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Article

Digital Risk and Institutional Preparedness for AI-Enabled Education in Bangladesh: A Mixed-Methods Study of Educational Continuity and Resilience

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ABSTRACT

Digital dependence can support educational continuity during disasters and other major disruptions, but it can also magnify existing inequalities when access and institutional capacity are uneven. This study assessed digital risk and institutional preparedness for artificial intelligence (AI)-enabled education in Sherpur Sadar Upazila, Bangladesh. A convergent mixed-methods design combined a 14-item survey of 207 students from five urban and three rural educational institutions with qualitative evidence from 25 education stakeholders. Survey data were analyzed descriptively, with non-response treated as missing; qualitative data were examined thematically and integrated through a joint display. Students strongly supported government investment in rural digital access (98.1%) and greater institutional use of technology (74.9%). At the same time, 72.5% reported that technology was difficult to use, 66.7% identified financial barriers, and more than 84% reported social or family constraints. Qualitative findings identified interconnected vulnerabilities involving infrastructure

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deficits, gendered digital exclusion, limited teacher preparation, weak technical and institutional support, socio-cultural restrictions, and policy-implementation gaps. The integrated findings reveal a preparedness paradox: favorable attitudes toward technology coexist with conditions that can undermine equitable participation and continuity during floods, cyclones, public-health emergencies, infrastructure failures, and other disruptions. Educational resilience therefore requires reliable connectivity and electricity, affordable devices, offline and backup learning arrangements, teacher capacity development, gender-responsive access measures, accountable AI governance, and the integration of digital continuity into institutional disaster-preparedness planning. The study contributes a risk-informed interpretation of technology acceptance while avoiding claims that the instrument constitutes a full validation of TAM3 or a direct measure of actual AI use.

KEYWORDS

artificial intelligence; digital risk; educational continuity; institutional preparedness; disaster resilience; Bangladesh.

1. Introduction

Artificial intelligence and other digital technologies can expand access to learning, support adaptive assessment, and provide new forms of feedback and educational assistance. Their benefits, however, depend on reliable infrastructure, affordability, digital literacy, teacher readiness, and governance arrangements that enable safe and equitable use (Alam et al., 2024; Siddiquee & Islam, 2024; Sultana & Faruk, 2024; UNESCO, 2021). In low-resource settings, these enabling conditions are unevenly distributed, and positive attitudes toward technology do not necessarily translate into sustained or effective use.

The problem is directly relevant to disaster risk management. Floods, cyclones, public-health emergencies, electricity failures, and other disruptive events can interrupt face-to-face instruction and increase dependence on remote or technology-supported learning. When connectivity, devices, teacher capacity, or household access are weak, the shift to digital delivery can amplify pre-existing educational vulnerability rather than protect continuity (Islam et al., 2026; Salam et al., 2026; Wang et al., 2024). The relevant risk chain is therefore: disruptive event or infrastructure failure, reduced digital access, interruption of educational functions, unequal consequences for vulnerable groups, and delayed recovery.

In this study, digital risk refers to the possibility that inadequate or unreliable technological systems, financial constraints, limited skills, social restrictions, or weak data governance will disrupt access to education or produce unequal outcomes. Institutional preparedness refers to the capacity of educational institutions to anticipate such disruptions through trained personnel, technical support, backup power and connectivity, offline learning alternatives, maintenance arrangements, data-protection procedures, and continuity plans. Educational resilience is understood as the capacity to maintain, adapt, and restore essential learning functions while protecting equitable participation before, during, and after disruption (Cvetković, 2025; Cvetković et al., 2025; Milenković & Cvetković, 2025).

The Technology Acceptance Model (TAM) and its extensions provide a useful interpretive lens for considering perceived usefulness and perceived ease of use (Davis, 1989; Venkatesh & Davis, 2000; Venkatesh & Bala, 2008). The present instrument, however, was not designed as a complete validated TAM3 scale. TAM3 is therefore used to organize interpretation rather than to claim a structural-model test. The analysis focuses primarily on descriptive response patterns and stakeholder explanations of the conditions that enable or constrain technology-supported and AI-enabled learning.

1.1. Research Problem, Aim, and Research Questions

Despite national initiatives promoting digital education, access and institutional readiness remain uneven across Bangladesh. Rural institutions often face weaker connectivity, limited electricity reliability, unaffordable devices, inadequate maintenance, and shortages of trained personnel (Aziz & Naima, 2021; Babu, 2021; Emon et al., 2024; Siddiquee & Islam, 2024). Gender and household conditions may further shape access, particularly where device use, mobility, or study time are constrained by social expectations (Akram & Majid, 2024; Sarker et al., 2025). Existing research has often considered these barriers separately, leaving a need for integrated, context-sensitive analysis of how they affect institutional preparedness and educational continuity.

Accordingly, this study aimed to assess digital risk and institutional preparedness for technology-supported and AI-enabled education in Sherpur Sadar Upazila. The objectives were to describe perceived educational value, usability, access, and institutional support; identify infrastructural, financial, institutional, and socio-cultural barriers; examine how gender and rural–urban residence shape reported experiences; and interpret the implications for educational continuity and disaster resilience.

- RQ1: What patterns of perceived educational value, usability, access, and institutional support characterize technology-supported and AI-enabled education?
- RQ2: Which infrastructural, financial, institutional, and socio-cultural conditions create digital risk and unequal access?
- RQ3: How do gender and rural–urban residence shape reported barriers to participation and educational continuity?
- RQ4: How do stakeholder accounts explain the implications of these conditions for institutional preparedness and educational resilience?

1.2. Theoretical Framework

This study draws on TAM and TAM3 as interpretive frameworks. TAM identifies perceived usefulness and perceived ease of use as central influences on the acceptance of technology, while TAM3 incorporates additional determinants and intervention conditions that shape these perceptions (Davis, 1989; Venkatesh & Davis, 2000; Venkatesh & Bala, 2008). Because the questionnaire did not include validated multi-item measures for all TAM3 constructs or actual AI use, the framework is not treated as a statistically validated causal model.

The risk-informed framework used here distinguishes three interacting domains. The first comprises digital-risk conditions: unreliable electricity and connectivity, device scarcity, financial barriers, limited skills, and gendered or socio-cultural constraints. The second comprises institutional-preparedness capacities: teacher training, technical support, maintenance, backup and offline learning arrangements, continuity planning, and accountable data governance. The third comprises continuity and resilience outcomes: sustained access, equitable participation, adaptation during disruption, and recovery of essential learning functions. Perceived usefulness and ease of use are retained as interpretive constructs linking individual experience with these wider institutional conditions.

Figure 1 summarizes this framework. It places hazards and disruptive events upstream of digital-risk conditions, identifies institutional preparedness as the principal protective capacity, and treats educational continuity and resilience as outcomes. Gender and rural–urban residence are cross-cutting vulnerability conditions rather than statistically validated moderators in the present study.

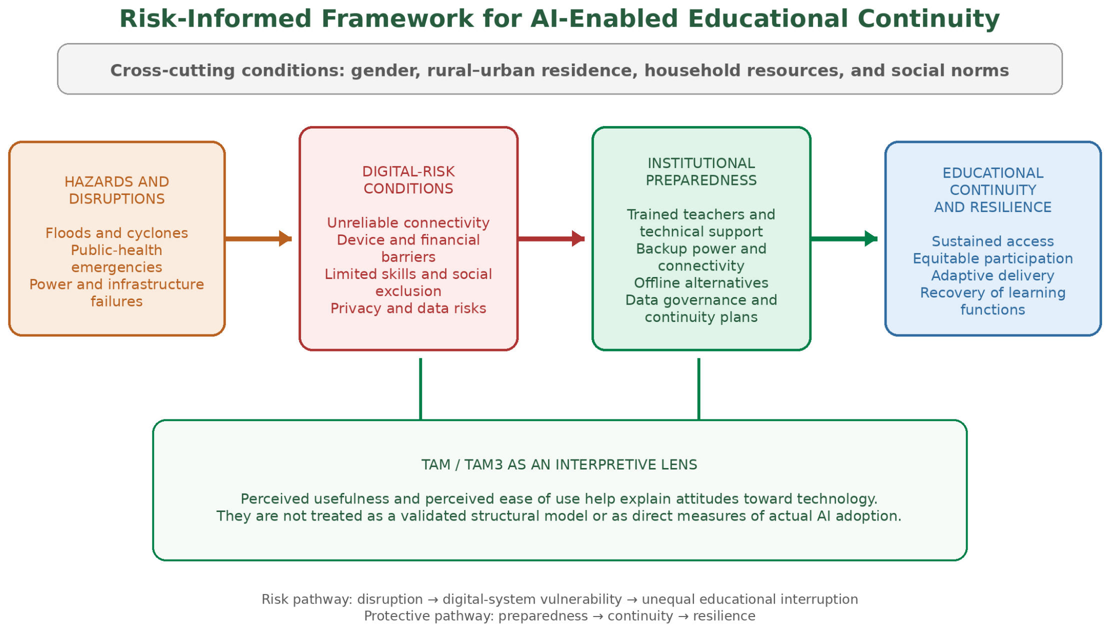

Figure 1. Risk-informed conceptual framework for AI-enabled educational continuity and resilience. TAM constructs are used as an interpretive lens rather than as a validated structural model.

1.3. Literature Review

Research on AI and digital education in Bangladesh highlights both pedagogical potential and implementation risk. AI-supported tools can expand access to information and personalized support, but their value depends on teacher competence, appropriate curriculum integration, ethical safeguards, and realistic institutional capacity (Habib, 2025; Sultana & Faruk, 2024; UNESCO, 2021; Wafik et al., 2024). The distinction between general digital access and actual AI use is important: access to a device or online platform does not by itself demonstrate meaningful, safe, or sustained adoption of AI.

Infrastructure, affordability, skills, gender, residence, and household decision-making shape digital inequality. Rural users may experience lower-quality connections and fewer devices, while women and girls may face additional limitations related to mobility, time, safety, and family expectations (Akram & Majid, 2024; Aziz & Naima, 2021; Karmaker & Cvetković, 2025; Sarker et al., 2025; Siddiquee & Islam, 2024). These conditions represent differential vulnerability because they influence who can continue learning when ordinary educational arrangements are disrupted.

Institutional readiness is equally important. Teachers may be expected to use digital tools without sustained professional development, technical assistance, maintenance budgets, or clear pedagogical guidance (Azad, 2024; Emon et al., 2024; Habib, 2025). Evidence from remote-learning interventions also shows that lower-technology and offline-compatible approaches can protect access where internet-based systems are unreliable, underscoring the need for redundancy rather than dependence on a single platform or delivery mode (Wang et al., 2024).

Disaster-management research provides a broader continuity perspective. Studies of academic institutions, school preparedness, mobile communication, and educational exclusion show that continuity depends on pre-disaster planning, institutional coordination, accessible communication, and explicit attention to vulnerable groups (Dada et al., 2025a, 2025b; Ocal & Torun, 2025; Razia, 2025; Salam et al., 2026; Yamah & Folorunsho, 2026). Digital systems can support continuity, but they also create new dependencies and points of failure.

Emerging-technology governance adds further concerns, including data integrity, privacy, accountability, algorithmic error, legal responsibility, and overdependence on automated systems. These risks are especially consequential when institutions lack validated models, clear procedures, or capacity for human oversight (Ahmad & Gupta, 2026; Hanspal et al., 2026; Nayak & Nayak, 2026; Vuletić, 2026). Responsible adoption therefore requires risk assessment alongside investment in access and skills.

Earlier studies by Karmaker and Cvetković examined digital literacy among rural women, policy and inclusion, and tensions between AI-supported and traditional learning (Karmaker & Cvetković, 2025, 2026a, 2026b). The present study differs in its explicit focus on digital continuity, institutional preparedness, and the disaster-resilience implications of unequal access. Because the setting and subject matter overlap, transparent disclosure of any shared participants, instruments, or qualitative material is essential to establish the manuscript's distinct contribution.

The resulting research gap is not simply whether students favor technology. It is whether educational institutions possess the infrastructural, human, social, and governance capacities required to convert favorable attitudes into equitable, safe, and disruption-resistant learning. Addressing that gap requires integrating descriptive survey evidence with stakeholder explanations and interpreting both within a disaster-risk and continuity-planning framework.

2. Methods

2.1. Study Design and Analytical Scope

The study used a convergent mixed-methods design. Quantitative and qualitative evidence was collected within the same overall period, analyzed separately, and integrated during interpretation. The survey strand described patterns of perceived value, access, usability, and barriers, while the qualitative strand examined the institutional and socio-cultural mechanisms underlying those patterns. The design supports triangulation and contextual explanation but does not establish causality or population-level prevalence.

2.2. Setting and Participant Groups

Data collection was conducted in Sherpur Sadar Upazila, Bangladesh, from 22 May to 8 December 2024. Eight educational institutions were included: five urban and three rural schools, colleges, or higher-level institutions. The quantitative sample comprised 207 students. The qualitative component involved 25 stakeholders from teaching, educational administration, policymaking, and research roles.

2.3. Sampling and Recruitment

Student participants were recruited through non-probability convenience sampling and completed group-administered paper or online questionnaires. No probability-based sampling frame or random-selection procedure was documented. Stakeholders were recruited purposively, with snowball recruitment used to identify additional information-rich participants. Eligibility was based on enrollment in, or professional involvement with, the participating institutions. The rural-weighted and female-majority composition is reported as a characteristic of the achieved sample and limits generalization and formal between-group inference.

2.4. Quantitative Instrument and Operationalization

The questionnaire contained 14 perception statements addressing educational value, ease of technology use, access to digital resources, institutional and policy support, financial constraints, family and community discouragement, and training needs. Response options were strongly agree, agree, disagree, and no response. No response was treated as missing. The items were analyzed individually because the available instrument did not provide validated multi-item measures for the full TAM3 structure, actual AI use, or behavioral intention. Accordingly, the study assesses preparedness for technology-supported and AI-enabled education rather than claiming a direct measurement of AI adoption.

A pilot test with 10 respondents produced a reported overall Cronbach's alpha of .79. Because the instrument combines heterogeneous domains, this coefficient is interpreted only as preliminary evidence of response consistency and not as confirmation of a unidimensional scale or construct validity. The final submission should include the full questionnaire, coding rules, and a clear item-to-domain mapping as supplementary material.

2.5. Qualitative Data Collection

The source documentation reports 17 semi-structured interviews and eight focus-group sessions involving 25 stakeholders in total. Sessions addressed barriers to technology and AI use, pedagogical change, gender roles, cultural norms, institutional support, and policy implementation. Interviews reportedly lasted approximately 30–45 minutes and focus-group sessions approximately 60–90 minutes. Sessions were conducted in Bangla, audio-recorded with permission, transcribed, and translated into English through peer checking by two researchers. The number of participants in each focus group, any repeat participation across sessions, and the stakeholder composition of each session must be confirmed from the original field records before submission.

2.6. Quantitative Data Processing and Analysis

Aggregate response counts were analyzed in GNU PSPP. Frequencies and percentages were calculated using the full sample, while item means and sample standard deviations were calculated from valid responses only. Missing responses were not assigned numerical values, and no imputation was performed. Because the revision materials did not contain the complete item-level dataset, construct definitions, coefficient tables, confidence intervals, or diagnostic output, previously reported correlation and regression estimates were removed. The analysis presented here is descriptive and does not test moderation, mediation, or causal relationships. The exact PSPP version should be reported from the archived analysis files before submission.

2.7. Qualitative Analysis and Mixed-Methods Integration

Qualitative data were analyzed manually using the six-phase logic of thematic analysis: familiarization, initial coding, theme development, theme review, theme definition, and reporting (Braun & Clarke, 2006). Two researchers reviewed the coding and resolved disagreements through discussion and consensus. A formal inter-coder reliability coefficient was not calculated. Integration was conducted through narrative triangulation and a mixed-methods joint display that assessed convergence and complementarity between survey patterns and stakeholder explanations.

2.8. Ethics and Data Protection

Ethical approval was granted by the Institutional Review Board of Nizam Uddin Ahmed Model College (Approval No. NAMC/01-02-24.00.04.00032). Adult participants provided written informed consent. For participants younger than 18 years, written parental or guardian permission and participant assent were obtained. Participation was voluntary and uncompensated. Direct identifiers were not collected, and survey data and audio files were stored on encrypted, password-protected systems accessible only to the research team. Consent materials and explanations were provided in Bangla.

2.9. Relationship to Related Publications and Data Integrity

The study shares a geographic setting and related subject matter with earlier publications by the first two authors (Karmaker & Cvetković, 2025, 2026a, 2026b). Before submission, the authors should provide a transparent statement identifying any overlap in participants, survey items, interview material, data-collection periods, or analytical outputs and explaining the distinct research question and contribution of the present manuscript. Undisclosed reuse of data or text could create concerns regarding redundant publication.

3. Results

3.1. Participant Characteristics

The achieved sample was predominantly female, rural, and concentrated in younger age groups. These characteristics define the context to which the findings are most directly transferable and require caution when interpreting gender- or residence-related patterns (Table 1).

Table 1. Demographic characteristics of student participants (N = 207).

Characteristic	Category	n	%
Age	17–20 years	116	56.04
	21–28 years	67	32.37
	29 years or older	24	11.59
Gender	Female	170	82.13
	Male	37	17.87
Educational level	SSC/HSC or Grade 12	113	54.59
	BA pass	32	15.46
	BSc	2	0.97
	Honours	58	28.02
	MA	2	0.97
Residence	Urban	68	32.85
	Rural	139	67.15
Marital status	Married	57	27.54
	Unmarried	150	72.46

Note. Percentages are based on the full student sample. Data were collected from May to December 2024.

The sample was predominantly female (82.13%, n = 170) and rural (67.15%, n = 139). More than half of participants were aged 17–20 years (56.04%), and 54.59% were enrolled at SSC/HSC or Grade 12 level. The small male subgroup (n = 37) and unequal rural–urban composition preclude robust comparative inference; subgroup differences are therefore interpreted qualitatively and descriptively.

3.2. Quantitative Findings

To address the first two research questions, the 14 survey items were summarized using strongly-agree frequencies, valid-response counts, and item means and standard deviations calculated from valid responses. Nonresponse was excluded from central-tendency and dispersion calculations and is displayed separately in Figure 2 (Table 2).

Table 2. Descriptive statistics for technology-supported and AI-enabled education.

Item	Statement	Strongly agree, % (n)	Valid n	Mean	SD
I1	Devices support learning	43.5 (90)	199	1.64	0.64
I2	Online classes are flexible and convenient	42.5 (88)	203	1.59	0.53
I3	Teachers' use of digital tools supports learning	50.7 (105)	205	1.50	0.52
I4	Preference for online rather than traditional learning	70.5 (146)	198	1.29	0.51
I5	Students face significant challenges in online learning	50.7 (105)	205	1.50	0.52
I6	Access to e-books, digital libraries, and educational apps	47.8 (99)	199	1.54	0.57
I7	Schools should rely more on technology	74.9 (155)	204	1.26	0.49
I8	Digital literacy should be compulsory	68.6 (142)	200	1.51	0.83
I9	Government should invest in rural digital access	98.1 (203)	206	1.01	0.12
I10	Financial constraints limit device access	66.7 (138)	199	1.35	0.56
I11	Social expectations limit online-learning time	84.1 (174)	206	1.16	0.36
I12	Family or community discourages technology use	85.5 (177)	205	1.15	0.38
I13	Technology is difficult to use	72.5 (150)	203	1.29	0.52
I14	Free and accessible technology training is needed	62.3 (129)	206	1.38	0.51

Note. Response options were 1 = strongly agree, 2 = agree, and 3 = disagree; no response was treated as missing. Strongly-agree percentages use N = 207 as the denominator, while means and standard deviations use the valid n shown for each item. The instrument assesses perceptions of digital and technology-supported education and should not be interpreted as a validated direct measure of actual AI use.

The strongest consensus concerned public and institutional responsibility. Government investment in rural digital access received 98.1% strong agreement, 74.9% strongly agreed that schools should rely more on technology, and 68.6% strongly agreed that digital literacy should be compulsory. These findings indicate strong demand for institutional action, but they do not demonstrate the frequency or quality of actual AI use.

Substantial barriers were reported at the same time. Technology was described as difficult to use by 72.5% of the full sample, 66.7% strongly agreed that financial constraints limited device access, 84.1% reported social expectations that reduced online-learning time, and 85.5% reported family or community discouragement. The combined pattern indicates high perceived value alongside substantial access, usability, and social vulnerability.

Figure 2 provides a visual comparison of agreement, disagreement, and item nonresponse across all 14 statements. It illustrates the central preparedness paradox: strong technology support coexists with financial, social, and usability barriers that may undermine continuity during disruption.

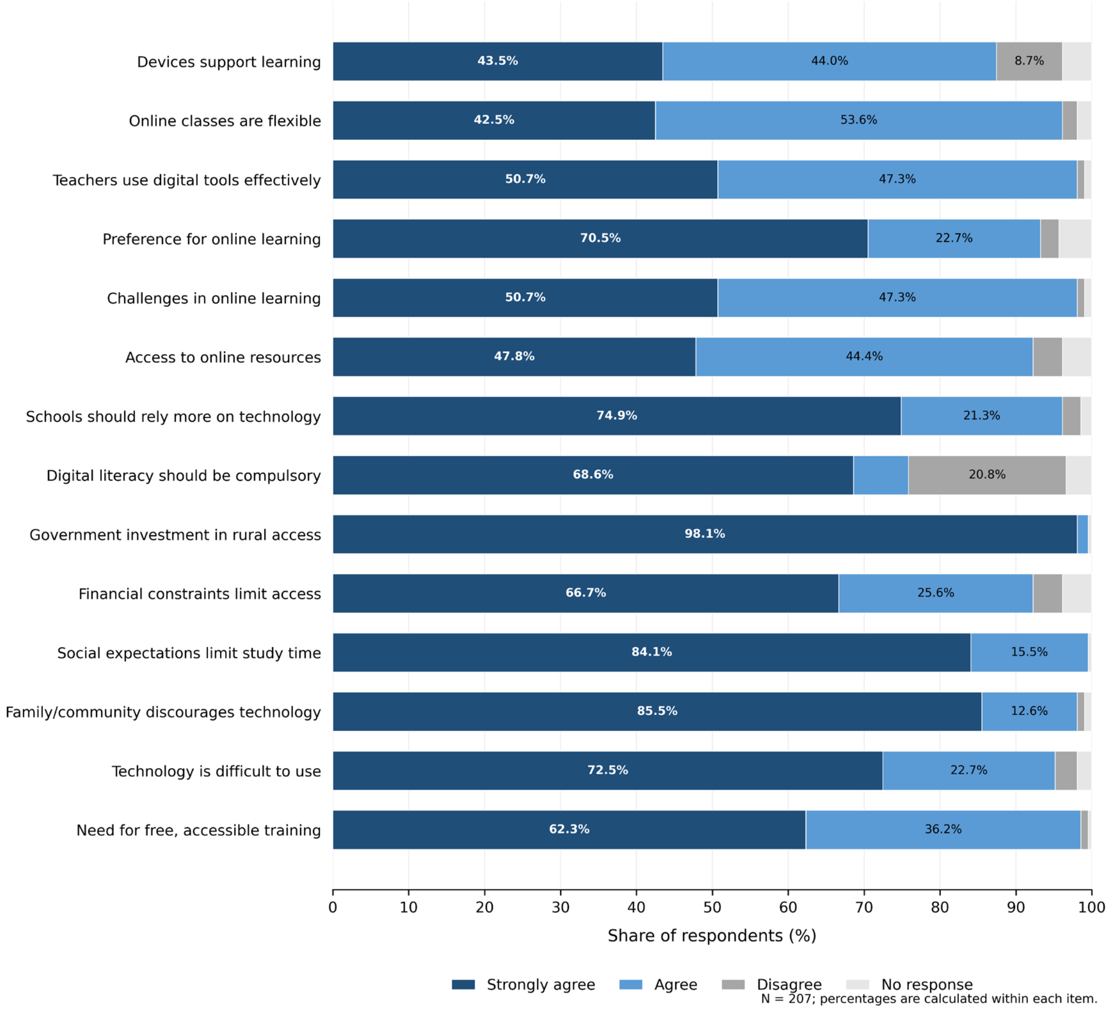

Figure 2. Distribution of responses to the 14 survey items on technology-supported and AI-enabled education (N = 207). Percentages were calculated within each item; no-response observations are shown separately and were excluded from item means and standard deviations.

3.3. Qualitative Findings

The qualitative analysis was organized as a joint display linking primary themes, subthemes, illustrative codes, and representative evidence. This structure shows how stakeholder accounts explain the survey pattern of high perceived value but constrained practical access (Table 3).

Table 3. Code-to-theme mapping for the qualitative analysis.

Primary theme	Subtheme	Illustrative codes	Representative evidence
Infrastructure deficit	Rural–urban connectivity divide	No internet; electricity problems; rural schools left behind; urban privilege	"This trend is new to many rural students, as they lack many facilities. Stakeholders need to familiarize them with its use and scope" (Participant B, FGD).
Infrastructure deficit	Resource and device scarcity	No computers; unaffordable smartphones; shared or broken devices; no AI software	"AI is mostly in the urban phase, so many obstacles still need to be addressed" (Participant D, FGD).

Gendered digital exclusion	Family and community restrictions	Technology prioritized for boys; marriage over education; community criticism	Participants described family preferences that gave boys earlier or greater access to devices.
Gendered digital exclusion	Mobility and safety constraints	Unsafe transport; movement restrictions; fear of harassment	Female students reported reduced access to training centers and institutions with digital resources.
Institutional unreadiness	Inadequate teacher training	Limited AI knowledge; no training; technology anxiety; self-directed learning only	"Well-trained teachers and an AI-supportive environment can extend the benefits to everyone" (Participant C, FGD).
Institutional unreadiness	Limited institutional support	No technicians; no maintenance budget; no AI curriculum; isolated initiatives	Participants linked poor implementation to limited leadership, technical support, and institutional planning.
Socio-cultural barriers	Normative beliefs about technology	Technology considered unsuitable for girls; STEM viewed as masculine; resistance from elders	Social and religious expectations were described as constraints on women's technological engagement.
Policy-implementation gap	Weak government–NGO coordination	Projects end abruptly; limited follow-up; duplication; funding gaps	Stakeholders reported that short-term projects frequently lacked continuity and monitoring.
Policy-implementation gap	ICT policy limitations	Outdated regulation; delays; procurement problems; weak local implementation	Participants perceived a gap between national digital strategies and local institutional capacity.
Perceived utility of AI	Optimism versus structural reality	AI assists with learning; strong interest but limited means; urban advantage.	"AI helps a lot in our education, but it requires broader assistance" (Participant A, FGD).

Note. The source documentation reports 17 semi-structured interviews and eight focus-group sessions involving 25 stakeholders in Sherpur Sadar Upazila, May–December 2024. Quotations were lightly edited for clarity without changing meaning. The number of participants per focus group and any repeat participation should be confirmed against the original field records before submission.

Five interconnected themes emerged: infrastructure deficit, gendered digital exclusion, institutional unreadiness, socio-cultural barriers, and policy-implementation gaps. Participants distinguished between enthusiasm for AI-enabled learning and the practical capacity to use it. Rural institutions were described as facing connectivity problems, electricity interruptions, device shortages, and limited technical support. Teachers were often expected to use digital tools without systematic professional development, maintenance assistance, or continuity arrangements.

The qualitative findings also clarified mechanisms of unequal access. Stakeholders described family preferences for boys' use of devices, restrictions on girls' travel to training centers, safety concerns, and community narratives that framed technology as unsuitable for girls. These accounts show how social and infrastructural conditions can suppress sustained participation even when learners value technology. Because the survey did not support robust subgroup inference, these findings should be treated as contextual explanations rather than quantitative estimates of gender or rural–urban effects.

3.4. Integrated Mixed-Methods Interpretation

The quantitative and qualitative strands converged on a consistent pattern: favorable attitudes toward technology were not matched by the infrastructural, institutional, financial, and social conditions required for equitable and disruption-resistant use. The evidence is best interpreted as an assessment of preparedness and vulnerability rather than as a validated measurement of actual AI adoption.

Table 4 integrates the principal survey indicators with qualitative explanations and identifies their implications for disaster preparedness, educational continuity, and resilience.

Table 4. Mixed-methods joint display of digital risk, institutional preparedness, and educational-continuity implications.

Integrated finding	Quantitative indicator(s)	Qualitative explanation	Disaster-risk and continuity implications
High demand but constrained access	98.1% strongly supported rural digital investment; 72.5% reported difficulty using technology; 66.7% reported financial barriers.	Connectivity and electricity problems, device scarcity, and unaffordable access limited practical use.	Positive attitudes alone cannot protect continuity; infrastructure and affordability failures increase the probability of educational interruption.
Institutional preparedness gap	74.9% supported greater school reliance on technology; 62.3% strongly supported free and accessible training.	Stakeholders reported inadequate teacher preparation, limited technical support, weak maintenance capacity, and no systematic continuity arrangements.	Preparedness requires trained personnel, maintenance, backup connectivity and power, offline alternatives, and tested continuity procedures.
Gendered and social vulnerability	84.1% reported social expectations limiting online-learning time; 85.5% reported family or community discouragement.	Stakeholders described preferential device access for boys and mobility, safety, and normative restrictions affecting girls.	Disruptions may deepen exclusion unless continuity measures are gender-responsive, safe, and accessible at household and community levels.
Rural–urban inequality	The achieved sample was 67.15% rural; no formal rural–urban inferential comparison was conducted.	Rural institutions were described as having weaker connectivity, fewer devices, and less technical support.	Risk assessments and investment plans should be place-specific and prioritize rural redundancy, maintenance, and local support capacity.
Governance and implementation gap	Strong demand for public investment was evident, but the survey did not measure policy implementation directly.	Stakeholders described short-term projects, weak government–NGO coordination, procurement delays, and limited follow-up.	Digital continuity should be embedded in school disaster plans, monitored through accountable indicators, and supported beyond short project cycles.

Note. Quantitative percentages are based on the full student sample (N = 207). Qualitative explanations derive from interviews and focus-group contributions. The integration identifies convergence and complementarity; it does not establish causal relationships.

4. Discussion

4.1. Summary and Interpretation of Key Findings

The central finding is a preparedness paradox: students expressed strong support for technology-supported education and public investment while simultaneously reporting substantial usability, financial, social, and institutional barriers. The qualitative evidence indicates that these constraints operate together. Adoption in this setting is therefore not merely an individual attitudinal choice; it is a socio-technical and risk-governance issue shaped by infrastructure, institutional capacity, household resources, gender norms, and policy implementation.

From a disaster-risk perspective, these conditions affect the capacity to maintain education during floods, cyclones, public-health emergencies, electricity failures, or other disruptions. A school may formally introduce digital tools yet remain unprepared if it lacks backup power, offline content, trained teachers, technical support, maintenance arrangements, secure data practices, or procedures for reaching students without reliable devices or connectivity. Educational resilience depends on the combined functioning of these capacities rather than on technology availability alone.

4.2. Comparison with Existing Literature

The findings are consistent with research showing that digital inclusion depends on infrastructure, affordability, skills, and institutional support (Aziz & Naima, 2021; Sarker et al., 2025; Siddiquee & Islam, 2024). They also align with evidence that lower-technology and flexible delivery modes can preserve access when broadband-dependent systems are impractical (Wang et al., 2024). The present study adds a rural-weighted, mixed-methods perspective and emphasizes the gap between favorable attitudes and operational preparedness.

The continuity implications complement disaster-management studies of academic institutions, school preparedness, mobile communication, and educational exclusion in hazard-prone communities (Dada et al., 2025a, 2025b; Ocal & Torun, 2025; Razia, 2025; Salam et al., 2026; Yamah & Folorunsho, 2026). Across these domains, preparedness depends on institutional coordination, accessible communication, redundancy, and explicit protection of vulnerable groups.

The findings also support responsible-technology scholarship emphasizing accountability, data integrity, legal clarity, and human oversight (Ahmad & Gupta, 2026; Hanspal et al., 2026; Nayak & Nayak, 2026; Vuletić, 2026). Expanding AI-enabled education without safeguards may create new risks involving privacy, unreliable outputs, algorithmic bias, or dependence on systems that institutions cannot maintain. Access policy and AI governance should therefore be developed together.

4.3. Theoretical Implications

TAM3 remains useful as an organizing heuristic because it directs attention to perceived usefulness, ease of use, and external conditions. The study does not, however, constitute a full empirical test of TAM3. Its theoretical contribution is a risk-informed contextual extension: individual perceptions are interpreted within a wider system of infrastructural vulnerability, institutional preparedness, social inclusion, governance, and continuity planning.

This interpretation is consistent with multidimensional approaches to disaster resilience, which emphasize interacting social, institutional, infrastructural, and governance resources (Cvetković, 2025; Cvetković et al., 2025, 2026a, 2026b, 2026c; Milenković & Cvetković, 2025). Educational technology should therefore be treated as part of a continuity system rather than as a stand-alone classroom innovation. Resilience is strengthened when institutions can maintain, adapt, and restore learning while preventing disruption from disproportionately excluding rural students, girls, and low-income households.

4.4. Practical and Policy Implications

A top-down expansion of AI without investment in foundational capacity is unlikely to produce equitable or resilient outcomes. Priority actions include:

- Targeted investment in reliable rural electricity, affordable devices, broadband connectivity, maintenance, and local technical support.

- Context-specific AI and digital-pedagogy training for pre-service and in-service teachers, supported by continuing technical assistance rather than one-time workshops.
- Gender-responsive measures, including device-lending schemes, safe and locally accessible training, community digital-literacy programs, and engagement with families to reduce restrictive norms.
- Continuity measures such as backup power and connectivity, downloadable or offline content, alternative communication channels, data backups, and procedures for reaching students who cannot access online platforms.
- Integration of digital risk, responsible AI governance, and educational continuity into school disaster-preparedness plans, local risk assessments, drills, monitoring systems, and government–NGO coordination mechanisms.

Public–private partnerships may help pool infrastructure costs, support open and locally relevant educational tools, and expand technical capacity. Clear requirements for accessibility, data protection, transparency, accountability, maintenance, and long-term sustainability should govern such partnerships. Procurement decisions should include continuity and exit planning so that learning services do not collapse when short-term projects end.

4.5. Limitations and Potential Biases

Several limitations constrain interpretation. The non-probability, geographically concentrated sample limits external validity, and the female-majority, rural-weighted composition prevents robust gender and rural–urban comparisons. The cross-sectional design cannot establish temporal order or causal effects. Voluntary participation may have favored individuals with stronger interest in technology, while discussion of gender and family restrictions may have been influenced by social-desirability or underreporting bias.

Measurement limitations are also substantial. The 14-item instrument was not validated as a complete TAM3 scale, did not document a dedicated multi-item behavioral-intention construct, and did not directly measure the frequency or quality of actual AI use. The overall pilot alpha does not establish construct-specific reliability or validity. Inferential correlation and regression estimates were removed because the revision package did not include sufficient item-level data, coefficient tables, confidence intervals, or diagnostics for verification. The composition of the focus-group component, public accessibility of the data repository, and possible overlap with related publications must be confirmed before submission. The conclusions are therefore descriptive, contextual, and non-causal.

4.6. Directions for Future Research

Future studies should use validated AI-literacy, technology-acceptance, institutional-preparedness, and educational-resilience scales. Multi-site probability or stratified sampling, balanced rural–urban and gender groups, objective connectivity measures, and longitudinal platform-use data would strengthen inference. Where moderation is examined, complete construct definitions, interaction models, marginal effects, confidence intervals, and diagnostic tests should be reported.

Research linking educational technology with disaster risk should test whether teacher preparation, backup infrastructure, offline learning options, and continuity plans improve access and recovery during floods, cyclones, public-health emergencies, and prolonged infrastructure outages. Quasi-experimental or longitudinal designs could evaluate whether targeted capacity-building reduces learning disruption and unequal exclusion over time.

5. Conclusions

This study assessed digital risk and institutional preparedness for technology-supported and AI-enabled education in Sherpur Sadar Upazila. Students strongly endorsed the educational value of technology and the need for government investment. However, usability difficulties, financial limitations, family and community discouragement, inadequate teacher preparation, and institutional implementation gaps constrained practical participation.

The principal contribution is conceptual and contextual rather than causal. The study shows that favorable attitudes toward technology do not constitute preparedness. Infrastructure, human capacity, technical support, gender-responsive access, responsible data governance, backup arrangements, and continuity planning are necessary if digital learning is to remain equitable and functional during ordinary periods and disruptive events.

AI can support inclusive educational transformation only when deployment is accompanied by validated measurement, accessible infrastructure, teacher competence, human oversight, and sustained institutional planning. Reducing digital vulnerability before crises occur is essential if AI-enabled education is to strengthen resilience rather than reproduce existing inequalities.

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Appendix A

Illustrative Participant Quotations

The following quotations are included to preserve selected stakeholder perspectives. Participant identifiers are pseudonyms.

"AI helps a lot in our education now; it even solves many interrelated issues related to our curriculum, but it requires broader assistance" (Participant A, focus group discussion).

"This trend is new to many rural students, as they lack many facilities. Stakeholders need to familiarize them with its use and scope" (Participant B, focus group discussion).

"Well-trained teachers and an AI-supportive environment can extend the benefits to everyone" (Participant C, focus group discussion).

"AI is mostly in the urban phase, so many obstacles still need to be addressed" (Participant D, focus group discussion).

Editorial Verification Checklist (Remove Before Submission)

- Confirm whether the qualitative component comprised 17 interview participants plus eight focus-group participants, or 17 interviews plus eight separate focus-group sessions; report the number and size of all focus groups.
- Confirm that the Figshare DOI is public and contains the item-level dataset, coding guide, questionnaire, and sufficient analysis documentation.
- Record the exact GNU PSPP version. Do not restore correlation, regression, moderation, or mediation results unless complete construct definitions, data, coefficient tables, confidence intervals, and diagnostic output are available.
- Disclose any participant, instrument, text, or data overlap with Karmaker and Cvetković (2025, 2026a, 2026b) and explain the distinct contribution of this manuscript.
- Confirm the CRediT contributions and authorship eligibility of H.B. and V.D.C. before final submission.

6. References

1. Ahmad, I., & Gupta, A. K. (2026). A comprehensive assessment of mining accident severity using machine learning methods. International Journal of Disaster Risk Management, 8(1), 277–292. https://doi.org/10.18485/khwvt756
2. Akram, A. A., & Majid, H. (2024). Inclusivity, gender, and learning gains: Are online education platforms the answer? Journal of Economics, Race, and Policy, 1–12. https://doi.org/10.1007/s41996-024-00159-x
3. Alam, M. J., Ogawa, K., & Ahsan, A. H. M. (2024). Quality assurance of science and technology universities in Bangladesh: A catalyst for sustainable employment during the 4IR. Journal of Science and Technology Policy Management. https://doi.org/10.1108/JSTPM-11-2023-0190
4. Azad, A. K. (2024). Challenges faced by teachers to use multimedia in the classroom and students' perception of it: A case study on a selected college in Bangladesh. Journal of Management and Business Education, 7(1), 54–69. https://doi.org/10.35564/jmbe.2024.0004
5. Aziz, A., & Naima, U. (2021). Rethinking digital financial inclusion: Evidence from Bangladesh. Technology in Society, 64, 101509. https://doi.org/10.1016/j.techsoc.2020.101509
6. Babu, K. E. K. (2021). Artificial intelligence in Bangladesh, its applications in different sectors, and relevant challenges for the government: An analysis. International Journal of Public Law and Policy, 7(4), 319–333. https://doi.org/10.1504/IJPLAP.2021.118891
7. Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa
8. Cvetković, V. M. (2025). First responders in the Western Balkans: Strengthening capacities and preparedness for a resilient future. International Journal of Disaster Risk Management, 7(2), 361–384. https://doi.org/10.18485/ijdrm.2025.7.2.19
9. Cvetković, V. M., Aleksova, B., Renner, R., Gačić, J., Ivanov, A., & Milašinović, S. (2025). Community-based disaster risk reduction: Overcoming barriers to build stronger communities. International Journal of Disaster Risk Management, 7(2), 113–130. https://doi.org/10.18485/ijdrm.2025.7.2.7

10. Cvetković, V. M., Milenković, D., Bašić, J., Lukić, T., & Renner, R. (2026a). Predictive model of community disaster resilience across Serbia: A BRIC–DROP composite index and spatial patterns. Safety, 12(3), 59. https://doi.org/10.3390/safety12030059
11. Cvetković, V. M., Milenković, D., & Lukić, T. (2026b). Measuring community disaster resilience in Serbia using an adapted BRIC framework grounded in DROP: Index construction and regional disparities. Geosciences, 16(4), 135. https://doi.org/10.3390/geosciences16040135
12. Cvetković, V. M., Milenković, D., Lukić, T., & Renner, R. (2026c). Theoretical evolution of measuring community resilience to natural and technological disasters: Past, present, and future—Empirical insights from qualitative research in Serbia. Open Geosciences, 18(1), 20250968. https://doi.org/10.1515/geo-2025-0968
13. Dada, K. S. J., Hamza, J. M., & Mohammed, H. A. (2025a). Disaster risk management in libraries and information centers: Global strategies, challenges, policy and recommendations. International Journal of Disaster Risk Management, 7(1), 203–214. https://doi.org/10.18485/ijdrm.2025.7.1.11
14. Dada, K. S. J., Mohammed, H. A., & Quadir, R. O. (2025b). Disaster risk management in academic institutions: An assessment of preparedness and recovery at Kashim Ibrahim Library, Nigeria. International Journal of Contemporary Security Studies, 1(1), 1–15. https://doi.org/10.18485/fb_ijcss.2025.1.1.1
15. Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 13(3), 319–340. https://doi.org/10.2307/249008
16. Emon, M. M. H., Khan, T., Rahman, M. A., & Siam, S. A. J. (2024). Factors influencing the usage of artificial intelligence among Bangladeshi professionals: Mediating role of attitude towards the technology. In 2024 IEEE International Conference on Computing, Applications and Systems (COMPAS) (pp. 1–7). IEEE. https://doi.org/10.1109/COMPAS60761.2024.10796110
17. Habib, F. A. B. (2025). Unveiling the role of educators' attitudes and intention toward artificial intelligence in teaching: A multidimensional analysis. Education and Information Technologies, 1–25. https://doi.org/10.1007/s10639-024-13271-0
18. Hanspal, M. S., Cvetković, V. M., Lipovac, M., & Popović, D. J. (2026). Regulating emerging technologies in disaster management: A comparative analysis of security governance and legal liability in India and Serbia. International Journal of Disaster Risk Management, 8(1), 147–162. https://doi.org/10.66050/5jedtn66
19. Islam, M., Islam, M. A., Afroj, F., Islam, A. A., Karmakar, O., Nayem, A. A. M., & Hoque, M. A. (2026). Volunteer-led emergency flood response in Bangladesh: Evidence for strengthening disaster-risk governance. International Journal of Disaster Risk Management, 8(1), 163–182. https://doi.org/10.66050/jf110s44
20. Karmaker, R., & Cvetković, V. M. (2025). Digital literacy and educational empowerment among rural women in Bangladesh: Bridging the technology access gap. International Journal of Disaster Risk Management, 7(2), 239–262. https://doi.org/10.18485/ijdrm.2025.7.2.13
21. Karmaker, R., & Cvetković, V. M. (2026a). Policy, risk and innovation: A mixed-methods framework for using AI to foster inclusion in marginalized communities in Bangladesh. International Journal of Disaster Risk Management, 8(1), 385–408. https://doi.org/10.66050/scv48268
22. Karmaker, R., & Cvetković, V. M. (2026b). The clash between AI-driven education and traditional learning in Bangladesh: A mixed-methods study of academic integrity and educational security in Sherpur Sadar Upazila. International Journal of Contemporary Security Studies, 2(1), 161–178. https://doi.org/10.18485/fb_ijcss.2026.2.1.13
23. Milenković, D., & Cvetković, V. M. (2025). Rethinking disaster resilience: Conceptual framework, core dimensions, and key actors. International Journal of Disaster Risk Management, 7(2), 455–468. https://doi.org/10.18485/ijdrm.2025.7.2.25
24. Nayak, J., & Nayak, M. R. (2026). Disaster recovery and data integrity in Odisha: Institutional corruption, crop loss mismatches, and the case for district-level destruction scorecards. International Journal of Disaster Risk Management, 8(1), 91–102. https://doi.org/10.66050/53hznm05
25. Ocal, F. E., & Torun, S. (2025). Leveraging artificial intelligence for enhanced disaster response coordination. International Journal of Disaster Risk Management, 7(1), 235–246. https://doi.org/10.18485/ijdrm.2025.7.1.13

26. Razia, B. (2025). Guardians of safety: Assessing awareness and preparedness of teachers along with school initiatives for disaster risk reduction. International Journal of Disaster Risk Management, 7(1), 325–338. https://doi.org/10.18485/ijdrm.2025.7.1.19
27. Salam, M. F., Gope, S., & Akter, S. (2026). Beyond the floodwaters: Unraveling the deep-rooted causes of educational exclusion in Haor communities in Bangladesh. International Journal of Disaster Risk Management, 8(1), 409–422. https://doi.org/10.66050/g2hpng07
28. Sarker, T., Roy, R., Yeasmin, S., Rabbany, M. G., & Asaduzzaman, M. (2025). Technology adoption intention and sustainable entrepreneurship ability of rural women in Bangladesh. Business Strategy & Development, 8(1), e70067. https://doi.org/10.1002/bsd2.70067
29. Siddiquee, M. S. H., & Islam, M. S. (2024). Factors determining the first and second level of digital divide in rural Bangladesh. SN Social Sciences, 4(10), 189. https://doi.org/10.1007/s43545-024-00988-5
30. Sultana, R., & Faruk, M. (2024). Does artificial intelligence increase learners' sustainability in higher education: Insights from Bangladesh. Journal of Data, Information and Management, 1–12. https://doi.org/10.1007/s42488-024-00121-4
31. UNESCO. (2021). AI and education: A guide for policy-makers. United Nations Educational, Scientific and Cultural Organization. https://unesdoc.unesco.org/ark:/48223/pf0000376709
32. Venkatesh, V., & Bala, H. (2008). Technology Acceptance Model 3 and a research agenda on interventions. Decision Sciences, 39(2), 273–315. https://doi.org/10.1111/j.1540-5915.2008.00192.x
33. Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. Management Science, 46(2), 186–204. https://doi.org/10.1287/mnsc.46.2.186.11926
34. Vuletić, D. (2026). Strategic risks of AI-enabled automation: Implications for crisis management and systemic resilience. International Journal of Disaster Risk Management, 8(1), 131–146. https://doi.org/10.66050/xhmjy003
35. Wafik, H. A., Mahbub, S., Arif, Z., Prince, S. K. A., & Huda, M. N. (2024). Academicians' perspectives on AI integration in Bangladesh's education: Balancing promise and ethical realities. Cognizance Journal of Multidisciplinary Studies, 4(2), 139–158. https://doi.org/10.47760/cognizance.2024.v04i02.014
36. Wang, L. C., Vlassopoulos, M., Islam, A., & Hassan, H. (2024). Delivering remote learning using a low-tech solution: Evidence from a randomized controlled trial in Bangladesh. Journal of Political Economy Microeconomics, 2(3), 562–601. https://doi.org/10.1086/730456
37. Yamah, D., & Folorunsho, T. (2026). Leveraging social media and mobile technology for disaster communication in Nigeria. International Journal of Disaster Risk Management, 8(1), 1–30. https://doi.org/10.66050/x77jr639