

Enhancing Forest Fire Communication: A Case Study of Oregon Government Social Media

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Abstract

Forest fires pose an escalating threat, demanding effective communication strategies for communities. While past research underscores the importance of community involvement and transparent communication, the dominance of social media in today's media landscape calls for a reassessment. This study investigates the utilization of social media, specifically Facebook, by the Oregon government during the 2022 fire season in the Lane County and Willowa County regions. Through Facepageman application for automated data retrieval, 4,576 posts and comments from Cedar Creek Fire and Double Creek Fire Facebook page were collected. Using the multi-coder approach and the Vader Algorithm, the data were analyzed focusing on post frequency, thematic content, and user sentiments. The result reveals that positive sentiment polarity scores were observed with 0.61 and 0.71 for Cedar Creek and Double Creek Fire, respectively. However, the thematic and post-frequency analysis suggest a need for government agencies to diversify their social media page content to cater to different informational needs and preferences. Additionally, timely updates, factual information, interactive engagement, and an emphasis on the scientific aspects of wildfires were identified as critical areas for improvement. The findings offer valuable insights for enhancing risk communication strategies, promoting informed public engagement, and guiding effective government communication in wildfire scenarios.

Keywords: forest fire communication, social media analysis, government outreach, public sentiment, emotion analysis

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Introduction

Effective communication is an indispensable element in managing wildfire events, encompassing a critical role in shaping public behavior and ensuring community preparedness. The imperative nature of this communication has been emphasized in previous research, highlighting the critical need for continuous community involvement, including government agencies, citizens, and stakeholders to yield positive outcomes in disaster situations (Taylor et al., 2007; Hagler et al., 2021). The essence of such effective communication lies in its ability to instill a sense of participation, where individuals feel that their voices and perspectives are not only acknowledged but also valued (Lovari & Bowen, 2020). Fostering a sense of involvement, especially in the face of the uncertainty that characterizes wildfire events, relies on transparent, open, and consistent communication channels (Reynolds & Seeger, 2005; Scolobig et al., 2015; Johnston et al., 2020; Ryan et al., 2020).

Scholars have argued that transparent and open communication is vital during disaster management as it serves as a conduit for disseminating critical information, safety instructions, and evacuation plans (Taylor et al., 2007; Palttala et al., 2012; Beggs, 2018; Shittu et al., 2018; Johnston et al., 2020; Hagler et al., 2021). Such communication ensures that the public is well-informed, which can lead to

better compliance with official guidance and evacuation orders (Hagler et al., 2021). Additionally, open communication that actively involves citizens and stakeholders in information sharing can foster a more resilient community response to wildfires by promoting a sense of collective responsibility, mutual support, and a shared understanding of risks (Beggs, 2018). This engagement enables communities to better coordinate their efforts, adhere to safety guidelines, and adapt to changing wildfire conditions, ultimately reducing the impact of these events (Taylor et al., 2007). Open communication is also instrumental during a crisis, as this can create a strong sense of reliability in the government and other authorities, enhancing community confidence and cooperation during wildfire events (Johnston et al., 2020).

Traditionally, the dissemination of information about wildfire events relied on news outlets, print media, and television channels, which were the primary tools employed by government bodies and wildfire authorities (Taylor et al., 2007; Velez et al., 2017). However, the modern media landscape has undergone a profound transformation, with social media platforms now dominating the information-sharing sphere. The rise of social media has redefined the way information is conveyed during wildfire events, enabling real-time updates and engagement with the public

and making it a powerful tool in wildfire communication (Houston et al., 2015; Simon et al., 2015). These platforms offer immediate access to a vast audience and enable the rapid dissemination of crucial information, such as evacuation orders, shelter locations, and safety tips, helping ensure public safety and preparedness.

The advent of social media platforms like Facebook, which has a total of 243.58 million active users in the U.S., or about 75.3% of the population (University of Maine, 2021), has revolutionized the way communities, the general public, and government entities exchange information during wildfire incidents. This transition to social media represents a paradigm shift, as it transcends the conventional linear communication model. In the contemporary era, the public is empowered to express their sentiments, opinions, and comments on government responses and measures as wildfire events unfold (Houston et al., 2015). Additionally, the public actively participates in creating and sharing wildfire-related content through blogs and forums (Paveglio et al., 2014; Cheng, 2018; Eriksson, 2018). These social networks facilitate citizen journalism and the real-time dissemination of wildfire information, contributing to a dynamic information ecosystem.

Incorporating social media into wildfire communication strategies enables dynamic engagement, fostering a participatory emergency communication system (Cheng, 2018; Riehl, 2021; Hagler et al., 2021). Platforms like Facebook facilitate two-way communication, allowing government agencies to both disseminate information and receive real-time feedback and reports from the public, enhancing community involvement in safety measures (Riehl, 2021; Hagler et al., 2021). Beyond dissemination, social media platforms support community building during wildfires, enabling residents to share experiences and support one another, fostering solidarity and mutual aid in coping with wildfire challenges (Paveglio et al., 2014; Simon et al., 2015).

To effectively manage wildfire communication dynamics, actively engaging with the public is essential. Monitoring social media allows authorities to gauge public sentiment and tailor strategies to build trust and cooperation (Paveglio et al., 2014; Luna & Pennock, 2018; Riehl, 2021). Emphasizing two-way communication helps combat misinformation and provide accurate information, establishing a more resilient communication framework (Simon et al., 2015; Luna & Pennock, 2018). Furthermore, responding promptly to public sentiment and addressing misinformation is critical to avoid losing control over the risk communication process (Glik, 2007). Thus, understanding how different media convey narratives and sentiments about wildfires and how the public perceives and reacts to these messages aids in informing authorities to identify triggers for dissatisfaction and allows adaptive messaging to ease community panic and fear.

Nevertheless, the realm of social media research concerning natural disasters lacks comprehensive exploration, especially regarding wildfires. Studies on the government's use of social media during wildfires and public interaction remain limited. Furthermore, there's a scarcity of research delving into the types of shared information,

thematic analysis, sentiment assessment, and social network dynamics used in government-run social media, like Facebook, during such disasters. This dearth of attention underscores the necessity for further investigation into harnessing social media for wildfire communication, potentially offering invaluable insights for practitioners and policymakers.

This research aims to fill these gaps, focusing on the 2022 Oregon wildfire events. It strives to answer three pivotal questions: the types of government messages prompting community responses during wildfires, the primary themes in wildfire-related posts by wildfire authorities on social media, and the sentiments and emotions of the community in response to these messages. Notably, understanding the impact of government messages during wildfires is crucial for optimizing risk communication strategies, tailoring efforts to engage the public effectively, and improving compliance with safety guidelines and evacuation orders (Luna & Pennock, 2018). Moreover, identifying primary themes in wildfire-related posts assists the public information officer (hereinafter POI) in crafting more relevant and effective information, enhancing the public's understanding, and fostering better compliance with safety guidelines during wildfire events (Cheng, 2018). Lastly, exploring community sentiments and emotions in response to public channel messages provides insights into the psychological and emotional aspects of wildfire communication. This data can inform strategies to alleviate fear, build trust, and promote community resilience during crises, considering the significant role of emotions in decision-making and risk perception (Glik, 2007; Cheng, 2018).

2022 Oregon wildfire In Oregon, wildfire season typically commenced in late July and extended through early September, a period characterized by dry and hot conditions conducive to wildfire ignition and spread (ODF, 2016). This traditional timeframe aligns with the typical peak of fire activity in the western United States. However, a notable shift has occurred more recently, with wildfires igniting as early as mid-July and continuing well into early October (ODF, 2020). This extended wildfire season challenges traditional notions of when Oregon is most vulnerable to wildfires and underscores the changing dynamics of fire risk and climate patterns in the region (Higuera et al., 2023).

Geographically, the distribution of wildfires impacting Oregon has been predominantly concentrated in the Southern, Central, and Northeastern regions, with some spillover into Northern California's mountainous areas (ODF, 2020). These areas are characterized by diverse ecosystems, from forests to grasslands, which are particularly susceptible to wildfire due to their flammable vegetation and the influence of regional weather patterns (ODF, 2022). This has made Oregon face a recurring and persisting wildfire problem.

The 2022 wildfire season in Oregon, especially, left a lasting mark on communities and ecosystems across the state. With a total area burned of 443,000 ac (180,000 ha), the fires have caused many negative externalities. One of the most immediate and visible impacts was on air quality and

public health. Wildfire smoke, filled with particulate matter and hazardous pollutants, blanketed many regions, leading to poor air quality and posing serious health risks to residents (Higuera et al., 2023). Individuals, particularly vulnerable populations like children and the elderly, faced increased respiratory issues, exacerbations of pre-existing conditions, and the need for medical attention (Vargo et al., 2023).

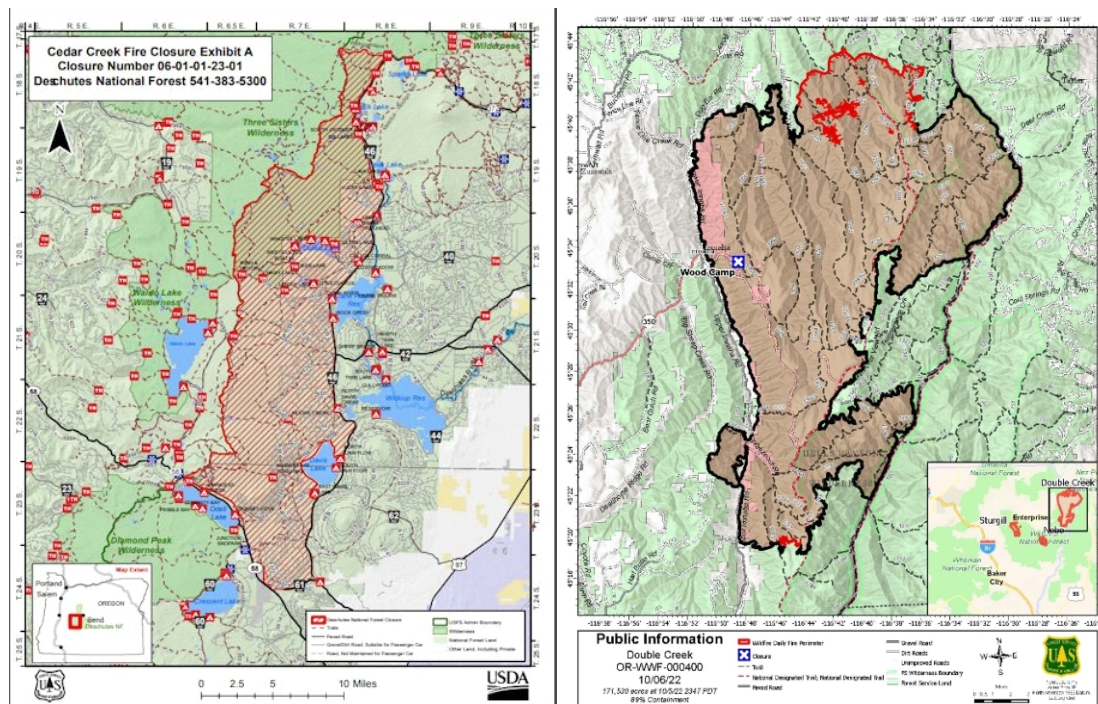
The consequences of the 2022 wildfires extended beyond health concerns (McEvoy et al., 2020). Transportation networks in various areas were severely disrupted due to road closures caused by fires or safety concerns related to falling trees and debris. These disruptions not only hindered the ability of residents to evacuate or travel but also had economic ramifications for the movement of goods and services. Additionally, the wildfires had significant impacts on timber resources, affecting the forest industry in Oregon, of which the timber industry is one of the economic drivers (Coughlan et al., 2022).

Furthermore, the extensive wildfire activity in 2022 had repercussions on the state's recreational activities and rural livelihoods. Popular recreational areas were closed due to the fire danger, affecting both tourism and outdoor businesses. Local economies that relied on these activities, such as outdoor guiding services, restaurants, and accommodations, faced financial challenges. Moreover, the destruction and damage to homes, properties, and critical infrastructure in some areas are also inevitable.

There are two areas in Oregon during the 2022 wildfire season that have burned more than 100,000 ac: 1) Cedar Creek Fire and 2) Double Creek Fire (US Incident Information System, hereinafter InciWeb, 2022) (Figure 1). The Cedar Creek Fire engulfed over 120,757 ac, primarily affecting residents in Lane County (InciWeb, 2022). Lane

County had a population of 381,000 with a median age of 39.8, and over a third of its residents (35%) had graduated from university (Data USA, 2021). Meanwhile, the Double Creek Fire ravaged more than 161,591 ac, predominantly impacting Wallowa County (InciWeb, 2022). In 2021, Wallowa County had a population of 7,330 people with a median age of 52.3, and over a third of its population (32%) had also graduated from university (Data USA, 2021). Given the significant size of the communities residing in these two areas and the severity of the wildfires, which have led to economic losses, infrastructure damage, biodiversity impacts, and extensive community disruption, these two wildfires are the primary focus of this study.

The Cedar Creek fire ignited due to a series of lightning strikes in the Willamette National Forest, situated approximately 15 miles east of Oakridge, Lane County, Oregon. This remote forested area provided the initial fuel for the fire, which soon grew in intensity and began burning through dense timber. The rapid progression of the fire necessitated evacuation orders, and over 2,000 homes in the vicinity were evacuated to ensure the safety of local residents (NWCC, 2022). The fire suppression efforts alone incurred a significant cost, estimated at a minimum of USD57.9 million, highlighting the financial strain and resources required to combat wildfires of this magnitude (NWCC, 2022). One of the far-reaching consequences of the Cedar Creek Fire was the impact of its smoke. Smoke from the fire drifted north and east, affecting regions as far away as Seattle, which is approximately 250 miles to the north of the fire's origin. The arrival of this smoke in Seattle led to the city recording the worst air quality of any major city in the world, emphasizing the extensive reach of wildfires and their potential to affect air quality over great distances (NWCC,



Sources: Interagency all-risk incident information management system web (InciWeb)

Figure 1 Cedar Creek (left) and Double Creek (right) during their fire season peak.

2022).

Similarly, the Double Creek Fire was also a lightning-caused wildfire that burned across the Hells Canyon National Recreation Area in Wallowa County, Oregon. The fire was Oregon's largest wildfire in the 2022 season. The fire grew significantly, moving north along Grizzly Ridge and east toward the Snake River. In the south, flames moved more slowly down the Granny Creek drainage toward Freezeout Road. The fire also burned 10 miles southeast of Imnaha, a remote community in Oregon's northeast corner. The area was under several evacuation levels, including "go now" evacuations. The fire also prompted evacuations by campers from Imnaha south to Palette Ranch. The wildfire has damaged 16 homes and 53 structures, resulting in 3 casualties and aggregate economic losses reaching more than USD300 million (NWCC, 2022).

Methods

Data extraction and overview Data for this study was collected from two active government-managed Facebook pages: 1) Double Creek Fire (Facebook ID: 100085178569600); and 2) Cedar Creek Fire (Facebook ID: 100084533790070). These two were chosen as in the 2022 Oregon wildfire season, both regions have the largest burned area and actively use Facebook pages as their communication tools. Double Creek Fire page has a total follower as many as 2,387 accounts and Cedar Creek Fire has 15,087 followers. Facepager (Jünger & Keyling, 2019) a third-party software that facilitates Facebook Page data extraction through Facebook's Application Programming Interface (API) was used to extract the Facebook pages' posts, user comments to posts, replies to comments, and engagement (i.e., Like, Love, Haha, Wow, Sad, and Angry). Contents posted between August 6, 2022, and October 15, 2022, were collected. The data comprised Facebook page posts from the Cedar Creek fire ($n = 387$) and Double Creek fire ($n = 121$) totaling $N = 508$ and Facebook page comments from the Cedar Creek fire ($n = 3,073$) and Double Creek fire ($n = 381$), totaling $N = 4,068$. A total of 4,576 posts and comments data were analyzed.

Data analysis *Extent of Facebook use* To examine the extent of Facebook use by the wildfire authorities, i.e., the public information officer (PIO), the study used the average number of posts per day (PPD) measure to link the number of daily posts to significant dates on which Facebook pages inform the community regarding on-going wildfire events in order to determine how particular events may affect the extent of Facebook use.

Thematic analysis of wildfires related posts The prevalent theme of each wildfire-related post was identified using a process involving several coders. First, the principal coders assigned the relevant themes to the wildfire-related posts. The themes are then reviewed, examined, and verified by other coders. Additionally, the postings' content was first reviewed and divided into manageable sections. For posts with multiple themes, the dominant theme i.e., the theme that made up the majority of the message was assigned. The themes covered a range of topics, such as status updates

(including area and road closure, smoke outlook, containment and suppression effort, and daily statistic summary), alert and evacuation information, fire science (including fire behavior prescribed fire), firefighters' story, appreciation, public reassurance and miscellaneous. Using N-Vivo, the number of posts that made up each of these themes and their proportion to the overall number of posts were reported. A further analysis of its text was also conducted to further detail the dominant themes.

Sentiment analysis The study performed sentiment and thematic analysis on comments made to acquire information and insights into how communities who utilize Facebook responded to and commented on government wildfire authority's postings. The Vader Algorithm (Hutto & Gilbert, 2014), which has been specifically designed for determining the sentiment in brief texts, was used to determine the sentiment polarity (SP) score for each comment. The sentiment polarity score value varies from -1 to 1 and was classified into five categories from very negative ($-1 < \text{score} < -0.5$), negative ($-0.5 < \text{score} < 0$), neutral ($\text{score} = 0$), positive ($0 < \text{score} < 0.5$), or very positive ($0.5 < \text{score} < 1$). This paper then analyzed emotions represented by Facebook reactions and used the remarks that were categorized according to the eight feelings listed in the theory of emotion (Plutchik, 2014) as follows: anger, fear, sadness, disgust, surprise, anticipation, trust, or joy. The positive feelings among the eight emotions are trust and joy, while the negative emotions include anger, sadness, fear, and disgust. Surprise and anticipation are not included in either of the two categories because they can be either positive or negative depending on the situation.

Results and Discussion

First and foremost, it is essential to recognize that while both Lane County and Wallowa County share similar levels of educational attainment among their demographics, they differ significantly in terms of the median age of their residents, and population size. As iterated before, Lane County residents have a median age of 39.8, with a population of 381,000, while Wallowa County residents have a median age of 52.3, with a population of 7,330. These demographic variations may influence social media usage patterns (Sharifian et al., 2021). Thus, any observable differences in the following findings may be attributed to these demographic disparities (Reed et al., 2014; Chang et al., 2015; Sigerson & Cheng, 2018).

Furthermore, as suggested by Yovi et al. (2023), cultural differences and varying levels of knowledge may lead to different behaviors in addressing potential climate-related risks. These differences in behavior may also be influenced by factors such as age groups, among others (Ayalon & Roy, 2023) which exists in this observation. Therefore, it is crucial to consider these factors when interpreting the study's findings.

Wildfires outreach efforts and public engagement In Table 1, aggregated statistics corresponding to the Facebook posts from Cedar Creek Fire and Double Creek Fire are presented along with the public engagement metrics. On a typical day

during fire season, the government agency managing the Cedar Creek Fire page posted around 5 Facebook posts per day which gathered 92 reactions on average from its followers. Those posts were then shared by around 44 accounts and were commented on by 8 accounts on average per day. Similarly, Double Creek Fire posted around 3 Facebook posts per day, and their posts were shared by 29 followers on average, had a reaction from 42 followers, and were commented on by at least three followers.

The findings underscore the pivotal role of social media in wildfire communication, notably in engaging the public during crisis situations. The frequency and content diversity of posts by Cedar Creek and Double Creek Fire agencies align with previous research emphasizing the significance of consistent and timely information dissemination during crises (Pan et al., 2012; Wei et al., 2014; Brynielsson, 2018). The substantial increase in engagement metrics during intensified wildfire impact, particularly in the second week of September, validates the effectiveness of these agencies' responsive communication strategies. These observations corroborate with studies advocating for adaptive communication approaches that align with evolving crisis stages to sustain public interest and involvement (Palen & Liu, 2007; Veil et al., 2020). Adapting communication approaches throughout the crisis timeline, from prevention to containment and recovery, can ensure the continual relevance and effectiveness of wildfire communication. As crises evolve, authorities must pivot communication strategies to address emerging concerns and provide timely, accurate, and accessible information to the public.

Additionally, Figure 2 and Figure 3 summarize the fluctuating level of user engagement with both Facebook pages' posts during the observed period for Cedar Creek Fire and Double Creek Fire, respectively. During the first and second weeks of September, both Facebook pages saw a considerable increase in public engagement metrics. The varying patterns of user engagement between Cedar Creek and Double Creek Fire agencies' posts highlight intriguing nuances in community behavior during crises. The preference for sharing posts by Cedar Creek followers versus Double Creek's audience's inclination toward reacting signifies distinct engagement preferences (Faas et al., 2017). This disparity could stem from demographic differences or the nature of information shared, underscoring the need for tailored communication strategies for different audience segments. Such distinctions in user behavior align with studies emphasizing the importance of understanding audience preferences to optimize engagement (Cheng, 2018).

Further, the analysis revealed that specific post types, such as evacuation notices and containment efforts, drove

higher engagement, underscoring the significance of content relevance and immediacy during crisis communication. However, there's a need to diversify content beyond immediate safety measures. Integrating scientific insights, environmental impact updates, and addressing community concerns, for instance, could foster a more comprehensive understanding among the audience (Avilés Irahola et al., 2022).

Additionally, the observed user behavior, preferring shares over giving reactions or comments in certain contexts, should inform communication strategies. While Cedar Creek's audience might appreciate informative shares, Double Creek's followers might seek more interactive engagement. These nuances call for a dynamic approach, catering to varied user preferences to maximize information dissemination and community involvement. This aligns with the evolving landscape of social media communication, emphasizing tailored content and interactive strategies for audience engagement during crises (Austin et al., 2012; Sutton et al., 2015; Wang et al., 2023).

In addition, analysis of the post engagement from Figure 2 shows that a typical post that has been the most shared by the communities is the post regarding the evacuation notice. Similarly, from Double Creek Fire Facebook engagement, in Figure 3, the post that got the most reactions and was the most shared is the post that highlighted wildfire containment and suppression efforts. Given this finding, agencies should try to implement a multifaceted approach that balances immediate safety-related information with comprehensive updates on environmental impacts and scientific insights that could foster a more informed public. Additionally, recognizing and accommodating audience engagement preferences, be it through shares, reactions, or comments, will be pivotal in crafting effective and inclusive communication strategies.

Thematic analysis The themes of area and road closure, smoke outlook, containment and suppression, and daily statistic summary were combined with the theme “status update” to focus on 7 other themes including, alert and evacuation information, fire science, firefighters' story, risk management, appreciation, and public reassurance. As shown in Table 2, posts on Firefighters' stories were dominant, especially for the Cedar Creek Fire Facebook page. For the Double Creek Fire Facebook page, the theme of status updates is the most prevalent. In terms of its frequency, after the firefighter story and status update, the following themes appear the most: alert and evacuation information, fire science, appreciation, and public reassurance.

Firefighters' story The government-managed Facebook

Table 1 Summary Facebook posts and engagements

Agency	Outreach effort		Public engagement		
	Total posts (n)	PPD mean (SD)	RPP mean (SD)	SPP mean (SD)	CPPmean (SD)
Cedar Creek Fire	387	5.45 (2.77)	92.19 (85.56)	44.61 (68.56)	7.94 (18.29)
Double Creek Fire	121	3.5 (1.93)	42.51 (52.16)	29.77 (53.75)	3.14 (6.22)

Note: PPD = post per-day; RPP = reaction per-post; SPP = Share per-post; CPP = comment per-post; n = total observation; SD = standard deviation

posts during wildfires tend to center narratives on the human aspect, particularly emphasizing the stories of firefighters, akin to coverage in mainstream media. Notably, these narratives, while less stereotyped, still predominantly highlight the bravery of firefighters rather than ecological ramifications. For instance, Cedar Creek Fire's Facebook page exhibits this focus in 40.82% of its 387 posts. While portraying firefighter stories may reassure readers about government efforts, it might limit public understanding of the wildfire reality, necessitating a shift to more diverse and critical perspectives (Morehouse & Sonett, 2010).

In addition, despite showcasing the dedication of firefighters and humanizing crises, these narratives might overshadow ecological implications (Cooper & Duncan, 2023). This emphasis, observed in Cedar Creek Fire's posts, resonates with societal admiration for firefighters but may detract from crucial aspects like ecological impact and fire management strategies. Scholars propose diversifying narratives to encompass critical analysis, aligning with the need for a comprehensive public understanding (Cooper & Duncan, 2023). It prompts the importance of multifaceted crisis communication, urging engagement with diverse

perspectives to enhance risk comprehension (Vigliano Relva & Jung, 2021).

The prominence of firefighter-centric narratives prompts a reassessment of wildfire communication strategies, emphasizing the need to reevaluate narrative structures and content framing. Media framing plays a pivotal role in shaping public attitudes and behaviors during crises. If firefighter-centric portrayals eclipse essential information on fire ecology and safety measures, public perception might skew regarding the severity and complexity of wildfires, impacting decision-making and community resilience (Reynolds & Seeger, 2005). Therefore, while acknowledging firefighter valor, supplementing these narratives with comprehensive information becomes imperative for informed decision-making and resilience.

Status updates Our analysis highlights the considerable impact of “status update” posts on Double Creek Fire's and Cedar Creek Fire's Facebook pages, constituting 42.15% and 35.66% of the total posts, respectively. These updates typically include crucial information such as area burned, containment measures, road closures, personnel and

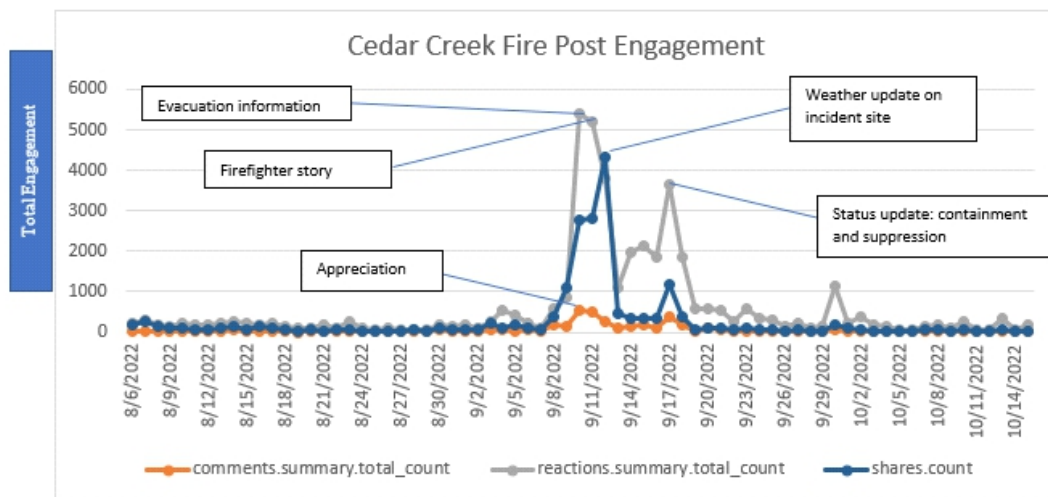


Figure 2 Public engagement on wildfire-related Facebook posts by Cedar Creek Fire public information officer (PIO).

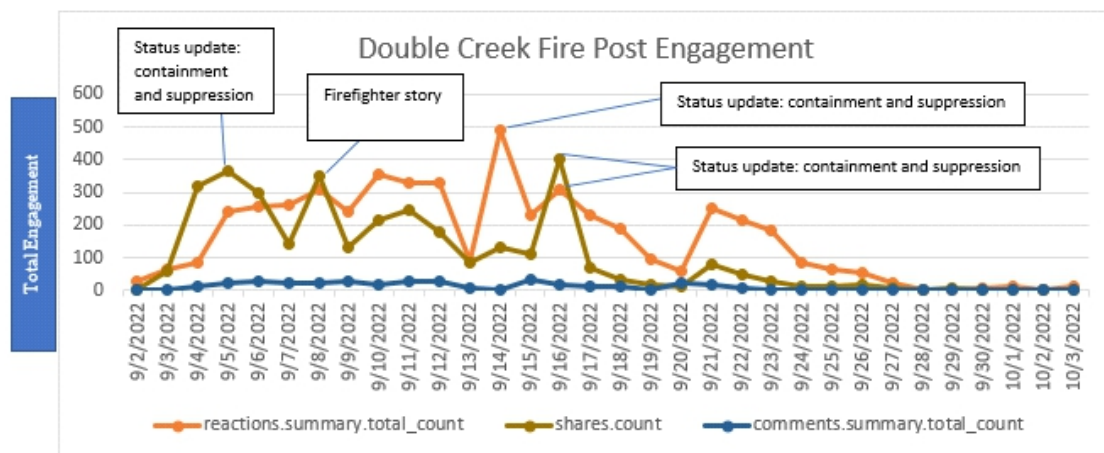


Figure 3 Public engagement on wildfire-related Facebook posts by Double Creek Fire public information officer (PIO).

equipment details, and smoke outlook, aligning with Forest Service USDA guidelines that emphasize comprehensive wildfire announcements encompassing various essential information types (USDA, 2013). This finding underscores the importance of disseminating timely, accurate updates during wildfire events, echoing existing literature stressing the role of social media in distributing real-time information during crises to ensure public understanding and safety (Cheng, 2018).

However, while these status updates comply with established guidelines for crisis communication, questions arise regarding their comprehensiveness. Despite meeting FS-USDA guidelines, these updates might overlook critical aspects of wildfire communication, such as addressing community concerns, offering preparedness guidance, or providing nuanced ecological insights. Previous research highlights the importance of integrating community-specific information and addressing public inquiries during crisis communication, suggesting the need for a more diversified content strategy (Houston et al., 2015).

Nevertheless, the substantial engagement observed with status updates underscores the public's strong interest in receiving timely, factual information during wildfire events. Social media serves as a primary source for real-time updates and community engagement during crises, highlighting the necessity for government agencies and wildfire authorities to prioritize clear, concise, and consistent updates on these platforms (Pan et al., 2012). However, while factual updates are essential, there's a need to consider the limitations of this content format in addressing the emotional and psychological needs of affected communities. Integrating empathetic and community-centric communication elements within status updates could enhance their efficacy in meeting diverse stakeholder needs (Veil et al., 2020).

Alert and evacuation information The post regarding alert and evacuation information is deemed helpful as indicated by the number of shares, comments, and reactions by the followers (29% and 18%) of the total post for Cedar Creek and Double Creek respectively. The observed trend highlights the potential of social media platforms as vital tools for authorities to promptly and effectively communicate evacuation directives during wildfire crises, aiding communities in monitoring and responding to evolving situations. However, while acknowledging the effectiveness of alert and evacuation posts in engaging social media users, it is essential to address potential challenges and limitations associated with this communication strategy.

Scholars have highlighted the complexities surrounding information dissemination during crises on social media platforms, particularly concerning the rapid spread of unverified or misleading information (Muhammed & Mathew, 2022). While prompt dissemination of evacuation notices is crucial, ensuring the accuracy and credibility of the information shared is equally imperative. Therefore, while emphasizing the dissemination of alert and evacuation information, government agencies must prioritize the verification and authenticity of the information to mitigate potential confusion or misinformation among the public.

Moreover, the observed engagement with evacuation-

related posts highlights the dynamic nature of social media communication during crises. It underscores the need for government agencies to continually adapt their communication strategies to meet evolving community sentiments and information needs. This aligns with the concept of agile communication during crises, emphasizing the importance of responsiveness and adaptability in addressing changing public concerns (Houston et al., 2015). Thus, while alert and evacuation posts prove effective in engaging social media users, agencies must remain flexible and responsive in their communication approaches to ensure relevance and efficacy.

Fire science The analysis of Cedar Creek Fire and Double Creek Fire Facebook pages reveals a notable but relatively less dominant frequency of posts focusing on fire science, constituting 13.95% and 16.52% of their respective total posts. Interestingly, these posts elicited substantial engagement from the general public, suggesting an opportunity for government-run pages to emphasize scientific perspectives on wildfire events. Strengthening these postings could offer diverse insights and understanding of fire science, fostering community resilience through increased knowledge sharing (Mahajan et al., 2022).

This observation underscores an opportunity for enhancing government communication strategies during wildfire events. Given the public interest and engagement, prioritizing fire science-related posts aligns with existing literature emphasizing the need for scientific information dissemination during crises (Paveglio et al., 2009). It is evident that a gap exists in the communication strategies employed by government agencies regarding the frequency of fire science-related posts, emphasizing the need for more comprehensive and transparent communication during such events.

In addition, the public's engagement with these scientific posts suggests a growing interest in diverse perspectives on wildfires, echoing the concept of participatory communication. Increasing content related to fire science aligns with this approach, enabling the dissemination of specialized knowledge and fostering community resilience through enhanced awareness and understanding. However, while advocating for a greater emphasis on fire science, it is essential for government agencies to ensure the accessibility and clarity of this information for diverse audiences. Tailoring communication strategies to cater to varying audience needs and expertise levels is crucial and the effective communication of technical information in a clear and understandable manner is key to engaging both experts and the general public (Heath et al., 2006; Houston et al., 2015).

Appreciation The limited prevalence of appreciative nuanced messages in the Cedar Creek and Double Creek Fire Facebook posts, constituting only about 2.84% and 1.65% respectively, also underscores an area for improvement in Oregon government agencies' crisis communication strategies during wildfire events. These findings highlight a gap in social media communication during crises, as existing literature underscores the significance of positive and

appreciative sentiments to bolster community resilience and perception (Veil et al., 2020). The considerable engagement these posts received signifies an untapped potential for government-run social media to amplify messages of appreciation, fostering community solidarity and resilience amid wildfire events. The engagement with nuanced appreciative messages suggests an opportunity for government agencies to enhance their communication strategies by incorporating more appreciative content. Such content not only fosters community solidarity but also acknowledges responders' efforts, enhancing morale amid challenging circumstances.

The substantial engagement observed with appreciative nuanced posts reflects an evolving public preference for positive and supportive messaging during crises. This aligns with the holistic concept of crisis communication, which not only disseminates information but also addresses emotional needs and promotes community well-being (Reynolds & Seeger, 2005). These metrics emphasize the importance of acknowledging and appreciating responders, volunteers, and affected communities, fostering unity and resilience. Hence, government agencies can leverage social media platforms to cultivate a sense of appreciation and gratitude, nurturing a supportive and resilient environment during wildfire events.

However, while advocating for increased emphasis on appreciative nuanced messages, ensuring the authenticity and sincerity of such communication is crucial. Maintaining trust and credibility during crisis communication on social media is paramount (Guo et al., 2021). Therefore, while promoting appreciative messaging, agencies should ensure authenticity to reflect a genuine appreciation for responders and affected communities. This sincerity plays a pivotal role in fostering trust and reinforcing community bonds.

Public reassurance Posts containing messages about public reassurance were also not dominant. On Cedar Creek Fire's Facebook page, for instance, they only have 8 posts, or 2.07% aimed to reassure the public about the control of wildfire events. Similarly, on the Double Creek Fire Facebook page, the public reassurance theme only has 3 posts or 2.47% of the total posts. Nevertheless, this type of post has gathered a significant number of reactions, comments, and shares.

This finding might signal various factors influencing the community's response to these posts. One possibility could be the nature of the wildfire events and the urgency or severity they posed. Scholar suggests that the tone and timing of reassurance messages during crises significantly impact their reception (Heath et al., 2006). If the wildfire events were particularly intense or posed immediate threats,

reassuring messages might have been perceived as less impactful or even inadequate, leading to lower engagement.

Additionally, the communication strategy or the framing of these reassurance posts could play a role. Content that lacked specific details, actionable information, or context might not have resonated effectively with the audience. Further, vague or generic messages might fail to engage or reassure the public effectively during emergencies (Cheng, 2018). Another aspect could be the potential saturation of certain types of content on social media during wildfire events. If there was an overwhelming amount of information, including reassurance messages, it is possible that these specific posts got lost in the flood of updates, impacting their visibility and subsequently their engagement levels.

Sentiment analysis As shown in Table 3, the Cedar Creek Fire Facebook page has a total of 3,073 comments and their average comment per post (CPP) was 7.94 for the observed period. Meanwhile, Double Creek Fire, which has a total of 381 comments has an average of 3.14 comments per post. The average sentiment polarity (SP) scores for both wildfire Facebook Pages were very positive sentiments with a score of 0.61 for Cedar Creek Fire and 0.78 for Double Creek Fire, respectively.

This shows that the majority of comments across both Cedar Creek and Double Creek Fire pages conveyed messages of appreciation, reflecting positive emotions like trust and joy. Conversely, comments expressing negative sentiments such as anger, sadness, fear, and disgust were less prevalent among followers. This positive trend in sentiments suggests a favorable reception to the agencies' communication efforts, fostering a sense of trust and community support during challenging times. Understanding the predominant positive emotions expressed by users underscores the impact of effective communication strategies on social media platforms, reinforcing the need for continued emphasis on transparent and informative content that resonates positively with the community. Moreover, acknowledging the limited occurrence of negative sentiments signals an opportunity for agencies to address and alleviate specific concerns or uncertainties expressed by a minority of followers, further enhancing overall community engagement and satisfaction during forest fire events.

Conclusion

The analysis of Oregon government agencies' social media engagement during the Cedar Creek and Double Creek wildfire seasons highlights the critical role of social platforms in crisis communication. These findings

Table 3 Sentiment analysis summary

Agency	Wildfire posts	Comments	CPP mean (SD)	SP mean (SD)
Cedar Creek Fire	387	3,073	7.94 (18.29)	0.61 (0.63)
Double Creek Fire	121	381	3.14 (6.22)	0.78 (0.82)

Note: CPP = comments per post; SP = sentiment polarity score. The sentiment polarity score value varies from -1 to 1, and was classified into five categories from very negative (-1 < score < -0.5), negative (-0.5 < score < 0), neutral (score = 0), positive (0 < score < 0.5), or very positive (0.5 < score < 1).

underscore the need for adaptable communication strategies, catering to evolving crises and diverse community sentiments. The nuanced differences in engagement between the agencies reveal the necessity for tailored communication approaches that resonate effectively with varied audience preferences and demographics. This underscores the importance of optimizing engagement strategies to ensure effective communication with different audience segments. Furthermore, the study emphasizes the importance of diversifying content beyond immediate safety measures. Integrating scientific insights and addressing broader community concerns alongside evacuation notices prove vital in crafting inclusive communication strategies. The dominant themes observed, such as status updates, signal the significance of real-time, factual information while urging for a more comprehensive approach to wildfire communication. The findings also underscore the imperative for government agencies to craft agile and diversified communication strategies. Embracing diverse narratives, integrating scientific insights, and amplifying appreciative and reassuring messages are crucial to fostering a resilient and informed community. Moreover, given the polarity score, the study emphasizes the need for empathetic and responsive communication strategies that acknowledge and address community concerns, fostering stronger community relations and trust during wildfire events.

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