ISSN–2278-5655

AMIERJ Aarhat Multidisciplinary International Education Research Journal

Volume–XV, Special Issues– I(a) Jan – Feb, 2026

OPEN ACCESS Original Research Article

DIGITAL ECHOES OF UNREST: A COMPARATIVE REVIEW OF AI-BASED SOCIAL MEDIA ANALYTICS FOR PREDICTING CIVIL VIOLENCE

** Gauri S. Mhatre & ** Gauri U. Ansurkar*

Department of Information Technology and Computer Science, KSD's Model College (Empowered Autonomous), Mumbai, India.

Abstract:

Social media platforms have become critical sources of real-time information for monitoring and predicting civil unrest and violent events. Recent advances in artificial intelligence have produced a wide range of analytical pipelines, including transformer-based language models, graph neural networks, temporal forecasting systems, and multimodal vision–language frameworks. However, existing studies remain fragmented across platforms, languages, and modeling paradigms, making it difficult to assess their relative effectiveness and applicability. This paper presents a comprehensive comparative review of AI-based architectures used for civil unrest prediction using Twitter and Instagram data. The study systematically analyzes model categories, data representations, performance trends, platform suitability, multilingual capability, and ethical considerations. By synthesizing findings across recent literature, this work highlights architectural trade-offs, identifies persistent research gaps, and provides practical guidance for selecting appropriate analytical frameworks. The review contributes toward a clearer understanding of current methodological capabilities and limitations in socially responsible unrest prediction.

Keywords: *Artificial Intelligence, Social Media Analytics, Civil Unrest Prediction, Early Warning Systems, multimodal, temporal, network driven, graph based, Violence Risk Assessment.*

Introduction:

The rapid growth of social media has transformed how political mobilization, public dissent, and collective action are organized and communicated. Platforms such as Twitter and Instagram enable real-time dissemination of protest-related information, making them valuable sources for monitoring emerging civil unrest. As a result, researchers have increasingly adopted artificial intelligence techniques to analyze social media signals for early warning and risk assessment.

Despite significant progress, existing research remains methodologically fragmented. Text-based transformer models dominate Twitter-focused studies, while graph neural networks capture coordination patterns and temporal models track escalation dynamics. In parallel, multimodal approaches have begun to analyze visual content on Instagram, yet remain

underutilized in unrest prediction tasks. Furthermore, multilingual coverage is limited, and ethical concerns such as privacy preservation and algorithmic bias are often insufficiently addressed.

Most prior studies evaluate individual architectures in isolation, making cross-model and cross-platform comparisons difficult. There is a growing need for systematic synthesis that evaluates how different modeling paradigms perform across platforms, languages, data modalities, and operational constraints.

ISSN–2278-5655

AMIERJ Aarhat Multidisciplinary International Education Research Journal

Volume–XV, Special Issues– I(a) Jan – Feb, 2026

OPEN ACCESS Original Research Article

This paper addresses this gap by conducting a structured comparative review of AI-based social media analytics pipelines for civil unrest prediction, with particular emphasis on Twitter and Instagram. By organizing existing methods into unified analytical categories and evaluating their relative strengths and limitations, this work aims to support more informed and responsible deployment of predictive social systems.

Literature Survey:

Social media has become a key resource for civil unrest prediction due to its ability to reflect real-time public sentiment and collective behaviour. Early studies established correlations between Twitter sentiment and offline political events using lexicon-based and statistical methods [1,2]. Later work showed that temporal trends in tweet volume and sentiment could anticipate protest activity and escalation [3,4]. However, these approaches were largely reactive and limited in modelling complex dynamics.

Deep learning significantly advanced protest analysis. Neural models were followed by transformer-based architectures that improved contextual understanding. BERT and related models enhanced sentiment and event classification [5], while multilingual transformers such as XLM-R enabled cross-lingual protest analysis [6]. These models have been applied to multilingual protest news and social media datasets [7], yet most pipelines remain text-centric, English-focused, and Twitter-dominated.

To capture escalation and coordination, researchers adopted temporal and diffusion-aware approaches. Hawkes processes and recurrent models forecast protest intensity and temporal evolution [8,9], while graph-based models leverage retweet and hashtag networks to capture information diffusion and coordinated mobilization [10,11]. Despite their effectiveness, these methods are often disconnected from semantic and multimodal representations.

Attention has recently shifted toward visual platforms such as Instagram, where protest communication relies heavily on images and videos. Research on visual activism shows that Instagram plays a critical role in framing grievances and mobilizing participants [12–14]. Computational studies suggest that visual content may provide early signals of unrest not captured by text alone [15]. Vision–language models like ViLBERT and CLIP enable joint reasoning over text and images [16,17], but their application to civil unrest prediction—particularly in multilingual and temporal settings—remains limited.

Ethical considerations, including privacy, bias, transparency, and accountability, have gained prominence in predictive social systems [19,20]. However, explicit ethical governance and risk-aware modelling are rarely integrated into existing unrest prediction pipelines. In summary, existing literature remains fragmented across platforms, languages, modalities, and ethical dimensions. These limitations highlight the need for unified hybrid frameworks that combine multilingual semantic modelling, multimodal perception, temporal escalation analysis,
diffusion-aware behaviour modelling, and ethical safeguards for responsible civil unrest prediction.

Problem Statement:

Current research on civil unrest prediction using social media is characterized by fragmented methodological development, platform bias toward Twitter, limited multilingual coverage, and inconsistent evaluation practices. The absence of systematic comparative analysis makes it difficult to determine which modeling architectures are most suitable for specific platforms, data modalities, and operational objectives. Additionally, ethical and governance considerations are rarely integrated into performance comparisons. This lack of unified evaluation hinders reproducibility, scalability, and responsible adoption of AI-based unrest prediction systems.

ISSN–2278-5655

AMIERJ Aarhat Multidisciplinary International Education Research Journal

Volume–XV, Special Issues– I(a) Jan – Feb, 2026

OPEN ACCESS Original Research Article

Research Questions:

RQ1: How do transformer-based, graph-based, temporal, and multimodal architectures differ in performance and analytical capabilities for civil unrest prediction?

RQ2: What are the relative strengths and limitations of these models when applied to Twitter versus Instagram data?

RQ3: How effectively do existing approaches support multilingual and cross-cultural unrest analysis?

RQ4: What ethical, technical, and operational gaps remain in current civil unrest prediction pipelines?

Research Methodology:

This study adopts a comparative review methodology to systematically analyze and synthesize AI-based social media analytics approaches used for civil unrest and violence prediction. Rather than proposing or training new predictive models, the methodology focuses on architectural comparison, analytical frameworks, and design paradigms reported in recent literature.

The review is designed to be language-agnostic and globally applicable, covering methods that operate across diverse languages, scripts, and cultural contexts using data from platforms such as Twitter/X and Instagram.

Five primary architectures / models are selected for civil unrest prediction methodology:

1. Transformer-based language models
2. Multilingual large language models
3. Graph neural network frameworks
4. Temporal forecasting architectures
5. Multimodal vision–language models

Evaluation Dimensions:

Each category was analyzed across standardized comparison criteria including core characteristics, strengths, key limitations and suitability for civil unrest prediction.

Cross-Platform Analysis:

Architectural performance trends were compared between text-dominant platforms (Twitter) and visual-centric platforms (Instagram) to assess modality-specific effectiveness.

Synthesis and Gap Identification:

Findings were synthesized to identify common limitations, emerging trends, and unresolved research challenges. Rather than proposing new models, the study emphasizes analytical comparison, methodological benchmarking, and evidence-based recommendations.

Architectural Comparison :

The compared architectures differ in their representational capacity, scalability, and suitability for civil unrest prediction. Traditional transformer-based pipelines provide strong semantic understanding but remain limited to text-centric analysis and lack temporal and structural awareness. Multilingual transformers improve cross-lingual generalization but struggle with low-resource languages and platform-specific noise. Temporal models capture escalation dynamics but operate independently of semantic and multimodal cues. Graph-based architectures effectively model information diffusion and coordination patterns, yet require dense network structures and offer limited content understanding. Multimodal vision–language models enable richer perception of visual protest signals but lack integration with temporal forecasting and ethical governance. These limitations motivate hybrid architectures that jointly integrate multilingual semantics, multimodal perception, temporal modeling, and diffusion-aware behavior analysis to enable robust, scalable, and risk-aware civil unrest prediction across social platforms.

ISSN–2278-5655

AMIERJ Aarhat Multidisciplinary International Education Research Journal

Volume–XV, Special Issues– I(a) Jan – Feb, 2026

OPEN ACCESS Original Research Article

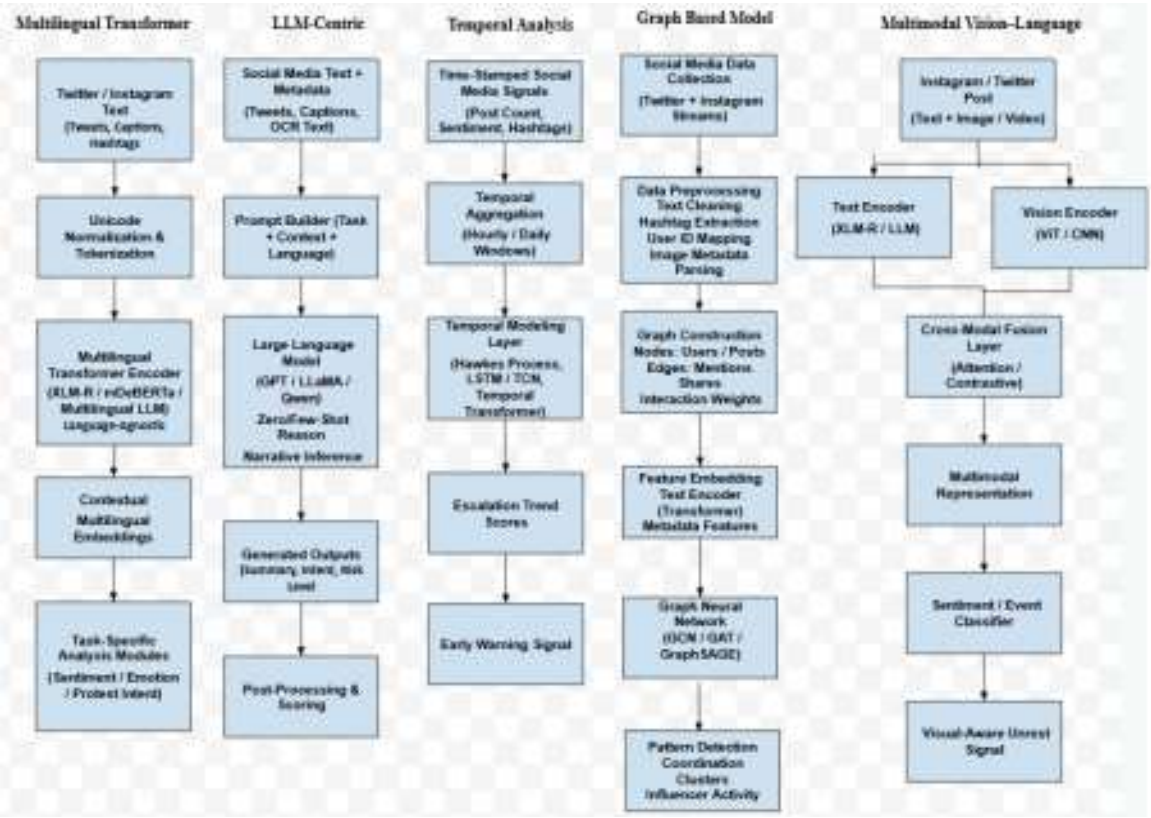

Figure 5.1: Architectural comparison of multilingual transformer, LLM centric, temporal, graph based and multimodal vision-language models

Characteristic Comparison:

Table 6.1 Comparative study of multilingual transformer, LLM centric, temporal, graph based and multimodal vision-language models

Architecture Type	Core Characteristics	Strengths	Key Limitations	Suitability for Civil Unrest Prediction
Text-Centric Transformer Pipelines (BERT, XLM-R, mBERT)	Text-only semantic encoders; often Twitter-focused	Strong sentiment and protest-topic detection; multilingual support	Weak temporal foresight; ignores visuals and diffusion	Suitable for short-term detection and retrospective analysis, especially in text-rich platforms
LLM-Based Analytical Pipelines	Prompt-based or fine-tuned large language models	Narrative understanding; zero-/few-shot transfer across regions	High computational cost; limited temporal grounding	Suitable for contextual interpretation and cross-regional qualitative analysis
Temporal Neural Models (LSTM, TCN,	Time-series modeling of post volumes and signals	Captures escalation trends and	Limited semantic depth;	Suitable for early warning signals when combined with semantic features

ISSN–2278-5655

AMIERJ Aarhat Multidisciplinary International Education Research Journal

Volume–XV, Special Issues– I(a) Jan – Feb, 2026

OPEN ACCESS Original Research Article

Temporal Transformers)		momentum	language-dependent inputs	
Graph-Based Models (GNNs, diffusion networks)	User–user, hashtag, or content interaction graphs	Detects coordination and mobilization patterns	Platform-dependent; privacy and sparsity issues	Suitable for analyzing collective behavior and coordinated unrest
Multimodal Vision–Language Models	Joint text–image/video representations	Effective on Instagram and visual protests	Data-intensive ; weaker temporal modeling	Highly suitable for visual-dominant platforms and symbolic protest detection

Platform-Wise Comparison: Twitter vs Instagram for Civil Unrest Prediction

Social media platforms differ substantially in content structure, interaction mechanisms, and user behavior, which directly influences the effectiveness of AI-based civil unrest prediction models. This section compares Twitter and Instagram across analytical, operational, and modeling dimensions.

Figure 7.1 Platform-Wise Comparison: Twitter vs Instagram

Dimension	**Twitter**	**Instagram**
Primary Modality	Text-dominant	Visual-dominant
Model Compatibility	Transformers, Graph Models	Multimodal Models
Interaction Networks	Dense, explicit	Sparse, implicit
Temporal Resolution	High-frequency	Slower engagement cycles
Multilingual Signals	Text-based	Visual and symbolic
Ethical Sensitivity	Moderate	High

Case Study Examples: Twitter vs Instagram in Civil Unrest Prediction Case Study 1: Twitter-Based Protest Mobilization Detection

Context :

During the 2019–2020 global protest movements (including climate strikes and political demonstrations), Twitter was widely used to coordinate protest participation and share real-time updates.

Analytical Approach :

Studies applied transformer-based sentiment classifiers combined with temporal trend analysis to detect rapid increases in protest-related hashtags and emotionally charged language. Graph neural networks were further employed to identify influential accounts responsible for information diffusion and mobilization messaging.

ISSN–2278-5655

AMIERJ Aarhat Multidisciplinary International Education Research Journal

Volume–XV, Special Issues– I(a) Jan – Feb, 2026

OPEN ACCESS Original Research Article

Key Observations :

- Sudden spikes in hashtag usage (e.g., protest slogans and location tags) provided early indicators of mobilization.
- Retweet networks revealed coordinated amplification by activist groups.
- Temporal models successfully captured escalation phases preceding offline protest events.

Implications :

Twitter-based pipelines demonstrated strong performance for early warning and coordination detection, particularly in text-driven protest movements.

Case Study 2: Instagram-Based Visual Protest Signal Analysis

Context :

During movements such as Black Lives Matter and regional protest campaigns, Instagram became a dominant platform for sharing protest imagery, banners, crowd scenes, and symbolic visuals.

Analytical Approach :

Multimodal vision–language models were applied to analyze protest-related images combined with caption and hashtag context. Image classification models detected crowd density, protest signage, and symbolic gestures, while textual components provided semantic framing.

Key Observations :

- Visual content revealed on-ground protest activity earlier than official reports in several cases.
- Image-based indicators captured emotional intensity and scale of participation not reflected in text alone.
- Hashtag-only analysis underestimated mobilization when visual narratives dominated communication.

Implications :

Instagram-based analysis highlighted the importance of multimodal modeling for capturing visual activism and symbolic mobilization patterns.

Existing Research Gaps in Civil Unrest Prediction Using Twitter and Instagram Data :

Despite progress in AI-based civil unrest prediction, several gaps persist. First, existing studies remain Twitter-centric and text-dominated, underutilizing Instagram's visual and multimodal signals. Second, multilingual and code-mixed language support is limited, reducing model generalizability across regions. Third, current approaches show weak integration of temporal dynamics and social network structure, constraining early escalation detection. Fourth, multimodal fusion methods are often generic and lack task-specific adaptation for protest-related imagery. Fifth, the absence of standardized cross-platform benchmarks and evaluation protocols hinders fair comparison across models. Finally, ethical safeguards, interpretability, and bias auditing are insufficiently embedded in most pipelines, raising concerns about responsible deployment.

Conclusion and Future Directions:

This comparative review examined state-of-the-art AI-based approaches for civil unrest prediction using Twitter and Instagram data, highlighting key trends across transformer-based language models, temporal analytics, graph neural networks, and emerging multimodal frameworks. The analysis shows that Twitter-oriented pipelines excel in capturing linguistic mobilization and coordination dynamics, while Instagram-based methods contribute valuable visual and symbolic context. However, current systems remain limited by platform bias, weak multimodal fusion, insufficient multilingual robustness, fragmented temporal–graph integration, and the absence of standardized benchmarking practices.

Future research should focus on developing cross-platform, multimodal benchmark datasets that support fair and reproducible evaluation. Improving multilingual and low-resource language modeling is

ISSN–2278-5655

AMIERJ Aarhat Multidisciplinary International Education Research Journal

Volume–XV, Special Issues– I(a) Jan – Feb, 2026

OPEN ACCESS Original Research Article

critical for global applicability. Greater emphasis is needed on hybrid temporal–graph learning strategies to better capture evolving protest dynamics. Additionally, task-aware vision–language fusion techniques should be refined to improve interpretation of protest imagery and visual narratives. Finally, embedding ethical governance mechanisms, including privacy protection, interpretability, and bias mitigation, will be essential for responsible deployment. Addressing these directions will enhance the reliability, fairness, and real-world utility of social media–based civil unrest prediction systems.

References:

1. *B. O'Connor et al., From Tweets to Polls, ICWSM, 2010.*
2. *J. Bollen et al., Twitter Mood Predicts the Stock Market, Journal of Computational Science, 2011.*
3. *J. Steinert-Threlkeld et al., Online Social Networks and Offline Protest, EPJ Data Science, 2015.*
4. *J. Choi et al., Forecasting Protest Activity Using Social Media Data, EPJ Data Science, 2019. [5] J. Devlin et al., BERT, NAACL, 2019.*
5. *A. Conneau et al., XLM-R, ACL, 2020.*
6. *A. Hürriyetoğlu et al., Multilingual Protest News Detection, ACL, 2021. [8] M. Rizoiu et al., Hawkes Processes for Events in Social Media, WWW, 2017.*
7. *B. Lim et al., Temporal Fusion Transformers, ICLR, 2021.*
8. *T. Kipf and M. Welling, Graph Convolutional Networks, ICLR, 2017. [11] P. Velickovic et al., Graph Attention Networks, ICLR, 2018.*
9. *J. Highfield and T. Leaver, Instagrammatics and Digital Methods, Communication Research and Practice, 2016.*
10. *L. Manikonda et al., Analyzing User Activities and Image Content on Instagram, ICWSM, 2014.*
11. *A. Caswell et al., Visualizing Protest: Instagram and Activism, New Media & Society, 2020. [15] E. Jackson and A. Foucault Welles, Visualizing Social Movements, Social Media + Society, 2016.*
12. *J. Lu et al., ViLBERT, NeurIPS, 2019.*
13. *A. Radford et al., CLIP, ICML, 2021.*
14. *S. Alam et al., Multimodal Hate Speech Detection, ICWSM, 2019.*
15. *B. Mittelstadt et al., The Ethics of Algorithms, Big Data & Society, 2016. [20] L. Floridi et al., AI4People, Minds and Machines, 2018.*

Cite This Article:

Mhatre G.S. & Ansurkar G.U. (2026). *Digital Echoes of Unrest: A Comparative Review of AI-Based Social Media Analytics for Predicting Civil Violence*. **In Aarhat Multidisciplinary International Education Research Journal**: Vol. XV (Number I, pp. 142–148). **Doi:** https://doi.org/10.5281/zenodo.18610034