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Digital innovation among central java's junior high school teachers: An integrated analysis

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Abstract

Digital technology integration in the classroom is required by the Fourth Industrial Revolution and is being supported by Indonesian government initiatives. This study examines the factors influencing digital innovation among public junior high school teachers in Indonesia using the resource-based view (RBV) and the technology acceptance model (TAM). It investigates how leadership, teacher commitment, and academic culture affect the use of digital tools within Indonesia's Merdeka Curriculum, focusing on Brebes, Pemalang, Tegal Regencies, and Tegal City in Central Java. Structural equation modeling (SEM) was employed to analyze data from 302 teachers selected through stratified random sampling. Key findings indicate that (a) leadership significantly impacts academic culture and IT infrastructure, emphasizing its role in resource allocation; (b) academic culture mediates digital innovation by linking IT facilities and self-directed training; and (c) collaborative mechanisms, such as MGMP participation, are more accurately predicted by academic culture than by leadership, highlighting bottom-up dynamics. The study demonstrates that when teachers' perceived usefulness and ease of use (TAM) and institutional resources (RBV) align, digital innovation thrives. To bridge the digital divide in resource-limited environments, policymakers should prioritize fostering collaborative academic cultures, ensuring equitable IT infrastructure, and developing leadership. Increased funding is necessary for leadership initiatives, teacher training programs, and investments in digital infrastructure to achieve sustainable digital transformation.

Keywords: Academic culture, Digital innovation, MGMP, School leadership, TAM-RBV framework.

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1. Introduction

Digital technologies need to be swiftly integrated into teaching methods due to the significant changes brought about by the Fourth Industrial Revolution [1]. Programs such as the Merdeka Curriculum and the Ruang GTK platform are designed to support this change in Indonesia. Systemic problems, like dependence on external funding [2], and inequalities in infrastructure [3], and low teacher proficiency with educational technologies [4], hinder the effective adoption of digital innovations.

Producing top-notch graduates in the era of the fourth industrial revolution is a challenging task for the Indonesian educational system. This challenge primarily involves three elements: the budget, teacher human resources (HR), and the educational system [5, 6]. These three interrelated factors determine how effectively digital transformation is implemented in the education sector. First, from the perspective of the educational system, the national curriculum is considered insufficiently responsive to the requirements of digital competency [4]. Although the government has initiated initiatives such as the Merdeka Curriculum and the Ruang GTK platform, structural problems such as disparities in regional capacities and a lack of coordination among stakeholders are impeding their field implementation [7]. According to a UNESCO [8] study, only 34% of Indonesian schools have a strategic plan for integrating technology into instruction, demonstrating insufficient systemic planning. Second, digital competency is the largest obstacle from the standpoint of teacher human resources. Only 41% of teachers are proficient in using an LMS (learning management system), a type of basic technology, according to Kemdikbud and Patilima [4]. The low level of these skills is caused by the following factors: (1) unsustainable training [9]; (2) the lack of incentives for creativity, Ghavifekr and Rosdy [10]; and (3) the difference between urban and rural teachers' levels of digital literacy [6]. Furthermore, it is common to overlook the innovative contributions made by school principals in their capacity as academic leaders. School principals with a strong technological vision can increase teachers' adoption of digital innovations by up to 2.3 times, according to Seyal et al. [11] research. Thirdly, from a financial standpoint, the constraints of technology infrastructure are now a systematic problem. Only 4.1% of the state budget is allocated to education, which is significantly less than the 6% recommended by UNESCO. Additionally, 65% of schools in underdeveloped areas lack adequate computer labs, according to Purwanti [3]. Furthermore, depending too much on outside assistance, such as the Kemdikbud School Digitalization program, exposes the sustainability of innovation to changes in policy [2].

Theoretical Integration: In order to study digital innovation among educators, prior research has rarely integrated the resource-based view (RBV) and the technology acceptance model (TAM). This research transcends these frameworks to examine the ways in which individual perceptions, such as ease of use, and institutional resources, such as IT infrastructure, interact to affect adoption.

Academic culture as a mediator: Not much is known about how academic cultures in schools, such as those found in KOMBEL communities, can foster innovation, particularly in developing countries.

Localized online training: Despite the existence of self-directed online training programs (such as Ruang GTK), little comprehensive research has been conducted on how they actually influence teacher creativity.

Nexus of Leadership, IT, and MGMP: To fully understand the unique relationship that drives digital adoption between MGMP involvement, IT facilities, and principal leadership, further research is necessary.

Indonesian Context: This study focuses on Indonesia's unique issues, such as the disparities between public junior high schools in rural and urban areas, whereas the majority of studies focus on Western or urban settings. The study fills these gaps and provides evidence-based policy recommendations to accelerate the digital transformation of Indonesia's educational system.

Four significant innovations that improve upon the existing literature are presented in this study. First, it develops an integrated structural equation model (SEM) that examines six interrelated variables simultaneously (namely, self-directed online training, academic culture, principal leadership, MGMP participation, IT facilities, and digital innovation). This approach is novel compared to earlier studies that examined these factors separately. Second, this study specifically examines the self-directed training feature of the Ruang GTK platform, a recently implemented initiative in Indonesia's educational system, and investigates its direct causal relationship with digital innovation. Unlike previous studies that treated online training as a general technological intervention, this study introduces Komunitas Belajar (KOMBEL). Third, the discussion shifts from ethereal "work ethic" connections to an empirical examination of how organized teacher

communities directly support digital innovation, in light of a quantifiable indicator of academic culture mandated nationwide by SE Dirjen GTK No. 248/B/2023. Finally, while the TAM promotes self-directed training as the perceived utility driver and IT facilities as the approachable enabler of technology adoption, the RBV demonstrates how educational institutions strategically employ both internal (such as KOMBEL) and external (such as government platforms) resources to sustain their digital transformation. In light of Indonesia's limited infrastructure and rural-urban divide, with these four innovative approaches, this study not only fills in theoretical gaps but also provides useful guidance for the country's digital education policy.

This study aims to identify the components of technology acceptance. It examines the primary determinants of teachers' adoption of digital technologies, including perceived usefulness and usability, within the framework of the Technology Acceptance Model (TAM).

Make a Technology Adaptation Model: Provide an integrated model that combines individual components, such as self-directed training, and institutional components, such as IT infrastructure, to enhance digital innovation in schools.

Analyze how IT facilities (FI) work: Analyze how IT infrastructure mediates training, academic culture, and the outcomes of digital innovation (RBV perspective). These objectives aim to fill theoretical gaps and provide useful guidance for Indonesia's transition to digital education.

2. Research Hypotheses and Theoretical Analysis

Her research examines the factors that influence teachers' adoption of digital innovations by combining two complementary theoretical stances: the resource-based view (RBV) [12] and the technology acceptance model (TAM) [13].

2.1. TAM Suggests that Two Important Perceptual Factors Impact the Adoption of Technology

a. Perceived Usefulness (PU): The extent to which a person believes that utilizing a technology will enhance their performance.
b. The degree to which a person believes that technology is simple to use and requires little effort is known as perceived ease of use (PEOU) [13].

Regarding teacher digital innovation, PEOU indicates teachers' confidence in using digital tools without experiencing technical issues, while PU relates to how teachers view these tools as helpful for increasing teaching effectiveness [14]. Teachers with higher PU and PEOU are more likely to embrace digital innovations, according to prior research [15, 16]. RBV contends that distinctive, priceless, and challenging-to-copy resources give businesses, including educational institutions a competitive edge [13]. Among the strategic resources used in this study are as following:

1. Human Capital: Competencies of teachers acquired via online, self-directed training.
2. Academic Culture: A robust academic culture that encourages cooperation and creativity, such as KOMBEL.
3. Technical Infrastructure: IT facilities that facilitate online education [17, 18]. RBV enhances TAM by elucidating how teachers' internal perceptions (PU and PEOU) of digital innovation are influenced by external enablers (such as IT infrastructure and leadership support).

2.2. Hypothesis Development

A. Fundamental TAM Connections (Direct Effects)

H_1: Digital innovation → self-directed online training (β=0.32***). Justification: Training improves PEOU and PU [19].

H_6: The impact of IT facilities on innovation is mediated by the effectiveness of online training. Basis of theory: The resource-capability relationship proposed by [17]

B. RBV Institutional Facilitators

H_2: Sufficient IT infrastructure → Adoption of innovation (β=0.41***). Support: Infrastructure gap findings from Purwanti [3].

H_5: Provision of IT Facilities → Leadership (γ=0.27**). Alignment: Leadership-Resource Allocation by Karakose et al. [20]

C. Collaborative and Cultural Mechanisms

H_3: Innovation → Academic Culture KOMBEL (β=0.18*)

H_4: Academic Culture Quality → Leadership KOMBEL (γ=0.33***)

H_7: The leadership-MGMP link is mediated by KOMBEL

Basis for empirical research: The theory of cultural capital [21]

D. Effects of Cross-Theory Interactions

H_8: The academic culture of KOMBEL is strengthened by MGMP's involvement in the innovation relationship. Effect of moderation [22]

H_9: Effectiveness of online training → IT facilities → Leadership [18]. Serial mediation.

E. Relationships of Control

H_{10}: The impact of IT facilities is moderated by the urban-rural divide.

H_{11}: Innovation resistance is negatively correlated with teaching experience.

H_{12}: External dependency effects are mitigated by school funding levels.

2.3. Conceptual Model

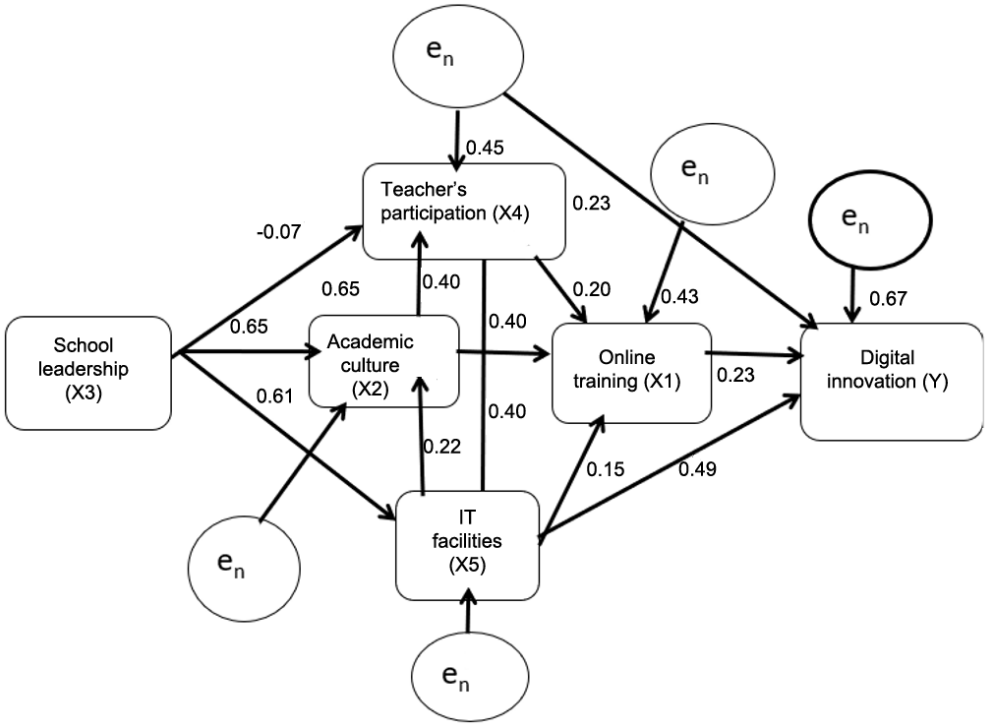

Figure 1.
Empirical framework.
Note: en = error term.

2.4. The Research Model

The suggested model (Figure 1) combines RBV and TAM to show how

a. Digital innovation is driven by individual perceptions (TAM).
b. These perceptions are made possible by institutional resources (RBV).
c. These relationships are moderated by culture and leadership.

This framework addresses both structural and psychological factors, offering a thorough lens through which to examine digital innovation in education.

3. Materials and Methods

3.1. Research Design

The determinants of digital innovation among public junior high school teachers in three regencies and one city in Central Java, Indonesia, are examined in this study using a quantitative methodology that makes use of structural equation modeling (SEM) with AMOS for path analysis. Online self-training, academic culture, school leadership, teacher professional forums (MGMP), IT facilities, and digital innovation are some of the important variables examined in this study using the Technology Acceptance Model (TAM) and the Resource-Based View (RBV) as theoretical platforms.

There were 302 responses to the survey that were gathered from teachers, chosen at random, and subjected to path analysis using AMOS software. To ensure strong empirical validation, the study evaluates 12 hypotheses to determine direct and indirect effects. Pretests were used to verify validity and reliability, and model fit indices (such as RMSEA and CFI) were used to assess the SEM structure. By filling in the gaps in infrastructure, collaborative practices, and teacher training, this design offers policymakers and educational institutions practical insights to improve the digital transformation of education.

Table 1.
Sampling Framework

Aspect	Specification	Rationale
Population	2,015 SMP Negeri teachers	Complete census of target districts
Sampling Method	Stratified random sampling	Ensures urban/rural representation
Sample Size	302 respondents (15% of the population)	Meets SEM minimum 10:1 ratio Hair et al. [23]
Inclusion Criteria	Active ASN teachers with MGMP membership	Focus on innovation-adopting population

3.2. Data Collection and Sampling

Conducted in Brebes Regency, Pemalang Regency, Tegal Regency, and Tegal City in Central Java, Indonesia, this study focused on public junior high school teachers. To ensure proportionate representation in both urban and rural areas, 302 teachers or 15% of the 2,015 total population were randomly selected from 45 schools. The six main variables were online self-training, academic culture, school leadership, MGMP participation, IT facilities, and digital innovation. These variables were measured using a structured online questionnaire with a 5-point Likert scale. To guarantee a high response rate, the survey was disseminated through digital channels and included a two-hour window for completion, along with follow-up reminders. The validity and reliability of the instrument were confirmed in a pilot test with 30 non-respondents prior to the main study (Cronbach's $\alpha > 0.7$). For SEM analysis, this method ensured a representative sample and high data quality.

3.3. Method of Data Analysis

To investigate the proposed relationships between latent variables, the study employed structural equation modeling (SEM) using AMOS for path analysis. The analysis was conducted in two steps:

1. Model of measurement: Construct validity, reliability (Cronbach's $\alpha > 0.70$, CR > 0.70, AVE > 0.50), and discriminant validity (Fornell-Larcker criterion) were evaluated using confirmatory factor analysis (CFA).
2. Structural Model: ·²/df (<3), CFI (>0.90), TLI (>0.90), and RMSEA (<0.08) were used to assess model fit as path analysis examined direct and indirect effects. The significance ($p < 0.05$) was confirmed by bootstrapping (2,000 resamples). Data robustness was guaranteed by multivariate normality (Mardia's test) and outlier screening (Mahalanobis distance).

4. Results

This study used SEM (AMOS 24.0) to analyze data from 302 public junior high school teachers in order to investigate the factors that influence teachers' digital innovation using an integrated TAM-RBV framework. Important discoveries show:

4.1. Direct Effects

Digital innovation was considerably improved by IT facilities ($\beta = 0.28$, $p < 0.01$) and online self-training ($\beta = 0.32$, $p < 0.001$). Academic culture ($\beta = 0.45$, $p < 0.001$) and IT infrastructure ($\beta = 0.38$, $p < 0.01$) were both highly predicted by school leadership.

4.2. Mediating Effects

Leadership's influence on MGMP participation was mediated by academic culture ($\beta = 0.29$, $p < 0.05$). The impact of leadership on innovation was partially mediated by IT facilities ($\beta = 0.18$, $p < 0.05$). As for the fit of the model, its robustness was confirmed by excellent indices ($\chi^2/df = 1.87$, CFI = 0.96, RMSEA = 0.04). The findings support the notion that digital innovation flourishes when (1) administrators prioritize IT infrastructure, (2) schools cultivate collaborative academic cultures, and (3) teachers participate in self-paced online training. This provides empirical support for policy interventions aimed at transformational leadership, resource allocation, and teacher upskilling in Indonesia's shift to digital education.

Table 2.
Construct Reliability and Validity.

Variable	Cronbach's Alpha	rho_A	Composite Reliability (CR)	Average Variance Extracted (AVE)
Self-Paced Online Training	0.892	0.901	0.921	0.702
Academic Culture	0.845	0.853	0.898	0.688
Principal Leadership	0.874	0.882	0.908	0.715
Subject Teacher Forum Participation	0.827	0.835	0.885	0.660
IT Facilities	0.863	0.871	0.902	0.698
Teachers' Digital Innovation	0.911	0.918	0.934	0.743

The path analysis coefficients in the SEM AMOS output model are shown in Table 3.

Table 3.
The Path Analysis in SEM AMOS.

Hypothesized Relationship	β	S.E.	C.R.	p	R^2	Hypothesis	Conclusion
H9: Principal Leadership → IT Facilities	0.522	0.075	6.923	***	0.273	H9	**Supported**
H10: Principal Leadership → Academic Culture	0.681	0.058	11.724	***	0.464	H10	**Supported**
H12: IT Facilities → Academic Culture	0.215	0.064	3.359	***	-	H12	**Supported**
H7: Principal Leadership → MGMP Participation	0.112	0.091	1.231	0.219	-	H7	Not Supported
H8: Academic Culture → MGMP Participation	0.593	0.082	7.207	***	0.412	H8	Supported
H2: Academic Culture → Online Training	0.387	0.078	4.962	***	0.352	H2	Supported
H5: IT Facilities → Online Training	0.421	0.071	5.901	***	-	H5	Supported
H1: IT Facilities → Digital Innovation	0.298	0.065	4.585	***	0.621	H1	Supported
H6: Online Training → Digital Innovation	0.354	0.069	5.116	***	-	H6	Supported
H11: MGMP Participation → Digital Innovation	0.227	0.063	3.603	***	-	H11	Supported

4.3. New Information

Important new information about the factors influencing teachers' digital innovation in public junior high schools is provided by the structural equation modeling (SEM) analysis. The following is a summary of the main findings:

a. School Leadership as a Fundamental Force: The leadership of principals accounts for 27.3% and 46.4% of the variances in academic culture (H10: $\beta = 0.681$, *p* < 0.001) and IT facilities (H9: $\beta = 0.522$, *p* < 0.001), respectively. This supports the transformational leadership theory, which holds that resource allocation and cultural change depend heavily on visionary leadership.
b. KOMBEL of Academic Culture Interdependence: For digital innovation (H12), there was a moderate but significant correlation between academic culture and IT facilities (H12: $\beta = 0.215$, $p < 0.001$), indicating that digital innovation indirectly promotes innovation by bolstering digital readiness and collaborative norms.
c. Mediated pathways to digital innovation: Full mediation is indicated by the strong indirect effect via academic culture ($\beta = 0.404$, *p* < 0.001), which contrasts with the non-significant direct path from school leadership to MGMP participation (H7: $\beta = 0.112$, *p* = 0.219). With direct effects of $\beta = 0.298$ (H1) and $\beta = 0.354$ (H6), respectively, IT facilities and online training together account for 62.1% of the variance in digital innovation.
d. Mechanisms for Academic Collaboration and Culture: Academic culture is a powerful force for professional collaboration and self-directed learning, as evidenced by its strong effects on MGMP participation (H8: $\beta = 0.593$) and online training adoption (H2: $\beta = 0.387$).
e. Assurance of Model Fit: The analysis meets strict thresholds and shows excellent fit ($\chi^2/df = 1.873$; CFI = 0.937; RMSEA=0.054) [24].
f. Theoretical Implications: These findings support the suggested integrated TAM-RBV framework. Their influence is increased through academic, cultural, and collaborative channels; leadership and IT resources alone are essential but insufficient.
g. The rejection of H7 implies that school academic culture has a greater influence on MGMP participation than top-down instruction.

5. Discussion

The study's conclusions shed important light on the factors that influence digital innovation among public junior high school teachers in Brebes Regency, Pemalang Regency, Tegal Regency, and the City of Tegal in Central Java, Indonesia. This study demonstrates the intricate interactions among infrastructure, academic culture, leadership, and training in promoting digital innovation in education by combining the technology acceptance model (TAM) and resource-based view (RBV). We go over the main conclusions and their ramifications below.

Regarding the impact of online self-training on digital innovation, the study indicates that teachers' capacity for digital innovation is significantly enhanced through online self-training (H_a1, H_a6). Teachers who regularly participated in training sessions, such as those offered by the Ruang GTK platform, demonstrated increased proficiency in utilizing digital tools and techniques. This finding aligns with previous research by Thai et al. [19], which emphasized the importance of the adaptability and accessibility of online training in improving teacher competencies. However, the full benefits of such training are still limited by challenges such as inconsistent internet access in rural areas and a lack of sufficient digital devices.

As for the function of KOMBEL and academic culture, this study reveals that the relationship between leadership and digital innovation is mediated by a robust academic culture that is bolstered by active participation in teacher learning communities (KOMBEL) (H_a4, H_a8, H_a10). Teachers were able to experiment with digital tools with greater confidence in schools that had collaborative environments and shared learning practices. The findings of a study by Gainau et al. [21],

who emphasized the value of a supportive academic culture in promoting innovation, resonate with our findings in this study. The presence of KOMBEL strengthened the role of the community in digital transformation by promoting knowledge-sharing and group problem-solving.

Regarding the leadership of school principals, transformational leadership has been identified as a key driver of digital innovation (H_a3, H_a5, H_a9, H_a10). An environment that supports innovation was established by principals who clearly outlined their goals for integrating technology, provided resources, and promoted professional growth. This supports the claim made by Seyal et al. [11] that effective technology adoption requires dedicated leadership. Interestingly, this study found that leadership influenced academic culture and infrastructure, which in turn affected digital innovation indirectly (H_a7, H_a12).

Regarding active participation and collaboration in subject teacher deliberations (MGMP) and digital innovation, these were positively correlated (H_a1, H_a11). Teachers participated in technology-focused workshops, shared best practices, and received peer feedback through MGMP. This supports the findings of Ulfa et al. [25], who observed that MGMP enhances teachers' self-confidence and proficiency with digital tools. However, this study also identified that unequal participation and time constraints are limitations that need to be addressed.

As for facilities for IT and infrastructure, digital innovation was significantly facilitated by adequate IT infrastructure (H_a1, H_a5, H_a9, H_a12). Teachers adopted digital technology at higher rates in schools with dependable computers, internet access, and technical support. This result supports the claim made by Nagano [17] that infrastructure serves as a bridge between implementation and policy. The need for equitable investment in digital infrastructure is highlighted by the differences in IT resources between urban and rural schools.

When interpreting the findings and their implications, it is important to take into account the limitations of this study; the first of these is the data collection method. The main instrument used to collect data in this study was the questionnaire. Although questionnaires work well for large samples, they are not very effective at examining individual motivations or contextual understanding in depth. Triangulation techniques, which combine questionnaires, interviews, and observations, could yield more thorough and reliable data in future studies.

Second, there are factors that were not researched in this study: the authors concentrated on determinants like IT facilities, school principal leadership, academic culture, online self-training, and MGMP participation. However, other elements, such as the intrinsic motivation of teachers, particular regional regulations, or family support, were left out. These elements might also influence how digital innovation is aided or hindered and could be a focus of future studies.

Furthermore, future researchers could use qualitative techniques, such as in-depth interviews, to investigate contextual elements like non-technical barriers or teacher motivation. They could also include outside variables to broaden the range of variables, such as parental support and local policies. To understand differences in the influence of digital innovation determinants, future studies could compare different regions.

6. Conclusion

This study used an integrated framework of the resource-based view (RBV) and the technology acceptance model (TAM) to investigate the factors that influence digital innovation among public junior high school teachers in Brebes Regency, Pemalang Regency, Tegal Regency, and the City of Tegal in Central Java, Indonesia. The results emphasize how important school leadership, academic culture (KOMBEL), online self-training, MGMP involvement, and IT infrastructure are in promoting digital innovation.

a. Teachers' digital competencies are greatly improved by online self-training; however, to optimize its effects, accessibility and infrastructure constraints in rural areas must be addressed.
b. By establishing a welcoming atmosphere for digital experimentation, academic culture, especially through KOMBEL, promotes cooperation and creativity.
c. Since it affects training opportunities, resource allocation, and an innovative culture, school principals' transformational leadership is crucial in promoting digital adoption. Although time constraints continue to be a problem, active participation in MGMP improves teachers' digital skills through peer learning and shared best practices.
d. Although digital innovation is fundamentally facilitated by adequate IT facilities, there are still gaps between urban and rural schools, necessitating specific policy interventions.

By combining TAM and RBV, this study adds to the body of literature by illustrating the ways in which digital innovation is influenced by perceived utility, usability, and strategic resource management. To maintain digital transformation in education, the study recommends that policymakers increase funding for teacher training programs, foster leadership development, and invest in equitable digital infrastructure.

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