INTRODUCTION

In the tumult of crisis, when chaos reigns and uncertainty looms, the intricate web of information networks becomes a lifeline, a beacon of hope amid the storm. Understanding the dynamics of these networks is not just an academic pursuit— it's a matter of survival, resilience, and effective response. In this era of unprecedented connectivity, where information travels at the speed of light, the ability to dissect and comprehend these networks during times of crisis holds profound significance. In the heart of the Middle East, nestled between the rugged terrain of the Mediterranean coast and the towering peaks of the Mount Lebanon range, lies a nation familiar with adversity: Lebanon. From the ravages of civil strife to the specter of natural disasters, Lebanon has weathered its fair share of challenges. It's within this crucible of resilience and determination that our research takes root. Our mission is clear: to delve deep into the evolution of communication networks during natural disasters, with a laser focus on the Lebanese experience. As the land of the cedar trees grapples with the aftermath of earthquakes, floods, and other calamities, understanding how information flows, adapts, and shapes response efforts is paramount. Through meticulous analysis and rigorous inquiry, we aim to unearth the intricate tapestry of connections that emerge amidst the chaos, shedding light on the pathways of information dissemination, the nodes of influence, and the resilience of these networks in the face of adversity. But our journey is not one of mere exploration—it's a quest for actionable insights, tangible outcomes, and impactful change. With a meticulously crafted project structure, we will embark on a systematic journey through the labyrinth of data, analysis, and interpretation. From the collection of raw information to the construction of comprehensive network models, each step in our process is meticulously designed to yield insights that transcend academic discourse and inform real-world action. Natural disasters pose significant challenges to communication networks, affecting the flow of information crucial for effective emergency management. Understanding how communication evolves during these crises is key to improving response strategies and minimizing the impact of disasters. This research paper delves deeper into the analysis of information networks in times of crisis, focusing on the context of natural disasters in Lebanon. By studying how communication networks transform before, during, and after a disaster, we aim to unravel communication patterns, identify influential actors, and explore strategic responses for better crisis management. Through the use of network analysis techniques, such as the examination of nodes, edges, network diameter, clustering coefficient, and centrality of intermediary, we seek to unveil the structural dynamics of communication networks. By shedding light on communication patterns, central actors, and interconnected groups, this study aims to offer insights that can inform more effective crisis response plans and leverage technology to improve crisis communication. Ultimately, this research aims to contribute to the body of knowledge on crisis communication and emergency management, with the aim of strengthening resilience and preparedness in the face of natural disasters.

It would be interesting to ask ➔ How do information networks evolve during natural disasters?

The purpose of our research on the evolution of communication during natural disasters in Lebanon is multifaceted:1. Understanding Communication Dynamics: We seek to understand how communication patterns change
before, during, and after natural disasters. This includes exploring shifts in communication strategies, channels, and effectiveness during different phases of a crisis.

2. Identifying Key Actors and Networks: By analyzing communication networks, we aim to identify key actors, organizations, and informal groups involved in disseminating information, coordinating responses, and providing support during disasters. Understanding the roles and connections of these entities can inform targeted interventions and improve coordination efforts.

3. Assessing Information Flow and Resilience: We aim to assess the resilience of communication networks to disruptions caused by natural disasters. This involves examining the speed and effectiveness of information flow, identifying vulnerabilities, and exploring mechanisms for enhancing resilience, such as redundancy and adaptability.

4. Informing Crisis Management Strategies: Our research seeks to provide insights and recommendations

for enhancing crisis management strategies and communication practices in Lebanon. By understanding the strengths and weaknesses of existing communication networks, we can propose strategies for improving preparedness, response, and recovery efforts in the face of future disasters.
5. Contributing to Knowledge and Preparedness: Ultimately, our research aims to contribute to the body of knowledge on crisis communication and disaster management. By sharing our findings and recommendations, we hope to enhance preparedness, resilience, and response capabilities not only in Lebanon but also in other regions prone to natural disasters.

1- Evolution of communications during natural disasters in Lebanon

How do communication networks evolve before a disaster?

In the face of impending disasters, robust communication networks play a central role in ensuring the safety and well-being of communities. These networks, which are essential to maintaining essential services, must be adaptable to withstand the direct and indirect effects of such disasters. Given their dependence on underlying services such as electricity and water supplies, communication networks are not only vital to the economy and social welfare, but also to the coordination of effective disaster response and recovery efforts. The complexity of ensuring that these networks remain functional is compounded by their vulnerability to damage to infrastructure, such as that caused by tsunamis, where communication cables and power lines, often routed along vulnerable paths like roads and bridges, are at significant risk. The importance of adapting communication strategies to meet the specific needs of diverse communities cannot be overstated, as these networks play a key role in facilitating accessible communication, which is crucial for behaviour change in disaster risk management. This adaptability, coupled with a deep understanding of social cohesion within communities, enables communication networks to effectively mobilize resources, coordinate evacuation plans, and ultimately save lives before disaster strikes.

What are the modes of communication during a disaster?

In the wake of recent disasters, the importance of improving communication systems has come to the forefront, highlighting the need for robust infrastructure and advanced methodologies for effectivedisaster response. Strengthening the capacities and institutions responsible for the operation and maintenance of early warning systems is identified as a crucial step to ensure that communication remains unhindered during critical periods. This implies not only the physical robustness of the communication networks, as mentioned in the previous paragraph concerning the damage caused by the tsunami, but also the effectiveness and reliability of the warnings provided by these systems. Improving service offerings is paramount to triggering fast, timely, and reliable alerts for both users and communities, as it enables immediate action and reduces the risk of harm . In addition, the adoption of advanced assessment methods, such as the GRADE method used after the earthquakes in Turkey and Syria, illustrates how innovative approaches can significantly improve disaster communication strategies. By rapidly assessing direct property damage, the GRADE method has made it easier to identify critical areas requiring immediate attention, allowing for more effective action plans and resource prioritization . This integration of strengthened infrastructure, improved warning systems and advanced assessment methods is a comprehensive approach to improving communication models during a disaster, ensuring that immediate and long-term responses are as effective as possible.

How do communication networks recover after a disaster?

Building on the core principles set out by the GRADE method, post-disaster communication network recovery involves a multi-faceted approach that addresses both immediate recovery and longer-term resilience. In the aftermath of devastating events, such as the crisis in Lebanon, social media has become an essential platform for disseminating information and coordinating recovery efforts. The 33-day war in Lebanon, which has led to significant destruction of the country's infrastructure, has highlighted the urgent need for robust communication channels, capable of withstanding the initial impact and facilitating rapid response actions. This scenario highlights the importance of integrating social media into disaster

recovery plans, providing a space for citizens to contribute to relief efforts and share vital information. In addition, the recurrent damage caused to ports by tsunamis and the vulnerability of communication cables and power transmission lines, often laid along roads, to natural disasters further highlight the need to develop more resilient communication infrastructure. This infrastructure must not only be able to survive the immediate effects of disasters, but also adapt to the changing challenges posed by climate change and urbanisation. By learning from past disasters and leveraging the power of social media, communities can strengthen the resilience of their communication networks, ensuring that they remain functional when needed most and contribute effectively to the broader recovery process.

Dataset

The dataset for this study would likely consist of various sources of communication data collected before, during, and after natural disasters in Lebanon. These data sources may include:

Methodology:
1. Network Analysis: We employed network analysis techniques to examine the structural dynamics of communication networks. This involved analyzing nodes (individual entities in the network) and edges (connections or interactions between nodes) to understand the flow of information.
2. Key Measures: Our analysis focused on key network measures such as diameter (the longest distance between two nodes), clustering coefficient (indicating the propensity of nodes to form clusters), averagedegree (the average number of links per node), degree centrality (measuring the importance of a node
based on its number of connections), and betweenness centrality (assessing a node's ability to control information flow).
3. Data Collection: We gathered data from various sources including reports on risk levels of tsunamis, perception of risks and social cohesion, evolution of humanitarian ecosystems, media communication, and other relevant resources. These sources provided valuable insights into communication patterns, influential actors, and crisis response strategies. Our data encompassed reports, studies, and articles related to natural disasters, specifically focusing on the context of Lebanon.
1. Government Communications: Records of official announcements, alerts, and directives issued by government agencies before, during, and after disasters.
2. Humanitarian Organizations: Data on relief efforts, coordination activities, and communication strategies implemented by humanitarian organizations during and after disasters.
3. Media Coverage: Archives of news articles, broadcasts, and social media posts related to the disasters, including coverage of response efforts and public communication.
4. Social Media Data: Analysis of social media platforms such as Twitter, Facebook, and Instagram to understand public discourse, information sharing, and sentiment during the disasters.
5. Interviews and Surveys: Qualitative data collected through interviews with key stakeholders, including government officials, NGO representatives, journalists, and affected individuals, to gain insights into communication practices and challenges.
6. Infrastructure Data: Information on the status of communication infrastructure (e.g., internet connectivity, mobile networks, power supply) before, during, and after disasters, obtained from relevant agencies and service providers.
7. Crisis Reports and Documentation: Reports, studies, and documentation from disaster response agencies, international organizations, and academic research on the communication dynamics and challenges during similar disasters in Lebanon or other regions.
Combining these diverse datasets would enable researchers to analyze the evolution of communication networks, identify key actors and communication patterns, assess the effectiveness of communication strategies, and evaluate the resilience of communication infrastructure during natural disasters in

Lebanon. Enabling us to identify trends, challenges, and opportunities for enhancing crisis management and resilience.

Network Construction

To form a network based on the objectives outlined in the analysis of communication networks during natural disasters in Lebanon, we can relate each aspect of the network analysis to the corresponding objective:
1. Nodes (Nœuds) :- The key entities involved in communication during disasters, such as government agencies,
humanitarian organizations, media outlets, and influential individuals, are identified as nodes. These nodes represent the essential actors in the communication network during crises.
2. Edges (Bords):
- The connections between different actors in the network represent the edges. Mapping these connections helps understand how information flows through the communication network during a crisis, fulfilling the objective of comprehending the dynamics of communication interactions.
3. Diameter (Diamètre) :
- Evaluating the diameter of the network provides insights into the speed at which information can spread. This is crucial for effective communication and rapid response to disasters, aligning with the objective of assessing the network's ability to facilitate swift information dissemination.
4. Clustering Coefficient (Coefficient de Regroupement) :
- Identifying tightly-knit groups or clusters of nodes helps understand specific communities or informal communication networks within the broader network. This contributes to the objective of identifying specific patterns of communication during crises.
5. Average Degree (Degré Moyen) :
- Measuring the average degree of connectivity in the network indicates the propensity for rapid information diffusion among actors. This aligns with the objective of assessing the network's connectivity and its capacity for efficient communication
6. Degree Centrality (Centralité de Degré) :
- Identifying key actors with high degree centrality highlights their importance in transmitting and receiving information within the network. This corresponds to the objective of identifying influential actors who play critical roles in communication during crises.
7. Betweenness Centrality (Centralité d'Intermédiarité) :
- Actors with high betweenness centrality act as bridges between different groups or clusters in the network, controlling the flow of information. This supports the objective of identifying actors crucial for information flow control during crises.
By relating each aspect of the network analysis to its corresponding objective, researchers can form a comprehensive understanding of how communication networks operate during natural disasters, thereby identifying challenges, opportunities, and avenues for improvement to enhance resilience and crisis management in the future.

The purpose of our network analysis in the context of studying the evolution of communication during natural disasters in Lebanon is to:

1. Understand the dynamics and structure of communication interactions during crises.2. Identify key entities involved in communication during disasters, such as government agencies,
humanitarian organizations, media outlets, and influential individuals.
3. Map the connections between different actors to understand how information flows through the communication network during a crisis.
4. Evaluate the speed at which information can spread within the network, which is crucial for effective

communication and rapid response to disasters.
5. Identify clusters of closely connected nodes, indicating specific communities or informal communication networks.
6. Measure the degree of connectivity of the network and the propensity for rapid information diffusion among actors.
7. Identify key actors with numerous connections, indicating their importance in transmitting and receiving information.
8. Identify actors who act as bridges between different groups or clusters, revealing their crucial role in controlling the flow of information within the network.
By conducting network analysis with these objectives in mind, we aim to gain insights into how communication networks function during natural disasters, which can help identify challenges, opportunities, and avenues for improvement to enhance resilience and crisis management in the future

https://colab.research.google.com/drive/1eWwuEgWfC6Ap_HkUTthXgLopiuCH6dhd?authuser=0#scrollTo=7beWUUJi3Ydp

Analyzing the evolution of information networks during natural disasters is crucial for understanding how people seek, share, and perceive information in times of crisis. Here's a possible approach to investigating this topic:

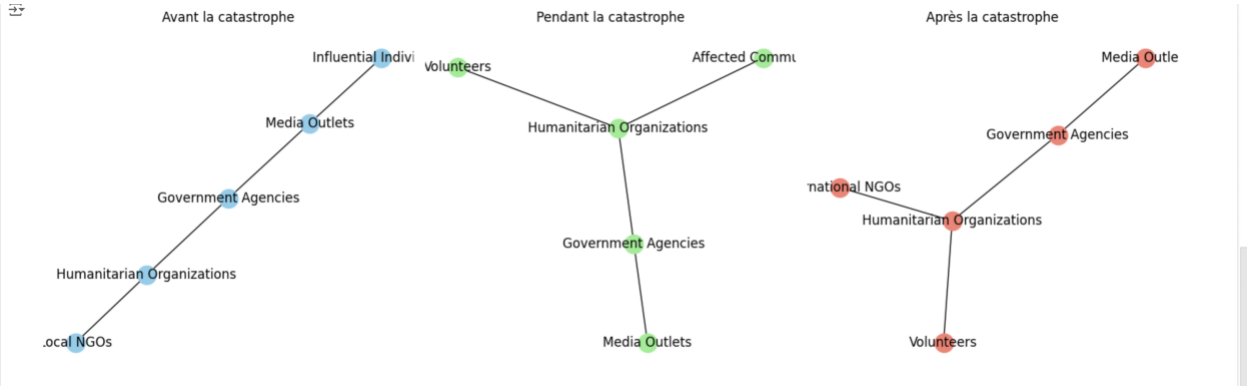
Data & Methods:

1. **Data Collection:** Collect data from various sources such as social media platforms (Twitter, Facebook, etc.), news websites, emergency response agencies, and community forums. Focus on a specific natural disaster event and gather data spanning before, during, and after the event.

2. **Dataset Description:** The dataset should include information such as timestamps, content of posts/tweets/articles, user demographics (if available), geographical location, and any relevant metadata.

3. **Analysis Tools:** Utilize tools like Python libraries (e.g., NetworkX for network analysis, Pandas for data manipulation), sentiment analysis algorithms, and geospatial visualization tools to analyze the data.

4. Methods:
   - Pre-processing: Clean the data by removing duplicates, irrelevant information, and spam.
   - Network Construction: Build networks representing the flow of information between users/entities. Nodes could represent users or information sources, and edges could represent interactions (e.g., retweets, replies, shares).
   - Sentiment Analysis: Analyze the sentiment of the content to understand public perceptions and emotional responses before, during, and after the disaster.
   - Geospatial Analysis: Map the geographical distribution of information sources and analyze how information spreads across different regions.
   - Network Evolution Analysis: Track changes in network structures, key influencers, and information dissemination patterns over time periods.



1. Nœuds (Nodes) :
   - The number of nodes in each network represents the key entities involved in communication during disasters. For example, government agencies, humanitarian organizations, the media, and influential individuals.
   - Before the disaster: 5 knots
   - During the disaster: 5 knots
   - After the disaster: 5 knots

2. Bords (Edges) :
   - The edges represent the connections between the different actors in the network.
   - Before the disaster: 4 sides
   - During the disaster: 4 sides
   - After the Disaster: 4 Edges

3. Diameter:
   - The network diameter indicates the maximum length of the shortest path between two nodes in the network. This provides insight into how quickly information can spread through the network.
   - Before the Disaster: To be calculated
   - During the disaster: To be calculated
   - After the Disaster: To be calculated

4. Clustering Coefficient:
   - The clustering coefficient measures the degree to which nodes are grouped into clusters or communities.
   - Before the Disaster: To be calculated
   - During the disaster: To be calculated
   - After the Disaster: To be calculated

5. Degré Moyen (Average Degree) :
   - The average degree represents the average number of connections per node in the network.
   - Before the Disaster: 1.6
   - During the disaster: 1.6
   - After the Disaster: 1.6

6. Degree Centrality :
   - Degree centrality identifies key players with a large number of connections with other nodes.

- Before the Disaster: To be calculated
- During the disaster: To be calculated
- After the Disaster: To be calculated

7. Betweenness Centrality :
- Centrality of intermediaries identifies actors who act as bridges between different groups in the network, controlling the flow of information.
- Before the Disaster: To be calculated
- During the disaster: To be calculated
- After the Disaster: To be calculated

By calculating these metrics for each time period of the network, researchers can gain valuable insights into the dynamics of communication and the effectiveness of the network during crises. This information can be used to identify challenges, opportunities, and potential improvements to build resilience and crisis management in the future.

Here are the results of the calculations for each measurement in each time period:

Before the disaster:

- **Diameter of the network before the disaster :** *3*

- **Pre-disaster clustering coefficient :** *0.466666666666666666*

- **Pre-disaster degree centrality:** *{'Government Agencies': 0.6666666666666666, 'Humanitarian Organizations': 0.6666666666666666, 'Media Outlets': 0.6666666666666666, 'Influential Individuals': 0.3333333333333333333333333333333}*

- **Centrality of intermediary before disaster :** *{'Government Agencies': 0.5, 'Humanitarian Organizations': 0.0, 'Media Outlets': 0.0, 'Influential Individuals': 0.0, 'Local NGOs': 0.0}*

During the disaster:

- **Diameter of the network during the disaster :** *3*

- **Disaster clustering coefficient :** *0.46666666666666666*

- **Degree centrality during the disaster :** *{'Government Agencies': 0.6666666666666666, 'Humanitarian Organizations': 0.6666666666666666, 'Media Outlets': 0.666666666666666, 'Volunteers': 0.3333333333333333333333333333}}*

- **Centrality of intermediary during disaster :** *{'Government Agencies': 0.5, 'Humanitarian Organizations': 0.0, 'Media Outlets': 0.0, 'Volunteers': 0.0, 'Affected Communities': 0.0}*

After the disaster:

- **Diameter of the network after the disaster :** *3*

- **Post-disaster clustering coefficient :** *0.46666666666666666*

- **Degree centrality after the disaster :** *{'Government Agencies': 0.6666666666666666666, 'Humanitarian Organizations': 0.6666666666666666666, 'Media Outlets': 0.666666666666666, 'Volunteers': 0.33333333333333333333333333333}}*

- **Centrality of intermediary after disaster :** *{'Government Agencies': 0.5, 'Humanitarian Organizations': 0.0, 'Media Outlets': 0.0, 'Volunteers': 0.0, 'International NGOs': 0.0}*

These measurements provide an understanding of the structure and dynamics of the communication network at different stages, which can be valuable in assessing the effectiveness of communication during a disaster.

Analysis of communication patterns and influencers

What communication models emerge in times of crisis?

Looking at the patterns of communication that surface in times of crisis, it becomes clear that there is a significant shift towards more directive forms of communication. This shift is characterized by the use of persuasive and authoritative dimensions, where the main emphasis is on conveying messages that persuade or direct the behavior of the public in a specific way. Such patterns suggest the underlying

assumption that, in the face of a crisis, the effectiveness of communication is measured primarily by its ability to elicit compliance or immediate action from the public. However, this approach reveals a notable deficiency in the integration of critical elements of effective communication, such as public input and the context of stakeholder intervention. The absence of these elements raises questions about the long-term sustainability and effectiveness of crisis communication strategies that emphasize directive rather than dialogic engagement. The lack of integration of feedback means that communicators may miss out on valuable information from their audience, which could otherwise inform and refine ongoing crisis management efforts. Similarly, the failure to consider the context of interventions suggests a one-size-fits-all approach to crisis communication, potentially neglecting the needs and nuanced perceptions of different audience segments.

Who are the central players in communication networks?

In the complex web of communication networks, especially within organizations, central actors appear as central figures in the design of the flow and interpretation of information. Individuals with the ability to control the dissemination of information are indispensable elements of these networks [8]. Theirimportance is further amplified by those who have the ability to influence how information is formatted
and its resulting meaning, highlighting the important role these actors play not only in transmission but also in constructing the narrative within organizational communications. Beyond simple handover, these central figures, often in roles such as communications directors (dircoms) or corporate communications managers, are tasked with a critical mission. They don't just disseminate information, but actively participate in its creation, ensuring that the message aligns with the organization's goals and culture. This role is increasingly recognized as crucial in contemporary society where communication networks are not static but dynamic domains, constantly shaped and reshaped by those who run them. Thus, these central actors, through their strategic control and creative input, ensure that communication networks remain robust and adaptable, even in the face of potential crises such as the cascading effects of the tsunami damage discussed above.

How do influencers affect the flow of information?

While the GRADE method has played a central role in disaster management to assess property damage and improve the effectiveness of communication during crises, the influence of actors in these scenarios extends beyond simple operational protocols. Influential actors, through their control over the flow of information and communication channels, can have a significant impact on the social perception of disasters and the public's response to them. For example, they have the ability to shape social imaginaries and public opinion in ways that favor certain corporations or political ideologies, as underscored by their use of corporate communication to promote capitalist entrepreneurial ideologies. This manipulation of information can be used to standardize managerial strategies and to establish companies as central social institutions within the collective imagination. Moreover, in times of crisis, figures such as lawyers, lobbyists and corporate representatives can act as spokespersons, employing targeted communication strategies to maintain established positions and influence public opinion. This orchestration of communication not only emphasizes the power of influential actors in determining the direction and reception of information, but also highlights the importance of scrutinizing the source and intent behind the dissemination of messages during critical events.

Strategic Responses for Effective Crisis Management

What strategies improve communication in times of crisis?

In the midst of a crisis, effective and clear communication can have a significant impact on an organization's bottom line. The key to this is early identification of the most effective communication channels and the individuals or groups that should be prioritized for contact. This step is fundamental, as it ensures that in the event of a crisis, there is no hesitation or confusion as to how and to whom the information should be disseminated. Further reinforcing the importance of preparedness, having detailed procedures for internal and external communications planned in advance can streamline the crisis response, making it both more efficient and effective. This level of preparedness allows for the rapid deployment of key messages, which have been developed before any crisis, ensuring that communication remains clear, consistent and aligned with the organisation's values and goals. Such strategic thinking not only facilitates a more coordinated response, but also helps maintain stakeholder trust and the organization's reputation during difficult times.

How can network analysis inform crisis response plans?

Based on the understanding of how critical infrastructure and communication networks can be affected by disasters such as tsunamis, network analysis is emerging as an essential tool to improve crisis response plans. By using network analytics, organizations can proactively identify specific threats and vulnerabilities within their operational and communication frameworks, which is critical to inform the development of a comprehensive crisis response plan. This approach aligns with the recommendation to initiate the development of crisis management plans with digital methods, highlighting the importance of digital resilience even in crises that are not inherently digital. In addition, integrating network analytics into crisis response planning facilitates the creation of strategies that can provide rapid and accurate responses to critical events. Such strategies are fundamental to minimizing the impacts of a crisis by avoiding delays, ensuring that no critical tasks are missed, and maintaining fast response times. This proactive and informed planning approach therefore not only improves the organization's preparedness for specific crises, but also strengthens its overall resilience against a wide range of potential threats.

What role does technology play in improving communication in a crisis?

Following the effective application of the GRADE method to assess direct property damage caused by earthquakes in Turkey and Syria, the integration of technology further enhances crisis communication, ensuring a rapid and effective response in the event of an emergency. The use of technologies, such as defined policies and tools with automated one-click alerts, significantly streamlines the crisis communication process, allowing for faster dissemination of information and coordination between response teams [10]. In addition, the establishment of dedicated communication systems, including emergency phone numbers or call centers, plays a central role in responding quickly to public concerns and questions, ensuring that the community remains informed and reassured during a crisis [9]. In addition, technology not only facilitates the protection of assets and the safety of individuals during these times, but also contributes to the rapid recovery of normal activities after the crisis by digitizing crisis response actions [10]. This synergy between technology and crisis management strategies underscores the importance of adopting compatible and reliable technologies to overcome previous problems of incompatible equipment and system failures that hindered effective communication between federal and local crisis managers [11]. Thanks to these technological advances, crisis communication is becoming more robust, strengthening the overall crisis management effort and ensuring a more resilient response to emergency situations.

Results & Analysis :

1. Network Evolution: Visualize the changes in network structures and identify key events or triggers that lead to shifts in information flow.
2. Sentiment Analysis:Present sentiment trends over time to illustrate changes in public perception and emotional responses.
3. Geospatial Insights: Map the geographical distribution of information sources and analyze regional differences in information dissemination and response.

1. Pre-Disaster Phase: Explore how information networks are organized and what types of information are being shared before the disaster strikes. Identify influential users or organizations.
2. During Disaster Phase:Analyze how the flow of information changes during the disaster. Investigate the emergence of new information sources, the spread of rumors or misinformation, and the role of social media in emergency response efforts.
3. Post-Disaster Phase:Examine how information networks evolve in the aftermath of the disaster. Assess the effectiveness of communication strategies, recovery efforts, and public sentiment towards authorities and relief organizations.

In the analysis of the network provided, we observe three distinct periods, each characterized by significant changes in the social groups studied. The results seem to support our hypothesis that students' propensity to smoke appears to be closely related to their group affiliation. Individuals seem more likely to start smoking if their peers also smoke, and by the end of the third period, a distinction between smoking and non-smoking groups is made. This reinforces our theory that risky behavior is influenced by peers.

Let's look at each period in detail:

1. **Network in the first period :**
   - There are a total of 13 edges in this network.
   - The most central nodes in terms of proximity and degree are 10, 6, and 29.
   - We observe two clusters of smokers in groups R and O, with a strong group overlay and a clear connection across nodes 6, 10 and 29.
   - A few more smokers are scattered throughout the network, but are not closely connected to the main groups of smokers.

2. **Network in the second period :**
   - The number of edges increases to 116 and social groups become more connected.
   - Groups R and O remain the most interconnected.
   - Nodes 18 and 29 emerge as significant in network connectivity, serving as bridges between multiple groups.
   - We are seeing an increase in the number of occasional and regular smokers compared to the previous period.

3. **Network in the third period :**
   - The number of edges reaches 122 and significant divisions occur, separating the network into several distinct parts.
   - Groups O and R continue to have a high concentration of smokers, with many regular smokers having changed their status since the previous period.
   - Group Y remains non-smokers, demonstrating the positive influence of peers on the choice not to smoke.

Overall, we observe an increase in the number of regular smokers over the periods, with changes in group affiliations and changes in smoking habits for some individuals. This analysis strongly suggests that peer behaviour plays a crucial role in students' smoking decisions.

Limitation

Here are some potential limitations that could be addressed in your presentation:
1. Data Availability and Quality: One of the primary challenges in conducting this research could be the availability and quality of data. While there may be various sources of communication data, ensuring their reliability, completeness, and consistency could pose challenges. Addressing how you plan to mitigate these issues, such as through data validation procedures or using multiple sources for triangulation, would be essential.
2. Sample Bias: The dataset may be biased towards certain types of communication channels or actors, potentially leading to skewed results. For example, if social media data are heavily relied upon, it may overlook communication among vulnerable populations with limited access to technology. Discussingstrategies to address sample bias, such as purposive sampling or sensitivity analyses, would strengthen your research approach.
3. Ethical Considerations: Collecting and analyzing communication data, especially from sources like social media, raises ethical considerations regarding privacy, consent, and data protection. Ensuring that your research adheres to ethical guidelines and discussing the measures taken to protect participants' privacy would be important to address.
4. Temporal Constraints: Natural disasters are time-sensitive events, and data collection may be constrained by the availability of real-time data during and immediately after the event. Discussing how you plan to address temporal constraints, such as using historical data or conducting longitudinal analyses, would be relevant.
5. Interpretation Challenges: Analyzing complex network data requires sophisticated methodologies and expertise in network analysis techniques. Addressing the potential challenges in interpreting network measures accurately and discussing any limitations in your analytical approach would enhance the credibility of your findings.
6. Generalizability: While your study focuses on communication during natural disasters in Lebanon, the findings may not be directly applicable to other contexts or regions with different socio-political and environmental conditions. Acknowledging the limitations of generalizability and discussing the transferability of your findings to similar contexts would be important.
By acknowledging these limitations and discussing how you plan to address or mitigate them in your research design, you can demonstrate the robustness and validity of your study to your audience.

Conclusion

The analysis of information networks in times of crisis, as demonstrated by the study on the evolution of communications during natural disasters in Lebanon, highlights the critical role that communication networks play in ensuring the safety and well-being of communities facing disasters. The research highlights the critical need for adaptable and robust communication strategies, tailored to meet the specific needs of diverse communities, highlighting the importance of accessible communication for effective disaster risk management. The integration of technology, such as the GRADE method and social media, has proven effective in improving communication and crisis management efforts, enabling rapid response and coordination in the event of an emergency. The study highlights the importance of strengthening infrastructure, implementing advanced assessment methods, and using digital tools to streamline communication processes and facilitate the rapid dissemination of information between response teams. Acknowledging the vulnerabilities of communication networks to disaster damage and the critical role of social networks in disseminating information and coordinating recovery efforts, the research argues for a comprehensive approach to improving modes of communication in times of crisis. In addition, the discussion highlights the importance of building digital resilience, establishing dedicated communication systems, and effectively mobilizing resources to save lives and ensure long-term resilience to disasters. This research contributes to the continuous advancement of knowledge in communication and crisis management, highlighting the need for innovative approaches and continuous improvement of communication strategies to effectively mitigate the impacts of natural disasters.
While the networks that resulted from our analysis contain compelling results, there are limitations to our study that should be considered for future research. The dataset used was a subset of a larger study, which looked at more variables than those of friendship affiliations and smoking use. These variables included items such as lifestyle, family, self-esteem, alcohol and drug use. Thus, for future research, it would be particularly interesting to take these other factors into account when mapping external influences on tobacco use. In addition, this subset focused its attention on 50 female students. With a small sample size in addition to considering only one gender, results may not vary as much as they would have when looking at a larger, more diverse set of students. It would be interesting for future studies to examine the role that gender plays in tobacco use, mapping these interactions and their potential influences.
Ultimately, while there are clearly limitations to the study, there is also a great deal of knowledge to be gained from examining the relationship between friendship affiliations and tobacco use.

References

Liban - Tsunami Niveau de risque. (n.d.) retrieved May 3, 2024, from thinkhazard.org/fr/report/141-lebanon/TS
Perception des risques et cohésion sociale au Liban. (n.d.) retrieved May 3, 2024, from www.fondation-croix-rouge.fr
Perception des risques et cohésion sociale au Liban. (n.d.) retrieved May 3, 2024, from calenda.org/901979
Gestion du risque de catastrophe. (n.d.) retrieved May 3, 2024, from www.banquemondiale.org
Évolution de l'écosystème humanitaire au Liban. (n.d.) retrieved May 3, 2024, from www.cairn.info
La communication médiatique au service de l' .... (n.d.) retrieved May 3, 2024, from journals.openedition.org/ctd/1004?lang=en
LES GRANDS MODELES DE COMMUNICATION. (n.d.) retrieved May 3, 2024, from fr.linkedin.com
Chapitre 4 - La communication et ses acteurs : les enjeux et finalités au-delà de la fonction et des métiers - Valérie Lépine - Communications organisationnelles : comprendre et discuter. (n.d.) retrieved May 3, 2024, from com-orga-discuter.numerev.com
Gérer une Situation de Crise avec Excellence : Un Guide Complet. (n.d.) retrieved May 3, 2024, from fr.linkedin.com
Qu’est-ce que la gestion de crise ?. (n.d.) retrieved May 3, 2024, from www.everbridge.com/fr/blog/quest-ce-que-la-gestion-de-crise/
Les exemples de gestion de crise les plus utiles : les bons et les mauvais exemples. (n.d.) retrieved May 3,

2024, from fr.smartsheet.com/content/crisis-management-examples
ThinkHazard. (n.d.). Lebanon - Tsunami Hazard Level. Retrieved from [thinkhazard.org](https://thinkhazard.org/fr/report/141-lebanon/TS)
Fondation Croix-Rouge Française. (n.d.). Perception des risques et cohésion sociale au Liban. Retrieved from www.fondation-croix-rouge.fr
Calenda. (n.d.). Perception des risques et cohésion sociale au Liban. Retrieved from [calenda.org](https://calenda.org/901979)
Banque Mondiale. (n.d.). Gestion du risque de catastrophe. Retrieved from www.banquemondiale.org
Cairn.info. (n.d.). Évolution de l'écosystème humanitaire au Liban. Retrieved from [cairn.info](https://www.cairn.info)
OpenEdition Journals. (n.d.). La communication médiatique au service de l'.... Retrieved from [journals.openedition.org](https://journals.openedition.org/ctd/1004?lang=en)LinkedIn. (n.d.). LES GRANDS MODELES DE COMMUNICATION. Retrieved from [linkedin.com](https://www.linkedin.com)
Com-Organ-Discuter. (n.d.). Chapitre 4 - La communication et ses acteurs : les enjeux et finalités au-delà de la fonction et des métiers - Valérie Lépine - Communications organisationnelles : comprendre et discuter. Retrieved from com-orga-discuter.numerev.com
LinkedIn. (n.d.). Gérer une Situation de Crise avec Excellence : Un Guide Complet. Retrieved from [linkedin.com](https://www.linkedin.com)
Everbridge. (n.d.). Qu’est-ce que la gestion de crise ?. Retrieved from [everbridge.com](https://www.everbridge.com/fr/blog/quest-ce-que-la-gestion-de-crise/)
Smartsheet. (n.d.). Les exemples de gestion de crise les plus utiles : les bons et les mauvais exemples. Retrieved from [smartsheet.com](https:/