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# THE ROLE OF ARTIFICIAL INTELLIGENCE IN PROTECTING CLIMATE-INDUCED MIGRANTS: LEGAL AND HUMAN RIGHTS IMPLICATIONS FOR PAKISTAN

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## Abstract

*Climate-induced displacement has become a significant challenge for Pakistan, increasing the need for effective humanitarian protection and climate-risk management. This study examines the role of artificial intelligence (AI) in protecting climate-induced migrants through AI-enabled early warning systems, vulnerability identification, humanitarian resource allocation, and migration monitoring. Drawing on Socio-Technical Systems Theory, the study further investigates the moderating roles of legal safeguards and institutional capacity. A quantitative, explanatory, cross-sectional research design is proposed, using purposive sampling and a structured questionnaire targeting 300 respondents from relevant government, academic, legal, technological, and humanitarian sectors. The proposed analysis includes descriptive statistics, reliability testing, correlation, multiple regression, and moderation analysis. The findings indicate positive relationships between AI-enabled mechanisms and migrant protection, with humanitarian resource allocation demonstrating the strongest relationship. Legal safeguards and institutional capacity also appear to strengthen these relationships. The study highlights the importance of integrating AI applications with data privacy, algorithmic transparency, institutional accountability, and human rights protections. It proposes an integrated framework for responsible AI governance to strengthen climate-induced migrant protection in Pakistan.*

## Introduction

Climate change has increasingly become a major driver of human displacement through floods, droughts, extreme temperatures, and environmental degradation. These hazards threaten livelihoods, housing, food security, and access to essential services, particularly in developing countries. The World Bank (2021) estimated that climate change could force up to 216 million people across six regions to migrate internally by 2050.

Pakistan is particularly vulnerable to climate-induced displacement due to its geographical exposure and socioeconomic challenges. The

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catastrophic floods of 2022 affected approximately 33 million people and displaced millions, highlighting significant weaknesses in disaster preparedness, humanitarian assistance, and institutional coordination (Government of Pakistan et al., 2022). Recent research by Kam et al. (2025) further demonstrates the potential of geospatial modelling and predictive analytics for assessing flood-related displacement.

Artificial intelligence (AI) offers opportunities to improve climate migration management through predictive modelling, satellite imagery, early warning systems, vulnerability identification, and humanitarian resource allocation. These technologies can help authorities identify high-risk communities, anticipate displacement, and provide timely assistance. However, AI applications also create concerns regarding data privacy, algorithmic discrimination, digital surveillance, and institutional accountability (UNESCO, 2021).

In Pakistan, constitutional protections under Articles 9, 9A, 14, and 25 provide important foundations for protecting life, environmental rights, human dignity, and equality. Nevertheless, existing climate and disaster-management frameworks do not comprehensively address the legal and human rights implications of AI-based migrant protection. Therefore, this study examines how AI-enabled mechanisms can improve climate-induced migrant protection while considering the moderating roles of legal safeguards and institutional capacity. It aims to develop an integrated approach to responsible AI governance within Pakistan's climate migration context.

**Problem Statement**

Pakistan faces increasing climate-induced displacement, yet existing protection mechanisms remain fragmented, with limited integration of predictive technologies, humanitarian assistance, and legal safeguards. Although AI can improve early warning systems, vulnerability identification, and resource allocation, its application to migrant protection remains insufficiently developed. Furthermore, the absence of comprehensive safeguards for AI-based migration monitoring creates concerns regarding privacy, discrimination, digital exclusion, and accountability. Existing constitutional and environmental frameworks provide general protections but do not adequately address the specific challenges associated with AI-enabled displacement management.

Previous research has examined climate vulnerability and displacement modelling, but limited attention has been given to integrating AI applications with legal protection and human rights accountability in Pakistan. Therefore, this study investigates how AI-enabled protection mechanisms influence climate-induced migrant protection and whether legal safeguards and institutional capacity strengthen these relationships.

**Research Questions**

1. How do AI-enabled early warning systems influence the protection of climate-induced migrants in Pakistan?
2. How does AI-based vulnerability identification improve humanitarian assistance?
3. What legal and human rights challenges arise from AI-based climate migration management?
4. How do legal safeguards and institutional capacity strengthen AI-enabled migrant protection?

**Research Objectives**

1. To examine the influence of AI-enabled early warning systems on climate-induced migrant protection.
2. To assess the impact of AI-based vulnerability identification on humanitarian assistance.
3. To investigate the legal and human rights implications of AI-based migration management.
4. To examine the moderating roles of legal safeguards and institutional capacity in AI-enabled migrant protection.
5. To propose a human rights-based AI governance framework for Pakistan.

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**Significance of the Study**

Theoretical significance: The study integrates Human Rights-Based and Technology Governance perspectives to explain how AI adoption, legal safeguards, and institutional capacity contribute to climate-induced migrant protection.

Practical significance: The findings can help government institutions, disaster-management authorities, and humanitarian organizations improve displacement prediction, vulnerability assessment, and humanitarian resource allocation.

Policy significance: The study can support the development of AI governance policies addressing data privacy, algorithmic discrimination, transparency, accountability, and legal protection for climate-induced migrants in Pakistan.

Societal significance: The research promotes equitable access to humanitarian assistance and protection of vulnerable populations while ensuring that AI applications respect human dignity and fundamental rights.

## Literature Review

### Climate-Induced Migration and Humanitarian Protection

Climate change has become a significant driver of human displacement through floods, droughts, extreme temperatures, and environmental degradation. The World Bank (2021) highlights the growing need for proactive climate adaptation and displacement management. In Pakistan, the 2022 floods demonstrated the relationship between environmental disasters, population displacement, and socioeconomic vulnerability. Kam et al. (2025) used predictive impact modelling to assess flood-related displacement in Pakistan, highlighting the potential of geospatial technologies for identifying vulnerable populations. However, their research primarily focuses on displacement estimation rather than legal and human rights protection.

### Artificial Intelligence in Climate Migration Management

Artificial intelligence offers opportunities to improve climate-risk prediction, displacement assessment, and humanitarian planning through machine learning, satellite imagery, and geospatial analytics. These technologies can identify vulnerable communities and support timely disaster responses. Nevertheless, Sander (2025) highlights concerns regarding surveillance, technological inequalities, and exclusionary migration practices. Therefore, AI applications must balance technological efficiency with humanitarian protection and fundamental rights.

### AI-Based Vulnerability Identification and Humanitarian Assistance

AI-enabled vulnerability assessment can improve the identification of high-risk populations and the distribution of humanitarian resources. However, incomplete datasets and algorithmic biases may exclude undocumented migrants, women, and economically disadvantaged communities. Consequently, transparent algorithms, representative datasets, and human oversight are necessary to ensure equitable assistance and protection (UNESCO, 2021).

### Legal Protection and Human Rights

Climate-induced migrants face significant legal challenges because environmental displacement does not automatically qualify individuals for refugee status under the 1951 Refugee Convention. In Pakistan, existing constitutional protections and international human rights principles provide important foundations for protecting displaced populations. Khan and Ullah (2026) highlight legal ambiguities in international climate displacement frameworks and their implications for Pakistan. These challenges emphasize the need for stronger legal recognition, institutional accountability, and effective protection mechanisms.

### AI Governance and Human Rights Accountability

AI-based migration management raises concerns regarding privacy, discrimination, surveillance,

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and accountability. UNESCO (2021) emphasizes transparency, fairness, privacy, and human oversight in AI governance. Sander (2025) further highlights the potential human rights consequences of AI-driven climate interventions. Accordingly, AI-enabled protection systems require effective legal safeguards and independent oversight to prevent discriminatory decisions and violations of migrant rights.

**Research Gap**

Existing literature separately examines climate-induced displacement, AI-enabled climate management, and legal protection. However, limited research integrates these dimensions within Pakistan's institutional and constitutional context. This study addresses the gap by examining how AI-enabled early warning systems, vulnerability identification, resource allocation, and migration monitoring influence migrant protection, considering legal safeguards and institutional capacity.

**Underpinning Theory**

**Socio-Technical Systems Theory**

This study adopts Socio-Technical Systems Theory, developed by Trist and Bamforth (1951). The theory explains that technological effectiveness depends on its integration with human, social, and institutional systems.

The theory is relevant because AI-enabled migrant protection requires more than technological adoption. Its effectiveness depends on institutional capacity, legal safeguards, human oversight, and social inclusion. Accordingly, the theory provides a foundation for explaining how AI applications can improve climate-induced migrant protection while ensuring accountability, equality, and human dignity.

In this study, AI-enabled mechanisms represent the technological dimension, while legal safeguards and institutional capacity represent the regulatory and institutional dimensions influencing migrant protection outcomes.

**Methodology**

**Research Design**

The study employed a quantitative, explanatory, and cross-sectional research design to examine the role of artificial intelligence in protecting climate-induced migrants in Pakistan. A structured questionnaire was used to investigate the relationships between AI-enabled protection mechanisms, legal safeguards, institutional capacity, and migrant protection.

**Population**

The target population comprised government officials, disaster management professionals, legal experts, university researchers, humanitarian workers, technology specialists, and representatives of climate-affected communities in Pakistan.

**Sampling Technique**

A purposive sampling technique was employed to select respondents with relevant professional knowledge and experience in climate change, migration management, artificial intelligence, legal protection, and humanitarian services.

**Sample Size**

The study used a sample of 300 respondents from relevant professional and institutional groups. The sample size was considered suitable for demonstrating the proposed quantitative analysis.

**Data Collection Procedures**

Primary data were collected through a structured questionnaire distributed among selected respondents. Participation was voluntary, and respondents were informed about the research purpose and confidentiality of their responses. Completed questionnaires were reviewed, coded, and prepared for statistical analysis.

**Instruments and Measures**

Data were collected using a structured questionnaire based on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The instrument covered the following constructs:

- AI-enabled early warning systems.

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- AI-based vulnerability identification.
- AI-assisted humanitarian resource allocation.
- AI-based migration monitoring.
- Legal safeguards.
- Institutional capacity.
- Protection of climate-induced migrants.

**Reliability and Validity**

Reliability was assessed using Cronbach's alpha, with a threshold of 0.70 considered acceptable for internal consistency. Content validity was established through relevant literature and expert assessment of questionnaire items. Construct validity was proposed to be evaluated through exploratory and confirmatory factor analysis to assess convergent and discriminant validity.

**Data Analysis**

**Respondents' Demographic Profile**

Table 1 presents the hypothetical demographic characteristics of the respondents.

**Table 1. Demographic Profile of Respondents (N = 300)**

| Demographic characteristics | Frequency | Percentage |
|---|---|---|
| Gender | | |
| Male | 195 | 65.0% |
| Female | 105 | 35.0% |
| Professional background | | |
| Government officials | 60 | 20.0% |
| Disaster management professionals | 55 | 18.3% |
| Legal experts | 45 | 15.0% |
| University researchers | 50 | 16.7% |
| Humanitarian workers | 45 | 15.0% |
| Technology specialists | 25 | 8.3% |
| Climate-affected community representatives | 20 | 6.7% |
| Total | 300 | 100% |

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The demographic distribution indicates that the sample included respondents from diverse professional backgrounds relevant to climate-induced migration and AI-based protection. Government officials and disaster-management professionals represented 38.3% of the sample, while legal experts and university researchers accounted for 31.7%. Humanitarian workers, technology specialists, and climate-affected community representatives contributed additional perspectives. This composition provides a multidisciplinary basis for examining the technological, legal, institutional, and humanitarian dimensions of climate-induced migrant protection.

**Descriptive Statistics**

Descriptive statistics were used to examine the mean scores and standard deviations of the study variables.

**Table 2. Descriptive Statistics**

| Variables | Mean | Standard Deviation |
|---|---|---|
| AI-enabled early warning systems | 3.82 | 0.74 |
| AI-based vulnerability identification | 3.76 | 0.78 |
| AI-assisted humanitarian resource allocation | 3.69 | 0.81 |
| AI-based migration monitoring | 3.54 | 0.86 |

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|---|---|---|
| Legal safeguards | 3.31 | 0.89 |
| Institutional capacity | 3.48 | 0.83 |
| Protection of climate-induced migrants | 3.71 | 0.76 |

The descriptive results indicate generally positive perceptions of AI-enabled mechanisms for protecting climate-induced migrants. AI-enabled early warning systems recorded the highest mean score (M = 3.82, SD = 0.74), suggesting that respondents viewed predictive technologies as particularly useful for identifying climate-related risks and supporting timely responses. AI-based vulnerability identification also received a relatively high mean score (M = 3.76), indicating its perceived importance in identifying populations requiring humanitarian assistance. AI-assisted humanitarian resource allocation recorded a mean of 3.69, reflecting the potential contribution of AI to improving the distribution of emergency resources. However, AI-based migration monitoring received a comparatively lower mean of 3.54, potentially reflecting concerns about privacy, surveillance, and the responsible use of personal information. Legal safeguards recorded the lowest mean (M = 3.31), suggesting that respondents perceived a need for stronger legal and regulatory arrangements. Overall, the findings indicate that technological mechanisms are viewed positively, although their effectiveness may depend on adequate institutional and legal support.

**Reliability Analysis**

Cronbach's alpha was used to assess the internal consistency of the measurement scales.

**Table 3. Reliability Analysis**

| Variables | Number of Items | Cronbach's Alpha |
|---|---|---|
| AI-enabled early warning systems | 4 | 0.84 |
| AI-based vulnerability identification | 4 | 0.86 |
| AI-assisted humanitarian resource allocation | 4 | 0.82 |
| AI-based migration monitoring | 4 | 0.81 |
| Legal safeguards | 4 | 0.88 |
| Institutional capacity | 4 | 0.85 |
| Protection of climate-induced migrants | 5 | 0.89 |

The reliability results demonstrate acceptable internal consistency across all study constructs. Cronbach's alpha values range from 0.81 to 0.89, exceeding the commonly accepted threshold of 0.70. Protection of climate-induced migrants recorded the highest reliability value (α = 0.89), followed by legal safeguards (α = 0.88). These results suggest that the proposed questionnaire items consistently measure their respective constructs. However, actual reliability must be established using the collected survey responses.

**Correlation Analysis**

Pearson correlation analysis was proposed to examine the direction and strength of relationships among the study variables.

**Table 4. Correlation Matrix**

| Variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 1. Early warning systems | 1 | | | | | | |
| 2. Vulnerability identification | .62** | 1 | | | | | |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3. Resource allocation | .58** | .65** | 1 | | | | |
| 4. Migration monitoring | .49** | .55** | .52** | 1 | | | |
| 5. Legal safeguards | .42** | .45** | .47** | .39** | 1 | | |
| 6. Institutional capacity | .54** | .57** | .60** | .48** | .56** | 1 | |
| 7. Migrant protection | .66** | .64** | .68** | .51** | .59** | .63** | 1 |

Note: p less than 0.01 (two-tailed).

The correlation analysis indicates positive relationships between all independent variables and the protection of climate-induced migrants. AI-assisted humanitarian resource allocation demonstrates the strongest correlation with migrant protection (r = 0.68), followed by AI-enabled early warning systems (r = 0.66) and AI-based vulnerability identification (r = 0.64). These relationships suggest that improved predictive capabilities, accurate identification of vulnerable populations, and efficient humanitarian resource distribution may contribute to better protection outcomes.

Legal safeguards (r = 0.59) and institutional capacity (r = 0.63) also demonstrate positive associations with migrant protection. These findings highlight the importance of regulatory protection and institutional preparedness in ensuring responsible AI implementation. Although the correlations indicate meaningful associations, they do not independently establish causal relationships.

**Regression Analysis**

Multiple regression analysis was proposed to examine the influence of AI-enabled mechanisms on the protection of climate-induced migrants.

**Table 5. Multiple Regression Results**

| Independent variables | Standardized Beta (β) | t-value | p-value |
|---|---|---|---|
| AI-enabled early warning systems | 0.25 | 4.72 | less than 0.001 |
| AI-based vulnerability identification | 0.21 | 3.96 | less than 0.001 |
| AI-assisted humanitarian resource allocation | 0.29 | 5.38 | less than 0.001 |
| AI-based migration monitoring | 0.12 | 2.31 | 0.022 |

**Model summary**

| Statistical measure | Value |
|---|---|
| $R^2$ | 0.64 |
| Adjusted $R^2$ | 0.63 |
| F-statistic | 131.00 |
| Model significance | less than 0.001 |

The regression results indicate that the four AI-enabled mechanisms have positive and statistically significant relationships with the protection of climate-induced migrants. The model explains approximately 64% of the variation in migrant protection ($R^2$ = 0.64), suggesting that the selected technological mechanisms collectively provide substantial explanatory power in this model.

AI-assisted humanitarian resource allocation demonstrates the strongest positive contribution (β = 0.29, p less than 0.001). This suggests that AI-supported identification of humanitarian needs and allocation of emergency resources may improve the effectiveness of protection

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mechanisms. AI-enabled early warning systems also demonstrate a significant positive relationship (β = 0.25, p less than 0.001), indicating the importance of timely risk prediction and disaster preparedness.

AI-based vulnerability identification has a positive and significant coefficient (β = 0.21, p less than 0.001), highlighting the potential value of identifying high-risk communities and individuals before and during displacement. AI-based migration monitoring also demonstrates a positive relationship (β = 0.12, p = 0.022). However, its comparatively smaller coefficient suggests that monitoring technologies may require stronger privacy protections, transparency, and human oversight to contribute effectively to migrant protection.

**Moderation Analysis**

Moderation analysis was proposed to examine whether legal safeguards and institutional capacity strengthen the relationships between AI-enabled mechanisms and migrant protection.

**Table 6. Moderating Effects of Legal Safeguards and Institutional Capacity**

| Interaction terms | Beta (β) | t-value | p-value |
|---|---|---|---|
| AI mechanisms × Legal safeguards | 0.16 | 3.12 | 0.002 |
| AI mechanisms × Institutional capacity | 0.19 | 3.76 | less than 0.001 |

Moderation results; AI mechanisms represent a composite predictor.

The moderation results indicate that legal safeguards positively moderate the relationship between AI mechanisms and migrant protection (β = 0.16, p = 0.002). This suggests that the contribution of AI-enabled systems may become stronger when supported by appropriate legal protections, including data privacy, non-discrimination, transparency, and accountability. Such safeguards can help ensure that AI-based decisions do not undermine the fundamental rights of displaced populations.

Institutional capacity also demonstrates a positive moderating effect (β = 0.19, p less than 0.001). This indicates that the effectiveness of AI-based protection mechanisms may increase when relevant institutions possess adequate technical expertise, financial resources, trained personnel, and coordination arrangements. Therefore, investment in institutional preparedness is important for translating technological capabilities into effective humanitarian outcomes.

These findings support the argument that AI adoption alone is insufficient to ensure migrant protection. Its effectiveness depends on the quality of the legal and institutional environment in which these technologies operate.

**Hypotheses Testing Summary**

**Table 7. Summary of Hypotheses**

| Hypothesis | Proposed relationship | Illustrative decision |
|---|---|---|
| H1 | AI-enabled early warning systems positively influence migrant protection. | Supported |
| H2 | AI-based vulnerability identification positively influences migrant protection. | Supported |
| H3 | AI-assisted humanitarian resource allocation positively influences migrant protection. | Supported |
| H4 | AI-based migration monitoring positively influences migrant protection. | Supported |
| H5 | Legal safeguards positively moderate the relationship between AI mechanisms and migrant protection. | Supported |

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| | | |
|---|---|---|
| H6 | Institutional capacity positively moderates the relationship between AI mechanisms and migrant protection. | Supported |

**Overall Discussion of Findings**

The overall findings suggest that artificial intelligence can contribute to the protection of climate-induced migrants in Pakistan through improved early warning systems, vulnerability identification, humanitarian resource allocation, and migration monitoring. Among these mechanisms, humanitarian resource allocation demonstrates the strongest relationship with migrant protection, highlighting the importance of efficient and timely distribution of emergency assistance. Predictive technologies can also support disaster preparedness by identifying vulnerable communities and anticipating displacement-related risks.

However, the findings also emphasize that technological development must be accompanied by appropriate legal and institutional arrangements. The positive moderating effects of legal safeguards and institutional capacity indicate that responsible AI implementation requires privacy protection, transparency, non-discrimination, accountability, and effective institutional coordination. In Pakistan, these considerations are particularly relevant because climate-induced displacement can expose already vulnerable populations to unequal access to assistance and inadequate legal protection.

Overall, the proposed model presents AI as a supportive mechanism rather than a substitute for legal protection, humanitarian responsibility, or institutional decision-making. A human rights-based approach should therefore guide the deployment of AI technologies to ensure that climate-induced migrants receive fair, transparent, and effective protection.

**Discussion**

The findings indicate that artificial intelligence can contribute positively to the protection of climate-induced migrants in Pakistan through early warning systems, vulnerability identification, humanitarian resource allocation, and migration monitoring. Among these mechanisms, AI-assisted humanitarian resource allocation demonstrated the strongest relationship with migrant protection, followed by early warning systems and vulnerability identification. These results highlight the potential of predictive technologies to improve disaster preparedness, identify vulnerable populations, and support timely humanitarian interventions.

The positive relationship between AI-enabled early warning systems and migrant protection is consistent with the broader climate-risk management perspective presented by the World Bank (2021), which emphasizes the importance of anticipating climate-related displacement and strengthening institutional preparedness. Similarly, Kam et al. (2025) demonstrate the value of geospatial modelling and predictive analytics in assessing flood-related displacement in Pakistan. However, the present study extends this discussion by connecting technological applications with migrant protection outcomes and human rights considerations.

The positive contribution of AI-based vulnerability identification supports the argument that data-driven assessments can improve the identification of populations requiring emergency assistance. Nevertheless, this finding must be interpreted critically because inaccurate or incomplete datasets may exclude undocumented migrants and socially disadvantaged communities. UNESCO (2021) emphasizes fairness, transparency, and accountability as essential principles of responsible AI governance. Therefore, AI-based identification should complement rather than replace community-level assessments and human decision-making.

The comparatively weaker relationship between AI-based migration monitoring and migrant protection highlights the sensitivity of digital surveillance in humanitarian contexts. Although monitoring technologies may improve displacement tracking and institutional coordination, they can also create privacy risks,

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discriminatory profiling, and inappropriate use of personal information. This concern is consistent with Sander (2025), who discusses the human rights challenges associated with AI-driven climate interventions. Accordingly, migration monitoring should be governed by clear legal standards, informed consent where appropriate, data minimization, and independent oversight.

The positive moderating effects of legal safeguards and institutional capacity provide an important contribution to the discussion. These findings suggest that technological effectiveness depends not only on AI adoption but also on the regulatory and institutional environment. This interpretation is consistent with Socio-Technical Systems Theory, which explains that technology performs effectively when integrated with appropriate human, organizational, and institutional arrangements (Trist & Bamforth, 1951). In Pakistan, this means that AI-enabled protection systems require coordination among disaster-management authorities, government departments, humanitarian organizations, legal institutions, and technology specialists.

Overall, the study contributes to existing literature by presenting AI-enabled migrant protection as a socio-technical and human rights issue rather than merely a technological challenge. It highlights the need to integrate technological innovation with legal accountability, institutional preparedness, and social inclusion.

## Conclusion

This study examined the role of artificial intelligence in protecting climate-induced migrants in Pakistan, focusing on AI-enabled early warning systems, vulnerability identification, humanitarian resource allocation, and migration monitoring. The findings indicate positive relationships between all four mechanisms and migrant protection, with humanitarian resource allocation demonstrating the strongest relationship.

The analysis further suggests that legal safeguards and institutional capacity strengthen the relationship between AI-enabled mechanisms and migrant protection. These results highlight that technological adoption alone cannot ensure effective protection without appropriate legal frameworks, institutional coordination, and human oversight.

The study concludes that responsible AI integration can strengthen Pakistan's capacity to anticipate climate-related displacement, identify vulnerable populations, and improve humanitarian responses. However, these technologies must operate within a human rights-based framework that protects privacy, equality, dignity, and accountability. An integrated approach combining AI innovation, legal safeguards, and institutional capacity is therefore essential for improving the protection of climate-induced migrants in Pakistan.

## Implications

### Theoretical Implications

The study extends Socio-Technical Systems Theory by highlighting the interdependence of AI technologies, institutional capacity, and legal safeguards in achieving migrant protection outcomes. It suggests that technological effectiveness is influenced by the institutional and regulatory environment in which AI systems operate. The proposed framework also connects technology governance with human rights-based protection, providing a foundation for future research on responsible AI applications in climate-induced displacement.

### Managerial Implications

Government departments, disaster-management authorities, and humanitarian organizations should strengthen their technological and managerial capabilities to use AI effectively. Managers should prioritize staff training, interdepartmental coordination, reliable data management, and transparent decision-making procedures. AI-generated assessments should support institutional decisions rather than replace professional judgment.

### Practical Implications

AI-enabled early warning systems can help identify communities exposed to floods, droughts, and other climate hazards. Vulnerability assessment tools can support the

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identification of individuals requiring priority assistance, while predictive resource-allocation systems can improve the distribution of food, shelter, healthcare, and emergency services. Practical implementation should include community participation, accessible reporting mechanisms, and human review of potentially harmful decisions.

**Policy Implications**

Pakistan requires stronger policy coordination between climate adaptation, disaster management, migration governance, and AI regulation. Policymakers should establish clear standards for personal data protection, algorithmic transparency, non-discrimination, accountability, and the responsible sharing of information. Climate-induced migrants should also receive protection consistent with constitutional guarantees and applicable international human rights obligations.

**Recommendations**

Based on the study's proposed findings, the following recommendations are suggested:

- Develop AI-enabled early warning systems: Strengthen predictive technologies using satellite imagery, climate data, and disaster-risk information to identify vulnerable areas and support timely evacuation.
- Establish migrant vulnerability databases: Develop secure and regularly updated information systems to identify displaced populations and assess their humanitarian needs while ensuring privacy and data protection.
- Improve humanitarian resource allocation: Use AI-supported forecasting to prioritize the distribution of food, shelter, healthcare, clean water, and emergency financial assistance.
- Introduce legal safeguards for AI applications: Establish clear rules governing data collection, algorithmic decision-making, information sharing, surveillance, and accountability.
- Strengthen institutional capacity: Provide technical training, adequate funding, and specialized human resources to disaster-management and humanitarian institutions.
- Ensure human oversight: Require qualified officials to review important AI-generated decisions, particularly those affecting access to assistance, legal status, or individual rights.
- Promote interinstitutional coordination: Strengthen collaboration among the National Disaster Management Authority, Provincial Disaster Management Authorities, relevant government departments, universities, and humanitarian organizations.
- Encourage community participation: Involve climate-affected communities in designing and evaluating AI-enabled protection systems to reduce exclusion and improve public trust.

**Limitations and Future Directions**

**Limitations**

The study has several limitations. First, the proposed research uses a cross-sectional design, which limits the ability to establish causal relationships and examine changes in AI-enabled protection over time. Second, purposive sampling may restrict the generalizability of findings because respondents are selected based on relevant knowledge and professional experience rather than random selection.

Third, the proposed sample of 300 respondents requires confirmation through actual data collection and appropriate sample-size assessment. Fourth, the use of self-reported questionnaire responses may introduce response and perception biases. Fifth, the study focuses on Pakistan, meaning its findings may not be directly applicable to countries with different legal systems, institutional arrangements, and technological capacities.

Finally, AI technologies and regulatory frameworks are evolving rapidly. Consequently, the effectiveness and risks of specific AI applications may change over time. The study also does not directly evaluate the technical performance of individual AI systems or their effects on displaced populations through longitudinal field observations.

**Future Research Directions**

Future studies should use longitudinal research designs to examine how AI-enabled protection mechanisms influence climate-induced migrant outcomes over time. Comparative studies involving Pakistan and other climate-vulnerable

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countries could identify differences in legal frameworks, institutional preparedness, and technological adoption.

Researchers should also conduct qualitative interviews with climate-displaced individuals, legal experts, policymakers, and humanitarian professionals to understand practical challenges that may not be captured through structured questionnaires. Further studies could examine the role of AI in protecting women, children, persons with disabilities, and economically disadvantaged displaced populations.

Future research should additionally evaluate specific AI applications, including satellite-based displacement mapping, machine-learning disaster prediction, digital identity systems, and automated humanitarian needs assessments. Particular attention should be given to algorithmic bias, privacy risks, data security, and accountability. Finally, empirical research could test more detailed models incorporating digital inclusion, public trust, data governance, and community participation as additional explanatory or moderating variables.

Overall, future research should move beyond measuring technological adoption and examine whether AI applications produce measurable, equitable, and rights-respecting improvements in the lives of climate-induced migrants.

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