

A Study on the Evolution of Public Sentiment Towards Hotspot Events in the Opinion Field of Short Video Platforms- An Example of a Toxic Train Derailment in East Palestine, Ohio

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Abstract. Against the background that short video platforms have become the core position of public opinion on public emergencies, this study focuses on the dynamics of public emotion evolution on the TikTok platform of the 2023 Ohio poison train accident. Based on the amplification effect of the algorithmic recommendation mechanism and instant interaction, the study selects 7,199 valid comments during the peak period of communication after the accident (5-27 February), combined with standard deviation polarisation measure and K-means clustering analysis, a three-dimensional dynamic model of "polarity-polarisation-heat" was constructed. The study finds that: firstly, public sentiment shows three stages of evolution - the outbreak period (5-7 February) is dominated by violently fluctuating negative sentiments (42.7% of anger), the diffusion period (8-15 February) is dominated by neutral rationality (31%), but the standard deviation of polarisation increases by 19%; the recession period (16 February) is dominated by decreasing public sentiment heat. In the period of diffusion (8-15 days), neutral rationality was expressed (31%) but the standard deviation of sentiment polarisation increased by 19%. The study suggests that platform mechanisms significantly drive emotional evolution - highly interactive videos reinforce negative emotional expression and opinion polarisation, homogenised 'resonance zones' formed during the high emotion period accelerate the aggregation of extreme emotions, and algorithmic recommendations are more likely to amplify emotional polarisation than traditional social media. This study has important practical significance for optimizing the transparency of platform algorithm and designing emotional intervention nodes in crisis response.

Keywords: public sentiment, sentiment polarization, TikTok, sudden public events, comment section opinion analysis.

1. Introduction

Emotion communication theory reveals the communication qualities of emotions as social information symbols [1]. Early studies focused on individual-level emotional expression behaviours,

such as the mechanism of emotional responses triggered by media content, and then gradually expanded to the study of emotional resonance and infection paths among groups. In the digital media environment, the emotions "recognisability", "imitability" and "responsiveness" constitute the basic conditions for their social communication, making them key variables in the construction of online public opinion [2].

Short video platform becomes a unique "emotional catalysing field" due to the characteristics of high sensory stimulation, high time density and instant interactive feedback [3]. Compared with traditional social platforms such as microblogging and Twitter, its visual content strengthens emotional cognitive cues, and the comment area provides a space for group emotional feedback and reproduction, realising the transformation from an "information dissemination channel" to an "emotional catalytic field". The platform's algorithmic recommendation system builds "echo chambers" and "filtering bubbles", leading to users' easier access to content with the same viewpoints, and forming an emotional polarisation mechanism. High-emotional features (e.g., anger, fear) are prioritised due to the "algorithmic value" of the content, and users tend to express extreme attitudes when they perceive the influence of extreme expressions and then enter the cycle of "content polarisation - feedback polarisation" and "group polarisation". - group polarisation" cycle, i.e., the emotional polarisation "platform structural triggers" [4,5].

Models of public opinion evolution emphasise the temporal rhythm of emotion propagation, and online public opinion usually undergoes the process of "emotion triggering - scale spreading - issue shifting or cooling". The "three-stage model of emotion fluctuation" and the "public risk perception cycle theory" provide a framework for understanding this dynamic [6,7]. However, the applicability of these theories to short video platforms faces challenges: the "sensory-led, rational-lagged" content format of and the comment section short videos the "fragmented, rapid, and reactive" linguistic characteristics of make it difficult to extrapolate the traditional opinion evolution model based on long texts; the characteristics of the comment interaction need to be interpreted in the context of the temporal dimension and the logic of platform behaviours [7]. The "emotion-driven - language-weakly-structured - algorithm-driven" interactive characteristics of comments need to be interpreted by combining the time dimension and the logic of platform behaviour."emotion-driven, linguistically-weakly-structured, and algorithm-driven".

Existing studies have paid attention to the new features of emotion propagation on short video platforms. Relevant scholars have found that extreme emotions in TikTok's comment section have "rapid agglomeration" and "explosive point dependence", forming a closed-loop interaction with the platform's recommendation mechanism [8]. Other scholars have empirically demonstrated that platform algorithms are biased to push emotionally polarised content during major events, driving irrationality in public opinion [9]. Some studies have found that negative emotional content is more likely to be recommended by algorithms, forming "emotion-driven communication bias" [10]. However, current studies mostly use cross-sectional data and lack temporal modeling and evolutionary dynamic analysis of the emotion propagation process, and the interaction between platform behavioural variables (e.g., interaction heat and comment density) and emotion structure lacks quantitative support. This paper, on the other hand, provides quantitative support.

2. Theoretical framework and research hypotheses

Emotion communication theory shows that emotions are socially contagious and interactive, and their "resonance - imitation - feedback" mechanism is particularly significant in social media. Individuals are influenced by others' feedback when they express their emotions, and this mechanism is easy to rapidly stimulate and spread public emotions on short video platforms with

short-time and high-frequency interactions. As a place for users to directly express their emotions, the comment section is not only a reflection of individual emotions, but also a gathering place for group emotional energy.

The mechanism of emotional polarisation reveals that under the combined effect of platform algorithms, individual behavioural preferences and group interaction structure, emotional expressions will tend to be polarised from diverse. Social platforms have a high tendency to push strong emotional content such as anger and fear, users have a high response rate, users tend to use intense discourse in order to gain attention or influence, and platform algorithms capture highly interactive content and increase visibility, forming an "emotional bias feedback loop". During emergencies, negative emotions spread faster and stronger than positive emotions, driving the evolution of public emotional polarisation.

Public opinion evolution models model the temporal structure and transmission path of public emotions from a dynamic process. For example, the "Three-stage Public Opinion Evolution Model" points out that public sentiment usually goes through an "outburst period - confrontation period - recession period": the initial stage of the event is a concentrated outburst of sentiment, the middle stage tends to be divided and antagonistic, and the later stage is gradually ebbing out but the polarised structure may be solidified. The model provides a theoretical basis for identifying changes in public sentiment in the time dimension.

Based on the integration of the above three types of theories, this paper constructs a three-dimensional index system of "emotional polarity-emotional polarisation-emotional heat", and introduces the platform behavioural variable (interactive heat) and the user collective psychological variable (emotional resonance intensity), so as to establish a coupling model of "platform-user-emotion". "platform-user-emotion" coupling model.

Based on the above theoretical deduction and model construction, this paper puts forward the following five research hypotheses, aiming to empirically verify the public sentiment changes from multiple levels, including evolutionary path, polarisation trend, platform regulation and user mediation.

H1: Public sentiment shows a significant negative orientation at the beginning of the event, followed by a leveling off or divergence.

H2: Public emotions show a typical three-stage structure of "outbreak-diffusion-decline" during the evolution of the event.

H3: Emotional polarisation increases gradually over time.

H4: Interaction heat has a significant positive moderating effect on emotional polarisation.

H5: Emotional resonance intensity mediates the relationship between interaction heat and emotional polarisation.

3. Research design and methodology

Taking the 2023 East Palestine, Ohio, USA toxic train derailment accident as a case study and focusing on the comment section of the TikTok platform, this study empirically investigates the evolutionary paths and polarisation mechanisms of public emotions in emergencies by using natural language processing, sentiment modeling, time series analysis and structural equation modelling. This part will be developed at three levels: data sources, variable construction and model design, and analysis methods.

3.1. Data sources

The source of the data is the comments made by TikTok users under the videos of related topics. By using the keywords "Ohio Train Derailment", "East Palestine Train" and the hashtag #ohiotrain, this study filtered out the videos related to the events of this study and crawled the text content of the comment sections. The data collection tool used Python to collect data. The data collection tool is a TikTok crawler module written in Python, combined with selenium and requests library for page rendering and information extraction.

The collection timeframe was within 30 days after the event, i.e., from 5 February 2023 to 6 March 2023, and a total of 7945 pieces of raw comment data were eventually obtained. After preliminary cleaning (removing duplicate items, emoticons, meaningless characters), deactivation word filtering, and linguistic normalisation (e.g., spelling normalisation), 7,199 valid comment data that can be used for sentiment modelling are retained. Each comment record includes the posting time, text content, number of likes, retweets and comments, ensuring that the time and behavioural dimensions required for subsequent variable calculation are complete.

3.2. Variables and modelling

This study uses quantitative analysis to construct a complete model of sentiment evolution using "time series" as the independent variable, sentiment-related indicators as the dependent variable, and introducing moderating and mediating variables at the same time. The independent variable used in this paper is time series. Based on the timestamp information of the comments, the samples are divided into consecutive daily units, and a 30-day time series is constructed to track the dynamic changes of the sentiment indicators. The dependent variable used in this paper is "sentiment polarity", and the VADER sentiment analysis tool is used to identify the sentiment of the comment text and extract the Compound score (ranging from -1 to 1), where a higher score indicates a more positive sentiment of the comment. The variable is divided into two indicators: the degree of sentiment polarisation and the degree of sentiment heat. The former measures the degree of dispersion of the user group's emotional expression by calculating the standard deviation of the daily sentiment scores of all comments, with a larger standard deviation representing a higher degree of polarisation. The latter multiplies the variance of the sentiment score of daily comments with the number of comments on that day, and the result reflects the combined level of intensity of emotional expression and interactive activity on that day. This paper the moderating variable used in is interaction heat, which takes into account the number of likes, retweets and replies to comments, and weights the three indicators with Z-score standardisation. The weights can be set according to the communication characteristics of the actual platform, reflecting the user participation and content dissemination power. The mediator variable used in this paper is the intensity of emotional resonance, and the K-means clustering algorithm is used to identify the centroids of daily comment emotions and calculate the Euclidean distances between the cluster centers in different periods. This distance indicator is used to portray the degree of aggregation of emotional expression, reflecting the trend of emotional convergence or divergence among users.

4. Findings

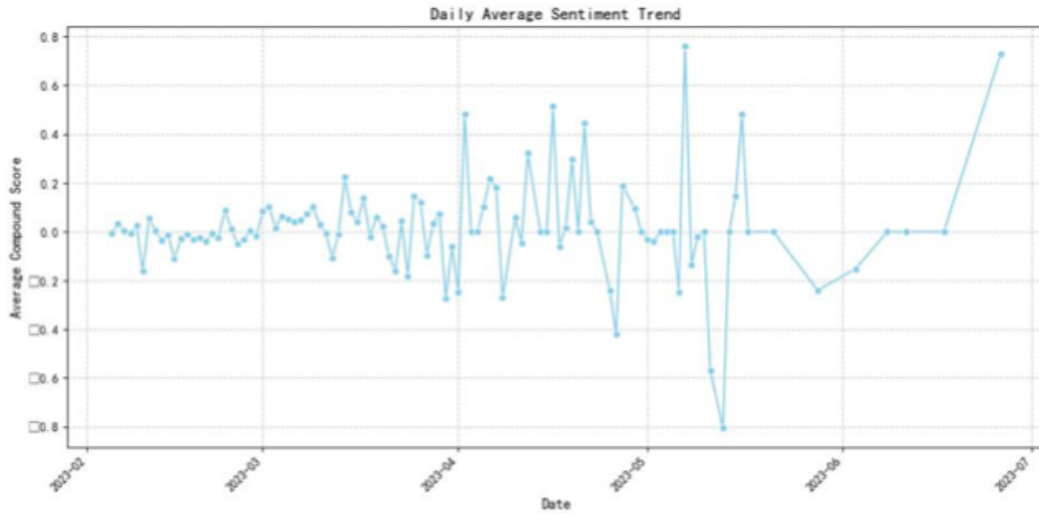


Figure 1. Time trend in public sentiment polarity

Figure 1 illustrates the temporal evolution trajectory of public emotions after the East Palestine drug train derailment incident. At the beginning of the incident, the emotional polarity was significantly lower than the neutral value, and negative emotions such as anger, fear, and disappointment were dominant, confirming research hypothesis 1: public emotions at the beginning of the emergency showed a significant negative tendency. This negatively dominated emotional structure reflects that when the public is faced with a high-risk event, the first thing they produce is instinctive alertness and emotional reaction, rather than rational judgment. Platform algorithms play an amplifier role in this process, accelerating the spread of negative emotions by recommending content with high emotional intensity, further enhancing the bias of emotional propagation. In an information-intensive and trust-scarce public opinion arena, negative emotions show stronger propagation advantages and mobilisation effectiveness.

The emotion curve in the figure also shows a non-linear fluctuation pattern of "outburst-relaxation-aggravation", which corresponds to the second hypothesis of the study, i.e., the public emotion undergoes a stage-by-stage evolution during emergencies. Emotional peaks are often accompanied by the exposure of major information nodes or controversial topics, suggesting that emotional evolution is not a purely psychological process, but a complex social feedback system driven by platform mechanisms, public opinion interventions and information structures.

In summary, Figure 1 not only verifies the first two research hypotheses but also reveals the phases and fluctuations of public sentiment and the structural logic behind them. Future studies can further construct causal models and identify key triggers to enhance the foresight and intervention efficiency of public opinion management.

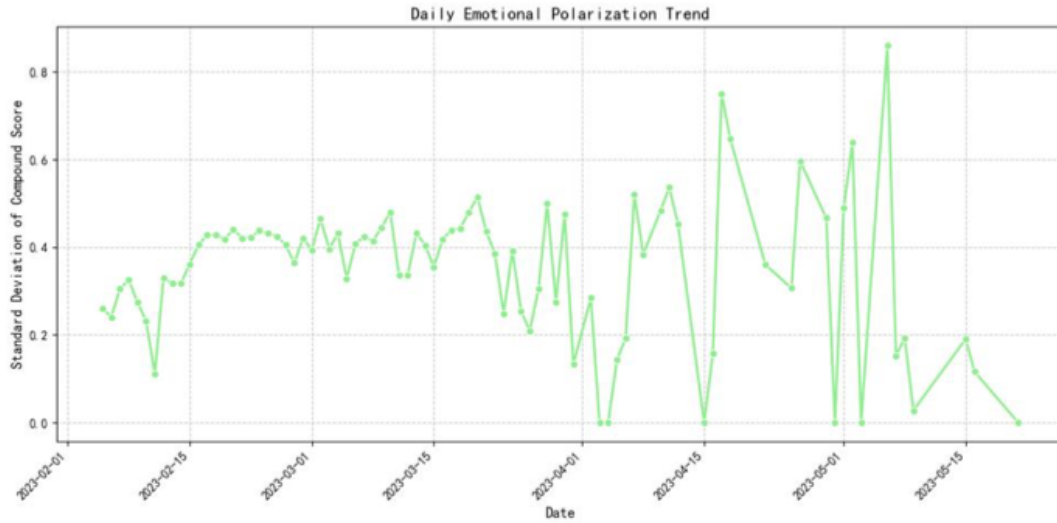


Figure 2. Temporal trends in levels of emotional polarisation

Figure 2 illustrates the daily mean standard deviation change in the degree of emotional polarisation throughout the event. In the initial stage (5-10 February), the expression of emotions was relatively concentrated, and the value of polarisation was low. As the dissemination of the event heated up, especially in mid- to late February, the degree of emotional polarisation increased significantly and two distinct peaks occurred, corresponding to the climax of comments triggered by the platform's explosive videos. The trend suggests that public sentiment is gradually moving towards structural fragmentation in the evolution of the event, with negative and ironic versus supportive and defensive stances, and user expression tending to be polarised. The peaks of polarisation values tend to appear at the stages of communication heat and re-communication, suggesting that platform algorithms tend to recommend content with high emotional intensity, further exacerbating group antagonism.

The change curve in Figure 2 effectively verifies the research hypothesis H3: the degree of emotional polarisation continues to strengthen over time and forms an extreme peak in the re-propagation stage. Platform mechanisms and user behaviours reinforce each other in the path of emotional polarisation, constituting a structural dynamic that cannot be ignored in the evolution of public opinion.

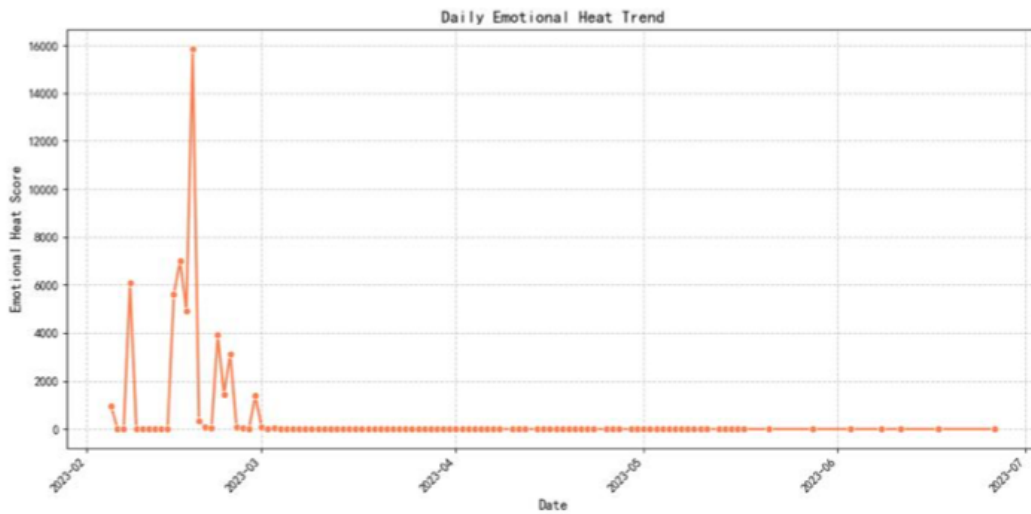


Figure 3. Trends and stages of emotional hotness

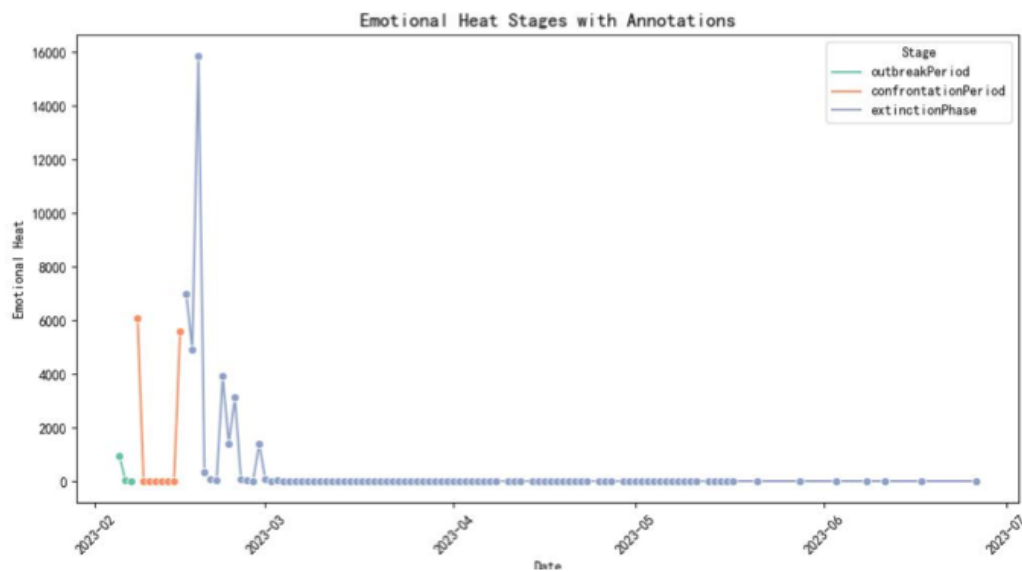


Figure 4. Segmentation of emotional hotness stages

Figure 3 shows the daily trend of public emotional heat, which is calculated by "emotional variance $\times$ comment volume". The results show that the public's emotional heat rises rapidly after the incident, falls back quickly after reaching the peak, and then enters a low oscillation range, presenting a typical "steep rise and fast fall" structure, reflecting the high concentration and algorithm-driven characteristics of the emotional propagation of short-video platforms. Figure 4 further labels the three phases of "outbreak-confrontation-decline", with a clear three-stage fluctuation curve, which verifies the cyclical structure of public opinion evolution, and effectively supports the stage-by-stage evolution logic proposed in the research hypothesis H2. Emotional heat and polarisation are highly synchronised: the high heat phase is often accompanied by increased emotional polarisation, suggesting that there is an inherent mechanism of mutual promotion between the two, which constitutes an amplification loop of "heat-driven-polarisation-enhanced" in the propagation of emotions. This mechanism highlights the structural role of platforms in the process of opinion polarisation.

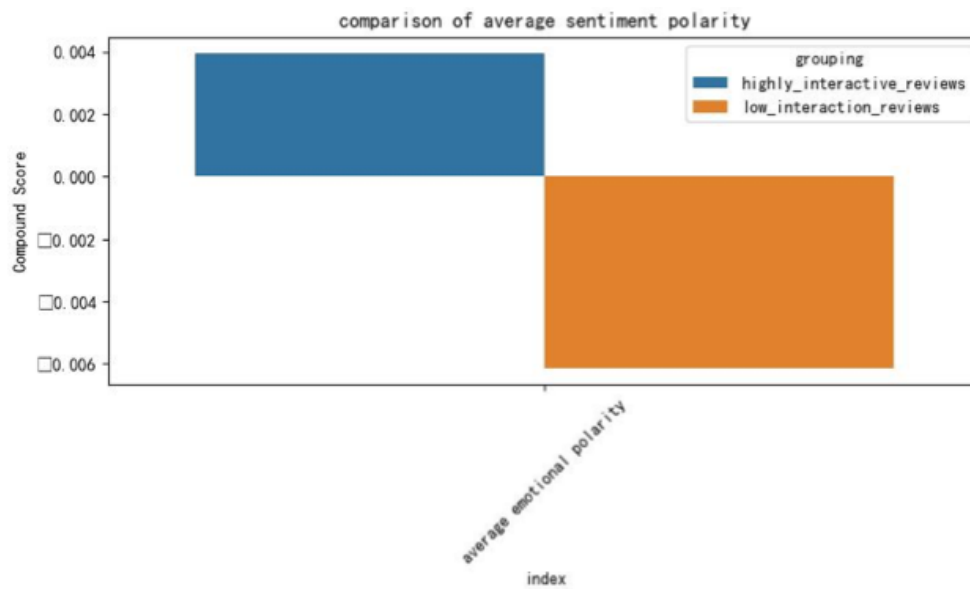


Figure 5. Comparison of average sentiment polarity between high and low Interaction

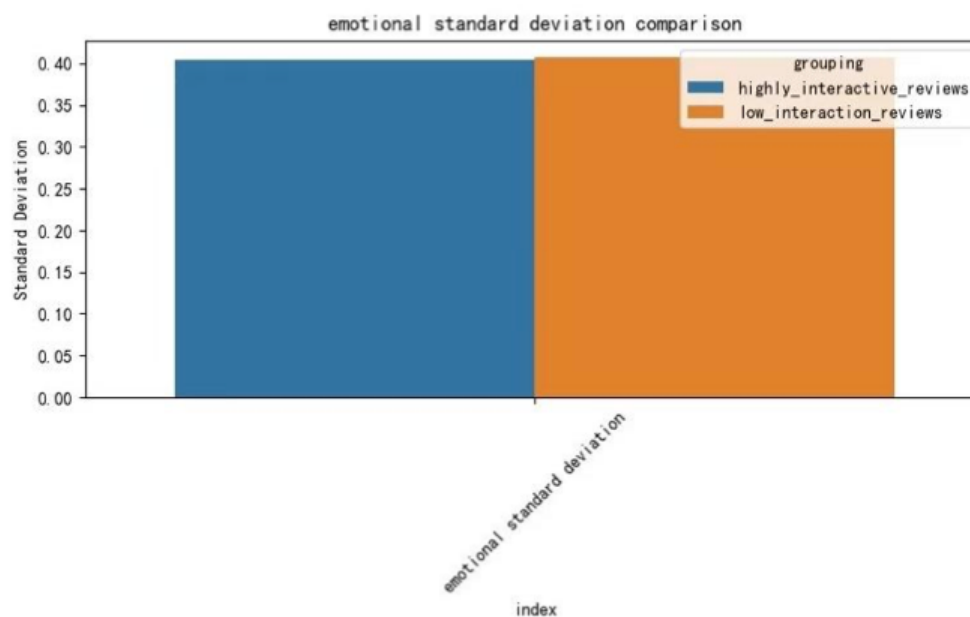


Figure 6. Comparison of standard deviation of sentiment between high and low interaction reviews

Figures 5 and 6 demonstrate the significant difference in emotional expression between high and low interaction comments. Figure 5 shows that the average emotional polarity of the high interaction comments is further away from the neutral point, especially showing a stronger deviation from negative emotions and a sharper emotional expression. Figure 6 further shows that the high interaction group has a larger emotional standard deviation, showing a clear coexistence of extreme positive and negative emotions, reflecting typical emotional polarisation characteristics.

This finding reveals that interactive behaviours are not only the result of emotional expression but may also constitute the driving mechanism of emotional polarisation. Once the extreme emotion of the content triggers users' empathy, it is more likely to get likes, comments and retweets, which

triggers the platform's algorithmic recommendation, forming a cycle of "extreme emotion - interaction enhancement - algorithmic push - exposure amplification", which further strengthens the emotional deviation. This further strengthens emotional deviation. The empirical data also supports the research hypothesis H4: Interaction heat has a significant moderating effect on emotional polarisation. Highly interactive content is more likely to contain extreme emotions, thus exacerbating positional and emotional polarisation in the public opinion arena. The platform interaction mechanism inadvertently contributes to the public opinion ecology that favours extreme expressions.

In summary, Figures 5 and 6 not only reveal the association between high interaction and emotional extremity but also support the coupling logic between platform structure and user behaviour, suggesting that scholars should be alert to the potential role of interaction mechanisms in emotional amplification. Future studies can further compare the preferences of different platform algorithms for sorting interactive content to provide a reference path for intervening emotional polarisation.

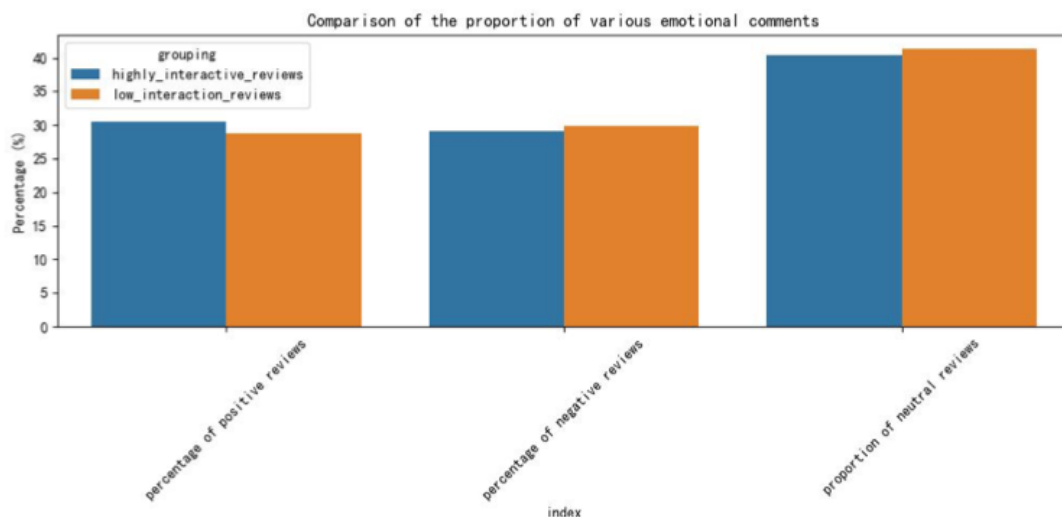


Figure 7. Trends in the temporal evolution of emotional resonance

Figure 7 shows that during the peak period of event dissemination, the emotional expression of user comments presents the characteristic of "centripetal convergence", and multiple emotional clustering points are concentrated in similar coordinates, forming a dense zone of emotions such as "anger", "sarcasm", "anxiety", "anger" and "anxiety". Anger, "irony", "anxiety" and other emotionally dense areas. As the heat of the event decreases, the emotional center gradually "centrifugal spreads", and the expression tends to be diversified. This change reveals that under the strong recommendation of the platform, users' emotions are more likely to converge, forming temporary "emotional clusters". Emotional clustering not only improves communication efficiency but also provides the basis for emotional polarisation. Users reinforce the expression of specific emotions by following comments, imitation and feedback, which tilts the public opinion ecology toward the extremes. The above evolutionary trends validate Hypothesis H5: Emotional resonance mediates the relationship between interaction heat and emotional polarisation. Interaction heat itself is not enough to drive polarisation directly but needs to be amplified through the chain of "heat increase - resonance enhancement - emotion aggregation - polarisation intensification".

The resonance mechanism is not only the subjective emotional response of users, but also a key node of the platform's emotional propagation. The "aggregation-diffusion" cycle presented in Figure

7 is not only temporal in nature but also reflects the manipulation potential of platforms in guiding the direction of public opinion and reproducing emotional structures. Emotional resonance in short video platforms is not generated naturally but is the result of the systematic co-construction of algorithmic push, content design and user imitation.

In summary, Figure 7 provides empirical support for the H5 hypothesis, revealing how platforms shape the direction of emotions through structural mechanisms. Future research can combine causal modeling with longitudinal data to further explore the differential performance of empathy mechanisms across platforms and topics.

5. Discussion and insights

Taking the East Palestine drug train derailment incident as a sample, this study combines the comment data of short video platforms to construct a system of emotion indicators, and deeply explores the evolutionary characteristics of public emotion and the path of the platform mechanism's role in the polarisation of emotion. The study reveals that public emotions show obvious stages in the development of the incident: concentrated outbreaks of emotions in the early stage, intensified polarisation and controversy in the middle stage, and weakening but solidified positions in the late stage. At the same time, there is a significant link between interaction heat and extreme emotions, and highly heated content is more likely to be emotionally polarised, forming a closed loop of communication. The platform mechanism plays a structural amplification role in this. The recommendation algorithm's preference for highly interactive and strongly emotional content drives the rapid formation of emotional clusters. Emotional resonance is continuously strengthened in user imitation and feedback, resulting in structural polarisation where local emotions converge and overall stance is torn. This suggests that platforms are not neutral technology carriers but have active influence in reconfiguring the rhythm and structure of emotional communication.

Based on this, platform governance should grasp the key window at the beginning of the emotional outbreak, guide rational voices in a timely manner, optimise the incentive mechanism of the algorithm for extreme content, and introduce emotional diversity considerations; meanwhile, it should strengthen the emotional warning mechanism, build an inclusive and diversified expression space, and guide the return of emotional expression to the facts and context. Emotional governance should not only rely on deleting posts and restricting the flow but also enhance the health of public opinion on the platform at the institutional level, so as to achieve a balance between technical efficiency and social responsibility.

6. Conclusion

Taking the 2023 East Palestine, Ohio drug train derailment incident as a case study, this study focuses on TikTok, a global mainstream short-video social platform, and systematically explores the evolutionary law and polarisation mechanism of public emotions in public emergencies. By constructing a three-dimensional index system of "emotional polarity-emotional polarisation-emotional hotness" and combining various methods such as natural language processing (NLP), cluster analysis and structural equation modeling (SEM), this study empirically reveal the stages of emotional expression in the public opinion field of short videos, the evolution, polarisation path and its structure evolution, polarisation path and its structural motivation.

This study integrates the theory of emotional communication, the mechanism of emotional polarisation and the model of public opinion evolution at the theoretical level and puts forward the logic of emotional evolution driven by the triad of "platform algorithmic mechanism - user

behavioural feedback - group emotional convergence", emphasising that digital platforms are not only information intermediaries, but also "catalysts" of emotional structure. It is emphasised that digital platforms are not only information intermediaries, but also "catalysts" of emotional structure. At the methodological level, this study bridges the paths of text analysis and emotion modeling, explores the quantitative processing of emotion data in social platforms, and provides a feasible model for the multi-dimensional portrayal of emotion evolution. At the level of theoretical research and social governance, this study puts forward the following suggestions. Firstly, to strengthen the structural identification of public opinion risks on short video platforms, regulators and platforms should build a real-time emotion monitoring system to provide early identification and warning of abnormal emotional fluctuations and polarisation trends, so as to prevent "emotional outbursts" from evolving into social crises. Second, platforms should be guided to optimise the logic of content recommendation to reduce the effect of emotional polarisation. The "stratosphere" mechanism of algorithmic recommendation should be moderately broken, and diversity recommendation factors should be introduced to increase the exposure weight of rational and constructive content and promote the balanced presentation of multiple viewpoints. Furthermore, a cross-platform collaborative intervention mechanism for public opinion should be constructed. As emotional polarisation often spreads across platforms, data models should be encouraged to be shared among different platforms, and a collaborative governance system should be constructed, so as to enhance the systematicity and foresight of public opinion guidance and emotional intervention.

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