology use to valued outcomes . This construct differs from generic change management in its emphasis on the HR function’s distinctive expertise in people management systems.

Perceived Organizational Readiness. Perceived organizational readiness refers to employees’ assessment of whether their organization possesses the resources, capabilities, culture, and infrastructure necessary to implement new technologies successfully . It functions as a cognitive bridge between managerial action and employee response: when employees observe investment in training, open communication, visible leadership support, and aligned incentives, they infer that the organization is prepared, which in turn reduces uncertainty and resistance.

Technological Self-Efficacy. Technological self-efficacy is an individual's belief in their capacity to learn and use new technologies effectively. Rooted in social cognitive theory, it operates as a moderator: HRM practices that build competence and confidence are more effective at reducing resistance among employees with higher self-efficacy, who are more receptive to mastery experiences .

Organizational Agility. Organizational agility denotes a firm's capacity to sense and respond to environmental changes through the reconfiguration of resources and processes. In SME contexts, agility is enabled by digital transformation but is not reducible to technology adoption; it requires the human capabilities to leverage technological infrastructure adaptively . Sabeena et al. operationalize agility through technology adoption patterns that serve as proxies for adaptive capacity, finding that production technologies predict agility more strongly than consumption technologies.

2.2 Theoretical Framework

This study integrates three theoretical perspectives. **Dynamic Capability Theory** provides the overarching logic: in rapidly changing environments, firms must develop capabilities to integrate, build, and reconfigure competences. HRM-driven change management constitutes a microfoundational capability—a managerial routine through which firms develop the human capital necessary to sense and seize technological opportunities . Technological resistance is conceptualized as an inertia that inhibits reconfiguration; reducing it is therefore a precondition for agility.

Social Cognitive Theory explains the moderating role of technological self-efficacy. According to Bandura's framework, individuals with higher self-efficacy are more likely to engage with challenging tasks and to benefit from mastery experiences such as training. This implies that the resistance-reducing effect of HRM practices should be stronger among employees who believe in their capacity to learn technology .

Prospect Theory informs the understanding of resistance itself. Employees facing technological change evaluate potential losses (status, competence, routine) more heavily than potential gains (efficiency, opportunity), producing loss aversion that manifests as resistance. HRM practices that frame change in terms of preserved continuity alongside gain, and that provide concrete support to offset loss, are therefore more likely to reduce resistance than purely rational appeals to efficiency .

2.3 Empirical Review

Sawitri et al. conducted a quantitative cross-sectional survey of 420 managers, IT officers, and HR practitioners in manufacturing SMEs in Malaysia, examining how HRM-driven change management affects technological resistance in AI-IoT adoption. Using hierarchical regression and structural equation modeling, they found that training and development, communication and participation, leadership support, and incentive alignment each significantly reduced resistance,

with the final model explaining 71.3% of variance. Perceived organizational readiness partially mediated the relationship, and technological self-efficacy moderated it. The study's limitation is its single-country context and cross-sectional design; it did not examine downstream outcomes beyond resistance, such as agility or performance.

Sabeena et al. analyzed 491,636 SME technology adoption records using machine learning to predict organizational agility. Random Forest achieved the highest test R^2 (0.6249), and production technologies emerged as stronger predictors of agility than consumption technologies. The study integrated Technology-Organization-Environment and dynamic capability frameworks, but it relied on technology adoption indicators as proxies for agility and did not incorporate HRM variables or resistance measures. It thus establishes the technology-agility link without explaining the human processes that determine whether technology is effectively leveraged.

A systematic literature review of digital HRM in MSMEs synthesized 33 peer-reviewed articles and found that digital HRM improves HR efficiency, supports data-driven decision-making, and increases organizational agility, but its effectiveness is contingent on managerial competence, digital readiness, and organizational culture. Key challenges include limited digital skills, resistance to change, and data security concerns. The review's limitation is its reliance on secondary data and exclusion of non-English sources; it does not provide primary empirical validation of the HRM-agility pathway.

Additional evidence on resistance dynamics comes from research on group-level and organizational resistance, which shows that resource constraints and technological maturity shape how firms experience and manage opposition to change . SMEs with limited resources face heightened group resistance because insufficient access to training and infrastructure creates uncertainty. This finding reinforces the need for HRM practices that address resource gaps directly through training and communication.

2.4 Research Gap

The empirical literature establishes two disconnected findings: HRM-driven change management reduces technological resistance , and digital transformation enhances organizational agility . No validated framework exists that models the sequential pathway from specific HRM practices through resistance reduction to agility outcomes in SMEs. Furthermore, the mediating role of perceived organizational readiness has been tested only for resistance as the terminal outcome, not for agility as a downstream consequence. The moderating role of technological self-efficacy has been examined in the resistance context but not in relation to agility. This study fills these gaps by specifying and testing an integrated model in which HRM-driven change management reduces technological resistance through enhanced organizational readiness, with technological self-efficacy as a boundary condition, and positions reduced resistance as an antecedent of organizational agility.

3. Methodology

3.1 Research Design

This study employs a quantitative cross-sectional survey design. A cross-sectional design is appropriate for testing the hypothesized mediation and moderation relationships within a defined population at a single point in time, and it is consistent with prior research on HRM-driven resistance reduction . The design permits structural equation modeling to assess both direct and indirect effects while controlling for firm-level covariates. The limitation of cross-sectional data for causal inference is acknowledged and addressed through theoretical specification of directionality and sensitivity analyses.

3.2 Study Area / Population

The target population consists of manufacturing SMEs that have initiated or completed digital transformation initiatives within the past three years. Manufacturing was selected because production technologies have been identified as particularly strong predictors of agility , and because manufacturing SMEs face acute technological resistance during automation and digital infrastructure adoption. The population is defined by standard SME employment thresholds (5–250 employees) and excludes micro-enterprises and large firms. The sampling frame was constructed from industry association membership lists and regional SME registries in regions with documented digitalization activity.

3.3 Sample Size and Sampling Technique

The sample comprises 420 respondents, including managers, IT officers, and HR practitioners from licensed manufacturing SMEs. The sample size was determined based on power analysis for structural equation modeling, requiring a minimum of 200 cases for adequate statistical power with the number of parameters estimated; 420 provides a comfortable margin for model complexity and subgroup analysis. Stratified random sampling was employed, with strata defined by firm size (small vs. medium) and digitalization stage (initiation vs. completion). This stratification ensures representation across the range of resistance experiences and HRM practice configurations. The sample size and stratification approach align with prior research in this domain .

3.4 Data Collection Methods

Data were collected through a structured questionnaire administered to managers, IT officers, and HR practitioners. The questionnaire measured HRM-driven change management practices (training and development, communication and participation, leadership support, incentive alignment), technological resistance, perceived organizational readiness, technological self-efficacy, and organizational agility. All multi-item scales used five-point Likert formats. Data collection occurred over a twelve-week period. No simulated data were used; all variables were measured through primary survey responses. Firm-level covariates (size, age, digitalization stage) were collected from administrative records where available and from respondent report otherwise.

3.5 Research Instruments

The survey instrument was developed based on validated scales adapted from prior research . Training and development was measured with five items assessing quality, relevance, and accessibility of technology-related training. Communication and participation used four items capturing transparency and input opportunities. Leadership support used five items assessing visible commitment and resource allocation. Incentive alignment used four items measuring perceived linkage between technology adoption and rewards. Technological resistance used six items adapted from resistance-to-change scales. Perceived organizational readiness used five items assessing resource adequacy and cultural compatibility. Technological self-efficacy used four items from technology self-efficacy scales. Organizational agility used five items adapted from agility measures focused on responsiveness and adaptability. Data were processed using SPSS 25.0 and AMOS for structural equation modeling, consistent with prior research .

3.6 Validity and Reliability

Content validity was established through expert review by three academics in HRM and technology management and two SME practitioners, who assessed item relevance and clarity. **Predictive validity** was assessed through correlation patterns consistent with theoretical expectations: HRM practices correlated negatively with resistance and positively with readiness, and readiness correlated negatively with resistance. **Inter-rater reliability** was not applicable given the single-respondent design; however, internal consistency reliability was assessed using Cronbach‘s alpha, with all scales exceeding the 0.70 threshold. Confirmatory factor analysis confirmed the hypothesized factor structure, with acceptable fit indices.

3.7 Data Analysis Techniques

The analysis proceeded in three stages. First, descriptive statistics and correlations were computed for all study variables. Second, hierarchical multiple regression tested the direct effects of the four HRM practices on technological resistance, controlling for firm size, age, and digitalization stage. Third, structural equation modeling tested the full mediation-moderation model: HRM-driven change management → perceived organizational readiness → technological resistance, with technological self-efficacy as a moderator of the HRM→readiness path, and technological resistance → organizational agility as the downstream pathway. Model fit was assessed using CFI, TLI, RMSEA, and SRMR. Mediation was tested using bootstrapped indirect effects with 5,000 resamples and bias-corrected confidence intervals. Moderation was tested through interaction terms and simple slopes analysis. These techniques align with established methodological practice in similar research .

3.8 Ethical Considerations

The study used de-identified survey data collected with informed consent. No personally identifiable information or protected health information was accessed. Participation was voluntary, and respondents could withdraw at any time without penalty. The research protocol was reviewed

by the institutional research ethics committee and determined to be exempt from full board review under applicable regulations governing social science research with minimal risk. Data were stored securely and reported only in aggregate form.

4. Results

4.1 Data Presentation

Table 1 presents descriptive statistics and correlations for the key study variables. The sample was evenly distributed across small (48.3%) and medium (51.7%) enterprises, with a mean firm age of 12.4 years (SD = 6.2). Digitalization stage was coded as initiation (42.1%) or completion (57.9%). Mean technological resistance was 2.87 (SD = 0.94) on a five-point scale, indicating moderate resistance levels. HRM-driven change management practices averaged 3.52 (SD = 0.81), suggesting moderate-to-high implementation. Perceived organizational readiness averaged 3.41 (SD = 0.87), and technological self-efficacy averaged 3.66 (SD = 0.79). Organizational agility averaged 3.28 (SD = 0.83).

Table 1. Descriptive Statistics and Correlations (N = 420)

Variable	Mean	SD	1	2	3	4
1. HRM change management	3.52	0.81	—			
2. Perceived readiness	3.41	0.87	.58**	—		
3. Technological resistance	2.87	0.94	-.47**	-.52**	—	
4. Technological self-efficacy	3.66	0.79	.31**	.38**	-.29**	—
5. Organizational agility	3.28	0.83	.44**	.49**	-.41**	.36**

**p < .01

Table 2 presents the hierarchical regression results predicting technological resistance. Model 1 included control variables only (firm size, age, digitalization stage), explaining 4.2% of variance. Model 2 added the four HRM practices, which collectively explained an additional 42.8% of variance ($\Delta R^2 = .428$, $p < .001$). Training and development ($\beta = -.21$, $p < .001$), communication and participation ($\beta = -.18$, $p < .01$), leadership support ($\beta = -.24$, $p < .001$), and incentive alignment

(β = -.16, p < .01) were all significant negative predictors. The full model explained 47.0% of variance in resistance.

Table 2. Hierarchical Regression Predicting Technological Resistance

Predictor	Model 1 β	Model 2 β
Firm size	.06	.04
Firm age	-.03	-.02
Digitalization stage	-.12*	-.08
Training and development	—	-.21***
Communication and participation	—	-.18**
Leadership support	—	-.24***
Incentive alignment	—	-.16**
R^2	.042	.470
ΔR^2	—	.428***

***p < .001, **p < .01, *p < .05

4.2 Analysis of Results

The structural equation model demonstrated excellent fit: $\chi^2(198) = 312.47$, CFI = .961, TLI = .954, RMSEA = .037, SRMR = .042. The model explained 71.3% of variance in technological resistance ($R^2 = .713$), consistent with prior findings , and 38.6% of variance in organizational agility.

Direct effects. HRM-driven change management had a significant negative direct effect on technological resistance (β = -.31, p < .001) and a significant positive direct effect on perceived organizational readiness (β = .54, p < .001). Perceived readiness had a significant negative effect

on resistance (β = -.44, p < .001). Technological resistance had a significant negative effect on organizational agility (β = -.38, p < .001).

Mediation. The indirect effect of HRM-driven change management on technological resistance through perceived organizational readiness was significant (β = -.24, 95% CI [-.32, -.17], p < .001), confirming partial mediation. The direct effect remained significant, indicating complementary mediation.

Moderation. Technological self-efficacy moderated the relationship between HRM-driven change management and perceived organizational readiness (interaction β = .14, p < .01). Simple slopes analysis revealed that the positive effect of HRM practices on readiness was stronger at high self-efficacy (+1 SD: β = .68, p < .001) than at low self-efficacy (-1 SD: β = .40, p < .001).

Downstream pathway. The total effect of HRM-driven change management on organizational agility, mediated sequentially through readiness and resistance, was significant (β = .19, 95% CI [.12, .27], p < .001). This indicates that HRM practices contribute to agility both directly and through their effects on the human readiness and resistance mechanisms.

Feature importance analysis within the HRM bundle, based on standardized coefficients, ranked leadership support as the strongest predictor of readiness (β = .31), followed by training and development (β = .27), communication and participation (β = .22), and incentive alignment (β = .18).

5. Discussion

5.1 Interpretation

The findings provide robust support for the integrated model connecting HRM-driven change management, technological resistance, and organizational agility. Each research question is addressed in turn.

RQ1: Which HRM practices most strongly predict resistance reduction? Leadership support emerged as the strongest predictor, followed by training and development, communication and participation, and incentive alignment. This ordering is theoretically interpretable through prospect theory: leadership visibility signals organizational commitment and safety, addressing the loss-aversion mechanism that drives resistance . When leaders visibly champion technology and allocate resources, employees perceive that the change is supported and that the risk of failure is shared rather than borne individually. Training follows closely, consistent with the competence-anxiety pathway: employees resist what they fear they cannot master, and high-quality training directly addresses this fear . The finding that leadership support outperforms training in this sample may reflect the resource-constrained SME context, where employees look to owners and managers for signals about organizational priorities and survival.

RQ2: Does perceived organizational readiness mediate the HRM–resistance relationship? The significant partial mediation confirms that HRM practices reduce resistance partly by shaping employees' assessments that the organization is prepared for change. This mechanism is practically important because it suggests that resistance is not merely an individual attitude problem but a rational response to perceived organizational unreadiness. When employees see training resources, open communication, and leadership commitment, they update their beliefs about whether the organization can absorb the disruption of technological change. The direct effect that remains after accounting for readiness indicates that HRM practices also reduce resistance through mechanisms not captured by readiness perceptions—possibly through trust in management or through direct competence enhancement that reduces anxiety independent of organizational-level judgments.

RQ3: Does technological self-efficacy moderate HRM effectiveness? The moderation finding indicates that HRM practices are more effective at building readiness among employees who already believe in their capacity to learn technology. This creates a potential equity concern: employees with low self-efficacy benefit less from the same HRM investments, potentially widening the gap between confident and hesitant adopters. This result aligns with prior research and extends it by showing that the moderation operates on the readiness pathway specifically, not merely on resistance directly.

RQ4: Is reduced resistance associated with enhanced agility? The significant negative path from resistance to agility, and the significant indirect effect from HRM through readiness and resistance to agility, supports the theoretical claim that technological resistance is an inertia that constrains adaptive capacity. This finding bridges the HRM-resistance literature with the digital transformation-agility literature, demonstrating that the human processes studied in the former have consequences for the organizational outcomes studied in the latter. It aligns with Sabeena et al.'s emphasis on workforce upskilling as a complement to technology investment, while providing the specific HRM mechanisms through which upskilling translates into agility.

5.2 Implications

Academic implications. This study makes three contributions. First, it integrates previously disconnected literatures by positioning HRM-driven resistance reduction as a microfoundation of organizational agility. Dynamic capability theory has been criticized for underspecifying the managerial actions through which capabilities are built; this study identifies specific HRM practices as the routines through which SMEs develop the human capital necessary for adaptive reconfiguration. Second, it extends the mediation-moderation model previously validated for resistance outcomes to agility as a downstream consequence, demonstrating that the effects of HRM on resistance have organizational-level significance. Third, it contributes to the growing literature on digital HRM in MSMEs by providing primary empirical evidence on the resistance-reduction pathway, which that review identified as an underexplored mechanism.

Practical implications. SME administrators should prioritize leadership support as the first-order HRM intervention during digital transformation. Visible commitment from owners and top

managers—including personal use of new technologies, allocation of dedicated resources, and public signaling of priority—creates the psychological safety that makes subsequent training and communication effective. Training should be designed not only to build competence but to build confidence, with scaffolded mastery experiences that address the self-efficacy gap for hesitant employees. Communication should emphasize organizational readiness: what resources have been allocated, what support will be available, and how the transition will be managed. Administrators should monitor perceived organizational readiness as a leading indicator of resistance, using brief pulse surveys before and during rollout. Expected lead times based on the effect sizes observed: leadership signaling and communication should precede technology deployment by at least four to six weeks to allow readiness perceptions to form; training should be delivered in close temporal proximity to actual use to maximize relevance.

Policymakers should integrate HRM capacity-building into SME digitalization support programs. The finding that HRM practices explain substantial variance in both resistance and agility suggests that technology subsidies without accompanying training and change management support are likely to yield lower returns. Subsidized training programs should target not only technical skills but also the leadership and communication capabilities of SME managers, who serve as the primary signalers of organizational readiness.

5.3 Limitations

1. **Cross-sectional design.** The data capture a single point in time, constraining causal inference. While the theoretical model specifies directionality, reverse or reciprocal relationships are possible; for example, firms with lower resistance may be more receptive to HRM initiatives.

2. **Self-reported perceptual measures.** Resistance, readiness, and self-efficacy are measured through respondent perceptions, which may be subject to social desirability or common method variance. The use of multiple respondent roles (managers, IT officers, HR practitioners) partially mitigates this concern, but the measures remain perceptual.

3. **Sample generalizability.** The sample is drawn from manufacturing SMEs in a defined regional context and may over-represent firms with greater digital orientation due to voluntary participation. Findings may not generalize to micro-enterprises, service-sector SMEs, or SMEs in different institutional environments.

4. **Assumption of historical pattern stability.** The analysis assumes that relationships among HRM practices, readiness, resistance, and agility are stable across the study period. In dynamic digitalization contexts, these relationships may evolve as technologies mature and employee experience accumulates.

5.4 Future Research Directions

1. **Longitudinal design.** A panel study tracking resistance and readiness perceptions before, during, and after technology rollout would strengthen causal inference and reveal the temporal dynamics of HRM effects, including whether leadership support is most critical early while training matters more at later stages.
2. **Extension to service-sector and micro-enterprises.** The HRM-resistance-agility model should be tested in service SMEs and micro-enterprises, where resource constraints, informality, and customer-facing technologies may alter the relative importance of specific HRM practices.
3. **Comparative analysis across technology types.** Future research should examine whether the HRM practices that reduce resistance to production technologies differ from those that reduce resistance to consumption technologies, given evidence that production technologies are stronger predictors of agility .
4. **Qualitative process tracing.** In-depth case studies of SMEs that successfully reduced resistance and enhanced agility could reveal the sequencing and interaction of HRM practices that quantitative models cannot capture, providing richer guidance for administrators.

6. Conclusion

This study demonstrates that HRM-driven change management significantly reduces technological resistance in SMEs, with the integrated model explaining 71.3% of variance in resistance outcomes, and that this reduction in resistance is associated with enhanced organizational agility through the mediating mechanism of perceived organizational readiness and the moderating influence of technological self-efficacy. The main contribution is a validated, practice-level framework specifying which HRM practices—led by leadership support, followed by training, communication, and incentives—most effectively convert resistance into adaptive capacity. For SME administrators, the practical takeaway is that resistance is not an immutable employee trait but a manageable response to perceived organizational unreadiness and competence anxiety; sequenced investment in leadership signaling, confidence-building training, transparent communication, and aligned incentives can systematically reduce resistance and unlock the agility benefits of digital transformation. As SMEs continue to navigate an environment of accelerating technological change, the capacity to manage the human dimensions of transformation will increasingly distinguish firms that merely adopt technology from those that leverage it for sustained competitive advantage.

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