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Toward Technology-Enabled Disaster Management: Institutional Barriers and Opportunities in Pakistan

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ABSTRACT

Purpose: *Pakistan's disaster management institutions still rely mainly on conventional, response-driven systems, even as artificial intelligence (AI), geographic information systems (GIS), remote sensing and mobile-based early-warning platforms take on a growing role in disaster risk reduction elsewhere. This study examines what constrains the adoption of these disruptive technologies within Pakistan's disaster management institutions and where the opportunities lie for a more technology-enabled approach.*

Design: *A qualitative design was adopted. Seventeen key informants from federal and provincial disaster management authorities, national and international non-governmental organisations, academia and the information-technology sector were purposively sampled and interviewed in depth until thematic saturation was reached. Data were analysed using Braun and Clarke's six-phase thematic analysis framework and interpreted through the lens of Complex Adaptive Systems (CAS) theory.*

Findings: *Four interrelated barriers emerged: institutional and policy-level fragmentation, weak physical and digital infrastructure, financial constraints tied to donor dependency, and socio-cultural resistance rooted in low digital literacy and mistrust of formal institutions. Five opportunities counterbalanced these constraints: expanding mobile and internet connectivity, growing inter-institutional and academic collaboration, a maturing domestic IT sector, curriculum reform in higher education, and an observable shift from reactive to proactive disaster governance.*

Policy implications: *The findings offer disaster management authorities a basis for designing coordination mechanisms, sustainable financing instruments and community-level digital literacy programmes that can convert existing technological potential into operational capacity.*

Value: *Prior research on disaster management in Pakistan has largely examined policy frameworks or single-hazard case studies. This study treats technology adoption itself, its institutional, financial, infrastructural and cultural preconditions, as the central unit of analysis, extending Complex Adaptive Systems theory to the country's disaster–technology interface.*

Keywords: *disruptive technology; disaster management; institutional barriers; digital connectivity; complex adaptive systems; Pakistan; qualitative research*

INTRODUCTION

Pakistan produces a negligible share of global greenhouse-gas emissions yet is routinely counted among the ten countries most affected by climate-related disasters (Shehzad, 2023; Somani, 2023). Twenty-nine major floods and repeated earthquakes have struck the country since 1950; the 2022 floods alone displaced 5.4 million people and cost an estimated USD 5 billion (Ashraf et al., 2013; UNOCHA, 2023). Losses on this scale have pushed disaster management institutions toward technologies built to anticipate hazards, not just respond once they strike (Aronsson-Storrier & Dahlberg, 2022).

Artificial intelligence, GIS, remote sensing, drones and mobile early-warning platforms, collectively "disruptive technologies", have already demonstrated real capability in Pakistan. During the 2022 floods, satellite and social-sensing data combined with machine learning flagged 18.9 million people at risk (Akhtar et al., 2023). SUPARCO has expanded satellite-based early warning (Mehboob, 2025), and thermal-imaging drones have located stranded flood victims (Arshad et al., 2025). None of this amounts to a working system, however. Each application on record has been short-lived, regionally confined, or dependent on a single donor grant (Niaz, 2022), which is a different problem from a lack of capability.

That distinction, between technological capability and institutional uptake, is where this study begins. Most existing scholarship on disaster management in Pakistan treats policy architecture, inter-agency coordination and single-hazard response as the object of study (Rana et al., 2021; Shah et al., 2020, 2022); technology adoption itself has drawn far less direct attention (Khan et al., 2019). Three questions follow from this gap: what stops disruptive technologies from taking hold in Pakistan's disaster management institutions, what would need to change for them to take hold, and how the people inside these institutions judge whether these tools are working. The answers matter for a practical reason. Pakistan's disaster management system is, unevenly but genuinely, moving from a reactive posture toward something more anticipatory. The barriers this study surfaces, institutional fragmentation, aid-dependent financing, uneven digital literacy, also recur across low- and middle-income disaster-prone states throughout South and Southeast Asia, so the case carries relevance beyond Pakistan itself.

LITERATURE REVIEW

Technology-enabled disaster management

Pakistan's disaster risk is unusually broad, spanning geophysical, hydrological, meteorological and climatological hazards driven by its tectonic position and monsoon system (Mahmood et al., 2015; Z. Manzoor et al., 2022). Against this backdrop, disaster management's working model, mitigation, preparedness, response, recovery, has held since the 1990s (Alexander, 2019), but what counts as best practice within each phase keeps shifting toward data. AI now forecasts rainfall and drought across South and Southeast Asia (Dash et al., 2018; N. Khan et al., 2020); combined machine-learning, IoT and remote-sensing systems support wildfire prediction elsewhere (Okoro et al., 2024); agent-based simulation models emergency-resource allocation (Maqbool et al., 2020). Munawar et al.'s (2022) systematic review draws the general conclusion these studies point toward: disruptive technologies can strengthen every phase of the disaster cycle, but only where institutions are equipped to absorb them.

Technology adoption in Pakistan's disaster management institutions

Evidence specific to Pakistan tells a story of technical success outrunning institutional readiness. Akhtar et al.'s (2023) combination of remote sensing, social-sensing data and machine learning during the 2022 floods produced flood-exposure estimates strongly correlated with subsequent damage (R^2 of 0.94–0.96); I. Khan et al. (2022) trace a rise in pre-disaster funding that tracks a shift in donor and government emphasis toward

proactive planning. The institutional literature is less optimistic. Rana et al. (2021) find Pakistan's disaster management cycle still weighted toward flood-specific, ad hoc response; Shah et al. (2022, 2023) trace persistent overlap between the NDMA and provincial disaster management authorities (PDMAs) to the 18th constitutional amendment, which devolved disaster management to the provinces without fully settling federal-level coordination. Hussain et al. (2023) find that the systems feeding Pakistan's hazard monitoring trail international practice on both currency and interoperability.

Research gap

Pakistan-focused disaster research overwhelmingly asks about policy frameworks, inter-agency coordination, and community-based resilience; it rarely asks what specifically enables or blocks technology adoption as its own object of inquiry (Shah et al., 2022). Where technology adoption does appear, it sits inside single-hazard or single-institution case studies instead of being examined across the full set of actors, government, humanitarian, academic, private-sector, whose combined decisions determine whether a pilot ever becomes standard practice (K. J. Khan et al., 2019). Drawing on seventeen informants across exactly those four groups, and treating barriers and opportunities as two views of one institutional system, is this study's response.

THEORETICAL FRAMEWORK

Complex Adaptive Systems (CAS) theory provides the interpretive lens for this study. It treats disaster management not as a chain of discrete decisions but as a network of interdependent agents, government agencies, NGOs, communities, technology providers, whose interactions routinely produce outcomes no single actor intended or controlled (Ellis & Herbert, 2010; Siegenfeld & Bar-Yam, 2020). Its practical implication is cautionary. Introduce a single technology, a drone fleet, an early-warning app, without addressing the institutional, financial and cultural system it lands in, and lasting change tends not to follow. The surrounding system adapts around the intervention instead of to it (Hodges & Larra, 2021; Dentoni et al., 2020). The analysis that follows treats the barriers identified in the data as evidence of systemic rigidity and the opportunities as evidence of latent adaptive capacity, returning to this framework directly in the discussion.

METHODOLOGY

Research design

With no empirical baseline for how technology adoption plays out inside Pakistan's disaster management institutions, a qualitative design was the more defensible choice: it can capture the texture of stakeholder experience that a survey instrument built without such a baseline would likely miss.

Sampling and participants

Participants were purposively selected for direct professional experience of disaster management and, where relevant, of the disruptive technologies used within it. Four groups were targeted: government officials (NDMA, Rescue 1122 and equivalent bodies); NGO and INGO staff with at least three years of relevant experience; IT professionals with working knowledge of GIS or remote sensing; and academics with substantive expertise in disaster management or related technologies. Excluded were individuals with a financial stake in promoting a specific technology, those unable to communicate in English or Urdu, and those involved in disaster response only sporadically. Recruitment continued until no new themes were emerging, at which point the sample stood at 17 participants (Table 1).

#	Organisation	Sector
1	National Disaster Management Authority	Government
2	National Disaster Management Authority	Government
3	Provincial Disaster Management Authority – Punjab	Government
4	Provincial Disaster Management Authority – Sindh	Government
5	Provincial Disaster Management Authority – KPK	Government
6	Provincial Disaster Management Authority – Balochistan	Government
7	Rescue 1122	Government
8	International Rescue Committee	INGO
9	Islamic Relief	INGO
10	International Federation of Red Cross and Red Crescent	INGO
11	UNOCHA	INGO
12	Tearfund	INGO
13	GIZ	INGO
14	National University of Sciences & Technology	Academia
15	University of Engineering and Technology	Academia
16	Abacus Solutions	IT sector
17	Devsinc	IT sector

Data collection and analysis

Senior stakeholders scattered across federal and provincial institutions are hard to convene in one room, so in-depth, semi-structured interviews built around an open-ended protocol were used instead of focus groups. Institutional policy documents and secondary case-study material supplemented the interview data. Transcripts were coded following Braun and Clarke's (2006, 2019) approach to thematic analysis, moving from familiarisation through initial coding, candidate-theme development, review, and final naming. Coding was largely inductive, letting themes surface from participants' own accounts; CAS theory entered only afterward, as a lens for interpreting patterns that had already emerged.

Ethical considerations and rigor

Institutional ethical approval was obtained before data collection. Every participant gave informed consent, was assured of confidentiality and anonymity, and was told they could withdraw at any point; a second facilitator sat in on data collection to guard against researcher bias. Rigor followed Lincoln and Guba's (1985) criteria. Credibility rested on purposive sampling carried to saturation and triangulation against policy documents. Dependability came from a documented, stepwise analysis procedure cross-checked against the second facilitator's independent notes. Confirmability followed from grounding every theme in verbatim participant statements rather than the researcher's summary judgement alone.

Two gaps are worth naming rather than glossing over. Member-checking, returning coded transcripts to participants for confirmation, was not carried out, and would strengthen credibility if added later. And the manuscript still lacks a reflexivity statement locating the researcher's own institutional or disciplinary vantage point, an omission worth correcting given how much interpretive judgement thematic analysis involves.

RESULTS

Thematic analysis of the 17 interviews produced four barrier themes and five opportunity themes, summarised in Table 2 and elaborated below with illustrative participant statements. Participant identifiers (e.g., Participant 6) are used in place of names to preserve anonymity.

Category	Theme	Representative sub-themes
Barriers	Institutional and policy-level fragmentation	Absence of a unified technology policy; overlapping NDMA–PDMA mandates; bureaucratic approval delays; policy discontinuity linked to political turnover
Barriers	Infrastructural and technological constraints	Weak connectivity in disaster-prone districts; unreliable electricity supply; limited cloud and data-centre capacity; poor maintenance of deployed systems
Barriers	Financial constraints	Dependence on external/donor funding; underinvestment in R&D; high import costs for hardware; budget skewed toward administrative expenditure
Barriers	Socio-cultural resistance	Low digital literacy in rural communities; mistrust of government-led systems; reliance on informal/traditional warning practices; gendered access gaps
Opportunities	Expanding digital connectivity	Rising smartphone and mobile-broadband penetration; feasibility of SMS-based and app-based early warning; potential for AI-supported risk targeting
Opportunities	Inter-institutional and academic collaboration	Growing GIS/remote-sensing use by NDMA–PDMA; university research output; youth and volunteer engagement in awareness campaigns
Opportunities	A maturing domestic IT sector	Local technical capacity in AI, IoT and drone applications; scope for structured public–private partnerships; disaster-focused prompt engineering for AI tools
Opportunities	Curriculum and capacity-building reform	Integration of disaster-risk-reduction content in university programmes; HEC-supported research on resilience and climate-change adaptation
Opportunities	A discernible shift toward proactive governance	Movement from top-down to participatory planning; growing reliance on data-informed decision-making over ad hoc response

BARRIERS TO ADOPTING DISRUPTIVE TECHNOLOGIES

Institutional and policy-level fragmentation

Ask what stops disruptive technology from taking root in Pakistan's disaster management institutions, and the answer government, humanitarian and academic participants converged on first was policy: no unified national framework exists for how technology should be used during a disaster. The 18th constitutional amendment devolved disaster management to the provinces, but what participants described was less a division of labour than an absence of one. "There is no clear policy direction that guides us about using new technologies like drones or AI during floods or earthquakes… everyone is doing their own thing," one participant said (Participant 12). Approval processes for pilot projects came up repeatedly as slow and risk-averse, and political instability compounded the problem: initiatives begun under one administration were routinely abandoned once the government changed. "The provincial Government of KPK showed great interest but after political shake up, the idea was put aside," said a participant who had proposed a drone-

based flood-monitoring system (Participant 6). Tellingly, the coordination gap was worst not during a disaster, when temporary platforms bring stakeholders together out of necessity, but after one, once those platforms dissolve.

Infrastructural and technological constraints

Damaged or absent roads, unreliable electricity, and thin internet coverage together ruled out real-time systems such as IoT sensors and cloud-based coordination in practice, whatever their promise on paper. Power outages, already a chronic national problem, tended to intensify exactly when disasters made communication systems most necessary. As one participant put it, installing a system and sustaining it are different problems: "we still need more advanced locally hosted and hybrid systems for data security, GIS and AI processing" (Participant 3). A monitoring platform deployed during a recent flood underperformed "due to unavailability of real-time data from field and lack of coordination at primary level" (Participant 9).

Financial constraints

Money was the third recurring obstacle, and not primarily at the point of purchase. What budgets consistently failed to cover was the recurring cost of maintenance, technical training and local customisation. "It's not just about purchasing disruptive tech but its ongoing maintenance cost that further burdens the organisations," one participant said (Participant 4). Underneath that pattern sits a structural dependence on donors, the World Bank, the Asian Development Bank, UN agencies, whose financing has historically gone toward infrastructure and staff training instead of research and technological innovation. Import duties on hardware and a shortage of professionals willing to take disaster-technology roles at domestic salaries added to the strain.

Socio-cultural resistance

The fourth barrier sat with the communities these systems exist to protect. Reliance on traditional, informal warning practices persisted over formal digital alternatives, reinforced by limited digital literacy and by interfaces available only in English. In one flood-prone area, an early-warning system went unheeded despite active awareness campaigns, simply because residents did not trust the digital alert enough to act on it. Gender compounded the gap further, with women in some communities routinely excluded from digital-literacy training. One participant's comment cut to the heart of it: "flood victim communities are generally more interested in getting financial aid rather than getting equipped with digital literacy" (Participant 2), a reminder that technology adoption is competing with far more immediate survival concerns.

OPPORTUNITIES FOR TECHNOLOGY-ENABLED DISASTER MANAGEMENT

Expanding digital connectivity

If one opportunity stood out as ready to act on now rather than later, it was connectivity: mobile and internet access has grown to the point where one respondent put smartphone penetration at roughly 80 percent of the population (Participant 9). Even where roads remain poor, that coverage makes SMS-based and app-based early warning technically feasible today. Participants saw room for AI-supported models to target high-risk areas, mobile apps to pull real-time needs data, and mobile-based cash transfers to speed up post-disaster assistance.

Inter-institutional and academic collaboration

Provincial disaster authorities described growing, if still uneven, use of GIS and remote sensing to visualise risk proactively: "we can now actually see the presence of danger zones and plan proactively, rather than responding haphazardly after disaster" (Participant 11). Universities, among them NUST, COMSATS, Hazara University and the Ghulam Ishaq Khan Institute, were named repeatedly as an underused resource, producing research output and even prototype drone technology not yet linked to institutional planning. University students and young volunteers, participants said, adapt to new technologies more readily and are well placed to carry digital-literacy outreach into disaster-prone communities.

A maturing domestic IT sector

According to IT-sector participants, Pakistan's technology industry already has the skills, AI, IoT, blockchain, machine learning, drone systems, that disaster management needs; what's missing is direction, not capability: "only need is the clear direction and guidance from the higher authorities" (Participant 17). Existing collaborations between organisations such as Islamic Relief and NDMA and local technology start-ups were cited as proof that structured public–private partnerships could be scaled well beyond their current scope.

Curriculum reform and a shift toward proactive governance

Academic participants pointed to curriculum reform across disciplines, environmental science, urban planning, civil engineering, development studies, incorporating disaster-risk-reduction content, supported by the Higher Education Commission, alongside growing institutional linkages between universities and organisations such as UNDP and NDMA. Across sectors, participants described a discernible, if incomplete, transition from centralised, top-down decision-making toward more participatory, data-informed planning, with decisions once made "in closed rooms" gradually shifting toward greater community input. Taken together with the barrier themes above, this shift suggests that the raw material for a more anticipatory disaster management system already exists within Pakistan's institutions; the question the discussion below turns to is what stands between that raw material and its consistent, system-wide use.

DISCUSSION

Why the barriers persist: a mechanism-level reading

Naming institutional fragmentation, weak infrastructure, financial dependency and socio-cultural resistance as four separate barriers understates what the data show, which is that they reinforce each other in a fairly specific sequence. Political instability shortens the investment horizon available for technology adoption (Section 5.1), which keeps financing tied to short-cycle donor grants instead of sustained domestic budgets. Donor-dependent financing then produces the infrastructural unevenness participants reported: a single funding cycle can pay for a monitoring platform, but not for the electricity and technical support it needs to keep running. What communities are left with is not unfamiliarity with digital tools. It is direct experience of tools that failed to work, a more plausible driver of socio-cultural resistance than a simple digital-literacy gap. That reframes resistance as a downstream symptom, not an independent barrier, with real consequences for where a policy response should be aimed (Section 7).

Situating the findings against prior research

The coordination gap this study finds between the NDMA and the PDMAs corroborates Shah et al.'s (2022, 2023) account of duplicated, poorly synchronised responsibilities, and extends Rana et al.'s (2021) description of a system weighted toward ad hoc, single-hazard response. Ali and Iqbal (2021) trace this fragmentation to the National Disaster Management Act 2010 itself. Participants experienced that same weakness specifically as an absence of policy direction for technology deployment, not as a general management shortfall, evidence that fragmentation operates here as a technology-adoption problem in its own right. This study also pushes past prior work on political discontinuity: Rashid and Rashid (2024) and Dwivedi (2024) document Pakistani institutions struggling to sustain initiatives across changes in government but do not ask why some initiatives survive administrative turnover and others don't. The present findings suggest an answer. Technology pilots need multi-year investment to move from demonstration to institutionalisation, which makes them structurally more exposed to political discontinuity than shorter-cycle interventions such as emergency relief distribution.

On infrastructure and financing, the pattern mirrors what Shah and Rana (2023) report for the Hindukush-Karakoram-Himalaya region and echoes Hashmi et al.'s (2021) link between spatial data infrastructure and disaster management outcomes across Pakistan. Nazeer and Gil (2023) find that the absence of AI-specific legislation constrains public-sector AI adoption well beyond disaster management, suggesting the barrier identified here reflects a wider governance gap (Section 7). The opportunities this study identifies fit inside a real but partial institutional reorientation: I. Khan et al. (2022) find pre-disaster funding rising; Waseem et al. (2023) document a working AHP–GIS early-warning system in Swat; Ikram et al. (2025) show inter-agency cooperation after the 2005 earthquake improving relief outcomes. What ties these cases together, though, is that collaboration intensified in response to a specific disaster instead of being sustained proactively between events, the same post-disaster dissolution participants in this study reported. Pakistan's system, in other words, responds well to acute triggers but lacks a standing mechanism for durable cooperation.

Theoretical contribution and conceptual model

Read through CAS theory, these findings show a system with the interdependence the theory predicts, government departments, NGOs, communities, technology providers, but not yet the feedback and self-organisation associated with adaptive systems (Siegenfeld & Bar-Yam, 2020). Barriers and opportunities are two faces of one systemic property, not separate lists. Barriers are where rigidity shows up, preventing reorganisation when disturbed. Opportunities are where adaptive capacity already exists, in a capable IT sector, an engaged youth population, expanding connectivity, but that capacity sits at the level of individual agents rather than integrated system-level coordination. Hodges and Larra (2021) argue that effective emergency management depends less on any single technology's sophistication than on a system's capacity for feedback and self-organisation. This study extends that argument by showing empirically what determines whether that capacity is realised. It is not the presence of opportunity, this study finds plenty of that, but institutional coordination capacity, the mechanism converting scattered opportunity into system-level adaptive response.

The four barrier themes and five opportunity themes converge on this single mediating condition. Where coordination capacity is weak, the barriers reinforce each other and opportunities stay scattered across individual organisations, consistent with participants' observation that promising initiatives dissolve once a disaster's acute phase passes. Where it strengthens, those same opportunities offset the same barriers and the system moves from reactive fragmentation toward proactive, technology-enabled management. Figure 1 sets out this relationship, with coordination capacity as the pivot variable, not a tenth theme, that decides which direction the system moves in.

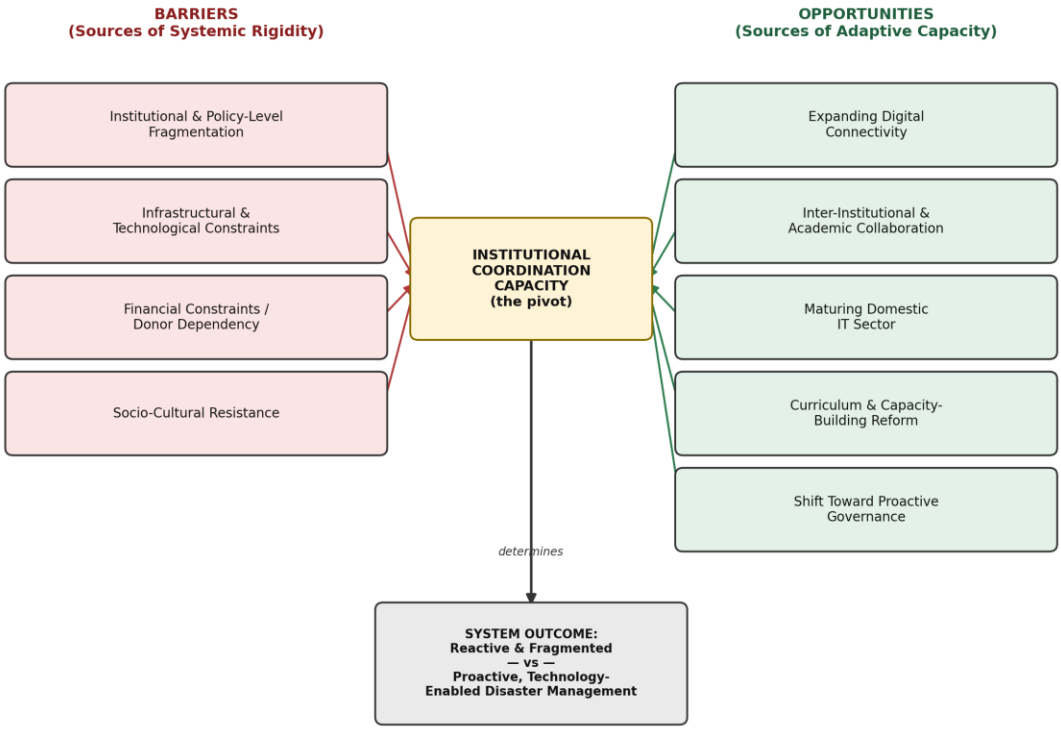

Figure 1. Conceptual model of barriers and opportunities in technology-enabled disaster management in Pakistan, showing institutional coordination capacity as the mediating condition that determines whether the system moves toward reactive fragmentation or proactive, technology-enabled disaster management. Source: developed by the authors from the thematic findings of this study.

The model yields a testable proposition. Interventions aimed directly at institutional coordination capacity should outperform interventions that introduce a single technology in isolation when it comes to converting existing opportunity into sustained practice, a sharper, more falsifiable claim than the general observation that Pakistan's disaster institutions face both barriers and opportunities in technology adoption.

POLICY AND PRACTICAL IMPLICATIONS

The findings point toward strengthening institutional coordination capacity specifically. That is the condition determining whether existing opportunities translate into sustained practice, not a general list of improvements. A jointly staffed, standing NDMA–PDMA technology coordination unit, convened permanently rather than only during a disaster, would directly address the pattern of coordination dissolving once the acute phase passes (Section 5.1). Its remit should include a national technology-adoption roadmap with defined data standards so that GIS and remote-sensing outputs already produced by individual PDMAs and universities become interoperable instead of siloed. This same coordinating body could formalise the informal IT-sector linkages participants described into a standing panel of pre-qualified domestic technology firms, engaged through defined procurement procedures instead of personal contacts.

Ongoing maintenance cost, not purchase price, is the binding financial constraint participants identified. Donor agreements and government budget lines should mandate a minimum proportion of funding for multi-year maintenance, technical training and local adaptation, instead of allowing funds to be exhausted at procurement. Socio-cultural resistance stems substantially from prior experience of unreliable systems,

not blanket rejection of technology (Section 6.1), which argues for piloting early-warning systems first in local languages, through community leaders and existing informal warning networks, before scaling nationally. And because the institutional barrier to AI adoption reflects a governance gap wider than disaster management alone (Section 6.2), authorities would do better engaging with Pakistan's broader national AI-policy process than developing sector-specific technology policy in isolation.

These recommendations translate into near-term action at different levels. Disaster management authorities could pilot the standing coordination unit at provincial level first, where institutional distance from federal decision-making is greatest, before scaling nationally. Universities can extend the disaster-risk-reduction curricula and internship pipelines participants described as already emerging organically. And technology developers are better positioned to gain institutional traction with low-infrastructure solutions, SMS-based alerts, offline-capable applications, than with infrastructure-intensive systems, given the connectivity and power constraints documented in disaster-prone areas.

CONCLUSION

Seventeen in-depth interviews across government, humanitarian, academic and technology sectors were enough to answer the question this study set out with: what actually stands between Pakistan's disaster management institutions and the disruptive technologies available to them. The answer is not a shortage of technical capability. Institutional and policy-level fragmentation, infrastructural weakness, financial constraints and socio-cultural resistance interact instead of operating as four separate problems, a pattern the Complex Adaptive Systems framework helps explain. Meanwhile, expanding digital connectivity, inter-institutional and academic collaboration, a maturing domestic IT sector, curriculum reform, and a gradual shift toward proactive governance show that the raw material for a technology-enabled system is largely already present.

What is missing is the institutional coordination capable of converting that raw material into durable practice, and sustained investment that treats maintenance, not just procurement, as part of the cost of adopting new tools. Disaster management authorities and their partners now have a reasonably specific evidence base for where to direct coordination and financing reform. A general case for investing further in technology alone would not have told them that.

The qualitative design and purposive sample of 17 participants, while sufficient to reach thematic saturation, cannot be assumed to represent the full range of stakeholder perspectives across Pakistan's disaster management sector. Findings may not generalise evenly across provinces with markedly different institutional capacity. Several participants, although working within relevant organisations, demonstrated limited familiarity with specific disruptive technologies, and access limitations meant that some senior officials holding potentially valuable institutional knowledge could not be interviewed.

Future research could move from the exploratory, perception-based approach adopted here toward quasi-experimental or longitudinal designs that track the real-world performance of specific technologies across successive disaster events, testing the barriers and opportunities identified qualitatively here against operational outcomes. Comparative research across provinces with differing institutional capacity would help clarify which barriers are structural to the national system and which are context-specific. Research examining the moderating role of political stability, donor-financing structure, or community trust would extend this largely descriptive account toward a more explanatory model of technology uptake in disaster-prone, low-resource institutional settings.