

Public Sentiment Analysis of India's Mangalyaan Mars Mission Using Multimodal Social Media Data: A Systematic Literature Review

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ABSTRACT

India's Mangalyaan Mars Orbiter Mission (MOM), launched in November 2013 and operational until September 2022, generated substantial public discourse across social media platforms including YouTube, Twitter/X and Reddit making it one of the most socially engaged interplanetary missions in history. Systematic extraction and analysis of this discourse offer valuable insights into public perception of low-cost space exploration, national scientific pride and science communication effectiveness. This paper presents a systematic literature review of 31 peer-reviewed publications to construct a unified 32-parameter multimodal framework for analyzing public sentiment expressed on social media in the context of the Mangalyaan mission. The 32 parameters span seven analytical categories: Text Analysis (speech-to-text extraction, subtitle sentiment, keyword polarity, emotion classification, negation and sarcasm detection, comment sentiment and emoji/hashtag sentiment), Audio Analysis (tone positivity/negativity, pitch and speech rate, emotional prosody and crowd reaction), Visual Analysis (facial expression recognition, body language, mission control reactions, event detection and scene color sentiment), Metadata Analysis (title/description sentiment, engagement metrics, upload timing and trending indicators), Mission-Specific Context (orbit insertion confirmation, telemetry loss references, official statement extraction and media sentiment comparison), Temporal Analysis (pre/during/post mission sentiment, trend over time and viral velocity) and Output parameters (overall classification, multimodal score, confidence score and visualization). Findings confirm that transformer-based models achieve F1 scores above 0.90 and multimodal fusion outperforms single-modality approaches by 8–15%. Critical gaps include the absence of Mangalyaan-specific annotated datasets, limited code-mixed Hinglish sentiment capability and underdeveloped cross-platform sentiment fusion for space mission discourse.

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1. INTRODUCTION

India's Mars Orbiter Mission (MOM), widely known as *Mangalyaan*, marked a defining moment in space exploration when it successfully entered Mars' orbit on September 24, 2014 on its very first attempt. This achievement made India the first Asian country and the fourth space agency in the world to reach Mars. What made the mission even more remarkable was its cost-effectiveness: developed for around ₹450 crore (approximately \$74 million), Mangalyaan proved that interplanetary missions do not always require massive budgets. Originally planned for a six-month lifespan, the spacecraft continued functioning for nearly nine years, with communication ending only in September 2022.

The mission also sparked widespread public engagement, particularly on social media. Both the

launch on November 5, 2013 and the Mars orbit insertion generated massive online activity across platforms like Twitter and YouTube. ISRO's live streams attracted thousands of real-time comments in multiple languages, reflecting a mix of national pride, scientific interest, economic discussions and emotional responses. This large-scale, time-sensitive social media interaction offers a valuable yet underutilized dataset for understanding how people perceive and engage with cost-effective space exploration (Vunnam, 2024).

However, despite the richness of this data, there is still no well-defined framework to systematically analyze public sentiment surrounding the Mangalyaan mission. Most existing sentiment analysis tools are designed for domains such as product reviews, finance, or politics, which differ significantly in language, tone and cultural context from space-related discussions (Hua et al., 2024).

Several challenges further complicate this analysis, including the frequent use of code-mixed Hindi-English (Hinglish), the presence of specialized technical terminology and the need to interpret multiple data formats such as text, audio and video simultaneously (Xie et al., 2024).

To address this gap, the present literature review examines 31 peer-reviewed studies and proposes a comprehensive 32-parameter framework for multimodal sentiment analysis tailored specifically to social media data related to the Mangalyaan mission. The review integrates insights from natural language processing, computer vision, audio analysis, social media analytics and even spacecraft telemetry to build a more context-aware and domain-specific approach.

2. BACKGROUND

2.1 Mangalyaan and its Social Media Footprint

Mangalyaan was conceived, developed and launched within 15 months a record for an interplanetary mission. Its low cost became a global talking point; Western media widely compared it to the production budget of the film *Gravity* (2013). This framing generated significant social media sentiment, with Indian users both celebrating the comparison and critiquing the framing. (Vunnam, 2024) documents the statistical context of global space launch trends, showing that Mangalyaan's 2013 launch coincided with the early growth phase of social media as a primary vehicle for public science engagement. On the day of Mars orbit insertion, ISRO's official Twitter account gained over 100,000 followers within hours and the hashtag #MarsOrbiterMission trended globally.

2.2 Social Media Platforms as Sentiment Sources

(Cheng & Li, 2024) establish that video-platform content with negative sentiment generates 23.7% higher engagement, while second-person framing increases shares by 18.4% across 101,292 TikTok news videos findings applicable to ISRO YouTube content. (Luceri et al., 2025) demonstrate that platform-specific multimodal detection is essential for accurate sentiment extraction in video-first social ecosystems.

2.3 State of Sentiment Analysis for Space Content

(Hua et al., 2024) systematically review 727 ABSA studies, documenting the shift from lexicon-based to transformer-based methods, with domain-specific models consistently outperforming generic ones. (Guo et al., 2024) show that human-annotated domain data outperforms LLM-generated annotations by F1 margins of 0.23–0.25 directly motivating the need for a Mangalyaan-specific annotated sentiment corpus.

3. METHODOLOGY OF REVIEW

3.1 Research Questions

This review is guided by: RQ1 What NLP, audio and visual methods are applicable across the 32 identified parameters for sentiment analysis of Mangalyaan social media data? RQ2 What performance benchmarks do existing methods achieve? RQ3 What are the critical

gaps preventing direct application to Mangalyaan mission discourse?

3.2 Search Strategy and Databases

Literature was sourced from Google Scholar, IEEE Xplore, Elsevier ScienceDirect, Springer, ACL Anthology, arXiv and MDPI. Search terms combined clusters including: sentiment analysis, emotion detection, NLP, social media, YouTube, space mission, satellite telemetry, facial expression recognition, emotional prosody, multimodal fusion, sarcasm detection and Mangalyaan/Mars mission.

3.3 Inclusion and Exclusion Criteria

Included: peer-reviewed publications from 2018–2026 addressing one or more of the 32 parameters, with reproducible methodology and reported performance metrics in English. Excluded: purely theoretical papers without empirical evaluation, unrelated domains with no transferable methodology and papers with insufficient methodological detail. Thirty-one papers met all inclusion criteria and are reviewed herein.

4. LITERATURE REVIEW BY PARAMETER CATEGORY

4.1 Text Analysis Parameters (Parameters 1–7)

4.1.1 Parameter 1 *Speech-to-Text Extraction from Video Audio*

(M. Manjunath, *Int. J. Sci. R. Tech.*, 2026 3(1), 111–, 2026) propose a unified video understanding framework integrating Whisper-based ASR with transformer summarization, achieving multilingual coverage essential for Mangalyaan commentary spanning Hindi, English, Tamil and Marathi. (Tongale et al., 2025) complement this with YOLOv8-based space video classification combined with OCR and Stanford NER to extract mission-specific entities, achieving 94.2% accuracy on space video corpora. Both works establish the ASR pipeline foundation for processing ISRO official streams and citizen reaction videos.

4.1.2 Parameter 2 *Subtitle/Caption Sentiment Analysis*

Caption-level sentiment analysis, as documented by (M. Manjunath, *Int. J. Sci. R. Tech.*, 2026 3(1), 111–, 2026), yields higher classification accuracy than raw ASR output due to temporal alignment with spoken events. For Mangalyaan content, captions can be synchronized with mission milestones Trans-Mars Injection (TMI), Mars Orbit Insertion (MOI) and periapsis adjustment maneuvers to produce event-anchored sentiment trajectories. This temporal alignment represents a novel methodological direction not yet explored in the literature.

4.1.3 Parameter 3 *Keyword Polarity Detection*

(Nageen, 2024) demonstrates that domain-specific FinBERT-based keyword polarity detection substantially outperforms general classifiers, improving prediction accuracy by 12.3% in financial transcripts. For Mangalyaan, keywords such as 'orbit insertion,' 'periapsis,' 'signal loss,' 'low cost,' and 'national pride' carry domain-specific polarity signals requiring

mission-calibrated lexical models. (Hua et al., 2024) further confirm through their ABSA systematic review that domain-calibrated lexicons consistently outperform general-purpose approaches across multiple sentiment benchmarks.

4.1.4 Parameter 4 Emotion Classification

(Zhang et al., 2024) achieve F1=0.88 on multi-label emotion classification using BERT and RoBERTa ensemble models on Weibo and Twitter, demonstrating that multi-label approaches capture co-occurring emotions significantly better than single-label classifiers. For Mangalyaan commentary, a single post can simultaneously express national pride, scientific excitement and economic comparison necessitating multi-label classification. (Mousoulidou et al., 2024) further show that negatively-framed content triggers stronger emotional responses, relevant to the economic criticism discourse surrounding Mangalyaan's development-priorities debate.

4.1.5 Parameter 5 Negation and Sarcasm Detection

(Šandor & Bagić Babac, 2024) apply BiLSTM and BERT to 1.3 million social media comments, achieving 93.7% sarcasm detection accuracy on balanced datasets but with significant degradation on code-mixed and domain-specific text. This limitation is critical for Mangalyaan analysis, where sarcastic commentary on India's development priorities versus space spending was prevalent. Ironic statements such as 'Great, now we can fix poverty from space' require pragmatic inference layers beyond standard sentiment models.

4.1.6 Parameter 6 Comment Sentiment Analysis

(Department of Computer Science, St. Albert's College, Kochi (Kerala), India. et al., 2024) achieve 89.2% accuracy on YouTube comment sentiment using TF-IDF with SVM and LSTM models, validating that comment sentiment trends strongly correlate with real-world events. Their finding that comment sentiment exhibits event-driven temporal patterns is foundational for analyzing Mangalyaan comment archives, where sentiment peaks align with the 2013 launch, 2014 orbit insertion and 2022 mission end events.

4.1.7 Parameter 7 Emoji and Hashtag Sentiment Detection

(Velampalli et al., 2022) demonstrate that SBERT-based emoji sentiment achieves 70% accuracy for unseen emoji combinations versus 98% for text, with distributed LSTM training enabling scalable social media volume processing. For Mangalyaan, hashtags (#MangalyaanMission, #MarsOrbiterMission, #ISRO) and emoji patterns carry inherent sentiment valence that requires contextual fusion with surrounding text a rocket emoji following orbit insertion carries unambiguously positive sentiment, while the same emoji in an economic critique thread may carry ironic connotations.

4.2 Audio Analysis Parameters (Parameters 8–11)

4.2.1 Parameter 8 Tone Positivity/Negativity

(Becker et al., 2024) demonstrate that deep neural networks achieve 98.3% audio classification accuracy on AudioMNIST using XAI-based interpretability via

Layer-wise Relevance Propagation, identifying diagnostic frequency bands for emotional tone. Applied to Mangalyaan commentary videos, tone-positivity classification can distinguish celebratory anchor commentary during Mars orbit insertion from the restrained, analytical tone of post-mission technical retrospectives.

4.2.2 Parameter 9 Pitch, Speech Rate and Loudness

(Wadle et al., 2024) demonstrate that pitch variability (F0 standard deviation) and speech rate deceleration achieve AUC=0.74–0.81 for emotional state detection using openSMILE and PRAAT feature extraction. These features differentiate excited commentary during Mangalyaan's historic Mars orbit insertion from the measured speech of ISRO scientists in press conferences.

4.2.3 Parameter 10 Emotional Prosody Detection

(Larrouy-Maestri et al., 2025) synthesize 30 years of emotional prosody research, concluding that acoustic-to-emotion mapping remains probabilistic with high inter-speaker and cross-cultural variability. For Mangalyaan audio analysis, prosody models must be calibrated to Indian English and Hindi speaker demographics, where culturally specific prosodic features differ from the Western English corpora on which most prosody models are trained.

4.2.4 Parameter 11 Crowd Reaction Analysis

(Katz et al., 2018) demonstrate that crowd vocal features (volume, spectral entropy, cheer/groan classification) reliably capture collective emotional states in spectator contexts. (AlGhamdi et al., 2025) develop VelocityNet for real-time crowd anomaly detection using optical flow and hierarchical clustering. Both methodologies apply to Mangalyaan public watch parties and university screenings captured on video.

4.3 Visual Analysis Parameters (Parameters 12–16)

4.3.1 Parameter 12 Facial Expression Recognition

(Mao et al., 2023) present POSTER++, achieving 92.21% accuracy on RAF-DB and 67.49% on AffectNet via window-based cross-attention fusing facial landmarks with image features. The iconic photograph of ISRO women scientists celebrating Mangalyaan's Mars orbit insertion became globally viral and represents a high-value target for facial sentiment analysis that could quantify the emotional intensity of the mission control celebration.

4.3.2 Parameter 13 Body Language Detection

(Sarma et al., n.d.) achieve 88.4% accuracy in behavioral intention classification from body language using action detection and posture analysis. Applied to Mangalyaan mission control footage and the viral celebration imagery, body language detection quantifies the degree of emotional expression in ways complementing facial expression analysis.

4.3.3 Parameter 14 Mission Control Reaction Detection

The Mangalyaan Mars orbit insertion on September 24, 2014, generated one of the most photographed mission control celebrations in space history. Combining POSTER++ (Mao et al., 2023) and body language

detection (Sarma et al., n.d.), mission control reaction detection creates a ground-truth emotional annotation layer for the most critical mission phases MOI confirmation, telemetry re-establishment and first image transmission from Mars.

4.3.4 Parameter 15 Rocket Launch Event Detection

(Tongale et al., 2025) achieve 94.2% accuracy in automated space video classification across ISRO, NASA, ESA and SpaceX content using YOLOv8 to identify rockets, launch pads and mission control rooms. For Mangalyaan, this enables automatic segmentation of the YouTube video corpus into launch phase (PSLV-C25 lift-off, November 2013), Trans-Mars Injection (December 2013) and Mars orbit insertion (September 2014) windows.

4.3.5 Parameter 16 Scene Brightness/Color Tone Sentiment

(Wei et al., 2023) establish with $p < 0.001$ significance that warm, high-brightness scenes generate more positive emotional responses than cool or dim environments across 120 participants. Mangalyaan's mission control celebration footage characterized by bright lighting, warm skin tones and colorful traditional clothing presents a distinctive visual-sentiment profile distinguishable from the cool telemetry monitoring footage of routine mission operations.

4.4 Metadata Analysis Parameters (Parameters 17–20)

4.4.1 Parameter 17 Title and Description Sentiment

(Dewantara et al., 2025) demonstrate that video title sentiment directly frames viewer expectations and initial emotional responses before content is consumed. For Mangalyaan YouTube content, title sentiment classification can rapidly categorize thousands of videos into celebratory, analytical, economic-commentary and critical categories enabling prioritized processing of the most sentiment-rich content.

4.4.2 Parameter 18 Engagement Metrics

(Cheng & Li, 2024) establish that negative sentiment content drives 23.7% higher engagement across 101,292 TikTok news videos. (Zhang et al., 2024) further demonstrate that content quality ratings and engagement patterns are strongly correlated in health-related social media content. For the Mangalyaan discourse, engagement metrics (like-to-dislike ratios, comment velocity, share counts) provide behavioral proxies that validate or challenge expressed-sentiment signals from text analysis.

4.4.3 Parameter 19 Upload Timing Relevance

(M. Manjunath, *Int. J. Sci. R. Tech.*, 2026 3(1), 111-, 2026) demonstrate that upload timestamp as a contextual feature improves NLP classification by 6.2%. For Mangalyaan, upload timing relative to the five key mission events (launch, TMI, MOI, first Mars image release, mission end) provides a critical contextualization layer a video uploaded within 24 hours of Mars orbit insertion carries fundamentally different interpretive weight than retrospective content uploaded years later.

4.4.4 Parameter 20 Trending Indicators

(Luceri et al., 2025) demonstrate that trending dynamics on video platforms can be systematically detected through network-based similarity analysis. During Mangalyaan's key milestones, trending placement amplified sentiment reach significantly the #MarsOrbiterMission hashtag trended in 17 countries during orbit insertion, representing an organic trending event of exceptional scope for an ISRO mission.

4.5 Mission-Specific Context Parameters (Parameters 21–24)

4.5.1 Parameter 21 Orbit Insertion Confirmation

(Opromolla et al., 2024) document orbital confirmation procedures and monitoring requirements in in-orbit servicing contexts. For Mangalyaan, the Mars Orbit Insertion was a single-engine burn of 24 minutes with no opportunity for real-time correction the tension of this irreversible maneuver was reflected in social media sentiment in the hours preceding and following confirmation.

4.5.2 Parameter 22 Telemetry Loss References

Mangalyaan experienced a planned 17-minute communication blackout during Mars orbit insertion as the spacecraft passed behind Mars. (Fejjari et al., 2025), (Engelstad et al., n.d.) and (Saraygord Afshari, 2024) collectively provide the telemetry anomaly detection taxonomy needed to build a mission-specific NLP lexicon for interpreting these references in social media commentary distinguishing the anxious anticipation before the blackout from the relief following signal reacquisition.

4.5.3 Parameter 23 Official Statement Extraction

(De Canio et al., 2024) present structured entity recognition and statement classification from official mission communications in the ESA Anomaly Detection Benchmark. Applied to Mangalyaan, this enables systematic extraction of official ISRO press conference statements and official social media posts creating a parallel institutional sentiment track for comparison against organic public discourse.

4.5.4 Parameter 24 Media Sentiment Comparison

(Denecke & Reichenpfader, 2023) document how formal institutional language and informal public discourse require separately calibrated sentiment analysis pipelines. For Mangalyaan, Indian mainstream media, international media and social media commentary exhibited markedly different sentiment profiles particularly regarding cost framing, where international media emphasized the ₹450 crore cost as exceptional while Indian media contextualized it within broader national development narratives.

4.6 Temporal Analysis Parameters (Parameters 25–27)

4.6.1 Parameter 25 Sentiment Before/During/After Mission Events

The Mangalyaan mission's nine-year operational lifespan provides an exceptional temporal dataset for pre/during/post sentiment analysis. Five principal sentiment windows are identifiable: pre-launch (October–November 2013), launch (November 5, 2013),

Trans-Mars Injection (December 1, 2013), Mars Orbit Insertion (September 24, 2014) and mission end (September 2022). (Mousoulidou et al., 2024) provide validated measurement methodology for pre/post event sentiment comparison applicable to structuring analysis across these windows.

4.6.2 Parameter 26 Sentiment Trend Over Time

(Hua et al., 2024) temporal trend analysis methodology and (Department of Computer Science, St. Albert's College, Kochi (Kerala), India. et al., 2024) time-series sentiment methods provide complementary frameworks for modeling how public sentiment toward Mangalyaan evolved across the nine-year mission period from launch excitement (2013) through operational plateau, anniversary discussions and retrospective reflections following communication loss (2022).

4.6.3 Parameter 27 Viral Velocity Tracking

(Luceri et al., 2025) document viral propagation mechanics through synchronized posting analysis and engagement cascade tracking. (Cheng & Li, 2024) provide quantitative parameters for viral engagement including like velocity, share-to-view ratios and comment-to-like ratios. For Mangalyaan, viral velocity analysis can quantify the spread rate differential between the global celebration sentiment and the economic-debate counter-narrative.

4.7 Output Parameters (Parameters 28–31)

4.7.1 Parameter 28 Overall Sentiment Classification

(Guo et al., 2024) establish that fine-tuned RoBERTa, BERTweet and SocBERT models outperform SVM baselines by 0.23–0.25 F1 on human-annotated social media data. (Montaser et al., 2025) validate BERT-based classification at 91.3% accuracy on social media business data. The overall sentiment classifier for Mangalyaan content should employ an ensemble of

these transformer models fine-tuned on a Mangalyaan-specific annotated corpus.

4.7.2 Parameter 29 Multimodal Sentiment Score

(Xie et al., 2024) present TMSON, integrating text, audio and visual modalities through Bayesian fusion with uncertainty estimation, achieving state-of-the-art performance on CMU-MOSI and CMU-MOSEI benchmarks. TMSON's uncertainty-aware fusion is particularly valuable for Mangalyaan analysis, where individual modality signals may be unreliable poor audio in public watch parties, low-resolution mission control footage from 2014, or ambiguous emoji sentiment in economic debate threads.

4.7.3 Parameter 30 Confidence Score

(Kumar et al., 2024) identify significant misalignment between LLM token probability and expressed confidence, consistent across multiple model architectures. For a Mangalyaan sentiment system, confidence score calibration is essential: low-confidence classifications in the economic-debate sentiment stream where sarcasm and irony are prevalent (Šandor & Bagić Babac, 2024) must be flagged to prevent misleading aggregate sentiment reports.

4.7.4 Parameter 31 Sentiment Visualization

(Becker et al., 2024) demonstrate XAI visualization via LRP heatmaps that reveal which audio features drive classification decisions, making model outputs interpretable to non-technical stakeholders. For Mangalyaan sentiment visualization, mission-timeline-anchored dashboards showing aggregate sentiment scores across the 2013–2022 lifespan with drill-down to specific events, platforms and parameter contributions would enable ISRO communication teams to act on public sentiment insights.

5. COMPARATIVE ANALYSIS

TABLE I. COMPARATIVE SUMMARY OF REVIEWED PAPERS ACROSS 32 PARAMETERS

Ref	Authors (Year)	Parameters	Method / Model	Dataset & Metric	Gap / Contribution
[1]	Srisailanath et al. (2026)	1,2,19 – ASR, Caption, Timing	Whisper + Transformer	YouTube; BLEU 0.87	No space domain; multilingual gap
[2]	Dewantara et al. (2025)	17 – Title/description	Thematic + NLP	816 comments; qualitative	No quantitative scoring
[3]	Fejjari et al. (2025)	22 – Telemetry anomaly	LSTM, Autoencoder, ML	Spacecraft; F1>0.90	Not applied to social media
[4]	Zhang et al. (2024a)	4 – Emotion classification	BERT, RoBERTa, ensemble	Weibo, Twitter; F1 0.88	No space domain
[5]	Sandor & Babac (2023)	5 – Sarcasm detection	BiLSTM, BERT	1.3M comments; Acc 93.7%	Fails on code-mixed text
[6]	Aiswarya & Haritha (2024)	6 – YouTube comments	TF-IDF + SVM/LSTM	YouTube; Acc 89.2%	No event-specific framing
[7]	Velampalli et al. (2025)	7 – Emoji & hashtag	USE, SBERT, LSTM	Tweets; Acc 98%/70%	Context-dependence unsolved
[8]	Becker et al. (2024)	8,31 – Tone, XAI viz	Deep NN + LRP	AudioMNIST; Acc 98.3%	Constrained audio only
[9]	Kanikanti (2024)	3 – Keyword polarity	FinBERT + lexicon	Earnings calls; R ² 0.76	Domain shift needed

Ref	Authors (Year)	Parameters	Method / Model	Dataset & Metric	Gap / Contribution
[10]	Wadle et al. (2024)	9 – Pitch, speech rate	openSMILE + PRAAT	Clinical; AUC 0.74–0.81	Clinical domain; needs adapt
[11]	Larrouy-Maestri et al. (2025)	10 – Emotional prosody	Acoustic + neural	30yr review	Cross-cultural variability
[12]	Katz et al. (2018)	11 – Crowd reaction	Audio segmentation	Sports crowd	Not space-applicable
[13]	Mao et al. (2023)	12 – Facial expression	POSTER++ CNN	RAF-DB 92.21%	Occlusion in crowds
[14]	Sarma et al. (2023)	13 – Body language	CV + action detection	Video; Acc 88.4%	Controlled settings only
[15]	Engelstad et al. (2025)	22 – Telemetry classify	LSTM + Mahalanobis	Digital twin; +7%P	Simulated data only
[16]	AlGhamdi et al. (2024)	11,13 – Crowd motion	VelocityNet optical flow	Crowd benchmark; real-time	Not sentiment-labeled
[17]	Wei et al. (2023)	16 – Scene brightness	EEG + physiological	120 participants; p<0.001	Lab-based; not video
[18]	Denecke & Reichenpfader (2023)	24 – Media comparison	PRISMA scoping review	Clinical NLP corpus	Formal vs informal gap
[19]	Cheng & Li (2024)	18,27 – Engagement, viral	NLP+CV on 101K videos	101,292 TikTok; r	News context only
[20]	Zhang et al. (2024b)	18,20 – Content quality	DISCERN, JAMA scales	123 TikTok health videos	Not space-generalizable
[21]	Luceri et al. (2025)	20,27 – Trending, viral	Network CIB detection	1.35M TikTok videos	Inauthentic behavior focus
[22]	Opromolla et al. (2024)	21 – Orbit confirmation	Space ops review	ESA case studies	No NLP layer
[23]	Kotowski et al. (2024)	22,23 – Telemetry, statements	ML benchmark (10 algos)	ESA satellite data	No social media link
[24]	Tongale et al. (2025)	1,15,17 – ASR, launch detect	YOLOv8 + OCR + NER	Space video; Acc 94.2%	No sentiment scoring
[25]	Mousoulidou et al. (2024)	4,25 – Emotion, pre/post	Validated psych scales	N=312; ANOVA	Lab-based only
[26]	Vunnam (2024)	25,26 – Launch trends	Statistical analysis	1957–2023 launches	No sentiment dimension
[27]	Hua et al. (2024)	3,4,26 – ABSA trends	Systematic review (727)	Multi-domain NLP	No space/ISRO domain
[28]	AlGhamdi et al. (2024)	11,28 – Crowd output	VelocityNet dual-pipeline	Crowd benchmark	Not sentiment-labeled
[29]	Guo et al. (2024)	28 – Classification output	RoBERTa, BERTweet	6 health tasks; F1 gap	Health domain only
[30]	Xie et al. (2024)	29 – Multimodal score	TMSON Bayesian fusion	CMU-MOSI, MOSEI; SOTA	English; no space domain
[31]	Kumar et al. (2024)	30 – Confidence score	Token probability align	Multi-LLM benchmark	Confidence miscalibration
[32]	Al Montaser et al. (2025)	28,26 – Sentiment, trends	BERT + time-series	Twitter/Reddit; Acc 91.3%	USA business focus only

6. RESEARCH GAPS AND FUTURE DIRECTIONS

The systematic review of 31 papers across 32 parameters reveals seven critical gaps specific to Mangalyaan public sentiment analysis:

Gap 1 No Mangalyaan-Specific Annotated Dataset:

No training or evaluation dataset exists from Mangalyaan social media content. As emphasized by (Guo et al., 2024), human-annotated domain data is irreplaceable and outperforms LLM-generated annotations by significant F1 margins. Constructing a

multi-platform, event-annotated corpus spanning the 2013 launch, 2014 MOI and 2022 mission end is the single most critical prerequisite.

Gap 2 Code-Mixed Hinglish Sentiment Handling: A substantial portion of Mangalyaan commentary was expressed in Hinglish. (Šandor & Bagić Babac, 2024) confirm that standard NLP models degrade significantly on code-mixed text; no reviewed paper addresses Hinglish sentiment in a space mission context.

Gap 3 Sarcasm Detection for Economic Debate Discourse: The Mangalyaan economic debate generated high volumes of sarcastic commentary that confounds standard classifiers. The 93.7% accuracy of (Šandor & Bagić Babac, 2024) degrades substantially on out-of-domain irony.

Gap 4 Integrated Multimodal Pipeline for Space Social Media: While (Xie et al., 2024) present TMSON for multimodal fusion, no reviewed paper integrates audio, visual, textual and mission-specific metadata signals into a unified pipeline designed for space mission content.

Gap 5 Long-Duration Temporal Sentiment Modeling: Mangalyaan's nine-year lifespan offers an exceptional long-duration sentiment dataset. Neither (Hua et al., 2024) nor (Montaser et al., 2025) address multi-year sentiment evolution for a single mission.

Gap 6 Cross-Platform Sentiment Fusion: All reviewed papers analyze single-platform data. Mangalyaan discourse distributed across Twitter/X, YouTube, Reddit and Facebook simultaneously requires cross-platform fusion frameworks absent from the literature.

Gap 7 Real-Time Capability for Live Mission Events: No reviewed system meets the throughput and latency requirements of real-time sentiment analysis during live mission broadcasts. (Velampalli et al., 2022) provide partial methodological direction through distributed processing, but latency-optimized real-time pipelines remain an open research challenge.

Future directions include: (1) building an open-source Mangalyaan Sentiment Corpus with event-level annotations (Guo et al., 2024); (2) developing Hinglish transformer models for space discourse (Šandor & Bagić Babac, 2024); (3) building TMSON-extended multimodal pipelines incorporating mission telemetry metadata (Xie et al., 2024); (Fejjari et al., 2025); (4) deploying long-duration temporal dashboards using the Mangalyaan archive (Montaser et al., 2025); and (5) cross-mission comparative sentiment analysis across Mangalyaan, Chandrayaan-2 and Chandrayaan-3.

7. CONCLUSION

This paper presented a systematic literature review of 31 peer-reviewed publications to build and populate a 32-parameter multimodal framework for analyzing public sentiment expressed toward ISRO's Mangalyaan Mars Orbiter Mission on social media. The framework spans text, audio, visual, metadata, mission-specific context, temporal and output parameters providing a complete analytical pipeline from raw social media

ingestion to interpretable mission-sentiment visualizations.

Key findings demonstrate that transformer-based NLP achieves $F1 > 0.90$ (Guo et al., 2024); (Montaser et al., 2025), multimodal fusion outperforms unimodal approaches by 8–15% (Xie et al., 2024), facial expression recognition achieves 92.21% accuracy (Mao et al., 2023) and engagement metrics reliably proxy expressed sentiment with negative content driving 23.7% higher engagement (Cheng & Li, 2024). The Mangalyaan mission with its unique attributes of low-cost interplanetary success, nine-year operational lifespan, globally viral celebration imagery and substantial economic debate discourse represents an ideal and historically significant testbed for the proposed framework.

Critical gaps, including absent Mangalyaan-specific corpora (Guo et al., 2024), limited Hinglish NLP (Šandor & Bagić Babac, 2024) and underdeveloped viral velocity frameworks (Luceri et al., 2025), define a concrete research agenda whose completion would deliver both methodological advances in multimodal sentiment analysis and actionable insights for ISRO's science communication and public engagement strategies.

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