Information Communication Technology for Crisis Management and Shared Situational Awareness: Social Media Public Health Communication During the COVID-19 Pandemic

"This thesis submitted to fulfill requirements for the degree of Doctor of Philosophy in Business Information Systems submitted to the University of Sydney Business School."

by

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Statement of Originality

I certify that the intellectual content of this thesis is the product of my own work and that all the

assistance received in preparing this thesis and sources have been acknowledged.

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Authorship Attribution Statement

Chapter 4 of this thesis has been accepted for publication as Shahbazi, M., Bunker D & Sorrell, T. C. (2023). *Communicating Shared Situational Awareness in Times of Chaos: Social Media and the COVID-19 Pandemic. In Journal of the Association for Information Science and Technology (JASIST)*. I designed the study, collected and analysed the data, and wrote the drafts of the manuscript.

Chapter 5 of this thesis is prepared to submit to a respected conference in the field of IS. I designed the study, analysed the data and wrote the drafts of the manuscript.

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In addition to the statements above, in cases where I am not the corresponding author of a published item, permission to include the published material has been granted by the corresponding author.
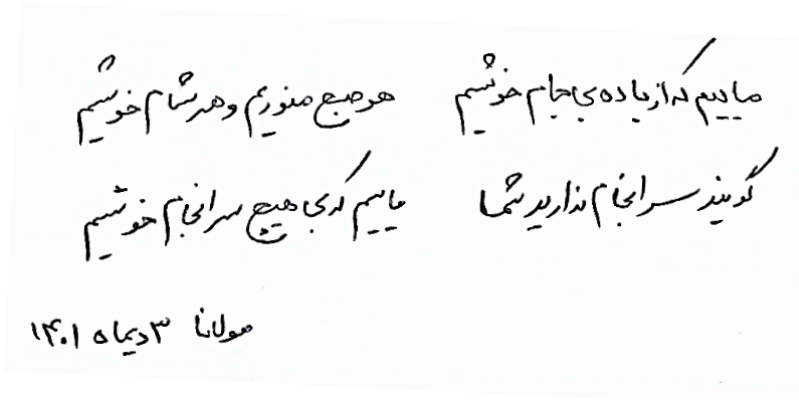
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As the supervisor for the candidature upon which this thesis is based, I can confirm that the authorship attribution statements above are correct.

Deborah Bunker,

Author Note

Thank you for reading this thesis. This work, in simple words, is about leveraging social media to manage a public health crisis, and it took me nearly four years to complete. I began this project a year before the COVID-19 pandemic rocked the world. Hence, I was both fortunate to have a unique live case study to research and unlucky to spend two years of my PhD life in a global pandemic. There were times when I adored every minute of my research and moments when I was unsure if I could complete it. I had the privilege of sharing this journey with Prof. Deborah Bunker, who professionally supervised my work while also emotionally supporting me along the way. I will forever be grateful to her and admire her wonderful character. As I write this note on 23rd December 2022, at 9:30 p.m., I envision a brighter future and am filled with happiness and excitement. I dedicate this thesis to my lovely parents and, of course, my beloved brother Farzad, my true friend in whom I have complete trust.

مولانا ۳ دی ماه ۱۴۰۱

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Abstract

The COVID-19 pandemic is characterised by threat, surprise, and rapid response. The pandemic has jeopardised the core values of the world's life-sustaining systems, causing enormous uncertainty regarding the crisis's evolving nature and effects. Many countries have been compelled to restrict economic and social activities as a result of the crisis; for example, in August 2021, all Australian state and territory jurisdictions had various "snap" lockdowns, costing the Australian economy billions of dollars.

Most decisions taken by governments, organisations, communities, and people to effectively manage a crisis are based on "shared situational awareness" (SSA) drawn from many information sources. Organizations leveraged ICTs to quickly reorganise, develop, and modify their reactions to the pandemic. Social media platforms improved communication between authorities and the public and engaged the public in crisis management. However, in the early stage of the pandemic, public uncertainty and confusion were impacted by health agencies' one-way reactive communication with the public and inadequate shared situational awareness. In this sense, understanding the role of social media in creating shared situational awareness and managing the COVID-19 crisis would enable agencies and government stakeholders to alter their crisis communication strategies within the digital context, thereby preparing them for future crises.

This thesis documents a longitudinal netnography, an online ethnography, of Australian public health agencies' Facebook communication across 2019 and 2020, exploring the impact of COVID-19 on crisis communication and the creation of SSA for the public. Analysing Facebook data and conducting field interviews with informants, this study shows how COVID-19 disrupted and transformed public health communication and its consequences.

The aim of this study is to enhance the body of knowledge in the area of social media adoption for crisis communication to assist organisations in improving their communication strategies for adequate shared situational awareness during a crisis.

This study was to achieve its goals by conducting three phases. This case study explores official Facebook health communication to understand the shared situational awareness during the COVID-19 crisis from three perspectives; *link content (information), link type (communication), and link quality (trust),* which, according to Seppänen et al. (2013) are important elements for the creation of adequate SSA during a crisis. Although my study took an inductive approach, it is important to acknowledge the significant contribution of the Seppänen et al. 2013 model in shaping my study and providing an initial theoretical lens. Seppänen et al. (2013) focused on communication within an inter-organizational context to create SSA for emergency response teams. This model served as a valuable framework for constructing my initial theoretical framework as I explored communication, information content, and the establishment of trusted shared situational awareness between emergency response agencies and the public. Building upon this model, I extended my study to examine the development of trusted SSA between public health agencies and the public, which is crucial for effective crisis response.

The results of the analysis are presented in four chapters of this thesis, i.e., chapters four, five, six, and seven.

Chapter four discusses a longitudinal netnography of Australian public health agencies' communications on Facebook across 2019 and early 2020 through the *Chaos Theory* lens. Chaos Theory is used as a theoretical lens to examine information perception, meaning, and assumptions relating to shared situational awareness from pre- to post-pandemic periods. This chapter explains *the normal operation of Facebook for public health communication* and then explores *how the*

initial stages of the COVID-19 pandemic disrupted public health communication patterns. Chaos Theory concepts were used to interpret changes in Facebook communications dynamics as the result of the pandemic disruption, identifying the sensitivity to initial conditions (butterfly effect), communication pattern breakdown (bifurcation), and new communication pattern emergence (self-organisation). The results showed that Facebook facilitated messaging behaviour change; however, the initial pandemic disruption and its butterfly effect swamped the health communication channel leaving little space for other important health issues.

In chapter five, the communication transformation is further examined in terms of both changes to communication volume and topics from pre to post-pandemic periods. Chapter five also highlights the importance of *secondary communication* in a crisis context and reveals Facebook users' (public) emotional factors like outrage influence their decision to share crisis information.

Chapters six and seven focus on the *quality of communication* and public *trust* in social media communication during a crisis. Chapter six reveals the way that Australian public health agencies used Facebook to mitigate misinformation. Chapter seven comprehends the learning by examining how the organisational effort impacted their audience's trust in information and source. The results show how organisational approaches, including the inconsistency in messaging and policies, as well as previous failures, erode audience trust in official public health social media communication channels and harm the creation of adequate shared situational awareness.

This study contributes to IS and communications research by enhancing knowledge in social media adoption for crisis communication and shared situational awareness, illustrating how a major crisis impacts a social media communications channel, and suggesting ways to improve public health crisis communication strategies.

While previous studies focused on enhancing situational awareness and the value of social media for crisis response teams, this study has examined the creation of trusted shared situational awareness for the general public, which is crucial for managing a health crisis such as the COVID-19 pandemic, and the public response.

My study investigated the social media *content (i.e., information)* and *connection type (i.e., communications approach)* shared between *actors* (i.e., Australian public health agencies and the public) in the context where the quality of communication, i.e., trust, is required for the development of shared situational awareness. This study highlights the factors underlying the effectiveness of social media crisis communication and suggests improvement actions. Learning from the results of this study enables crisis response agencies to develop their social media communication policies for effective crisis communication and adequate shared situational awareness.

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Chapter 1 Introduction

Emergency communication during the planning and response to public health crises, such as pandemics, has been an essential component of the management of national health emergencies for public health agencies (Savoia et al., 2013). Effective crisis communication helps people at risk understand and adopt protective behaviours during diseases, pandemics, humanitarian crises, and natural disasters. It allows specialists to listen to people's issues and needs and delivers appropriate, credible advice (*Communicating risk in public health emergencies*, 2017). Referring to the growing numbers of social media users, these platforms have become an effective channel for government agencies to reach their audience in public health communication during a crisis like the COVID-19 pandemic (Ades, 2020; Greenhow & Chapman, 2020). Figure 1 shows the number of users for different platforms in 2022; Facebook, with more than 2.9 billion monthly active users, is the most-used online social network worldwide (Statista, 2022). The use of social media platforms to access crisis event-related information and communication is often initiated by platform users (public) but also vastly utilised by emergency organisations. Integration of these channels in emergency communication has changed the traditional pathway for the flow of information from emergency organisations to the public (Simon et al., 2015).
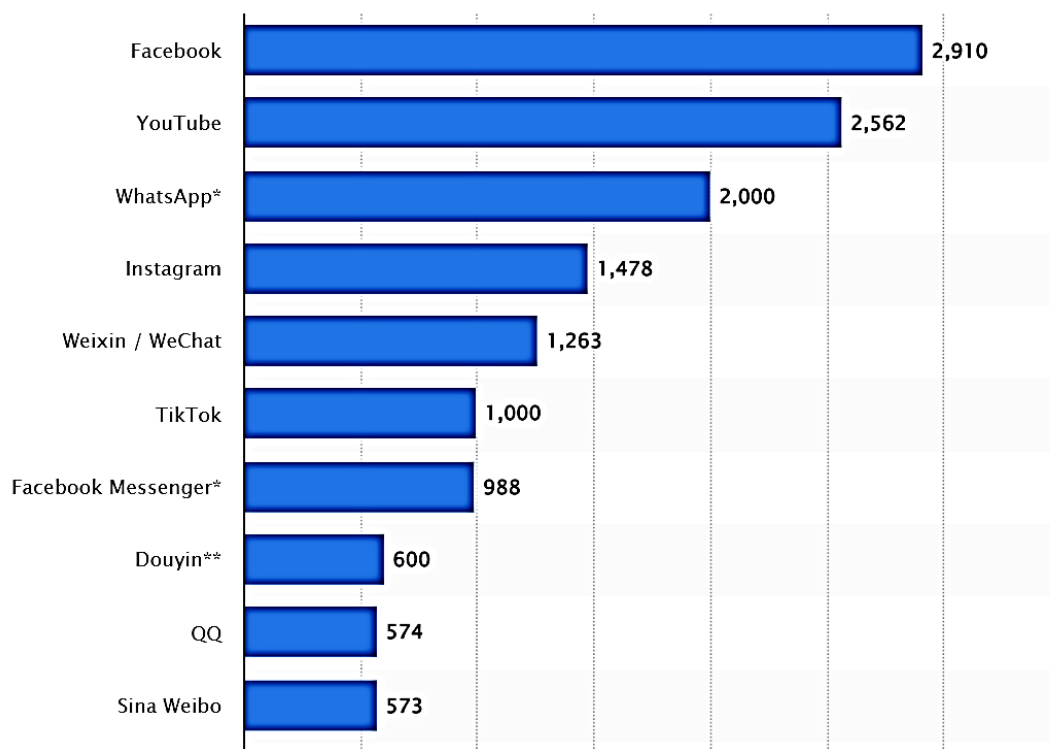
Figure 1 Number of Social Media Users in Million 2022, source © statista 2022, adopted from;
https://www.statista.com/statistics/272014/global-social-networks-ranked-by-number-of-users/
date, 13 November 2022

During an emergency, the public increasingly turns to social media for immediate and in-depth crisis information (Jang & Baek, 2019) that supports sense-giving, making, and breaking (Mirbabaie et al., 2020). Research highlights that digitally-enabled disaster response via social media has impacted crisis communication effectiveness and crisis dynamics, such as changing public response to a disaster (Sathish et al., 2020; Utz et al., 2013).

Social media platforms, such as Facebook, have significantly expanded the reach of public health information and have generated broader public awareness highlighting the attention to the threat and any subsequent health protection guidance (Seeger et al., 2018). Australian public health agencies have recognised these platforms as one of the most appropriate channels for information dissemination during a pandemic event (ANAO, 2017). Social media also provides a great source

of real-time information required by decision-makers to monitor and manage the crisis; however, these low-cost and effective communication tools are less utilised by health professionals to communicate public health information (Vance et al., 2009).

Public Health Crisis; the COVID-19 Pandemic and Social Media Communication

The COVID-19 pandemic has seen an emerging crisis of global proportions along with ensuing chaos and social and economic disruption. Over 82 million individuals had been infected with COVID-19, and over 1.8 million had been killed by 31 December 2020, as reported by WHO (2021b). The report claimed that the official data reported by countries are 1.2 million lower than preliminary estimates indicating the total number of "excess fatalities" worldwide attributable to COVID-19 in 2020 is at least 3 million.

As reported by the World Bank (2022) pandemic caused the worst worldwide economic crisis in over a century. The crisis exacerbated inequalities inside and across nations. The COVID-19 global health crisis forced many countries to lockdown business and social activities. Preliminary evidence suggests that emerging economies and economically disadvantaged populations will take longer to recover from pandemic-induced income and livelihood losses (The World Bank Group, 2022).

COVID-19 has greatly impacted the Australian economy since arriving in January 2020. In August 2021, all Australian state and territory jurisdictions were enduring various types of "snap" lockdowns costing billions of dollars and causing a spike in mental health impacts (Lathouris, 2021). The pandemic in Australia caused a major GDP drop during restrictions, and the country is expected to have suffered a cumulative loss of $158 billion relative to its pre-pandemic trajectory (ABS, 2022). The Australian government spends around $115 million (range: $72.3–$170.1 million) per annum to cope with influenza and influenza-like disease (Newall & Scuffham, 2008),

while in 2020-21, this budget increased to more than $16 billion for the health response to the COVID-19 pandemic (Department of Health and Aged Care, 2020).

These lockdowns have severely limited human movement and social interactions such as family visits, attendance at the workplace, and travel. Therefore, over the course of the pandemic, government and industry have used ICT to reshape, innovate, and adapt to rapidly changing pandemic conditions (Zaman et al., 2020), while individuals, families, and communities have relied on their access to and use of ICT to overcome the social isolation and dislocation of lockdown restrictions (Lee et al., 2021).

Digital social networking platforms like Facebook have played a critical role in the COVID-19 pandemic, aiding the communication of risk, crisis, and emergency by health agencies and the assessment of event-related information by the public. The emergence of social media like Facebook has facilitated a *change of scale, pace, and pattern* in the public health risk, crisis, and emergency communications between health agencies and the general public (Böttger et al., 2020; Raamkumar et al., 2020). In this context, social media platforms like Facebook have become essential in disaster and health crisis-related communication (Wang et al., 2021). These platforms engage the public, build real-time engagement, and motivate the public to take action in public health emergencies. For example, social media mediated information-seeking and dissemination during the COVID-19 pandemic (Kim et al., 2021) provided the public with health awareness for mitigating COVID-19, influenced their health actions offline, and significantly increased preventive behaviours (Khamis & Geng, 2021; Oh et al., 2020).

In addition, social media enabled real-time global communication between scientists during the COVID-19 outbreak (Pollett & Rivers, 2020). For example, over 3,000 physicians

(MD/DO/MBBS) have joined a Facebook group called the 'PMG COVID-19 'Subgroup' to discuss COVID-19 and its impact.

On the downside, however, platforms like Facebook have facilitated the explosion of information about COVID-19 in the form of an 'infodemic' and, in particular, the spread of misinformation that has affected the management of the pandemic (Cinelli et al., 2020; Zhou et al., 2021).
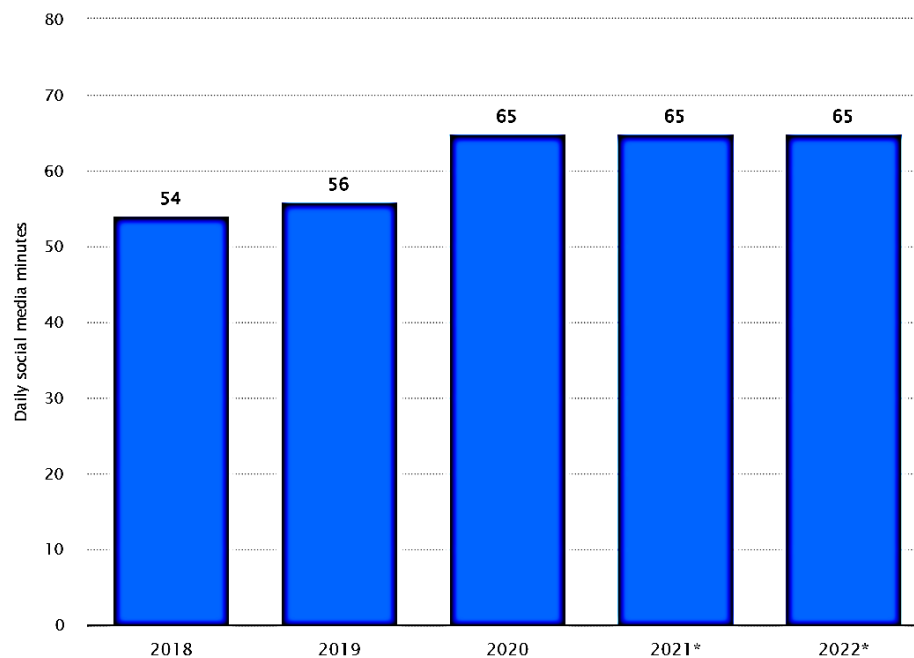
Figure 2 Average Daily Time Spent on Social Networks by Users in the United States from 2018 to 2022, source © statista 2022 adopted from; https://www.statista.com/statistics/1018324/us-users-daily-social-media-minutes/ date, 13 November 2022

During the pandemic, social media has enhanced the spread of fake news, false claims, half-baked conspiracy theories, and pseudoscientific therapies about the origin, diagnosis, treatment, prevention, and spread of the infection (Chipidza et al., 2020; Naeem et al., 2020). As a result, health agencies have faced new challenges, such as dealing with public anxiety and heightened stress responses and the emergence of vaccine refusal online collective behaviour that has

overburdened the health system while putting public health at serious risk (Garfin et al., 2020; Malecki et al., 2020).

Social media has vastly benefited public health communication, increased access to information, and empowered the community during the pandemic; however, these platforms posed new challenges and risks to emergency management and increased the burden of a crisis. Our experience with the COVID-19 pandemic is an excellent example of social media communication's positive and negative sides. The increased use of social media during the pandemic (from 56 minutes per day to 65, as indicated in Figure 2) highlight the importance of these platforms for crisis communication and the necessity of academic studies to enhance the knowledge in the field and assist government agencies and response organisations in developing effective social media communication strategies.

The unknown nature, unpredictability, and high level of uncertainty surrounding the COVID-19 pandemic have all the hallmarks of a crisis: interruption, confusion, and disorder. The *emergence of the initial threat*, the *surprise* of the pace of spread, the relatively *short health response time*, and the *devastating consequences* of the virus have also made the pandemic a unique *case study* to explore public health crisis management and crisis communication.

Studies on crisis communication have traditionally focused on sustaining and restoring image and trust in private organisations and assisting them in managing businesses to minimize the loss (Barton, 1994; Civelek et al., 2016; Sturges, 1994). Although public organisations are of particular interest since they are in charge of planning, communicating, and controlling large-scale societal crises, there is limited knowledge of crisis communication from the perspective of public organisations (Olsson, 2014). Furthermore, researchers in the field of Information Systems (IS)

have examined ICT from the perspective of emergency services, focusing on understanding the ways that agencies use the technology to create a range of management and decision-making tools (Fan et al., 2021; Gruntfest & Weber, 1998; Thomas & Ertugay, 2007), agencies' IS resources and capabilities (Bunker & Smith, 2009), ICT's role in improving coordination among agencies or between agencies and other stakeholders (Pan et al., 2012; Thompson, 2009). These studies are predominantly based on the command-and-control approach to disaster management, which inadvertently restricts the community's position to that of a "victim" who can only play a "reactive" role in crisis response and lack attention to the community's competent role (Leong et al., 2015).

To fill the gap, this study investigates *how government agencies use social media to communicate with the public and create shared situational awareness during the COVID-19 crisis*. This study also shows *how the communication system transforms over time to maintain the public's information needs* during different phases of the crisis and the consequences. Understanding the current application of social media platforms to manage the COVID-19 pandemic assists public health agencies and government stakeholders in understanding and establishing future risk and crisis communication strategies related to local and global hazards in a digital context (Bunker et al., 2019).

Social media platforms enable the rapid dissemination of crucial updates, news, and scientific findings related to the crisis, such as the COVID-19 pandemic. This immediate access to information allows individuals and organizations to stay informed about the evolving situation, enhancing their shared understanding of the crisis.

Through social media, people can share their experiences, concerns, and observations, fostering a sense of community and facilitating the exchange of information. This collective sharing and interaction contribute to the development of shared situational awareness, as individuals gain a

comprehensive understanding of the crisis based on the collective knowledge shared on social media platforms.

Moreover, social media serves as a platform for public health authorities and organizations to communicate directly with the public, providing official updates, guidelines, and instructions. This direct communication helps in aligning public perceptions and understanding of the crisis, promoting consistent and accurate information dissemination, and further enhancing shared situational awareness among the affected population.

During a pandemic, the speed of communication has reached unprecedented levels thanks to social media. The responsible use of social media platforms allows for the immediate dissemination of significant new information and relevant scientific findings. It facilitates discussions on diagnostic, treatment, and follow-up protocols, as well as the evaluation of alternative treatments on a global scale (Bunker et al., 2019; González-Padilla & Tortolero-Blanco, 2020). This ability to quickly share information through social media has never been possible in human history, enabling individuals worldwide to access and discuss critical updates and scientific advancements related to the pandemic.

By leveraging social media effectively, public health agencies and organizations can harness the power of shared situational awareness to address challenges, coordinate response efforts, and make informed decisions during a crisis. It acts as a bridge between different stakeholders, allowing for real-time information sharing, collaboration, and the establishment of trusted relationships

Crisis communication has been studied in many different contexts; however, the COVID-19 pandemic and the disruption it has caused in the era of social media are unique. In light of the new challenges presented by the COVID-19 pandemic, which will be fully discussed in this

dissertation, it is necessary to broaden the scope of current social media public health crisis communication knowledge.

Social media is defined as a group of Internet-based applications that have been built on the ideological and technological foundations of Web 2.0; these applications facilitate the creation and exchange of User Generated Content (Kaplan & Haenlein, 2010). Social media is an umbrella term that covers a vast array of different platforms and technologies, such as Microblogging Services, Social Networking Sites, Collaborative Web Maps, Wikis, and Media Content Sharing platforms (Kane et al., 2014). However, to obtain an in-depth understanding of the phenomena, I need this study a subset of social media and focus on a particular communication channel. Hence, this study investigated the *Australian public health* use of *Facebook* during the COVID-19 crisis.

Facebook is an important social media channel as it has the highest number of active users compared with other social media platforms. Facebook reported over 2 billion monthly active users for January 2019, including 15 million Australian users. It has increased to 2.5 billion globally and 16 million Australian users by December 2019, and approximately half of the Australian population logs into Facebook daily (Correll, 2020; Facebook, 2020). Facebook is the most popular social media channel for the Australian Government Department of Health[1], with 125K followers on March 8th, 2020, and has grown to 793K followers on November 24th, 2022. Correspondingly, this study focused on the use of Facebook by Australian public health organisations to manage the pandemic. Facebook communication patterns before the event, during 2019, and then during the initial crisis impact, continuous change, adaptation, and the emergence of new communication patterns were explored across 2020. The phenomena were explored at the

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[1] https://www.facebook.com/healthgovau/

organisational level. In the interest of contextualizing results, the researcher's interaction (i.e., workshops and interviews) with informants (e.g., public health communication managers, health practitioners, infectious disease experts, public health workers, and crisis managers) were conducted to assist in understanding the problem, framing the study, and enhance and validate the results (i.e., "professional judgments").

The Importance of the Study

Public health risk, crisis, and emergency communications between health organisations and the general public have seen a major scale, velocity, and pattern shift as a result of the emergence of online social networking platforms like Facebook (Almotawa & Aljabri, 2020a; Böttger, Ibrahim, & Vallis, 2020; Raamkumar & Wee, 2020). However, it is important to note that the development of authentic, accurate, timely, relevant, important, and trusted *shared* situational awareness gives weight and urgency to advice from and decisions by government and their public health agencies to the general public (Bunker, 2020). Instead, in the early stages of the pandemic, we have seen *one-way* reactive and ineffective communication with the public, which has caused widespread public uncertainty, confusion, and misunderstanding, along with failures in responding to the threat. This has led to devastating health and social outcomes for society, as well as being a major factor in prolonging the pandemic (Hyland-Wood et al., 2021; Kim & Kreps, 2020).

Various crises pose different risks and demand varying communication tactics (Mitroff, 1992; Seeger et al., 1998), which must be customised depending on the scenario. In this sense, understanding the current use of social media platforms to manage the public health response to COVID-19 will help agencies and government stakeholders to understand social media shortfalls and modify their crisis communication strategies for shared situational awareness in a crisis, within the digital context (Bunker et al., 2019).

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This thesis responds to this need for knowledge and explains ***how these platforms have been employed to mediate the interaction between public health agencies and the general public in an extreme event such as the COVID-19 pandemic***. This thesis investigates the use of Facebook by Australian public health agencies from different angles and reveals comprehensive knowledge, including the benefits and challenges involved in the use of Facebook in managing the event. I analysed Facebook's communication patterns to show the continual change triggered by the crisis, adaptation, and emergence of new communication patterns.

My thesis explores Australian public health communication during COVID-19, using a *case study* research approach to gain a comprehensive understanding of the phenomenon in its real-life context. The analysis is divided into four chapters. In chapter 4, I analyze Facebook data through *nethnographic* analysis, examining the information shared by Australian public health officials on their Facebook pages before and during the early stage of the pandemic. This chapter explores the impact of the crisis on Facebook usage and communication approaches.

Chapter 5 combines *statistical and quantitative content analysis methods* to enhance the findings from chapter Four. It extends the investigation to two years of public health Facebook communication, from January 2019 to December 2020, to shed light on the communication approach and its transformation during different phases of the crisis. It also examines public engagement and secondary crisis communication.

Chapters 6 and 7 are *qualitative case studies* focusing on misinformation and trust as the factors that influence SSA. They explore how Australian public health agencies used Facebook to address misinformation and its effect on the public's trust in information and its source. I conducted semi-structured interviews with field informants to gain further insights, and chapters 7 and 8 present the interview results.

I carefully selected appropriate approaches and methodologies for each chapter to collect and analyze data, aiming to extract in-depth, relevant information from the dataset and enhance the study's objectives and narrative. To establish the trustworthiness of qualitative case studies, I support my arguments and methods with relevant literature in each chapter, enhancing the overall validity (trustworthiness) of the study.

The research is grounded in the theoretical underpinning of shared situational awareness (SSA) and its factors, including information, communication, and trust. While previous studies focused on inter-organizational contexts, I apply this framework to the context of public health agencies creating SSA for the public. The four analysis chapters (chapters 4, 5, 6, and 7) examine the phenomena from different perspectives: information, communication, and trust.

As an interpretive researcher, I recognize the subjective nature of social reality and emphasize the significance of individual perspectives and the social construction of meaning. Shared situational awareness emerges through the dynamic interaction of various perspectives, incorporating a range of voices and interpretations.

The theoretical foundations and contributions of each phase are thoroughly explained in the respective chapters. Each chapter justifies the chosen methodology by referring to relevant literature, enhancing the overall validity of the study. The theoretical underpinning of the research is based on the concept of shared situational awareness, emphasizing the importance of communication, information, and trust in its formation.

The study recognizes the social construction of meaning and the active engagement of both agencies and the public in shaping shared situational awareness. The research process follows an

interpretive research paradigm, aiming to understand the meaning and significance individuals and groups assign to their experiences and actions. The framework and phases of the study are presented in Figure 9, with detailed explanations of each phase's theoretical foundation and academic contributions provided in the relevant chapters.

I have structured the remaining parts of this thesis to first define the phenomena under study by reviewing the previous works on the use of social media in public health crisis communication. Next, I explain my motivation for this study and how the study formed as well as the context by reviewing reports, literature, and my observation of the COVID-19 crisis in Australia.

I critically analyse and examine the methodologies used by researchers to study social media and crisis communication to gain a deep understanding of the alternative methodologies, and then I explain the study methodology.

The study analysis is presented in four independent but interconnected chapters, chapters 4, 5, 6, and 7, which are academic articles under review or published. These papers examine distinct yet interconnected research questions that contribute to the advancement of knowledge in the field of *social media adoption for adequate shared situational awareness during a health crisis*. Each chapter in this thesis presents an independent yet related study, and it is important to note that the submitted or published papers have not been revised to include them in the thesis. Therefore, when the phrases "in this paper" or "in this study" are used in the body of the papers, they specifically refer to the journal or conference paper that was presented in that particular chapter. This distinction is necessary to clarify that the content of the thesis represents a compilation of individual studies that have been conducted and published separately—similarly, the use of "we" instead of "I" in the papers.

Chapter 2 Literature Review

As discussed in the previous chapter, this study investigated social media public health Facebook communication in Australia, and the analysis was conducted in four independent phases reported in chapters 4, 5, 6, and 7. Hence, each chapter is prepared with a literature review section focusing on the specific topic of interest for that study phase. This chapter introduces study concepts to provide a general understanding of the phenomena using relevant literature. This chapter also supports the research methodology choice by reviewing alternative approaches and highlighting the benefits and shortfalls of each approach. Webster & Watson (2002) have stated that a good research review lays the groundwork for future research and identifies the gaps in our understanding.

Public Health Crisis Communication

A crisis is defined as a period of collective stress that threatens society's fundamental norms and structure, and crisis management is a process of restoring normality (Rosenthal, 2001). Quick response to a crisis can reduce the damage it can produce; hence crisis management is designed to mitigate and limit the harm, including crisis communication (Gephart Jr et al., 2018), defined as the strategic use of words and actions in managing crisis information and meaning during the event (Coombs, 2018; Coombs, 2010). Social media platforms such as Facebook, and Twitter are changing crisis communication approaches and strategies (Cheng, 2018).

Social Media

Matisse, a Tokyo-based online media environment, is where the word "social media" was first used in 1994 (Bercovici, 2010). There were almost 110,000 publications with the phrase "social media" in the title as of January 2020. Over the past 25 years, numerous scholars have come up with widely different definitions of social media (Aichner et al., 2021). However, the term 'social media remains vague, and there is no commonly accepted definition (Xiang & Gretzel, 2010). In

his 'Social Media Bible,' (Safko, 2010) describes social media as the media people use to be social. In general, social media are Internet-based applications that carry user-generated content. Kaplan & Haenlein (2010) defined social media as "*a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0, and that allow the creation and exchange of User Generated Content*" (p. 61). This includes media impressions made by users, usually based on relevant experience, and stored or shared online so that other users who might be influenced by them can easily find them. Social media connecting a profile with that of other individuals and/or groups allow for the growth of online social networks (Obar & Wildman, 2015). In research, the term "social media" (SM) is used to refer to a wide range of websites and applications, such as blogs, photo sharing, business networks, collaborative projects, microblogs, product reviews, enterprise social networks, forums, social bookmarking, video sharing, social gaming, social networks, and virtual worlds (Aichner & Jacob, 2015).

Social media has transformed how people communicate, share, and connect. It includes platforms and tools for creating, sharing, and exchanging content in virtual communities. Understanding social media's core notion and relationships with neighboring words is essential to understanding its influence and potential.

Social media platforms let people and businesses connect, participate, and collaborate. They enable real-time messaging, commenting, and sharing of thoughts, ideas, and opinions on many topics. These platforms let users connect with friends, family, coworkers, and professionals. These networks offer professional development, job searching, mentorship, and knowledge exchange.

In social media, users often have a more symmetrical relationship, where individuals can send and receive information. Social media lets people create and share text, photos, videos, and audio. Users can share their talents and participate in conversations, communities, and trends. Social

media makes material viral. Memes, trends, challenges, and viral campaigns can swiftly attract millions. Social media influencers can influence trends, consumer behaviour, and brand endorsements.

E-commerce on social media networks allows businesses to sell directly to consumers. Businesses use social media to reach and engage with customers. Social media lets users discover, review, and buy products. Targeted advertising, sponsored content, influencer collaborations, and analytics let organisations design and measure marketing plans.

Social media has helped civic involvement and political activity. It lets people create awareness, mobilise communities, and advocate for causes, affecting public opinion and societal change.

Social media, also known as the "new media" and "traditional media," are different communication and information distribution types.

Social media allows users to produce, share, and interact with content. Discussions, comments, and direct communication are available to users. Users can create and share text, photographs, videos, and live broadcasts. Users can share their opinions and join discussions. However, traditional media tends to have a more asymmetrical relationship between senders (e.g., journalists, broadcasters) and receivers (audiences). Media organizations have traditionally held the power to create and disseminate information, while audiences have had limited opportunities for direct participation or influence. Traditional media, such as News outlets and periodicals, provide information to a passive audience in a one-to-many paradigm. Audience participation is limited. Professional journalists, reporters, and content creators produce and distribute news, articles, videos, and other information. Media organisations centralise content creation (Al-Deen & Hendricks, 2011).

Furthermore, real-time updates and information dissemination are social media strengths. Social media allows fast sharing and engagement of news, events, and trends. Social media connects millions of individuals globally. They target information and ads by demographics, interests, and preferences. Traditional media, such as television, radio, newspapers, and magazines, reach a vast audience but are frequently geographically confined. Traditional media advertising rarely personalises (Bruhn et al., 2012; Rajendran & Thesinghraja, 2014).

In terms of information asymmetry, traditional media and social media platforms differ greatly. Information asymmetry occurs when one party has more or better information than another, resulting in a power imbalance and potential disadvantages for the less-informed party. Let us contrast two kinds of media platforms:

Traditional media channels such as newspapers, television, and radio have historically served as information gatekeepers. To assure the accuracy and integrity of the information they give, they employ professional journalists who adhere to ethical standards and fact-checking procedures.

Traditional media is often controlled by a small group of organisations or corporations. They have editorial control over the content and make decisions about what information is published to the public. Başlar (2011) argues that governments and capital owners use psychological strategies and mind control methods through media to control and manipulate information, depriving people of their right to be properly informed. This results in an information asymmetry between the media and society, where the media can be used as a tool to mislead and control the public.

On the other hand, users on social media sites can produce and share material. Individuals, organisations, and news outlets can all contribute to the content published on these platforms.

Social media sites have decentralised control, allowing users to publish content without much editorial scrutiny. Social media enables the sharing of information in real-time. Viral sharing allows news and updates to spread quickly, allowing the public to obtain information virtually instantly. This can lead to a broader range of opinions, but it also raises questions about information accuracy and reliability.

Social media platforms have facilitated a more decentralised and immediate flow of information, whereas traditional media sources have typically operated as information gatekeepers with established journalistic practices. The characteristics of the medium assisted in information asymmetry and overload during a crisis like the COVID-19 pandemic (Li et al., 2020). However, the lack of strict editorial oversight and fact-checking systems in social media might contribute to the increased spread f misinformation, necessitating users' critical evaluation of the material they encounter on these platforms.

Social media can be broadly categorized into several subgroups based on their primary functionalities and purposes. The first category involves digitally communicating and socializing with known individuals, such as family and friends, through these platforms. Users can stay connected, share updates, and engage in conversations with their existing social circle. The second category pertains to interacting with unknown individuals who share common interests. These platforms enable users to discover and connect with like-minded people, fostering new relationships and expanding their social networks. The third category encompasses accessing and contributing to digital content, including news, gossip, and user-generated product reviews. Users can consume and engage with various forms of online information, actively participating in discussions and sharing their own perspectives (Apple et al., 2020). Here are some common subgroups of social media:

Social network sites (SNSs) focus on connecting individuals and facilitating social interactions. Examples include Facebook, LinkedIn, and MySpace. *Microblogging platforms* allow users to share short updates or posts with their followers. Twitter is the most well-known microblogging platform. Social network sites and Microblogging platforms primarily serve the purpose of facilitating the creation and nurturing of networks or communities through the sharing of messages and various types of media (Seargeant & Tagg, 2014).

Media sharing platforms increasingly feature social network capabilities, enabling users to share and discover various media types, such as photos, videos, and audio content. Popular examples include Instagram, YouTube, and Snapchat.

Professional networking platforms cater specifically to professionals and focus on building and enhancing business connections. LinkedIn is a prominent example in this category.

Discussion forums and communities, furthermore, provide spaces for users to engage in discussions on specific topics of interest. Examples include Reddit and Quora.

While not exclusive to social media, *blogging platforms* often have social features that allow users to engage with and follow each other's blog content. WordPress and Tumblr are popular blogging platforms.

Review and recommendation platforms enable users to share reviews, ratings, and recommendations for products, services, and places. Yelp and TripAdvisor fall into this category.

Messaging and chat applications focus on private or group messaging and communication. WhatsApp, Messenger, and WeChat are widely used messaging apps.

Live streaming platforms allow users to broadcast and view live video content in real-time. Examples include Twitch, YouTube Live, and Facebook Live. Social media applications have changed over the past two and a half decades Social media applications have changed over the past two and a half decades; Table 1 summarises some of the major applications of social media.

Table 1 Major Applications of Social Media

Study	Social media application	Example
Aichner & Jacob (2015); Lazakidou (2012); Sponcil & Gitimu (2013); Williams & Merten (2011); Parreñas (2005)	By socializing with friends and communicating with families, users feel supported and belong to online communities of like-minded individuals.	Sharing significant life events through status updates, images, etc. A tool for migrant people to maintain contact with their families.
Papp et al. (2012); Sponcil & Gitimu (2013); Fox & Warber (2013); Suler (2004)	Romance and flirting, shaping and defining our relationships.	Contacting a crush through social media in the starting phases of a relationship, online dating is more convenient, and rejection is less painful.
Lyon & Montgomery (2013); Baird & Parasnis (2011); Malthouse et al. (2013)	Facilitating two-way communication between companies and customers.	Companies use social media to collect information, inform their customers, provide after-sales service or consultancy, receive feedback, and promote their products or services. Customers use social media to communicate easily and quickly with the company.
Koch et al. (2018); Fertig (2017); Sinha & Thaly (2013); Van Dijck & Poell (2013); Chiang & Suen (2015)	Job-seeking and professional networking.	Companies searching LinkedIn to expand their talent pool. Also, LinkedIn profiles allow users to create idealized portraits.
Culnan et al. (2010); Malthouse et al. (2013); Dholakia & Durham (2010); Pan & Chiou (2011); Ridings & Gefen (2004)	Impacted doing business and how companies approach clients and vice versa.	Improve companies' internal operations and understanding and informing customers, e.g., customers' engagement via online customer communities.
Bharati et al. (2015); Nisar et al. (2019) Hemsley & Mason (2012); Sigala & Chalkiti (2015)	Creates a dynamic, recursive socio-technical information and knowledge-sharing system. Promote organizational efforts in knowledge management and increase employees' creativity.	Information cascading within and between multiple weakly linked personal social networks. Collaborating with friends and strangers around the world (wikis). Social media enhance organizational performance through embedded information and social communication.

In the context of social media, there are several key concepts that play a significant role in understanding its dynamics and functionalities.

Channel: A social media channel refers to a specific platform or website through which users can engage and interact with others. Examples include Facebook, Twitter, Instagram, and YouTube.

Post: A post is a piece of content shared by a user on a social media platform. It can include various forms such as text, images, videos, or links. Posts allow users to share updates, thoughts, opinions, or media with their connections or the public.

Comment: Comments are responses or reactions made by users to a post on social media. They provide a way for users to engage in conversations, share their thoughts, ask questions, or express opinions about the content.

Like: A like is a form of positive feedback or appreciation given by users to a post they find interesting, entertaining, or agreeable, it is usually represented by a button or icon on social media platforms.

Share: Sharing involves reposting or forwarding someone else's content on your own social media profile or directly with others. It allows users to distribute interesting or valuable content with their network, increasing its reach and visibility.

These concepts are fundamental to the social media environment and shape the way users interact, communicate, and engage with each other and the content they encounter.

Social Media and Crisis Management

Social media also plays an important role in disaster management. A disaster is described as a serious disruption to an area's or society's work at any level caused by dangerous events interacting with exposure conditions, vulnerability, and ability, resulting in the following losses and impacts in human, material, economic, and environmental domains (UNDRR, 2009). A disaster is also

defined as a sudden, catastrophic event that seriously disrupts the operations of a community or society and generates losses that are beyond the capacity of the community or society to cope with using its own resources, that causes material and financial losses (IFRC, 2012). Despite their similarities, *disasters* and *crises* are distinct yet linked situations. The two terms are often used interchangeably (Shaluf & Said, 2003), as is also done in this study. It has been pointed out that no generally agreed-upon definitions of disaster or crisis have yet been produced (Perry, 2007; Turner, 1976).

Information and communication technology (ICT) refers to the technologies and tools used to handle, process, transmit, store, and retrieve information. It encompasses a wide range of hardware, software, networks, and digital systems that facilitate communication, data management, and information sharing. ICT includes various technologies such as computers, smartphones, the internet, telecommunications networks, software applications, and digital media platforms. It plays a crucial role in modern society, enabling the creation, exchange, and utilization of information across different sectors, including business, education, healthcare, entertainment, and governance. ICT has revolutionized communication and information management, facilitating faster and more efficient access to information and enhancing connectivity between individuals, organizations, and societies. ICT encompasses a wide range of media platforms, including traditional forms like radio and television, as well as newer technologies such as cell broadcasting, the internet, and satellite radio. All these mediums have a significant role in educating the public about the potential risks and impending disasters. Information and communications technology (ICT) can be pivotal in disaster prevention, mitigation, and management. Remote sensing for early detection and warning is made possible by various available technologies, including telecommunication satellites, radar, telemetry, and meteorology. ICT encompasses both traditional

media (radio, television) as well as new media (cell broadcasting, Internet, satellite radio), all of which play a major role in educating the public on the risk of a potential or impending disaster (Etamike & Agah, 2011). Fazeli et al. (2021) further highlight the positive impact of utilizing ICT in crisis management, leading to improved performance and a reduction in casualties. Social media is widely used in disaster/crisis responses and improve communication and coordination. The utility of social media in crisis management is broad (Alexander, 2014) and includes but is not limited to extending emergency response public awareness (Yin et al., 2015), risk communication, and the public in natural disasters such as floods (Bruns et al., 2011), earthquake (Yates & Paquette, 2010), extreme weather condition (Goncalves et al., 2014), or managing human-made crisis such as terrorist attack (Falkheimer, 2014), as well as community resilience (Dufty, 2012).

Some applications of social media are highlighted in Table 2.

Table 2 Application of Social Media for Crisis Management

Study	Social media application for crisis management	Crisis phase
Yates & Paquette (2011); Hashim et al. (2015); White (2011)	A powerful tool to communicate critical information in real-time, and became the most popular ICT resource for crisis information-sharing	Pre-Crisis - During Crisis - Post Crisis
Dufty (2016)	Social media as a tool for hazard risk identification, community engagement in disaster mitigation and preparedness, early warning communication, and resource allocation during disaster recovery. Twitter's critical usage as a crowdsourcing medium for providing real-time information, emotional support, and recognising the needs and vulnerabilities of affected communities	Pre-Crisis During Crisis
Kaewkitipong et al. (2016); Ferris et al. (2016)	Social media play an important role in knowledge management systems for disaster and emergency management. The utility of these platforms as a knowledge-sharing tool facilitates emergency response.	Pre-Crisis During Crisis Post Crisis
Leong et al. (2015); Ahmed (2011); Almansoori & Habtoor (2018)	Social media empower the community through structural, psychological, and resource empowerment to create collective involvement, shared identification, and collaborative control, leading to more resilient communication.	During Crisis Post Crisis
Wang & Ye (2018) Yan & Pedraza-Martinez (2019)	Increase situational awareness, inform disaster victims and improve disaster response.	During Crisis

Facebook and Crisis Communication

Facebook was the first social network platform to exceed one billion registered accounts and currently is the most popular social media platform, with more than 2.89 billion monthly active users worldwide. Facebook said that more than 3.58 billion people used its core Family products, WhatsApp, Facebook Messenger, and Instagram, every month in the third quarter of 2021 (Dixon, 2022).

Facebook, among social networking sites, boasts the largest population of daily active users. Social media platforms that were introduced after Facebook have become tremendously popular, yet Facebook has remained unbeaten. Even though there are numerous formidable competitors, such as Twitter, LinkedIn, and Instagram, Facebook remains on top (in terms of number of users). Studies investigating Facebook in a public crisis show the importance of the platform in different phases of a crisis and, in particular, during the event. Figure 3 shows the growing number of Facebook active users from 2011 to 2022.
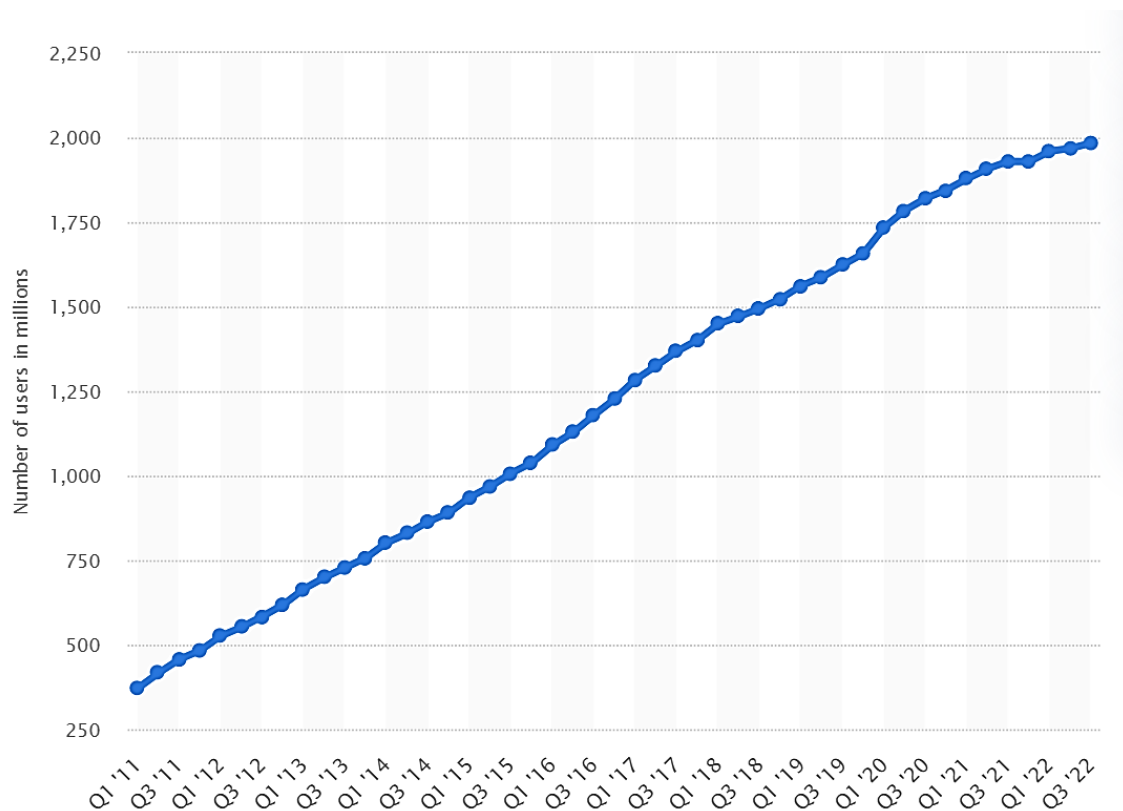
Figure 3 Number of Daily Active Facebook Users Worldwide as of 3rd quarter 2022(in millions), source; © statista 2022, adapted; from https://www.statista.com/statistics/346167/facebook-global-dau/ date 13 November 2022

Table 3 summarises examples of roles the platform played during different stages of crises showing that this platform plays various significant roles in all phases of a crisis. Considering the

popularity of Facebook and its dominant position in a crisis, this study narrowed down the scope

to focus on the role of Facebook in public health communication during the COVID-19 pandemic

in Australia.

Table 3 Facebook's Role in Crises

Study	Event	Facebook role	Crisis phase
Atkinson et al. (2021)	The Australian 2019–20 Bushfire	Response agencies used Facebook as a one-way communication channel to broadcast timely, accurate information information to the affected community.	During Crisis
Ross et al. (2018)	Terrorist attacks in Berlin, London, and Stockholm	Facebook features like Emojis provide an opportunity for Emergency service agencies to disseminate information more effectively by listening out to their reactions and optimising messages accordingly.	Pre-Crisis During Crisis
Möller et al. (2018)	The Tropical Cyclone Winston in Fiji, 2016	Facebook raised funds and donations during the recovery phase and assisted with diversifying disaster aid and relief funds.	Crisis Recovery
Tampere et al. (2016)	The Fukushima Daiichi nuclear disaster, 2011	Facebook discussion of a crisis helps organisations to clarify citizens' perceptions of crisis.	During Crisis Post Crisis
Bygstad & Presthus (2013)	Eyjafjallajøkull volcano in Iceland and ash crisis in April 2010	Social media can replace traditional CRM systems; Facebook resolves the shortcomings of traditional CRM. The openness of Facebook allows for more dynamic interaction between the company and its customers.	During Crisis
Dabner (2012)	Canterbury earthquake in the South Island of New Zealand	'Facebook' became a prominent source of support; it effectively supports information sharing, communication, and collaboration in higher education contexts.	During Crisis

Social Media Public Health Communication

Social Media platforms have significantly facilitated public access to health information, increased public awareness, and attracted users' attention to health guidance (Seeger et al., 2018). Accessing and seeking health information online directly impact people's knowledge, choices, and health behaviours, influencing health outcomes. Social media platforms have the potential to reinforce health promotion and prevent disease (Weaver III et al., 2009). Smoking habits, cholesterol consumption, and condom consumption are examples of health behaviours that have changed due to public communication efforts, including traditional media coverage of health issues and deliberate communication programs. Studies showed that those health communication programs that covered a wide population were more successful (Hornik, 2002); hence social media, with billions of users, has provided new platforms for effective health communication with the public. Table 4 highlights the main use and benefits of social media for Public health communication.

Table 4 Applications of Social Media for Public Health Communication

Study	Use of Social Media	Benefits
Freeman & Chapman (2007); Rhebergen et al. (2012); Andersen et al. (2012); Giustini et al. (2018); Allen et al. (2020)	Facilitate dialogue between patients to patients and patients and health professionals.	Enhanced users' interactions with others and peers, emotional and social support
Venegas-Vera et al. (2020); Hennessy et al. (2019); Giustini et al. (2018);	Decreased knowledge transition time to other healthcare providers	Enhance scientific community and health professionals' collaboration and lifelong learning
Tian (2010); Denecke & Nejdl (2009); Greene et al. (2011); Allen et al. (2020)	Provide health information on a range of conditions	Increased access to shared and tailored health information,
Adams (2010); Kim & Kwon (2010)	Discussion forums and online consultations, answers to medical questions. Reduce stigma	Increase accessibility & widening access to health support. Facilitate dialogue between patients and health professionals.
Lagu et al. (2010); Velasco et al. (2014); Fung et al. (2015); Skaik & Inkpen (2020); Tahir et al. (2018)	Collect data on patients, Used for health intervention, health promotion, and health education experiences and opinions.	Public health surveillance
Chan & Nyback (2015); Krowchuk et al. (2010)	Tool to develop cultural competence and skills needed to provide effective healthcare service	Reduce health disparities, and improve cultural competence in healthcare.

Social media can educate, empower, and engage patients; hence, the application of social media by healthcare providers to communicate with patients has been endorsed by health studies (Krowchuk, Lane, & Twaddell, 2010). These platforms have been extensively utilised by health agencies such as World Health Organization (WHO), hospitals, and health practitioners (Antheunis et al., 2013; Eyrich et al., 2008; McNab, 2009) to improve public health communication (Dawson, 2010; Green et al., 2010).

Social media platforms like Facebook and Twitter are reliable tools for monitoring real-world events (Dredze, 2012); these platforms have vastly been used in managing public health crises like the COVID-19 pandemic.

Social Media Public Health Crisis Communication

Public health crises such as disease outbreaks also impact community health and cause loss of life, as well as a considerable effect on the economy (Naik et al., 2019).

Emergency communication with the public during the planning and response phases of a public health crisis (e.g., diseases outbreaks) is an essential component of the emergency management and responsibility of public health agencies (e.g., The Australian Government Department of Health, State and territory government health departments, the Public and private hospitals, etc.). Effective communication during public health, like infectious disease epidemics, supports the success in preparedness, response, and recovery of the public health emergency (Dickmann et al., 2015b). Referring to the growing numbers of Social media users (Statista, 2018), these platforms have become an essential channel for health agencies to reach a broad audience. These platforms had initially been used by the public to access event-related information and communication and were later vastly utilised by emergency organisations.

However, health organisations also need to align their social media health communication with existing public health problems. For instance, Jha et al. (2016) explored how State Health Departments (SHDs) in the US utilised Facebook during the 200 days study period (2013 to 2014). They compared the attention of the health organisation in these social media activities to the information related to the community behavioral risk factors and health indicators provided by the Behavioural Risk Factor Surveillance System (BRFSS) in Centres for Disease Control (CDC). They reported an apparent inconsistency in content provided by SHDs on Facebook that affected

the outcome reflecting the concern that the organization's social media communication effort may not always assist crisis management.

It is critical to respond to public health hazards as soon as possible in order to prevent harm to populations. During a crisis, there is a high demand for relevant, precise information and directions in order to save lives, manage the crisis, and mitigate any potential damage. As the crisis unfolds, numerous parties enter a space where they can give and receive information. This debate takes place across multiple media platforms, including print periodicals, online sources, social networking sites, and weblogs. Multiple factors, such as the growth of media options and the increasing dispersion of editorial power, have contributed to the evolution of crisis communication into a more sophisticated and fluid state (Rodin et al., 2019). Crisis communication increasingly relies on online communication to exchange information and opinions on a crisis and enable the coordination of resources such as equipment, personnel, and knowledge (Denecke & Atique, 2016). Social media users are more active during extreme events like the Arab Spring, COVID-19, and MERS-CoV. In 2015, a cross-sectional study in the Persian Gulf countries surveyed 2741 people about MERS-CoV. 37% of Saudis use social media, and 20% use the Ministry of Health (MOH) website to learn about MERS-CoV(Alqahtani et al., 2017).

Utilizing mass media, including social media, to engage a broad population in health decision-making processes is strongly suggested for government organisations (WHO, 2019).

Studies showed that the integration of these platforms in monitoring and controlling public health emergencies and crises had created new opportunities for emergency services (Avery, 2017; Guidry et al., 2017) as well as new challenges, such as disseminating rumors and the emergence of vaccine refusal online collective behaviour (Dredze et al., 2016; Kata, 2012).

COVID-19 and Crisis Communication

In late December 2019, the China office of the World Health Organization identified a new strain of SARS (severe acute respiratory syndrome) in Wuhan, China. On January 30, 2020, the World Health Organization (WHO) declared the epidemic as an "International Concern" tied to a Public Health Emergency. On March 3, 2020, the WHO declared a global pandemic. COVID-19 is one of the few recently discovered infectious diseases to provide such an unprecedented global public health crisis and has devastated many aspects of daily life. During the COVID-19 pandemic, social media crisis communication was crucial in encouraging the public to alter their behaviour and cope with the risk (Lu et al., 2021). To combat the ongoing pandemic of COVID-19, governments implemented lockdowns, and many people were compelled to drastically cut back on their mobility and social interactions. At a time when everyone needs better information, ICT can assist governments, organizations, and the public in combating a pandemic. Because of the impact of the pandemic on public communications, people are now more likely to get their information from social media as well as other sources. During the COVID-19 crisis, social media tools helped spread the latest news and health information (Agius et al., 2020); social media also spread crisis information faster compared to the virus (Merchant & Lurie, 2020). Below is a review of the pros and cons of the use of social media use during the COVID-19 pandemic. Table 5 and Table 6 highlight some of the benefits and drawbacks of social media during the pandemic.

Table 5 Social Media COVID-19 Studies_ How Social Media Supported Managing the COVID-19 Crisis

Study	The Positive Role of Social Media in COVID-19
Almotawa & Aljabri (2020b); Al-Dmour et al. (2020)	Creating Public Awareness
Jiang et al. (2021); Kudchadkar & Carroll (2020); Kearsley & Duffy (2020)	Facilitate information sharing, access to key data, and rapid dissemination of knowledge across geographical boundaries.
Ghalavand et al. (2022); Chereka et al. (2022)	Rapid knowledge sharing and collaboration between health professionals.
Taylor et al. (2022); Zhang et al. (2020)	Assist in understanding people's emotions and shed light on psychology, public health, and economic challenges during COVID-19.
Lu, Li, & Qian (2021); Tsoy et al. (2021)	Social media influences people's emotions, perception of risk, attitudes, collaboration, and interaction behaviours toward the crisis.
Karami et al. (2021); Han et al. (2020); Lyu et al. (2022); Boon-Itt & Skunkan (2020)	Enhance understanding of public opinion regarding COVID-19, e.g., vaccine.
Van Slyke et al. (2021); Lakamana et al. (2022); Zolbanin et al. (2021)	Pandemic surveillance and prediction
Limaye et al. (2020); Bunker et al. (2022)	Maintaining connectivity and Forming public trust; facilitating good faith political expression and discourse.
Thelwall & Thelwall (2020); Cauberghe et al. (2021); Hamilton et al. (2020)	Social support, e.g., Helping the public to cope with social isolation.

The COVID-19 pandemic has shown that the spread of misinformation, fueled by social media and other digital platforms, poses a threat to global public health comparable to that of the virus. People may now stay informed, connected, and protected thanks to the internet and other forms of modern technology. The same resources, however, facilitated and amplified the ongoing infodemic that undermined the global response and threatened control measures for the pandemic.

Table 6 Social Media COVID-19 Studies_ the Problems Posed by Social Media During the COVID-19 Crisis

Study	The Negative Role of social media in COVID-19	Consequences
Valika et al. (2020); Pang (2021); Mohammed et al. (2022); Fan & Smith (2021); Jiang (2022)	Information overload[2]	Wide variability in practice causes confusion and affects the ability to respond adequately. Cause social media fatigue also reduces health fact-checking. Negative impact on well-being during the COVID-19 pandemic.
Bermes (2021); Pool et al. (2021); Li, H. O.-Y. et al. (2020); Badell-Grau et al. (2020); Hotez (2021)	Spread of misinformation, disinformation, and conspiracy theories	Create confusion, fear, anxiety, and mistrust in response organisations. Negative behavioural responses in consumers, e.g., irrational panic buying. Accelerate anti-science activities and hinder the implementation of the best public health policies.
Depoux et al. (2020); Radwan et al. (2020); Ahmad & Murad (2020)	Panic and fear transmission	Negative impact on their mental health and psychological well-being.
Wong et al. (2021); Wang & Zhou (2022)	Spread of a high volume of low-quality, contradictory, and not verified information	Cause anxiety and foster distrust of credible health information.
Bayer et al. (2019); Molter & DiResta (2020); Kelso & Altinay (2022)	Sharing propaganda or sponsored content	Manipulate public opinion and their decisions, e.g., creates genuine insecurity, such as the COVID-19 vaccine hesitancy. Misleading public opinion on political parties or the government's pandemic response. Pandemic-themed commercials.

This study investigates public health Facebook communication during a crisis, i.e., the COVID-19 pandemic; hence at the planning stage of this study, the research approaches and methodologies used by social media researchers to make an informed decision on the most appropriate methodology were analysed to understand how to best achieve the study objectives. In the

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[2] Information overload is described as a circumstance in which there is an abundance of information but insufficient information-processing capabilities (Schick et al., 1990).

following sections of this chapter, I review social media studies from different disciplines to focus on their methods and explain the benefits and limitations of each methodology. This analysis assisted in the choice of the most appropriate methods for the various stages of this study and also raised awareness of the limitations and risks associated with each method.

Social Media Studies; Methodologies and Concerns

Clinical and social media data has been used in the early detection of disease outbreaks and has successfully reduced the economic burden of these events. Twitter microblogging activities have been used as a source of data for Influenza surveillance and real-time prediction for influenza activity (Santillana et al., 2015; Woo et al., 2016). These studies (Ibid.) as well as Corley et al. (2009), used secondary blogging datasets and applied text mining and machine learning methods to detect the keywords within posts or search queries on social media datasets. In these quantitative studies, the researchers traced the keywords within the social media dataset, and by longitudinal analyses of relational data, they tracked the patterns in the spread of the keywords within the network before, during, and during a recovery period of an outbreak event. Then they correlated the change in patterns with the pandemic real-time activities using regression methods, mostly the Support Vector Regression (SVR) model. Finally, they trained the machine with the sequence of past events to be able to use it for predicting upcoming events. Using these studies help health organisations in disease detection, as well as epidemiologic monitoring and surveillance. However, a selection bias can exist as the data is generated by social media users, and the information related to the non-users is not used in training the machine. Moreover, only limited researchers (e.g., Gao et al. (2018)) considered the messages (e.g., posts, tweets, etc.) that are unrelated to the event as a control variable to explain the utilisation of these platforms in extreme events, especially disease outbreaks. Considering the high volume of online activities happening on social media platforms,

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the conclusion on the effectiveness of the application of social media in crisis communication by referring to the number of event-related interactions is not very reliable. Although the use of computer programs in these methods enables researchers to analyse a high volume of textual data, the accuracy of categorization that is supposed to be representative of concepts might be less reliable compared to studies in which researchers clean, analyse, and categorise the event-related texts manually.

On the other hand, studies used social media data (e.g., Twitter data) and looked at different properties of the network, as well as the characteristics of the account holders, for instance, whether the Twitter account is held by health agencies, governments, or individuals (Safarnejad et al., 2020; Yun et al., 2016). These studies built upon *network* and *graph theories* (e.g., network centrality (Freeman, 1977)), and the researcher used both statistical and Social Network Analysis (SNA) techniques to disclose the relational and absolute attributes of the location of a node/agent (social media users) within the online communication network. They generally describe the relationship between different features of a node (i.e., agencies, government, individuals) within the network and the objectives of the study reflected as dependent variables (e.g., influence maximization in Amato et al. (2019) study). Rooted in influence theory (Kelman, 1958), it is assumed that social media users can influence each other, and an agent's position within a social network can initiate the notion of power and influence within the network. It is assumed that nodes that were located at the most central points within the network experience advantage of influencing other platform users via their direct and indirect connections. This mechanism has been mostly used by marketing researchers (e.g., Aleahmad et al. (2016)) to develop the *word of mouth marketing* strategies and detect the most influential social media users in information dissemination through the platforms. Likewise, in the context of public health communication in outbreak events, similar techniques

can be used to identify the most central accounts within an social media platform and engage them to transmit the outbreak information to the targeted audience.

These techniques have been prevalent and practical in the marketing field, also, have been used to study the effectiveness of information diffusion via social media in crisis responses (Kim & Hastak, 2018). However, it can be argued that in this approach, the researchers use the historical relational behaviour of agents within the network to determine their power and influence degree; while the agent's behaviours are rational (Fishbein, 1975), their behaviour might dramatically change during and influence by an extreme event. However, rational behaviour might dramatically change during and be influenced by an extreme event such as a disease outbreak. Toilet paper panic buying in Australia at the threat of the COVID-19 pandemic (2020) is an example of the dramatic change in human behavior. Therefore, it may not be trustworthy to over-rely on this method and use it as the only source of information essential for organisations in their social media strategy setting.

Moreover, this method is effective if researchers can access a rich dataset of high-volume online interaction and analyze a complex network created by the interaction between users. Under these circumstances, researchers can utilize valuable information by exploring different properties of the network and can also trust that the network features will remain stable in the near future, so the result of such a study is generalizable. However, online interaction/discussion about infectious disease epidemics is usually limited and not consistent. Yun et al. (2016) observation showed fewer Twitter accounts that had twitted on Flu-related topics during seven weeks of the 2013 flu season showed activity during the same period in the next year (i.e., seven weeks of the 2014 flu season).

On the other hand, the social media content and the way that these platforms are utilised by health practitioners may impact the publics' responses to the outbreak. Using content analysis techniques, a case study explored the ways that health organizations utilised *Instagram* and *Twitter* in the Ebola outbreak (2013) communications with the public (Guidry et al., 2017). They (Ibis.) randomly collected 779 tweets and comments published by three leading health organisations (i.e., CDC (@CDCgov), WHO (@WHO) and Doctors without Borders (@MSF)) and their followers, as well as all the 107 Instagram messages that were posted by the organisations using a four months sampling window. In the content analysis and comparable approaches, researchers analysed the characteristics of the texts and coded the content according to the context and objective of the research. For instance, Guidry et al. (2017) were concerned with the primary emotion expressed in the posts and looked at three variables to their research question, i.e., how (1) different organisations utilise (2) different social media platforms to communicate information with the public in an outbreak event, and (3) whether this impact the public responses?

Textual data taken from social media has also been used to capture the public concerns and emotions related to the crisis. Ahmed et al. (2018) used Twitter and Facebook messages to understand the relationship between using social media to access health information and influenza vaccine acceptance. The finding of their study showed those social media users who used social media (i.e., Facebook and Twitter) to obtain health information were more likely to be vaccinated compared with other users. Generally, this approach being used by researchers to highlight a factual situation and fails to provide information related to the intention or motivation of the users that caused or initiated the phenomenon observed by the researchers (e.g., the public fear reflected on Twitter live chat during Ebola outbreak observed by Lazard et al. (2015). Moreover, access to

the content of social media data may be restricted due to privacy settings, and the personal information of the users is often difficult to verify.

Moreover, access to social media data may be restricted by privacy settings, and the personal information of the users is often difficult to verify. Sampling bias might also be involved in the process; the choice of keywords can dilute the data. Moreover, researcher bias might affect the result of these studies as the content of the messages needs to be read and interpreted and the keywords should be selected by the researcher.

My review of the literature has highlighted that using different research methods in analyzing social media data enables researchers to study various aspects of the topic and obtain different types of information. However, in my review of research methods, it was evident that these failed to assist researchers in explaining social media users' intentions and motivations that initiate their online behaviours. Hence, it is problematic for researchers to demonstrate causal relationships between social media concepts by only exploring historical data obtained from social media platforms. It is necessary to conduct complementary studies of the community, including analysing a sample of the targeted audience for the communications and not only social media users in general. Moreover, health organisation should also assist researchers in interpreting social media and community data to develop more reliable conclusions on the cultural dimensions of social media use by health organizations to communicate with the public.

Furthermore, in designing social media policy for health organisations, concerns like limited access to the platforms during extreme events due to infrastructure breakdowns or channel disruptions should also be considered. However, it seems these issues are not significant in the case of infectious disease outbreaks. Instead, in epidemic events, the fear of identification,

vilification, and exclusion may render social media users unwilling to share health information. This limitation is even more severe in those countries where social media users need to use their real names for registration on social media platforms.

My conclusion from the review of social media research methods is that each method enables the researcher to obtain different types of information; however, almost all methods failed to explain the users' intentions and motivations that initiate their online behaviours. Hence, it can be inferred that it is less expected that researchers can obtain a deep understanding of different aspects of the topic study (e.g., explain causal relationships) by using one method only to explore data obtained from social media platforms. Hence, complementary studies such as online surveys or interviews (in a case focussed way) may assist researchers in drawing more reliable conclusions on utilizing social media by emergency organisations for crisis management.

Chapter 3 Framing the Study, Research Approach, and Framework

Infectious disease epidemics have first been documented in ancient Greece and Egypt. It has been highlighted that the morbidity and mortality of the burden of epidemics over time shaped the culture, politics, and commerce in these societies (Nelson & Williams, 2014). Disease outbreaks such as infectious epidemics can fundamentally impact the community and cause a social/global crisis (Naik et al., 2019). The history of worldwide *Influenza* (1918-1919), *SARS* (2002-2003), and *Measles* pandemics are examples of the potential threat and the high death rate caused by pandemics (Fiegel et al., 2006).

Although public awareness of communicable diseases has significantly increased, infectious diseases are responsible for over 13 million worldwide deaths each year and remain an important global problem in public health (Cohen, 2000). Hence, understanding the control of infectious disease spread has always been important to practitioners and researchers.

This chapter elucidates how this study was formed, starting by explaining how I identified the research problem and which this study scoped to focus on the use of social media during the COVID-19 public health crisis. I further explain the research approaches, methods, and theoretical underpinning, which are the backbone of the study.

Problem Statement and Framing the Research; an Engaged Scholarship Approach

Background

To understand the problem, my research benefited from an *engaged scholarship* (Van de Ven, 2007) approach, and I have actively interacted with diverse stakeholders and scholars such as Australian practitioners, public health organisation members, and members of emergency services as well as academics from different disciplines, through workshops, informal interviews, and meetings. During my Ph.D., I was a member of the *Communications and Technology for*

Society Research Group (CATSRG), formerly known as *Interoperability for Extreme Events Research Group* (IEERG), led by my supervisor Prof. Deborah Bunker, and the *Sydney Institute for Infectious Disease*, previously known as *Marie Bashir Institute NSW Australia*, which was managed by my auxiliary supervisor Prof. Tania Sorrell. I have constantly been involved in organizing workshops and participating in seminars with practitioners working in public health and disasters and emergency management. This gave me an enormous opportunity to actively interact with practitioners and experts in the field, learning about the real-world problems they deal with in managing emergencies and pandemics as well as learning from their tactical knowledge of using social media and engaging the community in crisis management.

There are a variety of issues and challenges that practitioners face when managing extreme events; these were discussed during focused workshops to add to the body of knowledge in IS but also to assist organisations and society in coping with emergencies and crises.

The CATSRG workshop, Health Communications for Epidemics Workshop, on 9th July 2019, highlighted the immediate health challenges for health crisis management in Australia (please see a summary of the outcome in Table 7).

Table 7 the Summary of the Workshop Outcome; drafted by Anthony Sleigh, an Executive member of CATSRG, and shared between participants (2019)

1	There is a need to develop a "total health systems view" of communications during epidemic disease events. This should include developing a better understanding of the horizontal communications between stakeholders and groups in the health sector.
2	The Australian general public is not a homogeneous mass. Cultural context (in its many forms) in health communications is an important consideration, i.e., the ability to be able to communicate with cultural sub-groups in a targeted, efficient and effective manner.
3	Surveillance systems should capture and utilise sub-group data in an appropriate and sensitive manner.
4	There is a need to announce early (with an effective message that everyone takes notice of), but there is a tension between local and global information as well as the need to know versus privacy considerations.
5	Understanding risk in public health is context-dependent, and there is a need for general education and awareness to facilitate behavioural change.
6	There is a balance to be developed between individual and societal (real and perceived) risk assessment as well as the identification and definition of systemic outcomes. This requires the application and use of ethical methods and approaches.

Improving organisations' and people's capacity to use social media to coordinate responses to public health emergencies was widely acknowledged as a crucial approach to "*lending a hand*" during times of crisis.

One of the initial outcomes of the workshop was the "*development of strategies and approaches to increase the potential of social media platforms to support public health agencies in managing and influencing an influenza scenario to limit contagion*" *-p43*(Bunker et al., 2019). This informed the objective of my research. My research aims to assist public health organisations in developing strategies and tactics for future use of social media to assist infectious disease containment while minimizing social and economic, short, and long-term health consequences. Using workshops as a live research method and active participation of the stakeholders for co-creation and framing the research through engaged scholarship has been recognized in the literature as an effective approach to designing research in crisis communication and the use of technology, e.g., social media in this context (Elbanna et al., 2019). My research involved interacting with practitioners to assist with;

1) *understanding the problem, 2) data enrichment and enhancing results,* and 3) *evaluating the outcome*.

The Motivation of the Study and Planning Research

"Control of infectious disease epidemics, currently focused on the disease process (itself) and preventing its spread, assumes that transmission will be controlled by the public health system and private practitioners (i.e., vaccinations and medicines), in a context where significant drivers of spread and lack of control are social interactions and behaviours"; I wrote this sentence in February 2019, almost a year before the global COVID-19 pandemic started.

The spread of infectious disease and pandemic control, particularly in the absence of a vaccine and treatments to prevent the emergence of a new deadly virus, further necessitate community engagement for prevention and control. Public health communication is capable of influencing health behaviours, such as smoking, sexual activities, and obesity control (Hornik, 2002). Public health organisations can use social media to manage social interaction and control epidemics. However, various factors impact the effectiveness of information transmission and communication during a public health crisis that remains unknown.

Communicating health information and engaging heterogeneous populations like Australian communities during a crisis like the COVID-19 pandemic is even more challenging. Furthermore, social media communication is a dynamic process in which sources and receivers of information continuously interchange their roles, and the interaction between the component of the system is influenced by various internal and external factors. Hence, health agencies face known and unknown challenges and need to make additional efforts to communicate with their audiences at their level of technology use as well as health literacy.

The Australian government has recognized social media as an official channel of communication that supports public health organizations. However, these low-cost and effective communication tools were not fully utilized for communicating public health crisis information, at least in the time my research framed, i.e., before the COVID-19 pandemic. In 2019, when I was framing my study, I had three meetings with practitioners seeking the way that an IS researcher can assist them in managing a crisis caused by an infectious disease pandemic.

These meetings were to elicit background and context for my study. These were a few comments about the use of social media by public health agencies that highlight commonly held assumptions of the time, i.e., pre-COVID-19.

A manager of a public health unit working in communicable diseases stated that " … *we regrettably don't want our social media followers to post their questions to our social media pages; we don't have enough resources to respond to their questions; we want people to contact us through our channels, e.g., seeing GPs and nurses call us*, ...".

An academic who is also a medical specialist and senior member of a healthcare medical research center mentioned, "*I don't know if patients get the information from social media, and I personally don't use social media, and I don't post any health information on these platforms, I don't know how much XXX health does it.*"

A clinical infectious diseases specialist who was also a senior university researcher advised, *"you need to think about your argument about the necessity of your study; how do you want to convince the academic assessment panel that your research is important, and why do we need social media crisis communication to manage an outbreak. Medical science is now advanced enough that we will be able to control infectious disease using vaccines and medical treatments, and the chance*

that an infectious disease outbreak creates a crisis is very low." Not too long after these comments, the first case of the novel coronavirus in Australia was reported in Victoria on 25 January 2020, with additional three cases confirmed in New South Wales later that day. On 16 March 2020, the Minister for Health declared a Public Health Emergency. On the 26th of March, after a year of research, I defended my proposal online due to the severity of the outbreak and the consequent social distance limitations. In my presentation, I used the number of daily/hourly deaths caused by the pandemic to highlight the importance of my study. I also evidenced the infodemic accelerated by social media and the resulting confusion and negative public response to the crisis to defend the importance of social media in managing the crisis; I will explain this further in the following section.

Context of Study

WHO identified the novel coronavirus (cause the COVID-19 disease) in December 2019 when the Wuhan Municipal Health Commission, China, reported a cluster of cases of pneumonia in Wuhan, Hubei Province (WHO Timeline, 2020). The novel coronavirus spread from China to 20 other countries over the first six weeks of 2020. On 30 January 2020, the WHO declared a public health emergency of international concern due to the spread of COVID-19 and the severe global threats.

The COVID-19 pandemic is characterised by threat, surprise, and a short response time which fits Hermann (1963) definition of a crisis. The COVID-19 pandemic globally threatened the core values of life-sustaining systems, induced a sense of urgency, and created significant uncertainties about the nature of the event and its consequences, which is also described as the definition of crisis at the community level (Olsson, 2014).

By March 2020, COVID-19 had reached almost all countries globally, many of which instituted travel lockdowns and quarantine measures to protect their communities. The COVID-19 lockdown restrictions affected over a third of the global population, with restrictive social distancing and mass isolation. According to Loye & Eisler (1987), crises and pressures that affect large segments of the global population drive systems breakdown and lead to social and economic chaos. Hence, I considered the COVID-19 pandemic a crisis that created global social and economic chaos; therefore, it was thought that Chaos Theory is an appropriate lens for interpreting the behaviours of social and organizational systems impacted by the pandemic.

The COVID-19 Pandemic in Australia

In late January 2020, the first case of COVID-19 was identified in Australia. Cases rapidly increased to over 6500, with over 80 deaths in only three months. The government in Australia is a complex multijurisdictional network, with a national Federal government (Australia) and a federation of six states (New South Wales (NSW), Queensland, South Australia, Tasmania, Victoria (VIC), and Western Australia) and two Territories (Australian Capital Territory and Northern Territory). The Australian Federal government led a national response to the outbreak by convening a National Crisis Cabinet comprised of the Australian Prime Minister and all heads of State and Territories. It must be noted, however, that this body had no official legislative power. For instance, the Federal government has legal responsibility for international ports, aged care, quarantine and vaccination rollout, and the States and Territories for everything else, but National Crisis Cabinet was an attempt at developing consensus and consistency for the implementation of health advice received from both Federal and the various State and Territory health departments. This body was guided by the *Australian Health Sector Emergency Response Plan for Novel Coronavirus* (2019). Initial action involved implementing Federal (national) transmission

minimisation measures like health screenings at ports and airports and travel bans for travellers from mainland China. The restriction on travellers then increased to the level that Australian national borders were closed to everyone apart from Australian citizens, residents, and their immediate family by late March 2020 as cases escalated. Additional restrictions were then also broadly considered and implemented across all States and Territories. For instance, National Crisis Cabinet recommended limiting the size of indoor and outdoor gatherings, and Australians in all States and Territories were required to stay at home unless they had to perform essential services or functions. Over the intervening months, the National Crisis Cabinet lost its focus, and these restrictions (except the national border restrictions) were relaxed, and that was reinstated on a jurisdictional basis as the pandemic crisis ebbed and flowed. For instance, the Victorian State Government imposed curfews and highly restricted people's movement in Melbourne and its surroundings due to a 'second 'wave' outbreak in July 2020 that lasted for more than three months.
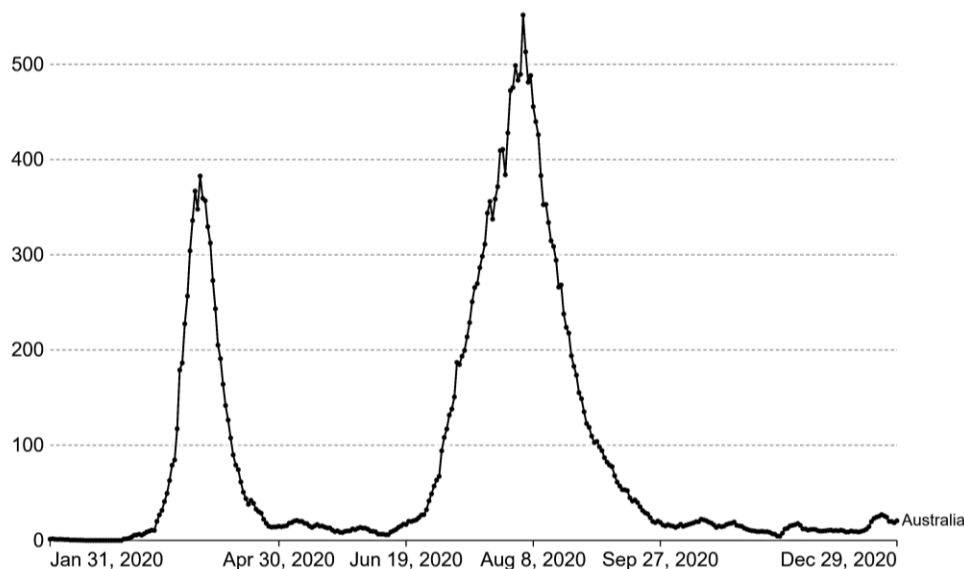
Figure 4 Daily New Confirmed COVID-19 Cases in Australia. Source: Johns Hopkins University the Center for Systems Science and Engineering (CSSE), adopted from: https://ourworldindata.org/coronavirus/country/australia, accessed 22 September 2021

Figure 4 illustrates the daily new confirmed cases of COVID-19 detected in Australia from February to December 2020. The figure shows two peak points in the number of new cases in March and August 2020.

Australian Federal, State, and Territory health agencies used social media from the early stages of the COVID-19 outbreak to transmit infection risks and health messages to their communities. The COVID-19 cases were mostly occurring in Victoria as well as some in NSW, and so the focus of this studie's Facebook analysis looked at the communications of these two State-based health agencies, i.e., Victoria and NSW, as well as those of the Federal government health agency.

Due to the lack of medical solutions in the early stages of the pandemic, Australian Federal, State, and Territory health agencies extended their attempt to change public health behaviours through social media communications; however, the public response contradicted the effectiveness of the effort. For instance, in early March 2020, the Australian public health agency suggested people avoid panic buying (e.g., "… *There is no need to bulk-buy products at supermarkets, including toilet paper, paracetamol and canned food[3]*"). However, by mid-March 2020, the news and social media communications drew attention to many aggressive panic-buying behaviours across the country (Figure 5).

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[3] NSW Health posted to Facebook on 5 March 2020, post ID 1239123602953645

Figure 5 Toilet Paper Panic Buying by the Public in the Early phases of the COVID-19 Pandemic 2020 Australia, source: 9NEWS Australia

Li et al. (2019) recognized the role of social networks (e.g., social media) and information/rumors diffusion in irrational public behaviours during extreme events like epidemics. Interestingly, social media (7NEWS, 2020) blamed media, particularly social media, for creating such problematic behaviours.

These public behaviours surprised and frustrated the Australian Federal government. "*It's ridiculous, it's un-Australian, and it must stop*"-Prime Minister Scott Morrison tells Australians to cease panic buying, 18 March 2020, Canberra.

Figure 6 Empty Supermarket Shelves as COVID-19 Infections Rise in Australia, source; author.
04 March 2020

In March 2020, I took the pictures in Figure 6 when I was looking for essentials, e.g., food and hygiene, on the empty shelve in Coles and Aldi supermarkets in Sydney, Australia.

In mid-March 2020, the New South Wales Ministry of Health (branded NSW Health) advised on social distancing and asked people to consider the social distancing requirements in their daily interactions with others (e.g., "Social distancing reduces the risk of catching viruses like COVID-

19[4]"). Later, the NSW State government closed beaches to the public after images of crowded Sydney beaches went viral online (Figure 7)

Figure 7 Bondi Beach Closed over Crowds amid the COVID-19 Pandemic, source; ABC NEWS, 21 March 2020

In late March 2020, NSW Health announced that further restrictions needed to be applied as the outbreak gained momentum in NSW (e.g., "As of 23 March 2020, many facilities will be restricted from opening[5]"). As a consequence of this announcement, thousands of newly unemployed Australians queued for hours outside the social security offices, disregarding physical distancing requirements to lodge a claim for unemployment benefits.

These examples of conflict between public health social media messaging and public response motivated me to explore how Australian public health officials use social media, primarily Facebook, to communicate health information with the public and how the process was impacted by a chaotic crisis scenario, i.e., that of the COVID-19 pandemic.

Objectives of Study

This study was initially designed to contribute to a better understanding of the difficulties in social media public health communication with diverse communities and to determine the best practice in the utilisation of social media platforms in managing infectious diseases. Facing the COVID-19

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[4] NSW Health posted to Facebook on 14 March 2020, post ID 1245323879000284
[5] NSW Health posted to Facebook on 22 March 2020, post ID 1253410354858303

crisis in Australia shifted the focus of the study to the use of these platforms in communicating health information with the public and managing the crisis from the public health organizational perspective. The main goal of this study is still to improve public health communication for the prevention and control of infectious diseases; however, since COVID-19 severely impacted the world and Australia in early 2020, the main contribution of this study is to enhance the effectiveness of ICT and in particular social media as an emerging technology (not radically novel anymore but relatively fast-growing) for public health crisis communication. Therefore, this study attempts to investigate the utilization of social media, i.e., Facebook as the most popular platform, by Australian public health organizations during COVID-19 crisis communication.

The results of this study aim to assist health policymakers in using social media as a powerful mediating tool, improving their interactions with Australian communities, and enhancing public engagement in managing a public health crisis.

This study adds to the body of knowledge on social media adoption for public health communication and crisis management. Finally, this study paves the way for social media researchers and sheds light on taking a rigorous academic approach to study social media in the crisis management context.

This study investigates the phenomena from the organizational and public covering three perspectives: *1) information, 2) communication (link type), and 3) trust.* Investigating these three perspectives on the topic assisted me in understanding how *Australian public health agencies use social media to create a shared situational awareness during the COVID-19 pandemic*. Furthermore, the longitudinal analysis of the large dataset enabled an understanding of the COVID-19 pandemic's *digital disruption in health communication and crisis management*.

Situational Awareness (SA)

Situational Awareness (SA) is a person's mental representation of their surroundings that shape the person's decisions and actions. Situational awareness was initially defined for emergency response organisations to improve communication between and within response teams. From this perspective, situational awareness refers to an incident commander's perspective and understanding of an occurrence, including its hazards, risks, and operational actions. It also includes how a commander believes the crisis will unfold based on their actions (National Fire Chiefs Council guidance[6]).

CDC's Center for Preparedness and Response also stated situational awareness enhances public health emergency planning and response and keeps communities safer and healthier. The center transforms critical information on the wide range of threats to public health into actionable resources and *shares them with policymakers and first responders*[7]. I extensively searched emergency response agencies' websites for records related to situational awareness, and I found that resources mostly focused on sharing information with *response agencies, governmental and non-governmental partners*[8], and helping *leaders and responders*, not the public and communities. For instance, the Situation Awareness 2022 Natural Hazards and Severe Weather Website is designed to "*provide a platform to share information and data with State, Local, Tribal, and Territorial public health partners*[9]." Situational awareness plays a critical role in shaping individuals' and groups' mental models of decision-making, and undermining the importance of creating effective shared situational awareness for the public will not benefit the extensive need

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[6] https://www.ukfrs.com/guidance/search/situational-awareness
[7] https://www.cdc.gov/cpr/sa-branch.htm
[8] https://emergency.cdc.gov/situationawareness/naturalhazards/winterwx.asp
[9] https://emergency.cdc.gov/situationawareness/naturalhazards/

for public engagement in managing crises like the COVID-19 pandemic. Information Systems (IS) studies also focused on understanding the ways that technology and social media platforms can assist response agencies in having a better understanding of the situation and enhancing their situational awareness in response to an emergency and crisis (Avvenuti et al., 2015; Giridhar et al., 2018; Kryvasheyeu et al., 2016; Marbouti et al., 2017; Yin et al., 2015). However, digital technology and, in particular, social networking technologies facilitate communication through networks, where nodes/agents are people[10]; their behaviours can be rational or irrational, which are influenced by various personal and environmental factors. Social media communication is a complex system that facilitates people-centered communication, which swapped and moderated the power of top-down communication (agency to the public) during extreme events. This decentralized people-based communication model extensively influenced shaping shared situational awareness and public response to a crisis. Endsley, 2021 stated that all incoming information from various sources, e.g., sensors and digital systems, social media, and the outside world, influences a person's understanding of what is happening in the current scenario. Hence, all sources must come together and collaborate to create a shared situational awareness during a crisis effectively. Information systems are capable of producing an enormous volume of data. In this sense, social media is becoming increasingly important, influencing our social relationships, individual and group activities, and prevalent beliefs. These platforms play an important role as a source and channel of information and communication during a crisis (Heverin & Zach, 2010; Vieweg et al., 2010). Due to the range, reach, and pervasiveness of social media in our everyday life, these platforms extensively benefited (e.g., access to timely and unfiltered information) and challenged (e.g., infodemic and noise in communication, misinformation propagation, etc.) the

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[10] The bots, virtual influencers, and other non-human nodes' activies are excluded from this study

creation of an effective public shared situational awareness during extreme events (Bunker, 2020; Simon et al., 2021; Vemprala et al., 2018). Hence, understanding the way these platforms perform during a crisis and their impact on the crisis is an essential assignment for IS researchers.

In this context, my research focuses on understanding the complexity of Facebook's public health communications during the COVID-19 crisis, where social media was the predominant means of communication, and then the forming of shared situational awareness. Built upon relevant literature, I designed this study to analyse the topic, i.e., SSA during COVID-19, discussed through the channel and reveal the communication pattern before and after the crisis. By doing this, I reveal the impact of the event and the way that Facebook's communication system transformed to cope with the crisis, including the organizational approach and community engagement. I then dived deeper into the analysis and looked at the concepts of trust in public health crisis communication and communication fluency. This investigation uncovered the various facets of *how Australian public health organisations utilised Facebook to handle the COVID-19 pandemic*.

The volume of information and communications on social media platforms has grown out of control during the COVID-19 pandemic, reducing the effectiveness of communication and, in consequence combating risks and managing the crisis. In this situation, crisis response agencies have limited influence over social media communication, making monitoring and analysis more challenging. In this sense, my research assists public health agencies in better understanding social media public health crisis communication, developing policies and strategies to better manage future extreme events like pandemics and their impact, in both the short and long term through social interactions, enhancing individual and group engagement, and influencing public attitudes toward official health responses.

Thus this is informed by 1) literature on social media crisis communication and situational awareness (e.g., Endsley & Garland, 2000; Haer et al., 2016; Kedia et al., 2022; Linke & Zerfass, 2012) and 2) my observation of emergency response agencies (e.g., CDC in the US and Royal Commission into National Natural Disaster Arrangements in Australia) social media pages and their websites during my study.

Study Design

My thesis investigates Australian public health communication during COVID-19 to understand the phenomena, which can be recognised as *case study research* to generate an in-depth, multi-faceted understanding of a complex phenomenon in its real-life context (Crowe et al., 2011). When in-depth knowledge of a phenomenon is required, a case study is an excellent tool for gaining such knowledge (Eisenhardt, 1989). The analysis conducted in this study is divided into four phases presented in chapters 4, 5, 6, and 7. Chapter 4 reports the results of my nethnographic analysis of Facebook data, which explores the *information* broadcasted through Australian public health officials' Facebook pages across 2019 until April 2020, i.e., the early stage of COVID-19. Chapter 4 explains how Facebook was used by Australian public health organisations for health communication before the COVID-19 pandemic and how the emergence of the crisis impacted Facebook use. I further developed a rich insight into the phenomena and analysed the large Facebook dataset by combining quantitative and qualitative methods, which, as advised by Venkatesh et al. (2013), assisted me in developing an IS substantive theory. Thus chapter 5 combines statistical and quantitative content analysis methods to enhance the study findings, extending the investigation to two years of public health Facebook communication from January 2019 until December 2020 to shed light on the *communication approach* (link) and its *transformation* during different phases of the crisis to the *emergence of a new system* and its

characteristics. Chapter 5 further looks at communication from the agencies' public audience perspective, analysing their *engagement in Facebook communication* and *secondary crisis communication*.

Chapters 6 and 7 narrow down the analysis and focus on the concept of misinformation and trust and use qualitative content analysis to explore how *Australian public health agencies used Facebook to mitigate misinformation* and how their approach impacted their public audience's trust in information and its source. I complete my understanding of Facebook use by public health agencies by conducting a set of *semi-structured interviews* with informants in the field. Chapter 8 reports the results of interviews that assisted me in interpreting and evaluating the findings.

I employed the most appropriate approach and methodology to conduct the data collection and analysis in each chapter and the selection of methods aimed at extracting in-depth relevant information from the dataset to enhance previous findings, the narrative, and the study's objectives.

Justifying the trustworthiness of qualitative case studies can be challenging. For any justification to be persuasive, it has to rely on arguments rooted in the relevant literature (Darke et al., 1998). Hence, in each chapter, I support my arguments, including a section on the appropriate method, by using relevant literature, which enhances the face validity of the overall study (Dooley, 2002).

Theoretical Underpinning and Research Process

This thesis is structured as a case study investigating the use of Facebook by public health government agencies to create public *shared situational awareness* during COVID-19 in Australia.

Endsley (1988) defined situation awareness (SA) as "*the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future- p97*". I previously highlighted the need for situational awareness in effective crisis response for the general public, government agencies, and organisations, as they all contribute to the response (please see page 68).

Built upon previous literature investigated the development of shared situational awareness (SSA) for crisis management (Ödlund, 2010; Virrantaus et al., 2009; Waugh Jr & Streib, 2006), Seppänen et al. (2013) explained creating an adequate shared situational awareness between crisis actors requires "*fluent communication*" where "*common concepts are used, trust exists and relevant information can be accessed easily- p1*". *In this regard,* Seppänen et al. (2013) identified three factors that influence inadequate *shared situational awareness* (SSA), shown in Figure 8.
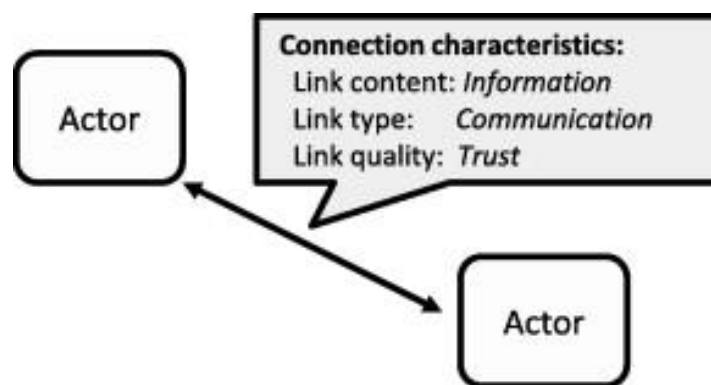
Figure 8 Information, Communication, and Trust explained by the source of the figure (Seppänen et al., 2013) as factors affecting the formation of SSA

Although Seppänen et al., 2013 studied the creation of an adequate SSA in an inter-organisational context, I utilized their model to frame my study in a context where an emergency response organisation creates SSA for the public. There are four chapters of analysis, each looking at the phenomena from a perspective; *Link Content; Information (chapter 4)*, *Link Type; Communication (chapter 5)*, *and Link Quality; Trust (chapters 6 & 7)*, which are identified as factors influencing the formation of shared situational awareness during a crisis (Seppänen et al., 2013).

In this sense, I investigate the Australian public health agencies' Facebook *communication* approach and use of Facebook *(link type)* to share information *(link content)* and create SSA before and during the COVID-19 crisis. I also investigate how the ogranisational approach impacts audience trust *(link quality)* and the creation of adequate SSA.

Interpretive research is a research paradigm grounded in the belief that social reality is not singular or objective but rather shaped by human experiences and social contexts (ontology). It suggests that the best way to study social reality is by understanding it within its socio-historic context and by reconciling the subjective interpretations of its participants (epistemology). As an interpretive researcher, I recognise that social reality is deeply embedded within its social settings and cannot be abstracted from them. Therefore, I engage in the process of "interpretation" to make sense of this reality rather than relying on a hypothesis-testing approach, aiming to understand the meaning and significance that individuals and groups assign to their experiences and actions.

In terms of shared situational awareness, I emphasize the significance of individual perspectives and the social construction of meaning. The specific parties involved in sharing awareness play a crucial role, as they bring their unique interpretations and understandings to the collective understanding of a situation. The importance lies not only in the awareness being shared but also in the process of sharing and negotiating different perspectives to create a collective understanding.

The role of agencies in shaping shared situational awareness is significant. However, rather than perceiving the public solely as passive receivers, I also recognise their active engagement in interpreting and contributing to the situational awareness discourse. The shared aspect of situational awareness emerges through the dynamic interaction of various perspectives, incorporating a range of voices and interpretations that may coexist or conflict.

The study framework and phases as well as the overall objectives of each phase are outlined in Figure 9.

I comprehensively outlined the details of each phase's theoretical foundation and academic and practical contribution in the relevant chapter.
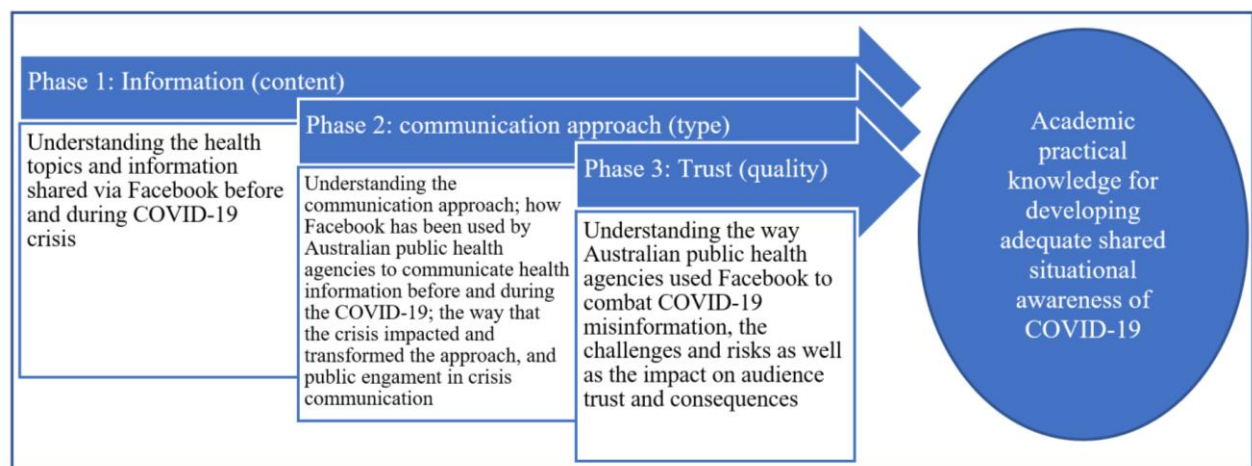
Figure 9 Study Framework and Phases

The first phase of this study is presented in chapter 4, where I investigate the content and information shared by the organizations via their Facebook page to create shared situational awareness before and during the early stage of the pandemic. Chapter 5 investigates the communication type and the organisaational approach in using Facebook for crisis communication highlighting the change in the communication triggered by the pandemic. Chapters 6 and 7 look at the concept of *trust* in communication, highlighting the factors that impact public trust in authorities and the information. These chapters present the analysis conducted to fulfill the objectives of each paper and discuss the findings. Each chapter is prepared in the format of an academic article, published, submitted, or ready to be submitted in high-ranked journals and conferences in the field. Hence, each chapter includes an independent literature review to support the objectives of the studies as well as a comprehensive discussion of results and contributions.

Application of Chaos Theory and Crisis Studies

The COVID-19 pandemic is a crisis characterised by threat, surprise, and a short response time (Hermann, 1963). The pandemic has threatened the core values of global life-sustaining systems, creating significant uncertainties about the constantly evolving crisis and its consequences. This crisis has forced many countries to lockdown business and social activities; for instance, in August 2021, all Australian state and territory jurisdictions endured various "snap" lockdowns costing the Australian economy billions of dollars (Lathouris, 2021).

An important communicative problem during a crisis is achieving appropriate Situational Awareness for all parties, including those directly impacted, official crisis management and response agencies, and the general public (Steensen et al., 2018).

During the COVID-19 pandemic, organisations used information and communication technologies to reshape, innovate, and adapt responses to rapidly changing pandemic conditions (Siau & Han, 2020; Wade & Shan, 2020; Yang et al., 2020). However, the infodemic and the absence of credible information sources, which makes the public vulnerable to rumors and an abundance of misinformation generated and spread across social media platforms, eventually made the health crisis develop into an information crisis (Bordia & DiFonzo, 2004; Shibutani, 1966). Social media platforms have been widely criticised and are often held responsible for the information crisis and its' subsequent confusion, cynicism, fragmentation, irresponsibility, apathy (Beckett & Livingstone, 2018; Luo et al., 2021), and compromised shared situational awareness. The problem was more intense in the early stages of the pandemic when one-way reactive communication with the public, denials, and misinformation about COVID-19 caused widespread public uncertainty and confusion, distracting crisis response (Bunker et al., 2022; Kim & Kreps, 2020). Xie et al. (2020) insisted the COVID-19 global information crisis requires prompt attention from the information science research community to develop information strategies to assist individuals and societies in understanding the situation and making effective health decisions.

In light of the literature suggesting that information and communication technologies (ICTs) and social media contributed to the information crisis during the pandemic, the current study examines public health social media (i.e., Facebook) communication to understand how the system contributed to the creation of SA for the public. This study explains how the system transformed during the onset of the COVID-19 pandemic to cope with the event. The results of this study assist effective government crisis communication that can garner maximum support and participation during a public health crisis (Hyland-Wood et al., 2021) and reduce the burden of the information crisis. Situational awareness plays a critical role in shaping individuals' and groups' mental models

of decision-making, and undermining the importance of creating effective shared situational awareness for the public will not benefit the extensive need for public engagement in managing crises like the COVID-19 pandemic. Due to the range, reach, and pervasiveness of social media in our everyday life, these platforms extensively benefited (e.g., access to timely and unfiltered information) and challenged (e.g., infodemic and noise in communication, misinformation propagation, etc.) the creation of an effective public shared situational awareness during extreme events (Bunker, 2020; Simon et al., 2021; Vemprala et al., 2018). Understanding how these platforms perform during a crisis is thus an important assignment for IS researchers assisting agencies and government stakeholders in modifying their crisis communication strategies for shared situational awareness within the digital context, preparing them for future crises (Bunker et al., 2019).

Social media is a complex system consisting of many interacting heterogeneous components and behaviors that are not characteristic of those observed in a "simple" system (Guliciuc, 2014; Mikhaeil & Baskerville, 2019). The system can exist at varying scales and go through change processes that cannot be described by a single rule or reduced to a single level of explanation (Weisbuch & Solomon, 2007). The system can adapt to inputs (e.g., external or internal force, like the COVID-19 crisis) and evolve; diversity, ambiguity, and unpredictability of outputs relative to inputs or changes in conditions are defining characteristics of complex systems (Guliciuc, 2014; Guo et al., 2009). Because of the interaction of the number of components, the variety of interactions, and the rate of change in each, we cannot predict the complex system behaviour and its future, and it is also more challenging to control (Collinson & Jay, 2012; Weisbuch, 2018).

In this sense, Chaos Theory (Lorenz, 1963) explores behaviour of complex non-linear systems like unpredictability, sensitive dependence on initial conditions, and bifurcation as a system breaks

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down has provided a valuable means for understanding and examining the behaviour of social systems (Kiel & Elliott, 1996). The theory has been used to analyse and understand the role of communications during crises such as organisational crises, natural disasters, and pandemics (Dawkins & Barker, 2020; Liu & Pompper, 2012; Purworini et al., 2019). I use Chaos Theory, as this study is concerned with a few parameters of the complex system and their dynamics, such as the emergence of complex, aperiodic, and seemingly random behaviour from the iteration of a simple rule (Rickles et al., 2007) and tends to explain how communication systems respond to the COVID-19 crisis and change over time. The study of Complexity, on the other hand, is concerned with both the structure and dynamics of systems, as well as their interaction with their environment.

Chaos is defined as the amplified impact of small changes in the present that contribute to long-term unpredictability (Bertuglia & Vaio, 2005). Although I investigate chaos (random states of disorder and irregularities) in a complex non-linear system (social media), complex systems are not necessarily chaotic but can be for some elements or control parameters. However, "the sensitivity to initial condition" is an essential condition of both chaos and complexity due to nonlinearity (Bertuglia & Vaio, 2005). Like other complex systems, social media communication exhibits self-organization, which occurs when systems spontaneously order themselves, usually in an optimal or more stable manner (Lichtenstein, 2000).

Hence, I used Chaos Theory as a suitable theoretical lens to explain how a complex system like the Australian public health communication system was disrupted and then transformed by the onset and early stages of the COVID-19 pandemic. The chaotic behavior of COVID-19 and its impact on many social systems have been studied, e.g., Necesito et al. (2022) and Buchanan et al. (2020), and are regarded as out of the scope of this study.

This study investigates public health social media communication and its transformation during the onset of the COVID-19 crisis to understand how the system works to create shared situational awareness for the public. Shared awareness is "*the perception of the elements in the environment within a volume of time and space, comprehension of their meaning, and the projection of their status in the near future* (Endsley, 1988, p.97)." Shared situational awareness during a crisis enables actors to interact effectively in dynamic and complicated contexts (Endsley, 1995). However, creating adequate shared situational awareness during a public health crisis, like the COVID-19 pandemic, which characterised by distractions, risk, fear, and unpredictability, as well as the absence of precise measurement of crisis and understanding of its impact (Sharma et al., 2020), is challenging for crisis response agencies.

This study discusses a longitudinal netnography, of Australian public health agency communications on Facebook across 2019 and 2020. In chapter 4, I used Chaos Theory to explain how the initial stages of the COVID-19 pandemic disrupted public health communications patterns and how new patterns then emerged.

Chaos Theory (CT) ....." *represents a particularly powerful framework for understanding the radical system breakdown experienced during organizational crisis. CT also links organizational crisis, and its communicative dimensions to broader notions of system stability and instability and decline and renewal*" Seeger (2002) - page 329.

Chaos Theory explores behaviour of complex nonlinear systems like unpredictability, sensitive dependence on initial conditions, and bifurcation as a system breaks down has provided a valuable means for understanding and examining the behaviour of social systems (Kiel & Elliott, 1996). Researchers have used Chaos Theory to analyse and understand the role of communications during

crises such as organisational crises, natural disasters, and pandemics (Dawkins & Barker, 2020; Liu & Pompper, 2012; Purworini, Purnamasari, & Hartuti, 2019).

Complexity science and Chaos Theory are not new to the Infomation Systems (IS) discipline. IS researchers used the theory to develop interpretive frameworks for understanding topics as diverse as the blogosphere, information systems strategy implementation, or the effect of internal and external events on patterns of behaviours of information systems (Benbya et al., 2020; Dhillon & Ward, 2002; McBride, 2005). Guo et al. (2009) utilised Chaos Theory to interpret the world of internet blogging to find "*underlying order in this apparent random and complex phenomenon, p.102*".

Chaos Theory

Chaos Theory (CT) has its roots in work by Feigenbaum (1983) and rapidly progressed in biological and physical sciences (Gleick & Berry, 1987; Holden, 1986; Lorenz, 1984). It is often used in mathematics, physics, and biology to explain the behaviour of nonlinear, unpredictable systems that do not behave in a conventional (causal) manner over time. Chaos Theory has become an increasingly popular meta-theoretical interpretive framework in the social sciences, including political science, management, education, economics, sociology, psychology, organisational studies, crisis communication, and disaster management, and for studying new sociotechnical systems such as social media (Benbya et al., 2020; Butz, 1997; Mathews et al., 1999). Chaos Theory represents related concepts, including sensitivity to the initial condition (butterfly effect), fractals, bifurcation, strange attractors, and self-organisation to describe the behaviour and features of both the chaotic (disrupted) and then the reorganised (transformed) state of the system.

Social systems can become chaotic, and theoretical chaos arguments can be used as an explanatory lens for the behaviour of entities such as groups, individuals, institutions, and organisations; hence these arguments are applicable to a large domain of social science problems (Gregersen & Sailer, 1993). The following sections explain the components of Chaos Theory. Based on my observation of the surrounding environment, I will provide some examples of how COVID-19 caused chaos and disruption in social systems. It stands to reason that just as COVID-19 disrupted the social system, communications systems were also impacted by this same phenomenon. Social media communication during a crisis like the COVID-19 pandemic is influenced and reflected by social events. Understanding social system disruption helped me better understand social media communication and facilitated a thorough analysis of social media data in this study.

Sensitivity to Initial Condition (Butterfly Effect)

The *butterfly effect* is a principle of Chaos Theory that describes a system's *'sensitivity to initial conditions'*. The butterfly effect explains how a small event, like the flapping of a butterfly's wings, may start a chain of events that leads to a large-scale event that can have a much more significant impact. For example, the COVID-19 pandemic started with an infectious disease outbreak and quickly spread to create significant global changes in everyday life and business. The short-term result has included social distancing and wearing masks in public and more long-term and permanent changes such as Twitter's Permanent Remote-Work Policy (Forbes, 2020). The long-term impacts of remote learning for millions of students globally are also unknown. As a result of these social impacts and the accompanying health measures, I have seen substantial changes in the type, frequency, and volume of health information and communications to the general public.

Fractal

Fractal, coined by Benoit Mandelbrot in the late 1970s*,* is another tenet of Chaos Theory. It comes from the Latin *fractus*, meaning irregular, and is defined as a qualitative measurement of "*the relative degree of complexity of an object*" (Murphy, 1996, p. 100). Fractals replace quantitative measures when they become flawed yardsticks to describe the world (Eldridge et al., 1996). As Chaos Theory tends to describe the complexity of the chaotic situation, the observer's standpoint and measuring tools play an essential role in understanding the object and subject of communication.

In my examination of COVID-19 communications in Australia, I observed that officials, right from the early stages of the epidemic, communicated the importance of social distancing and no need for panic buying of food and goods. In many cases, these messages received an unexpected, undesirable response from the public. In this sense, researchers reported that inconsistent messaging to the public to change social behaviour to limit the spread of COVID-19, such as initially recommending not wearing face masks in public and then a few weeks later asking people to 'mask up' had a wide-ranging public reaction (Feng et al., 2020). The impact of scientific uncertainty and inconsistent COVID-19 messaging impacted individual perceptions and responses, which resulted in face mask use becoming a controversial issue during the pandemic (Malecki, Keating, & Safdar, 2020). I argue that organisations and individuals (actors) have different viewpoints (measures or fractals) on the severity of the situation that influences their responses.

Bifurcation

Bifurcation is another major aspect of Chaos Theory that is referred to as radical systematic changes that emerge in response to a chaotic environment. *Bifurcation* represents the turning point

of change where a system's direction, structure, and/or character has been fundamentally disrupted. Crisis events associated with environmental dependence and change can be seen as these turning points of system bifurcation (Seeger et al., 1998).

Bifurcation points are associated with a collapse of sense-making or a collapse in the routine way of operating a system and where it deviates from the established path (Freimuth, 2006). Prior pandemics like the Spanish flu had a decisive effect on the history of the twentieth century, corresponding to changes in architecture and urban planning and a higher awareness of public health (Spinney, 2017). In the same way but on a broader scale, the disruptive force of the pandemic hammered the global economy, truncated globalization, and radically accelerated the digital revolution. The event affected geopolitical rivalry between countries.

Strange Attractors

Strange attractors are fundamental points when a complex system starts to emerge from bifurcation back to order and regular operation. It is a point where the process of self-organisation begins. Strange attractors can also be family cultures, a common set of values, or organising principles that help a system rebuild after a disaster (Freimuth, 2006). Strange attractors within the chaotic system enable it to move away from bifurcation and find a new order through self-organisation principles. For instance, Sellnow et al. (2002) highlighted the role of the US Federal Emergency Management Agency (FEMA) and the National Guard's contribution to controlling the historic Red River flood crisis that represents a point where strange attractors helped citizens move from bifurcation to self-organisation.

In the same way, I observed that as the COVID-19 pandemic evolved in Australia, the Federal, State, and Territory governments applied health restrictions to slow the spread of the virus. These public health orders, i.e., new mandatory restrictions, mainly included behavioural modification

messaging such as social distancing and personal hygiene, which were widely broadcast through Facebook and other social media, facilitating the move from bifurcation to a new state of normal.

Dickmann et al. (2015a) suggested that communication interventions during a public health crisis like a pandemic support the success in preparedness, response, and recovery of the emergency. Considering the unstable nature of the infectious disease outbreak and its control, however, there is little time for dialogue and health promotion activities grounded in traditional health or crisis communications (Holmes, 2008). Considering the absence of a vaccine or a cure for COVID-19 in the early days, health authorities focused on behavioural interventions to influence and change pandemic outcomes by using social media platforms and other forms of media, such as print, TV, and radio, to reach diverse audiences.

Self-Organisation

Self-organisation is a state where a new form of overall order arises from interactions between elements of an initially disordered system. Because at the time that I write this chapter, the pandemic is not over, we still do not have a clear understanding of "living with COVID-19." How the social, economic, and communication systems emerge from the pandemic (e.g., banking, finance and markets, supply chains, emergency management. health communication, business systems, etc.) is still a work in progress.

Research Process Model

I developed a simple yet effective process model for my study to lead and connect different phases in a way each phase produces independent knowledge and answers a valid research question while all chapters are interdependent and support the study objectives. This study takes the exploratory approach and collects a rich dataset to explore the phenomenon and create conceptual arguments. I collected data from multiple sources of evidence, as has been suggested by Miles & Huberman (1994), for this case study research. My research process map in Figure 10 shows the research process and the sources of data for this study.
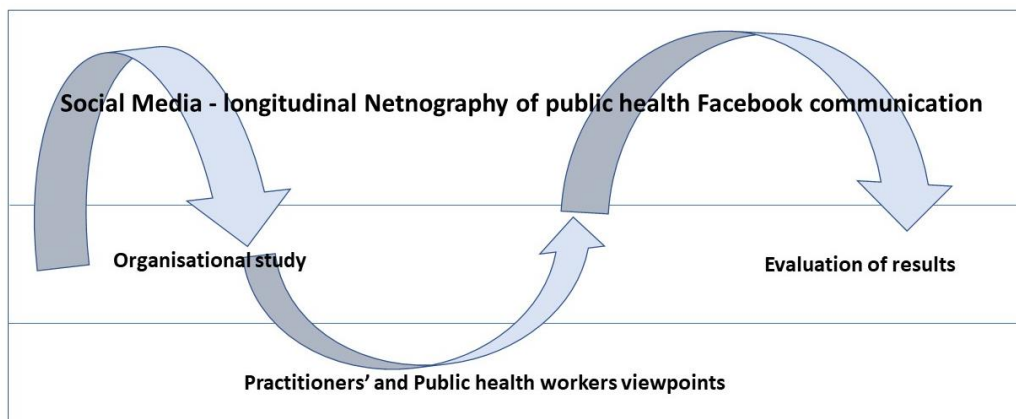
Figure 10 The Research Process Model

My process model can lead other researchers to study social media and policy development in different contexts aiming to create comprehensive knowledge in the area of social media adoption and communication by looking at the phenomena from different perspectives and designing effective social media communications strategies.

Here, I briefly explain the research process visualized in Figure 10

As I discussed before (please see page 55), the engaged scholarship approach and evolving practitioners and organizational members, as well as academics, led to understanding the problem

and forming the research question(s). During live workshops, I understood the problem and later formulated the research question using existing knowledge and literature.

The COVID-19 pandemic created a unique crisis that can be studied in the form of a case study, as suggested by (Yin, 2009).

In the interest of pragmatism and guided by case-study methodological literature (Benbasat et al., 1987; Gerring, 2008; Pan & Tan, 2011), I scoped the research to focus on three Australian public health agencies *as representatives* of the Australian public health system and also their unique role in managing the COVID-19 crisis in Australia, which is the study topic of interest.

As a communications medium, Facebook has a wide reach within Australia. With over 1.6 billion daily active global users in December 2019 (Facebook, 2019), Facebook is Australia's most dominant social networking service. Approximately half of the total Australian population is an active Facebook user (Correll, 2020). Analysis of Facebook communication patterns before and at the onset of the pandemic provides meaningful insight into the impact of a chaotic event on public health communications and any lasting effect on communications strategies overall. In Australia, public health agencies have established Facebook pages as one of their official communications channels to provide critical health information to the general public (Australia, 2020).

I selected *NSW Health,* the *Victorian Department of Health,* and the *Australian Federal Government Department of Health* as organisations that represent Australian public health government agencies. The Australian Federal government led a national response to the outbreak by convening a National Crisis Cabinet comprised of the Australian Prime Minister and all heads of State and Territories. *New South Wales* and *Victoria* were selected because these two states are 'Australia's most populous states and also reported the highest number of COVID-19 cases during

the first four months of the outbreak in 2020 (3,045 and 1,366 cases, respectively). The NSW public health system is also the biggest public health system in Australia.

The most appropriate unit of analysis is informed by the research question and phenomena of interest. This study investigates organisations' social media communication, so social media use at the organizational level is the appropriate space to study the phenomena.

During the COVID-19 pandemic, as countries remained under lockdown, researchers, like other nonessential workers, were required to stay at home and only leave to purchase medicine or food, do essential work, and exercise. This means while there was a significant demand for research covering different aspects of the outbreak, researchers experienced severe difficulties in collecting data. The circumstances restricted typical methods of data collection like the in-person interview, physical observations, and surveys.

Some characteristics of the COVID-19 pandemic that exclusively impacted researchers' work included (1) the broad geographic scale of the extreme event required extensive observation to capture different aspects of the event, (2) there was a great risk that the observer (the researcher) would be exposed to COVID-19 and become infected during the field study, (3) the access to the focus groups such as health workers, patients, and the vulnerable groups were very limited, (4) researchers movements between sites might have impacted a break down of lockdown restriction, (5) the uncertainty of the circumstances increasing the desire for longitudinal studies that provided an opportunity to trace different stages of the outbreak; however, collecting panel data in the middle of the pandemic was even more challenging.

In this sense, social media provided researchers with a high volume of event-related data that could be used by IS researchers to study the crisis. This study suggests that the netnographic method was

effective for data collection and analysis related to the crisis event and could help researchers and emergency organizations access accurate and timely information during a crisis event like COVID-19.

Netnography is a qualitative and interpretive research methodology that adopts *ethnography* techniques in the study of social media.

Ethnography means *'writing about people'* and is the study of a group of people to describe their socio-cultural patterns and activities (Burns, 1997). Ethnographies are concerned with studying culture (Creswell, 2013) lie in the eighteenth century in the work of German historians, linguists, and natural historians such as Gerhard Friedrich Müller, who studied rituals, costumes, and religions of the Siberian ethnic groups (Vermeulen, 2008). Ethnography with indistinct semantic boundaries has some overlap with other methods, such as 'qualitative inquiry,' 'fieldwork,' 'interpretive method,' and 'case study' that were developed in the social sciences to enable researchers to study social and cultural phenomena (Hammersley, 2007).

Netnography is a set of research practices associated with data collection and analysis, also ethnographic, ethical, and representational practices (e.g., handling large digital datasets, investigating online communities and topics, and analysing digitally contextualised data) used in exploring the essence of human beings in the technological age (Kozinets, 2015). *Netnography* can look in detail at how the Internet is experienced in use and study the everyday practices around the technology. It can also be used as a means of understanding the relationships and activities of internet users in contemporary digital communications contexts.

Ethnography is an ideal methodological starting point for studying the crisis and looking in detail at the way that the public reacts to the threat with the objective of making clear the taken-for-

granted and often implicit ways in which people make sense of the extreme event. This article argues that using netnography is less expensive, simpler, faster, and more realistic than focus groups, observation, or interviews in collecting data during an emergency event.

I selected Netnography as the most appropriate methodology for understanding the internet culture and studying social media communication in this research. Netnography helped me accurately investigate online communication and understand the phenomena. My netnographic study has been complemented by a set of interviews with organizational members, decision-makers, and informants, as illustrated in the research model, Figure 10. This also developed my understanding of the organization's perceptions, assumptions, and expectations from the application of social media in public health communication, as well as their strategy and approach. To ensure Theory-Data-Model alignment (Klein & Myers, 1999), the theories learned from the social media analysis were compared, verified, and updated by the information collected through interviews with organizational members and informants. The concepts, models, and theories developed in the study are essential for the organization in their approach to social media communication with the public. Social media emerged as vital channels for information and communication during crises. Netnography, a comprehensive research approach, proves valuable in studying these events by capturing real-time data and providing a deep contextual understanding from unique perspectives. By uncovering social dynamics, communication patterns, and human experiences, netnography contributes to effective crisis management strategies and interventions. This paper presents a netnographic observation of a Facebook online community, focusing on the distinct contextual aspects of COVID-19 crisis communication. Through netnography, I gained insights into the communication strategies employed by Australian Public Health on Facebook for infectious disease prevention and pandemic crisis management.

Methodology- Netnography or Virtual Ethnography

We are facing a health crisis of epic proportions, which will reshape the culture and behaviour of global and national societies into the future. We are also seeing the profound impact and influence of information systems and technologies on the economy, culture, and behaviour, as the effects of COVID-19 force countries to lock down social activities and distance us from one another. Whole industries are reshaping their business models and using technology to innovate, while individuals and families are using technology to overcome social isolation and dislocation.

Our usual research approaches and methods to study these developments have been curtailed; however, the COVID-19 crisis showed us that we might be unable to perform physical observation during major crises. A crisis can also significantly restrict focus groups or conducting interviews. In this context, netnography provides us with an excellent mechanism to study Facebook communication and pursue my PhD research during the COVID-19 pandemic, while I was unable to use other socially close approaches.

"Virtual ethnography," also known as *"cyber-ethnography,"* and most commonly *'online ethnography*," has been referred to as the study of 'society's culture and behaviour when data is gathered from online sources such as social media platforms (Kozinets, 2010a). *"Netnography"* is a form of *online ethnography* introduced by Kozinets (1998) and is mostly used in consumer and marketing research (Kozinets, 2010b). *Netnography* is a qualitative and interpretive research methodology that adopts *ethnography* techniques in the study of social media, e.g., Facebook, Twitter, and Instagram.

Netnography is a set of research practices associated with data collection and analysis, also ethnographic, ethical, and representational practices (e.g., handling large digital datasets,

investigating online communities and topics, and analysing digitally contextualised data) used in exploring the essence of human beings in the technological age (Kozinets, 2015). Netnography offers the ability to closely examine the user experience of the Internet and technology, allowing for an in-depth study of everyday practices and the interactions between users and the technology itself (e.g., Burford & Park, 2014; Dilleen et al., 2023). It can also be used as a means of understanding the relationships and activities of Internet users in contemporary digital communications contexts (Ivan, 2019).

Netnography adopts ethnography methods to study online communities and understand the meanings, symbolism, and consumption patterns of online groups. Kozinets (2015) distinguished netnography from "*unengaged content analysis*" (p. 96) and explained its a "*more human-centred, participative, personally, socially and emotionally engaged vector*" (p. 96). Analogous to ethnography, Netnography allows researchers to delve into the contextual factors that are specific to each individual extreme event, thus shaping the study in accordance with what Knorr-Cetina (1983) refers to as the *'locally situated, occasioned character'* of crisis. Netnography, like ethnography, is an ideal methodological starting point for studying the crisis and looking in detail at the way that the public reacts to the threat to make clear the taken-for-granted and often implicit ways in which people make sense of the extreme event.

The application of netnographic research methods to communications and crisis communications studies allows researchers to focus on the contextual factors of a chaotic event, what Knorr-Cetina (1983) calls the *"locally situated occasioned character"* of the event that influences communications.

The concept of "netnography" developed by Kozinets (2002) is an online marketing research method that refers to adopting ethnography to study online communities and understand the meanings, symbolism, and consumption patterns of online consumer groups.

Ethnography has been utilized in crisis management to gain insights into various aspects of crises (e.g., Kriyantono (2012) studied public's needs and interests in a crisis) and inform effective strategies. The characteristics of ethnography (Emerson et al., 2011; Van Maanen, 2011) make it particularly suitable for studying events and help researchers uncover the underlying meanings, values, and practices that shape events. Events can be dynamic, with unexpected developments and shifts in social dynamics. Ethnographers can adjust their focus, follow leads, and explore new avenues of inquiry as the event unfolds. This adaptability is particularly valuable when studying complex and rapidly evolving events like emergencies and crises. During the COVID-19 pandemic, traditional field research faced limitations due to social distancing and self-isolation measures; researchers like Podjed (2021) turned to remote and technology-enabled ethnographic research methods.

Social media plays a significant role in crisis management, extending emergency response awareness, risk communication, and public engagement in various crises (Stieglitz et al., 2018). Health agencies and practitioners utilize social media platforms to enhance public health communication (Dawson, 2010; Eyrich et al., 2008). Social media analysis in public health studies enables real-time disease outbreak monitoring, early detection, and understanding of public sentiments (Lyson et al., 2019; Meadows et al., 2019; Seeger et al., 2018; Zadeh et al., 2019).

Social media platforms have been vastly used by the public to access event-related information and communication with other users, including officials (Ross et al., 2018), and also utilized by

emergency organisations to manage a crisis (Avery, 2017; Guidry et al., 2017). The integration of these channels in emergency communication has changed the traditional pathway for the flow of information from emergency organisations to the public (Simon et al., 2015). It also provides a great source of public information (e.g., infoveillance) to decision-makers and assists them in monitoring and managing crisis events (Eriksson, 2014; Vance et al., 2009; Woo et al., 2016).

Past crises like bushfires in Australia or California, floods, storms, terrorist events, and the Covid-19 pandemic sparked discussions on social media (Beydoun et al., 2018; Mirbabaie et al., 2020; Mirbabaie et al., 2022). The abundance of information and misinformation on social media, known as an "Infodemic" during the early phase of the Covid-19 pandemic (Zarocostas, 2020), emphasized the need for reliable information (Elbanna et al., 2019). Government agencies are progressively utilizing social media as a means to communicate effectively during times of crisis, making it an integral tool for sharing essential updates and messages (Basyurt et al., 2022).

Like ethnography, netnography is a naturalistic and unobtrusive research approach that focuses on studying social practices within their everyday context (Kozinets, 2010). Researchers can investigate the unique features and factors that define each event using Netnography, resulting in a full grasp of its dynamics and complexity. This method allows for a full examination of the situation, revealing its unique contextual intricacies and ensuring that the study retains its significant importance.

In this sense, using the ethnographic approach in the study of social media (i.e., netnograghy) is a well suitable method for contextualization of the activities carried out via social media platforms during an extreme event and provides exclusive information about the event that might be difficult to access through other methods.

I argue netnography offers several advantages (Kozinets, 1997; 1998; 2002; 2006) that are highly beneficial for understanding crisis events. It allows researchers to access a large volume of free data from various time periods and geographic locations. Being non-intrusive, netnography captures a rich dataset without directly asking questions, reducing the influence of observer bias. It provides a real-world view of social media users' sentiments and beliefs through user-generated data. However, the interpretation of human behaviour remains an inherent characteristic of netnography.

Netnography enables researchers to adapt to the unpredictable nature of crises by gathering data in changing contextual conditions. The role of the netnographer is akin to a narrator, describing the interconnected elements of virtual activities and establishing connections with the actual event. This interpretive approach is valuable in crisis management studies, allowing for a deep understanding of the event, analysis of crisis response, and exploration of different aspects. The interpretive approach involves sense-making, where researchers integrate their understanding of the event, surrounding news, rumors, socioeconomic factors, cultural characteristics, and historical information.

An ethnography of the Internet can look in detail at the ways in which the technology is experienced in use, study the everyday practices around the Internet, and also as a means to understanding the relationships and activities of Internet users in the setting and participating in those processes.

Netnographers study the extreme event in a virtual space setting at a single point in time (i.e., cross-sectional) or over an extended period of time (i.e., longitudinal) to provide insight into the crisis. In the study of a crisis, netnographers focus on various topics of interest by creating a

theoretical lens, such as; social media users' convergent behaviour archetypes (Bunker et al., 2017) or the effect of socioeconomic characteristics of the impacted society on social media crisis communication (Shahbazi et al., 2018). Netnography helps researchers to uncover human interaction in the online space and gain a deeper understanding of an extreme event in a timely manner that is not tied to the crisis's geographic location.

The advantage of using netnography for understanding a crisis event is not only limited to time and geographical location but also allows researchers to access a high volume of free data. Moreover, the netnographer captures a rich dataset directly without being intrusive force, such as directly asking questions. Hence, it can be inferred that the results of the netnography study are less influenced by the observer/researcher effect. However, like ethnography, the researcher's interpretation of human behaviour (i.e., users' behaviour and interaction in online space) is an inherent characteristic of the method.

A real-world view of social media user sentiments and beliefs can be observed from user-generated data (i.e., social media posts). Netnographers collect descriptive data by observing social media users' online activities before, during, and after an extreme event to understand various aspects of the event from participants' and observers' views. The user-generated data can be harvested frequently in changing contextual conditions (e.g., coverage at a single point of time or as a sequence of observations over time (Chang et al., 2014) that enhance the ability of the researcher to cope with the unpredictability nature of extreme events.

In netnography, the role of the researcher could be understood as a narrator, describing the interwoven elements of the virtual activities. These interpretive studies try to make sense of online activities related to the event in a way that the researcher may interpret the observed virtual activities and connect them to the actual event. In this situation, observing the reflective behaviours

provides understanding of the event in the same way as the researcher practicing observation in collecting data from a social phenomenon.

In studying the crisis, Netnography can be used to discover the key characteristics forming the basis, develop initial codes and categories, and gain new theoretical insights in a grounded manner. In this sense, Netnography is comparable with observation in observing the pattern of online interaction and other data-gathering methods, such as using transcribed group discussions mostly used in qualitative research.

The nature of researcher immersion and participation directs a researcher on how to adopt netnography in the study of a phenomenon in virtual space. Netnographers may adopt an interpretive lens and describe their observation from an online space. They can link the observed activities and interactions with the characteristics of the account holders (e.g., public, individual, group, organization). The researcher sees the phenomena through the eyes of social media users and tries to provide a deep understanding of the users' perceptions. To study an extreme event using user-generated digital data, researchers can place themselves in different positions in a continuum between taking a descriptive approach and reporting on the observation about the platform's users' activities (i.e., the content of texts related to the event). Alternatively, interpreting the users' online activities by understanding their characteristics (e.g., economic, current profession, level of education, and ethnic background or heritage), emotions, and even the features of the event as an environment/situation with unique culture to obtain a deep understanding of the topic. Taking the interpretive approach to netnographic study involves the researcher in the sense-making process. The researcher's understanding of the event, surrounding news, and rumors about the event, including socio-economical and cultural characteristics and historical information about

the area and population impacted by the disaster, can form the interpretation process and influence the results of netnography study.

Social Media platforms have significantly facilitated public access to health information and are increasingly being used as an information source and tool for individuals and organisations to share resources and engage in health-related discussions (Allen et al., 2020; Seeger et al., 2018). Social Media platforms have been recognised as one of the appropriate communication channels to transmit health information to a large number of people and promote public health awareness (Lyson et al., 2019; Thackeray et al., 2012).

In this sense, social media has provided an exclusive opportunity for researchers to assist the health sector in monitoring, real-time prediction, and early detection of disease outbreaks (Corley et al., 2009; Santillana et al., 2015; Woo et al., 2016; Zadeh et al., 2019), as well as understanding public emotions and concerns in response to the crisis (Lazard et al., 2015; Meadows et al., 2019). Applying the netnographic method, I explored the online interactions related to the COVID-19 Pandemic that occurred through social media and the public health agency's Facebook channel to understand the movement and change in the pattern of communication and responses.

Criticism around Netnography

Netnography, like other research methods has inherent challenges and limitations that may impact the outcome of a study if the researcher is not well aware of them. As Netnography is extensively used in this research project, but there are challenges, concerns, and limitations involved with the method.

The emergence of netnography as a method to study social media use adds new research practices to the area, such as locating community and topic selection, data collection and narrowing large

digital datasets, analyzing the contextualized data, and, more importantly, handling online ethical matters (Kozinets, 2015).

Social media, as a mediator platform, has created space to connect individuals and groups and enable them to interact through virtual communities. The online communities encounter their unique or common culture comparable with the traditional definition of culture is belonging to a group of people. To study the culture adopted or created by an online community netnographers need to explore large, complex digital datasets.

Handling the complex social media dataset for a qualitative study is a big challenge for researchers. The complexity of social media datasets is driven by a wide variety and high volume of data. Sampling in netnography is fairly restricted; however, not all researchers follow the requirements that can limit the sampling bias in netnography.

Most social media platforms provide APIs (application programming interface), which is a software intermediary that allows the interaction between two applications for developers, researchers, and other third-party users to drain textual data from social media.

Assuming that there is no selection bias formed in designing the API (i.e., the algorithm has been designed to provide data randomly), users can download (1) all the interactions that happened within a selected online community during a defined time frame, (2) the text generated or disseminated by users and include a specific (i.e., targeted) keyword(s) (e.g., fetching tweets that contain a determined keyword or #hashtags on Twitter). In the first instance, the researcher needs to decide about the sampling window and consider the high volume of the users' activities. The window cannot be broadly defined as the volume of data would be too large and hard to handle. However, the question is how the timeframe of the data should be captured to ensure the researcher

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will be able to capture all aspects of the phenomena, including the relevance and applicable timeframe to the data collection. In this regard, netnographers can take a different approach to collecting social media data, including choosing a specific point in time (i.e., significant dates such as the first date or the peak of the infection outbreak) and accordingly support their sampling method by defining an event chronology.

Using keywords in sampling social media data is very common; however, the decision about the keywords that the researcher uses to fetch the digital data (i.e., social media text) is a point of argument. Considering the high volume of social media online interactions, the choice of keywords can severely skew the dataset toward a certain direction (i.e., selection bias) and, consequently, manipulate the results of the netnography study. Netnographers generally choose these keywords based on their understanding of the event and objectives of the study. It is essential the choice of keywords covers all aspects of the phenomena, and researchers might use more general keywords to obtain data from APIs and then use text analytics tools to detect the most frequent keywords. By digging into the text, including these keywords, the researcher may have a better understanding of the situation and will be able to choose more accurate keywords to clean the data for a netnographic study or collect the final dataset. In this sense, using informers and people from outside of the field of study to validate the keywords might assist the researcher in improving the quality of the netnography study.

In this study, I used a self-developed Python app that allowed me to connect to Facebook API and collect communication records from public Facebook pages during the determined time window. My automated random sampling approach was not restricted by keywords.

Finally, studying the culture of the online environment requires broad knowledge about the characteristics of the social actors (i.e., social media users in netnography research). In the case

that the account holder is a public figure or agency, the information is more accessible and less involved with ethical issues. However, browsing profiles of individual and private account holders could be restricted by the users or even by the platform. Ethical concerns around the use of social media data have increased since the number of scandals related to the bridge of information privacy has escalated (e.g., the Cambridge Analytica scandal in early 2018), and that has encouraged platform providers to increase the restriction on access to these data.

The security of social media data and users' privacy are important concerns for netnographic research. In this sense, the University of Sydney has particular policies (e.g., Research Data Management policies) in place to mitigate the ethical risks; hence this study carefully, in collaboration with the University Ethics office, considered the data security and privacy concerns of the social media data in planning the study. Before data collection started, I obtained approval from the University Research Integrity and Ethics office for this study, project approval # 2019/827.

Methodologies and Approach

The pandemic has placed extraordinary pressure on the human and technical systems that normally facilitate data gathering for research and knowledge production (Shankar et al., 2021). In mid-2021, as many countries remain under or are moving in and out of lockdown, researchers are also required to stay at home and work remotely for research purposes. While there is significant demand for COVID-19-related social research, the research community is experiencing difficulty in data collection that uses traditional methods like face-to-face interviews, observations, and surveys.

I applied a *netnographic* approach to the analysis of public health posts on Facebook to investigate the official and authorised use of social media communications at the Federal and State level before and during the onset of the COVID-19 pandemic.

In this netnographic study, I use situation analysis, semantic and content analysis of news and social media activities to obtain deep insight into the impact of COVID-19 on public health communications on Facebook before the disruption, during the onset, and the transformation after the COVID-19 outbreak. The netnographer (i.e., author of the thesis) is situated within the context of the study (living in Australia during the COVID-19 outbreak), which helps to generate in-depth descriptions of the event. The major strength and limitation of the research, however, is that the netnographer is a non-participant observer, i.e., outside of the public health organisations under study, with limited involvement in the research setting, which means that as an outsider, I could remain impartial to and independent of the study but must also exercise care in our study conclusions.

The interpretive case study research methodology has been considered appropriate for such *exploratory research*, "*an attempt to discover something new*" (Swedberg 2020, p.17) and the development of theory from data (Siggelkow, 2007).

Exploratory research is appropriate because it encompasses a broader concept beyond qualitative research and emphasizes the development of theory from data. While qualitative research is often associated with exploration, it focuses more on the methodology and data collection processes, whereas exploration encompasses the entire process of theory development. By engaging in exploratory research, I can explore new phenomena, uncover novel insights, and generate theories based on the data collected (Stebbins, 2001). This method allows us to discover (the public health communication) operational processes (Gephart Jr, 2004) that are tight to the contexts aiming at

finding solutions to the "how" question (i.e., our research questions) (Pan & Tan, 2011; Walsham, 1995). Scholars in the field of information systems (IS) have been conducting qualitative studies in the interpretivist tradition for about 30 years (Orlikowski & Baroudi, 1991; Walsham, 1993). The use of interpretive research paradigms has become acceptable in IS research; however, the concern is that the research output might be mostly explanatory and not often applicable to the solution of problems encountered in research and practice (Peffers et al., 2007). Many qualitative researchers indeed consider theory development as a significant aim of their empirical efforts. However, when researchers identify themselves solely as qualitative researchers, it can overshadow the theory development aspect of their work. By recognizing the broader notion of exploration, researchers can better appreciate the role of theory development in their scientific endeavors (Stebbins, 2001). Hence, this study articulates a framework that assists researchers as well as policymakers with an explicitly applicable solution to the problem, ensuring the approach will meet both organization and academic requirements. Moreover, this study places explicit value on understanding Internet culture and social media crisis communication in designing Social Media policies as an effective applicable problem solution that is new in the study of social media public health communication.

The following section explains how I utilized nethnographic approach to this study.

The Application of Netnography in this Study

"Netnography" is a form of *online ethnography* introduced by Kozinets (1998) that was developed to study online cultures and communities created through computer-mediated social interaction (Bowler Jr, 2010).

As with traditional offline research methodologies, it is crucial to recognize that researching online communities demands the same level of rigor, trustworthiness, and ethical concern (Bertilsson,

2014). In conducting this study, I followed the five steps of netnography as outlined by Kozinets (2010a), including 1) *defining the research question, 2) online community identification and selection, 3) online observation and data collection, 4) data analysis and iterative interpretation of findings and 5) presenting research findings and theoretical and practical implications*.

I use various techniques such as situation analysis, i.e., an outline of the pandemic context and sequence of the events, as well as content and thematic analysis of news and social media activities to understand the context and be able to conduct a thorough netnographic study. As the netnographer, I was situated within the context of the study (living in Australia during the COVID-19 pandemic), which helped generate in-depth descriptions of the event and interpretation of findings. However, in this study, the Netnographer is a nonparticipatory (passive) observer with limited involvement in the research setting. Hence my study is an entirely *unobtrusive netnography*, which means that as an outsider, I remain impartial to and independent of the study context (Costello et al., 2017). The unobtrusive and passive study of the research context allowed me to collect naturally occurring communications without influencing the data and which also supports my ability to analyse sensitive content within the dataset, e.g., tensions and conflicts (Langer & Beckman, 2005). My case study approach is considered appropriate for such exploratory research (Siggelkow, 2007). This method has allowed me to discover operational processes (the public health communication) (Gephart Jr, 2004) that are "tight" to the context of the information system aiming at finding solutions to the "how" question (i.e., the study research questions) (Pan & Tan, 2011; Walsham, 1995).

Online Community Identification and Selection Criteria

Online communities are seen as communities of practice, a concept derived from ethnographic studies of real-world communities (Lueg, 2007; Wenger, 1999).

Kozinets (2010a) stated that selecting online sources relevant to the *topic at hand* (study objectives) should be guided by the *research questions*. Accordingly, I have chosen three large online Facebook communities that are representative of Australian public health agencies (*Australian Federal Government Department of Health, New South Wales Health, and Victoria Health)* public health communication channels as the source for my data collection.

Facebook is Australia's most dominant social networking service (Correll, 2020). In Australia, public health agencies have established Facebook pages as one of their official communications channels to provide critical health information and situational awareness to the general public (Australia, 2020).

The Australian Federal Government Department of Health develops and delivers policies and programs and advises the Australian Federal Government on health policies. Their Facebook page serves as an important source of health-related news, information, and general situational awareness for the Australian community. Furthermore, New South Wales and Victoria are 'Australia's most populous states and reported the highest number of COVID-19 cases during the first four months of the pandemic in 2020 (3,045 and 1,366 cases, respectively).

Data Collection

For this study, firstly, I collected Facebook posts and their linked reactions and comments published by *NSW Health, Victorian Health,* and the *Federal Government* department of health from January 2017 until December 2020 using a self-developed python app. These three Government agencies are termed "Australian health agencies" in this thesis.

Table 8 Summary of Facebook Dataset 2017–2020

Year	NSW Health				Victorian Department of Health				Australian Department of Health			
	posts	Comments	like	Share	posts	Comments	like	Share	posts	Comments	like	Share
2017	188	2872	13112	2764	282	729	5583	1340	570	1372	9296	2842
2018	400	11725	27520	3284	325	1719	2762	1084	597	770	9551	1468
2019	499	29422	27351	3597	507	895	7407	1723	598	879	6631	138
2020	1731	200763	708321	351458	1061	53414	190058	125449	1727	140128	257829	933873

Table 8 provides information about the initial Facebook dataset collected for this study. Although the focus of this study is to investigate the public health Facebook communication during the COVID-19 pandemic, I first looked at a broader time window of data, from 2017 to 2020 to better understand the stability of online communication and engagement (i.e., the volume of communication within the channel) during the time before the pandemic and the alteration due to the emergence of the pandemic in 2020. I used different sampling approaches to take a sample of this dataset for my analysis in different sections, as I presented in the remaining chapters (the articles) of this thesis. I also collected the emotional reactions of the Facebook users (i.e., Facebook Emojis) that were required to complete the investigation in chapter 5.

I begin each chapter of analysis with an introduction to the study that provides material that was not included in the main body of the chapter since it was written in the format of a journal/conference article.

Chapter 4 is the manuscript of the full research paper accepted for publication in *JASIST*. The complete list of authors: Maryam Shahbazi, Deborah Bunker, and Tania C. Sorrell.

I designed the study, collected and analyzed the data, and wrote the first draft of the paper. The two co-authors in this paper supervised my work and contributed to the revisions of the paper; they kindly permitted me to use this as a component of this thesis.

Chapter 4 Communicating Shared Situational Awareness in Times of Chaos: Social Media

and the COVID-19 Pandemic

This chapter explored the Federal and state-based (NSW and Victorian) public health Facebook communication channels through the lens of Chaos Theory when global and local economic and social systems were hugely impacted and disrupted by an unexpected event, i.e., the COVID-19 pandemic. Social media communities, e.g., Facebook channels, as an "emergent technology," are complex nonlinear systems as they are composed of a vast number of different elements with nonlinear interactions (Guliciuc, 2014). So, like other complex systems, the social media communication system loses its coherence due to an internal or external chaotic force. In this type of situation, the fundamental elements of the system become unstable and unpredictable, and expected relationships among system elements may break down. Although a system as a coherent whole is lost in a chaotic event, new underlying patterns may be visible by observing the system from a great enough distance and over a long enough time (Singh et al., 2016). In this sense, complexity interpreting theories like Chaos Theory can assist our understanding of systems behaviour, which is difficult to predict and control.
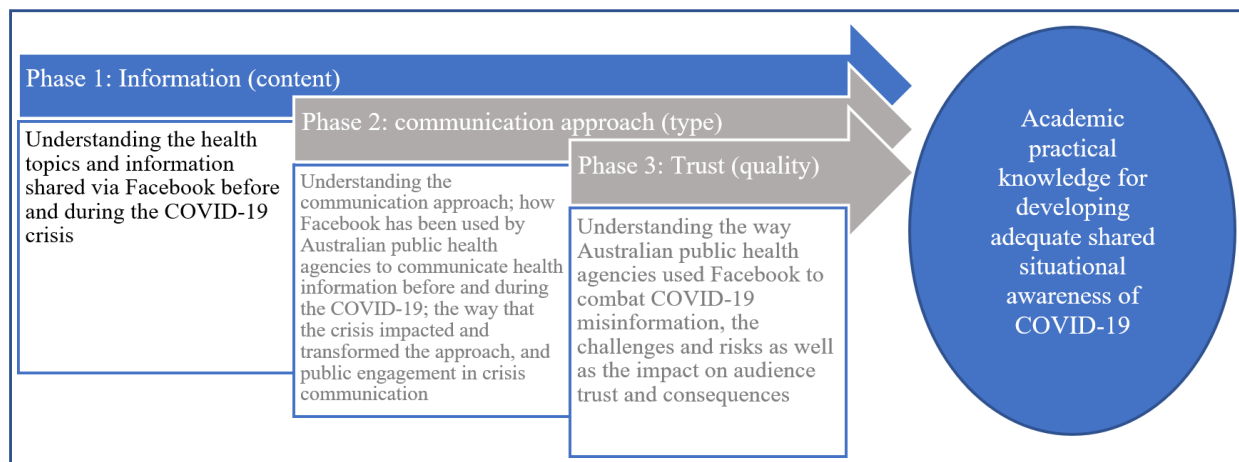
Figure 11 Study Framework and Phases -Phase one; Understanding the Information (content)

This chapter presents phase one of the study (see Figure 11) analysis of the information shared with the public before and during the COVID-19 pandemic highlighting the change in the topics and approach due to the emergence of the crisis. In this phase of the study, I applied concepts of

Chaos Theory to interpret the disruption to public health Facebook communications caused by the COVID-19 pandemic in Australia. I highlighted the changes in Facebook communication and the emergence of new self-organised communication patterns. I used Netnography and analysed the content of Facebook posts through a Chaos Theory interpretive lens. The application of netnography and Chaos Theory is unique in social media crisis communication studies.

Crisis communication has been studied in many different contexts; however, the COVID-19 pandemic and the disruption it has caused in the era of social media are unique. Public health officials can learn from this case study to improve their crisis communication strategies. This paper will also assist information systems researchers in applying Chaos Theory as an interpretive lens to understand communication system disruptions and emergence better.

This chapter assists in understanding:

1- The way that Australian public health agencies used Facebook to manage public health communications before the COVID-19 pandemic.

2- The way that Australian public health agencies used Facebook to manage public health crisis communications during the initial onset of the COVID-19 pandemic.

3- The way that a chaotic event like the COVID-19 pandemic disrupted and transformed public health social media communications patterns.

This study suggests conscious improvements to public health communication strategies at the onset of a major public health crisis.

Communicating Shared Situational Awareness in Times of Chaos: Social Media and the COVID-19 Pandemic

Abstract

To effectively manage a crisis, most decisions made by governments, organisations, communities, and individuals are based on "shared situational awareness" (SSA) derived from multiple information sources. Developing SSA depends on the alignment of mental models, which "represent our shared version of truth and reality on which we can act." Social media has facilitated public sensemaking during a crisis; however, it has also encouraged mental model dissonance, resulting in the digital destruction of mental models and undermining adequate SSA. The study is concerned with the challenges of creating SSA during the COVID-19 pandemic in Australia. This paper documents a netnography of Australian public health agencies' Facebook communication across 2019 and early 2020, exploring the initial impact of COVID-19 on the creation of SSA. Chaos theory is used as a theoretical lens to examine information perception, meaning, and assumptions relating to SSA from pre- to post-pandemic periods. Our study highlights how the initial COVID-19 "butterfly effect" swamped the public health communication channel leaving little space for other important health issues. This research contributes to information systems, information science, and communications research by illustrating how the emergence of a crisis impacts social media communication, the creation of SSA, and what this means for social media adoption for crisis communication purposes.

Keywords: COVID-19; social media; public health communication; Chaos Theory; crisis communication; netnography

Introduction

The COVID-19 pandemic is a crisis characterised by threat, surprise, and a short response time (Hermann, 1963). The pandemic has threatened the core values of global life-sustaining systems, creating significant uncertainties about the constantly evolving crisis and its consequences. This crisis has forced many countries to lockdown business and social activities; for instance, in August 2021, all Australian state and territory jurisdictions endured various "snap" lockdowns costing the Australian economy billions of dollars (Lathouris, 2021).

An important communicative problem during a crisis is achieving appropriate Situational Awareness (SA) for all parties, including those directly impacted, official crisis management and response agencies, and the general public (Steensen et al., 2018). Situation awareness is "*the perception of the elements in the environment within a volume of time and space, comprehension of their meaning, and the projection of their status in the near future* (Endsley, 1988, p.97)." A shared understanding of that subset of information, i.e., *shared situational awareness (SSA)* (Endsley et al., 2003), enables actors to interact effectively in dynamic and complicated contexts, e.g., a crisis event (Endsley, 1995). However, creating adequate SSA during a public health crisis, like the COVID-19 pandemic, which is characterised by distractions, risk, fear, and unpredictability, as well as the absence of precise measurement of crisis and understanding of its impact (Sharma et al., 2020), is challenging for crisis response agencies.

Research Objectives

This study analyses the use of Facebook by Australian public health agencies before and during the early stage of the COVID-19 crisis to understand how the communication system transformed from day-to-day operations to create crisis situational awareness for the public.

During the COVID-19 pandemic, organisations used information and communication technologies to reshape, innovate, and adapt responses to rapidly changing pandemic conditions (Siau & Han, 2020; Wade & Shan, 2020; Yang et al., 2020). However, the infodemic and the absence of credible information sources hampered the creation of an effective public SSA (Bunker, 2020). During a public health crisis like a pandemic, the general public becomes vulnerable to rumours and an abundance of misinformation generated and spread across social media platforms, which increases fear and uncertainty during informational ambiguity (Xie et al., 2020). The issue was particularly severe in the early stages of the pandemic, as one-way reactive communication with the public, denials, and misinformation about COVID-19 led to widespread uncertainty and confusion among the public, distracting crisis response and decision-making (Bunker et al., 2022; Kim & Kreps, 2020). Understanding the use of social media for crisis communication is an essential assignment for IS researchers assisting agencies and government stakeholders in modifying their crisis communication strategies for SSA within the digital context, thus preparing them for future crises (Bunker et al., 2019). The results of this study can be used to improve government-to-citizen communication and the creation of SSA during a crisis by altering the widespread use of social media by public health agencies.

Our study is unique in different aspects:

First, crisis communication theories (e.g., Image restoration and Situational Crisis Communication Theory) mainly focus on sustaining and restoring image and trust in private organisations, assisting them in managing businesses, and minimising financial losses (Barton, 1994; Benoit, 2008; Civelek et al., 2016; Coombs, 2007; Sturges, 1994). However, public organisations are of particular interest since they are in a position of public trust for the prevention, planning, response, and recovery from large-scale societal crises.

Furthermore, as noted by Elbanna et al. (2019), the majority of research in this field has focused on two main areas: (1) the ways in which the general public uses social media during a crisis and (2) how crisis response organizations can benefit from the data and information generated by this process. They also noted that most of the published research in this field has focused on the post-crisis phases of an extreme event. In order to address this gap, this study investigates the use of social media *by government agencies* to understand the *disruption and transformation* in social media (i.e., Facebook) public health communication at *the early stage* of the COVID-19 crisis.

Besides, research on situational awareness for crisis management has largely focused on inter or between-organizational contexts, and relatively little attention has been paid to developing effective SSA for the general public. This has created a knowledge gap for public organizations in terms of crisis communication and developing situational awareness among the public during different stages of a crisis event (Olsson, 2014). To close the gap, we study how official public health communication on Facebook was transformed in response to the onset of the COVID-19 pandemic to promote SSA among the public. We employ Chaos Theory as an interpretive lens and framework to explore this transformation. Social media is a complex system consisting of many interacting heterogeneous components and behaviors that are not characteristic of those observed in a "simple" system (Guliciuc, 2014; Mikhaeil & Baskerville, 2019). We apply concepts from chaos theory to elucidate the changes in the components of Facebook communication, namely *information* (content) and *communication type*, that have occurred as a result of the emergence of the pandemic

As explained by Seppänen et al. (2013), *information (content), communication type,* and *trust (link quality)* are the factors that impact the creation of SSA between actors (i.e., public health officials and the general public) during a crisis (Figure 12). Therefore, this study investigates the change in

(1) the *information (content)* communicated and (2) *the way that the information is communicated (communication type)* through a *trusted (link quality)* channel, i.e., the Australian public health official Facebook channel.

We first examine the use of Facebook by public health agencies before (i.e., across 2019) and then during the initial stages of the crisis, i.e., the COVID-19 pandemic (i.e., from January to April 2020 that covers the emergence and the first peak of the pandemic in Australia).
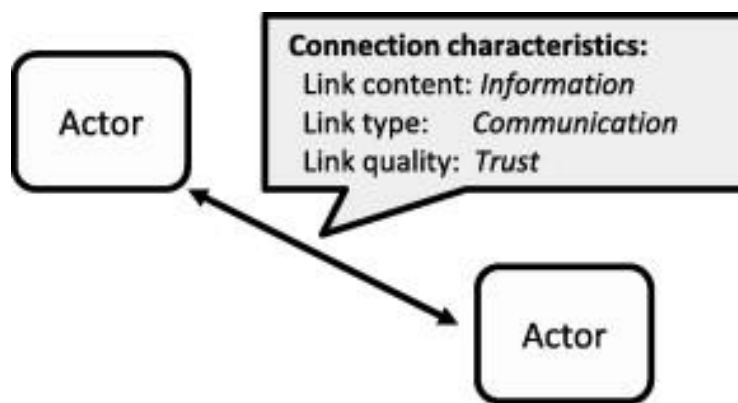
Figure 12 Information, Communication, and Trust explained by the source of the figure (Seppänen et al., 2013) as factors affecting the formation of SSA

Our research is timely and essential. Due to the range, reach, and pervasiveness of social media in our everyday life, these platforms have extensively benefited and challenged the creation of effective public SSA during extreme events (Bunker, 2020; Simon et al., 2021; Vemprala et al., 2018).

Theoretical Background

Chaos Theory was used to explain how the Australian public health Facebook communication was disrupted and transformed during the early stages of the COVID-19 crisis. Social media is a complex system that can exist at varying scales and undergo change processes that cannot be described by a single rule or reduced to a single level of explanation (Weisbuch & Solomon, 2007).

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Complex systems can adapt to inputs such as the COVID-19 crisis and evolve, but their outputs in response to changes in conditions are often diverse, ambiguous, and unpredictable. (Guliciuc, 2014; Guo et al., 2009). Because of the interaction of the number of components, the variety of interactions, and the rate of change in each, we cannot predict the complex system behaviour and its future, and it is also more challenging to control (Collinson & Jay, 2012; Weisbuch, 2018).

In this sense, Chaos Theory (Lorenz, 1963) can help interpret the behaviour of complex non-linear systems, such as their unpredictability, sensitive dependence on initial conditions, and bifurcation as they break down (Kiel & Elliott, 1996). Therefore, it was valuable in understanding the behaviour and transformation of the communication system during the pandemic.

Social media, e.g., Facebook, as an "emergent technology," are complex non-linear systems composed of many different elements with non-linear interactions (Guliciuc, 2014). During a public health crisis, unexpected internal or external forces can cause the social media communication system to lose its coherence and effectiveness. This can result in instability and unpredictability among system elements, leading to a chaotic state where the system becomes a fragmented whole. However, Chaos Theory can assist in understanding the underlying patterns that may emerge over time (Singh et al., 2016). Hence, Chaos Theory, "*the qualitative study of unstable aperiodic behaviour in deterministic non-linear dynamical systems*" (Kellert, 1994, p.2), can assist us in understanding the communication systems' unstable behaviour, which is difficult to predict and control (Kiel & Elliott, 1996).

The theory has been used in crisis communication studies to analyse and understand the role of communication during crises such as organisational crises, natural disasters, and pandemics (Dawkins & Barker, 2020; Liu & Pompper, 2012; Purworini et al., 2019). When crises and pressures affect significant portions of the global population, they often result in system

breakdowns and lead to social and economic chaos (Loye & Eisler, 1987). COVID-19 and its impact on the Facebook communication system is the subject of this study.

This paper also documents the application of netnographic methods (i.e., online or digital ethnography) combined with a chaos theory lens as an innovative approach to understanding irregular communication behaviour during a crisis. The impact of COVID-19 has necessitated a rethink of traditional research methods for Information Systems (IS) (Zhang et al., 2020), and the application of netnography and chaos theory for analysis and interpretation of our dataset makes a significant contribution to the study of IS for the development of SSA.

Our paper consists of a literature review on the role of social media in public health crisis communications and SSA development. We describe our research approach, dataset, and context, then present our analysis results using Chaos Theory concepts to explain disruption and transformation during a significant crisis. We conclude with observations and recommendations for public health social media communication strategies aimed at establishing SSA during crises.

Literature Review

Social Media Public Health Communications

Social media, such as forums, microblogging, and social networking, are Internet-based applications built on the technological and ideological foundations of Web 2.0 that offer real-time information and can significantly influence people's attitudes, beliefs, and decisions (Chipidza & Yan, 2022; Lee et al., 2022; Varathan et al., 2017).

Social media platforms have greatly improved access to public health information, emotional support, and surveillance and have influenced health policy development (Chang et al., 2021; Lee

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& Smith, 2022). Public health systems have adopted social media worldwide to increase awareness, communicate health interventions, and serve as a vital surveillance tool (Kass-Hout & Alhinnawi, 2013; Lyson et al., 2019; Stellefson et al., 2020). With over three billion frequent users, social media has become the dominant source of information and communication, particularly during crises such as the COVID-19 pandemic (Freberg et al., 2013). The pandemic has also brought about the phenomenon of the "digital infodemic," which has made social media crisis response critical in crisis management for organisations and individuals (Banerjee & Meena, 2021). Social media crisis response, therefore, became an important matter in crisis management, helping organisations and people to cope and recover from a crisis like the COVID-19 pandemic.

Social Media Public Health Crisis Communications

A crisis can be defined as a highly unpredictable and unstable situation, where a significant change is imminent, and there is a high probability of a severely unfavorable outcome. Crisis management is considered the practice of mitigating risk and uncertainty in order to enable institutions to achieve their objectives with as little disruption as possible (Fink, 1986).

During a crisis, people turn to social media to seek timely, unfiltered information to gauge the scale of a disaster, as well as to communicate with family and friends, maintain a sense of community, and seek and express physical and emotional support, all of which have an impact on SSA, public decisions and crisis response (Bunker et al., 2015; Fraustino et al., 2017; Haimson et al., 2021; Mirbabaie et al., 2020; Sathish et al., 2020; Shahbazi et al., 2018; Tim et al., 2017). Social media offers emergency officers valuable information about time-sensitive situations, allowing them to comprehend the impact of threats and implement prompt emergency solutions (Yin et al., 2015).

Table 9 Positive and Negative Impact of Social Media on the Creation of SSA During the COVID-19 pandemic

Studies	Where Social Media Supported SSA During the COVID-19 Crisis
Wang et al. (2021); Zheng et al. (2020); Al-Dmour et al. (2020); Khamis & Geng (2021); Lu et al. (2021); Oh et al. (2020); Li et al. (2020); Dutta et al. (2022); Tsao et al. (2021)	Social media is crucial for generating, sharing, and consuming information, influencing the creation of situational awareness that enhances preventive behaviours and offline public health actions.
Kim et al. (2021); Liao et al. (2020); Mheidly & Fares (2020); Rufai & Bunce (2020); Sutton et al. (2020)	Officials use social media to respond to the pandemic and infodemic by explaining guidelines, promoting science-based knowledge, engaging the public, and sharing health information.
Loewenson et al. (2021); Gesser-Edelsburg (2021)	Social media platforms facilitate real-time communication between authorities and the public, enabling community involvement in decision-making and multi-sectoral action related to the COVID-19 response.
Anwar et al. (2020); Nabity-Grover et al. (2020); Power & Hadidi (2021)	Social media provided equal access to healthcare information, reduced discrimination and isolation, and helped people cope with lockdown restrictions.
Studies	Where Social Media Hampered SSA During the COVID-19 Crisis
Parviainen (2020); Chipidza et al. (2020); Houli et al. (2021); Naeem et al. (2020); Wang et al. (2022); Xie et al. (2020); Dwivedi et al. (2020)	Social media spread fake news and conspiracy theories about COVID-19, affecting information management and SSA.
Garfin et al. (2020); Malecki et al. (2020); Bunker (2020)	The social media infodemic created public anxiety and impacted trust and heightened stress responses that have overburdened the health system while putting public health at serious risk.
Cinelli et al. (2020); Zhou et al. (2021); Tran et al. (2021)	Social media infodemic and misinformation have led to confusion, fraud, financial abuse, and fear, undermining government-generated situational awareness during the pandemic.

The unknown nature, unpredictability, and high level of uncertainty surrounding the COVID-19 pandemic have all the hallmarks of a crisis that causes interruption, confusion, relatively short

(health) response time, and disorder (Hermann, 1963). In this situation, failures in successful information-sharing slowed down an effective response to the pandemic (Shankar et al., 2021; Zheng et al., 2020; Zheng et al., 2021), inevitably leading citizens to become fearful, uncertain, and anxious (Chen et al., 2020). *Table* 9**Error! Reference source not found.** reviews relevant studies to summarise how social media communication has influenced the development of SSA for the general public during the COVID-19 pandemic.

Situational Awareness (SA)

Situational awareness (SA) can be considered a person's mental model of their environment. All incoming information from different sensors and systems, the outside environment, and other sources need to be integrated to create "*a person's understanding of what is happening in the current situation*" (Endsley, 2021; Maitlis & Christianson, 2014).

Shared situational awareness is essential for a timely, efficient, and effective crisis response and can be constrained by unreliable and delayed communications (Kedia et al., 2022; Maitlis & Sonenshein, 2010).

Previous studies have focused on improving situational awareness and the relevant value of social media for crisis response teams, which is why the phenomenon has been termed shared or intergroup SA (Cameron et al., 2012; Harrald & Jefferson, 2007; Sonnenwald & Pierce, 2000; Van de Walle et al., 2016; Yin et al., 2012). However, our experience with the COVID-19 pandemic has shown that the general public and crisis-affected communities are essential actors in crisis response. This study argues that public health organisations and the general public are two actors in managing the COVID-19 crisis, and the information communicated between actors via social media enabled the creation of SSA during the crisis.

Situational awareness is the concept of *knowing what is going on so that you can decide what to do* (Yang et al., 2016). Situational awareness during the COVID-19 pandemic was influenced by frequently changing information obtained through social media and other sources, which shaped public health behaviours and crisis response (Qazi et al., 2020).

Shared situational awareness implies that the technology platform provides adequate information to geographically distributed decision-makers to make decisions and act as if they were receiving and perceiving the same information (Harrald & Jefferson, 2007). However, With the increased use of social media platforms such as Facebook for communication, the issue of digital destruction, which causes mental model dissonance, jeopardises mental model alignment and SSA during a crisis (Bunker, 2020). For instance, the propagation of misinformation and rumours on social media through the application of artificial intelligence, data analytics, and individual user profiling by social media providers combined with financial rewards paid to social media influencers creates a complex information environment in which to create SSA (Donaldson & LeFevre, 2022; Mirbabaie et al., 2022; Singh et al., 2021).

Building upon the Seppänen et al. (2013) study, we investigate the social media link content (i.e., information) and link type (i.e., communications) that were shared between actors (i.e., Australian public health agencies and the general public) to understand the factors that underpin the development of SSA during the crisis. As we investigate the communication on the official public health Facebook channel, the assumption is that a level of trust exists between actors, the agencies, and their audience.

Through the lens of Chaos Theory, this study explains the unexpected and radical departures from established normal communication and the shift in the communication approach for creating SSA.

We use Chaos Theory, as this study is concerned with parameters of the complex system and their dynamics, such as the emergence of seemingly random behaviour from the iteration of a simple rule, explaining how Facebook communication was impacted by the COVID-19 crisis and changed over time. In contrast, Complexity Theory takes a holistic view, looking for larger patterns of relationship, and is concerned with both the structure and dynamics of systems, as well as their interaction with their environment (Gilpin & Murphy, 2010; Rickles et al., 2007).

Chaos is a property of a system that exhibits sensitivity to initial conditions, defined as the amplified impact of small changes in the present that contribute to long-term unpredictability (Bertuglia & Vaio, 2005). We investigate chaos (random states of disorder and irregularities) in a complex non-linear system (social media, i.e., Facebook communication) where the system loses its coherence (i.e., the pattern of Facebook public health communication observed before the crisis) and radically changes to settle in the new normality. Complex systems are not necessarily chaotic but can be for some elements or control parameters. However, "the sensitivity to initial condition" is essential to both Chaos and Complexity due to nonlinearity (Bertuglia & Vaio, 2005). Like other complex systems, social media communication exhibits self-organization, which occurs when systems spontaneously order themselves, usually in an optimal or more stable manner (Lichtenstein, 2000).

Research Method, Dataset, and Analysis

The COVID-19 pandemic has placed extraordinary pressure on the human and technical systems that normally facilitate data gathering for research and knowledge production (Shankar et al., 2021). While there has been significant demand for COVID-19 related social research during the pandemic, when we were conducting this research during the early stage of the pandemic, the

research community experienced difficulty in data collection that used traditional methods like face-to-face interviews, observations, and surveys. In this context, a netnographic study of online communities can shed light on a wide range of facets of the COVID-19 crisis in this early stage, particularly the role of social media communication in public health crisis management.

Netnography

"Netnography" is a form of online ethnography introduced by Kozinets (1998) that was developed to study online cultures and communities created through computer-mediated social interaction (Bowler Jr, 2010). Analogous to ethnography, netnography allows researchers to focus on contextual factors of an event that is unique to each event and 'influence' the study of what Knorr-Cetina (1983) calls the '*locally situated, occasioned character*' of the event.

The advantage of using netnography for understanding a crisis event is not only limited to time and geographical location but also allows researchers to access a high volume of free data. However, a netnography narrative, in the strictest sense, can never be as authentic as ethnography, i.e., face-to-face interaction and the insights generated when traveling to a field site. However, as we study online communication, conducting a pure netnography is entirely appropriate and complete within itself (Kozinets, 2010).

This study is part of a broad investigation into public health social media communication. Observations of public health communication on Facebook commenced in February 2019 to understand how communication systems function to promote shared awareness of public health events. The netnographers (i.e., authors of the paper) observed the crisis event onset and the changes to social media communication from early in the pandemic (Feb 2020), which helped to generate in-depth descriptions and interpretations of the communication system transformation.

However, Netnographers are nonparticipatory (passive) observers with limited involvement in the research setting (i.e., unobtrusive netnography), which means that as outsiders, we remain impartial to and independent of the study context (Costello et al., 2017). The unobtrusive and passive study of our research context allows us to observe communications without influencing the data and which also supports our ability to analyse sensitive content within the dataset, e.g., tensions and conflicts (Langer & Beckman, 2005). Our case study approach is considered appropriate for such exploratory research (Siggelkow, 2007). This method has allowed us to discover operational processes (the public health communication) (Gephart Jr, 2004) that are "tight" to the context of the information system, in this case, the public health Facebook page, aiming at finding solutions to the "how" question (i.e., our research questions) (Pan & Tan, 2011; Walsham, 1995).

We followed the five steps of netnography 1) defining the research question, 2) online community identification and selection, 3) online observation and data collection, 4) data analysis and iterative interpretation of findings, and 5) presenting research findings and theoretical and practical implications as outlined by Kozinets (2010).

Our netnography research incorporates the concepts of chaos theory to interpret our observation from the information system, which is a unique approach compared with relevant studies such as those reviewed by Karanasios (2022).

Study Context and Scope

In Australia, the first case of COVID-19 was identified in late January 2020, and case numbers reached an initial peak at the end of March 2020 (Figure 13).
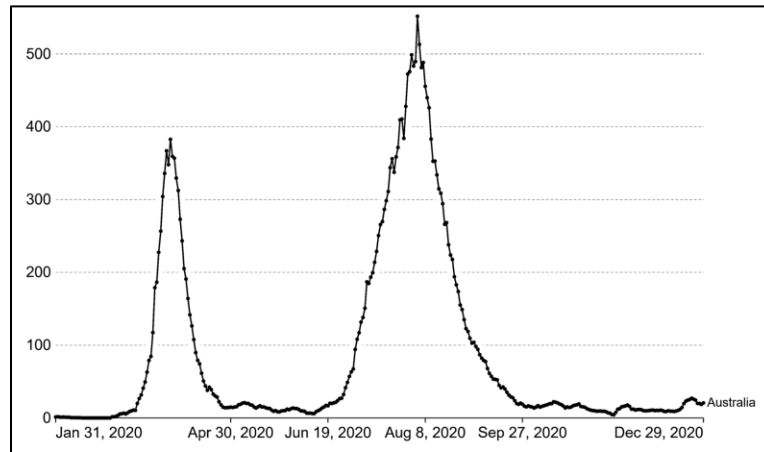
Figure 13 Daily New Confirmed COVID-19 Cases in Australia, source: CSSE (2021)

The Government in Australia is a complex multijurisdictional network, with a national (Federal) Government and a federation of six states and two Territories. Australian Federal, State, and Territory health agencies adopted social media to mitigate the impact of the Covid-19 pandemic, but it proved unsuccessful in at least some areas. For instance, in early March 2020, the Australian public health agency suggested people avoid panic buying (e.g., "*... There is no need to bulk-buy products at supermarkets, ...*[11]"). However, by mid-March 2020, the news and social media communications drew attention to many aggressive panic buying across the country. These public behaviours surprised and frustrated the Australian Government (e.g., "*It's ridiculous, it's un-Australian, and it must stop*": Prime Minister Scott Morrison tells Australians to cease panic buying, 18 Mar 2020, Canberra).

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[11] NSW Health posted to Facebook on 5 March 2020, post ID 1239123602953645

In mid-March 2020, the New South Wales Ministry of Health (branded *NSW Health*) asked people to consider the social distancing requirements in their daily interactions with others (e.g., "*Social distancing reduces the risk of catching viruses like COVID-19*[12]"). Later, the NSW State government closed beaches to the public after images of crowded Sydney beaches went viral online.

In late March 2020, NSW Health announced that further restrictions needed to be applied as the pandemic gained momentum in NSW (e.g., "*…, many facilities will be restricted from opening[13]*"). The day after, thousands of newly unemployed Australians queued for hours outside the social security offices, disregarding physical distancing requirements to lodge unemployment benefits claims.

We argue that the inconsistency between the crisis messaging and public crisis response was due to the lack of adequate SSA at the early stage of the COVID-19 outbreak, which hindered crisis management in Australia. Hence, we explore how Australian public health agencies used social media, i.e., Facebook, to communicate information and create SSA at the onset of the pandemic, highlighting the changes from non-crisis times. Accordingly, we constructed our research questions and searched for appropriate Facebook communities as a source of data for our investigation. Following Seawright and Gerring (2008) guidance, we selected Facebook as a key social media channel for this study on Australian public health social media communication. As the second-oldest platform (with Twitter being the first, adopted by agencies in May 2009), Facebook was a critical channel for disseminating information and promoting situational awareness during the COVID-19 pandemic. Australian public health channels on Facebook are

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[12] NSW Health posted to Facebook on 14 March 2020, post-ID 1245323879000284
[13] NSW Health posted to Facebook on 22 March 2020, post-ID 1253410354858303

highly popular and have considerably higher followers than their other social media channels, i.e., LinkedIn, Pinterest, Twitter, and Instagram. Furthermore, despite the prevalence of Facebook as a communication tool for Australian public health agencies during the COVID-19 pandemic, it has received less scholarly attention compared to Twitter data (e.g., Sleigh et al. (2021), Doogan et al. (2020), etc.).

Online Community Identification and Selection Criteria

Online communities are seen as communities of practice, a concept derived from ethnographic studies of real-world communities (Lueg, 2007; Wenger, 1999). Based on our research questions, we selected three Facebook communities that serve as typical examples of public health agencies' communication channels in Australia. By examining the data generated within these communities, we were able to observe the health agencies' communication practices. Facebook is Australia's most dominant social networking service (Correll, 2020) and one of the official communications channels to provide critical health information to the general public (Australia, 2020). Australian Government Department of Health develops and delivers health policies and programs. New South Wales and Victoria are Australia's most populous states and reported the highest number of COVID-19 cases during the first four months of the pandemic in 2020 (3,045 and 1,366 cases, respectively). To save space, we will use the acronym to refer to the health agencies "Federal" for the Australian Government Department of Health, "NSW" for New South Wales Health, and "VIC" for the Victorian Department of Health.

Using a self-developed python app, we collected Facebook posts and their linked reactions and comments published by these health agencies from 2017 until 2020[14]. Figure 14**Error! Reference source not found.** shows the volume of communication in the channel.
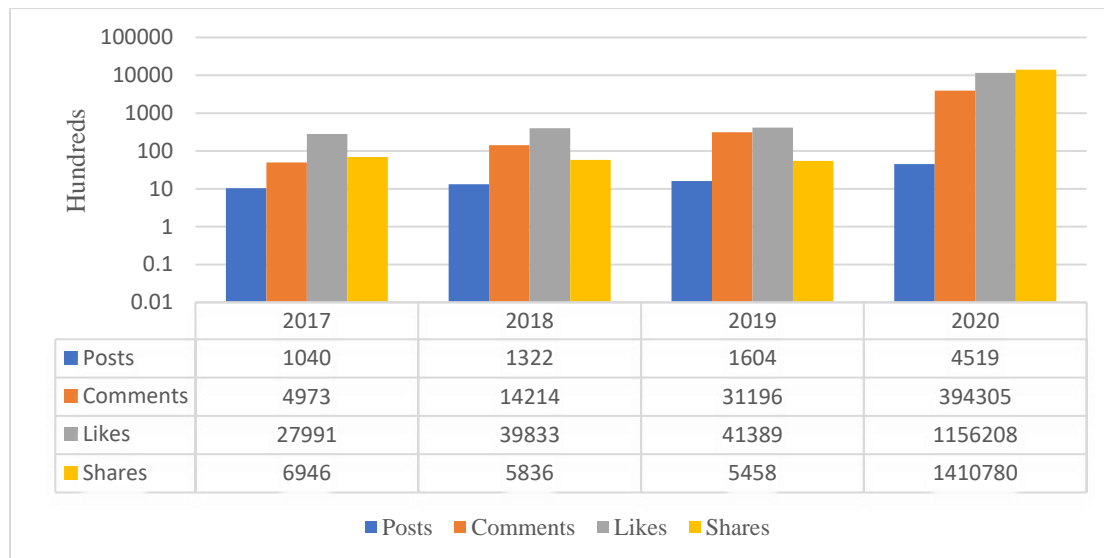
Figure 14 Heath Communication Engagements from Jan 2017 to Dec 2020 (source: Facebook data collected and visualised by the authors)

Figure 14**Error! Reference source not found.** shows that when COVID-19 emerged in Australia (in 2020), the number of posts published by the agencies (i.e., Federal, NSW, VIC) and public engagement in communication (i.e., comments, shares, likes, etc.) radically increased. The high volume of communication on the selected Facebook communities highlights the importance of the channels for crisis communication during the COVID-19 pandemic.

This study aimed to enhance understanding of the role of social media (i.e., Facebook) in public health crisis communication and SSA and reveal the impact of the COVID-19 pandemic emergence on communication patterns. To ensure a focused analysis, we narrowed the scope of

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[14] Our application was specifically designed to allow us to access past Facebook data

our study to the period between January 2019 and April 2020. This time window assists us in investigating communication behaviour during two time periods; before (P1) and during the initial onset of the public health crisis (P2). *Table 10* **Error! Reference source not found.** summarises the final dataset and the number of posts we analysed from each Facebook channel.

Table 10 Summary of Facebook Posts: P1, P2, and January 2019 to April 2020

	Number of Posts	
Public Health Organisation	**P1:** 1 Jan to 31 Dec 2019	**P2:** 1 Jan to 30 Apr 2020
NSW Health	499	431
Victorian Department of Health	507	334
Australian Department of Health	598	618
Total	1604	1383

Data Analysis and Findings

This paper is a component of our broader research on social media public health communication regarding infectious disease outbreak management. Hence, we had been monitoring online activities prior to the event. We closely followed the agencies' (i.e., Federal, NSW, VIC) Facebook pages from February 2019 until December 2020 to observe detailed communication behaviour and changes in communication patterns and keep field notes. Becoming a member of these online communities and conducting continuous observations of their Facebook communication patterns provided us with in-depth knowledge of the research context, which was useful for interpreting and presenting our findings on the purpose of using social media from an organisational perspective.

Our understanding of our dataset is shaped by a presumption about the parts of the posts leading to a whole-text interpretation. This approach is led by the "hermeneutic circle," which describes the process of understanding a text moving from part to whole (and back again), as cited in Myers

(2004). Our analysis was conducted by first understanding a piece of information communicated in a post, i.e., the meaning that the agency wanted to deliver through their Facebook posts within the context of the event (COVID-19 pandemic). Then, using this understanding, we move our analysis forward and place it within a larger communications context until a complete understanding is obtained (as identified by agency objectives for the use of social media and the patterns of public health communications/crisis communications).

P1 and P2 Analysis

We conduct *the general inductive approach* (Thomas, 2003) to the analysis of the posts seeking commonality and shaping them into inter-connected, cohesive communication discussion themes. Guided by Strauss and Corbin (1998), authors read the posts individually, and the coding frame was developed following group discussion sessions. The posts were reread and recategorized according to the agreed-upon coding structure, then abstracted into a higher logical level, which was conceptualised into final themes after further discussion. The rigorous and systematic reading and coding of post content revealed major themes. We then conducted an iterative analysis between post parts (keywords) and the whole of the text (posts), which revealed our dataset's underlying and coherent meaning. *Figure 15***Error! Reference source not found.** illustrates the coding process. Using the general inductive approach, we have been able to "*condense extensive and varied raw text data into a brief, summary format*" and "*establish clear links between the research objectives and the findings derived from the raw data*" (Thomas, 2003, p.2).
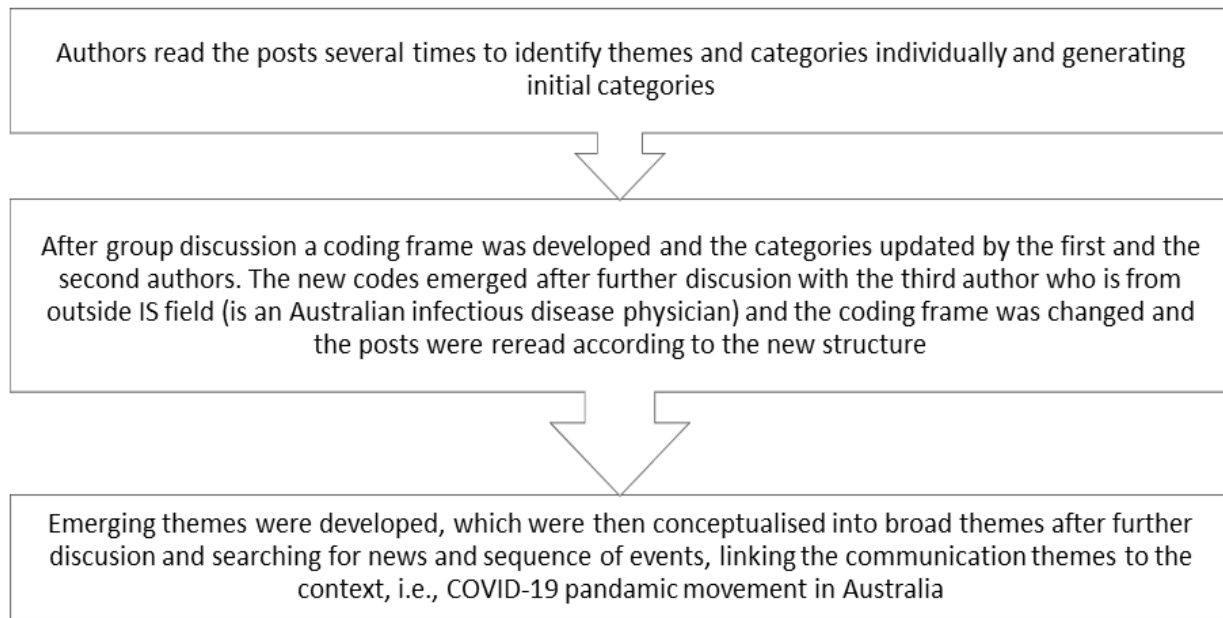
Figure 15 A Snapshot of our Inductive Approach to Coding our Textual Dataset

In the following section, we will briefly describe the system's normal operation. Our observations from 2019 will be used to illustrate the shift in the communication system caused by the pandemic in early 2020.

Health Communications Patterns: Pre-pandemic

This section reveals the approach and the type of *information* communicated via the channel (link) before the crisis impacted the communication system, i.e., normal day-to-day operations. Understanding the normal operation of the communication systems assists us in recognising the change in the system due to the emergence of the crisis.

From the most evident to the least widespread pattern, Figure 16**Error! Reference source not found.** shows the channel was primarily used, previous to COVID-19, to disseminate general health-related information rather than specific information related to a particular health issue or outbreak may be intended to promote overall health and wellness among the public and to raise awareness about health-related topics. In this category, we recorded several themes that received

little attention services (e.g., celebrating an event or congratulating an achievement) from the agencies.
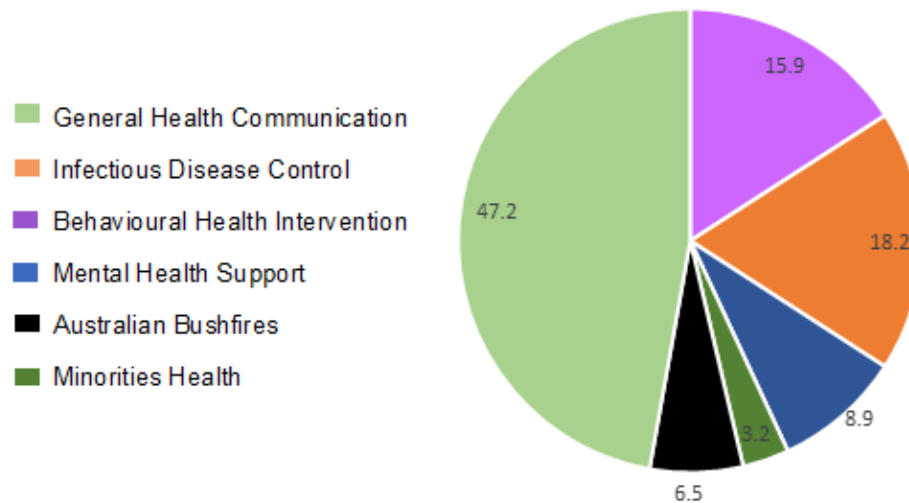
Figure 16 Theme Focus of Public Health Communication Facebook Posts in 2019

"*Infectious Disease Control*" was the dominant theme-based strategic communication before COVID-19. The Federal, NSW, and VIC health agencies utilized Facebook as a means to control the spread of infectious disease by implementing three strategies: 1) promoting vaccination and drug treatments, 2) raising awareness and enhancing health literacy about the disease, and 3) providing early warnings of potential epidemics, such as measles and influenza, in Australia, New Zealand, or other parts of the world.

In contrast, the "*Behavioural Health Interventions*" targeted Australians' dietary habits and emphasized the hazards of smoking and alcohol consumption.

The channels have also been used for supporting *Australian mental health* and also addressing *Minorities* and mostly the Australian Indigenous population's health issues ("*Minorities Health*" category). Indigenous Australians, representing 3.3% of the total population, have poorer than average health (*Indigenous Health and wellbeing*, 2020) and require consistent attention from

healthcare providers to close the gap of health inequality through improving access to healthcare (Jennings et al., 2018). In the following section, we will outline how the channels operated during the early stages of the pandemic, highlighting the changes in communication strategies and messaging that emerged over time.

Public Health Communications Patterns: Pandemic

In this section, we outline how communication transformed to create situational awareness in the presence of a public health crisis, i.e., the COVID-19 pandemic. Applying the same thematic approach, we analysed the content of Facebook posts published by the health agencies (i.e., Federal, NSW, VIC) during the first four months of the pandemic in Australia, i.e., January to April 2020. **Error! Reference source not found.** shows the distribution of communication themes discussed by public health agencies on Facebook during the first four months of 2020.
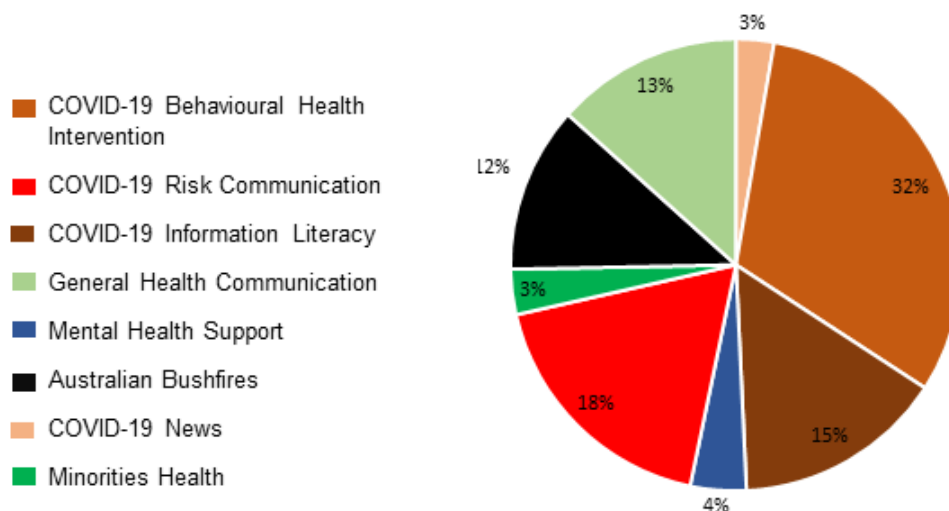
Figure 17 Theme Focus of Public Health Communication Facebook Posts, January to April 2020

We interpret Australian public health Facebook communication patterns through the lens of Chaos Theory, offering our observations on the creation of public SSA.

Applying Chaos Theory to Interpret Transformation in Public Health Crisis Communication patterns - January 2019 to April 2020

Chaos theory was originally developed in the nineteenth century as a subfield of applied mathematics. The theory demonstrates that complex systems like social media are highly sensitive to the impact of initial conditions. Chaos Theory provides a valuable framework for interpreting and understanding the initial shock and disruption to communication systems during the early stages of the pandemic. As an interpretive lens, it allows us to appreciate the complex and unpredictable nature of the communication landscape, where the emergent state of the system has no order in comparison to normal operation. By embracing the system's inherent disorder and nonlinear dynamics post COVID-19 onset, we can gain deeper insights into the patterns and processes that emerged during this critical period. This, in turn, enables us to identify key strategies and interventions that effectively promote SSA and manage the pandemic.

Sensitivity to the Initial Condition (Butterfly Effect)

The butterfly effect describes a system's *sensitivity to initial conditions* that may start a chain of events that leads to a large-scale event that can have a much more significant impact. The COVID-19 pandemic started with an infectious disease outbreak that quickly impacted everyday life and business globally. Short-term imposts on behaviour included staying at home, social distancing, and wearing masks in public. Long-term or permanent impacts such as *Twitter's Permanent Remote-Work Policy* (Forbes, 2020) are known, but the effect of other policies, such as remote learning by millions of students globally, are largely unknown (Radford et al., 2022; Reynolds et al., 2022).

Accordingly, we have seen substantial butterfly effects on social media communication, including changes in the component of the system, the information content and volume, and communication approaches (type) to create crisis SSA and keep the public informed. The change was triggered by detecting the first coronavirus case in late January 2020 in Australia, resulting in a radical shift in communication patterns (approach and content) which we explain further.

Our results also revealed a shift in the tone of the Facebook posts besides the changes to the volume and content of communication during the early stage of the pandemic. By applying the principles of chaos theory, we can delve deeper into the disruptions that occurred within the communication system, theme shifting, and breakdown of SSA during the early stages of the COVID-19 pandemic in Australia.

Bifurcation in Communication Type and the Content

Bifurcation is another major aspect of chaos theory that is referred to as radical systematic changes that emerge in response to a chaotic environment. *Bifurcation* represents the turning point of change where a system's direction, structure, and/or character has been fundamentally disrupted. Bifurcation points are associated with a collapse of sensemaking or collapse in the routine way of operating a system where it deviates from the established path (Freimuth, 2006).

Between February 2020 and April 2020, we noticed a significant deviation from the conventional health communication approach, with a shift towards the development of SSA concerning the COVID-19 pandemic. The Facebook communication transformation assisted public health agencies to fulfill the information needs that, as noted by Lueg (2020), were generated dynamically in the embodied interaction of the social environment impacted by the crisis. This radical (irregular) change highlights communication bifurcation as public health communication on

Facebook adopted new patterns focussed on COVID-19 themes, with a new dynamic at work to produce SSA on Facebook. Communication bifurcation is an important step in transforming social media to cope with the crisis information needs and creation of SSA.

As shown in Figure 16**Error! Reference source not found.**, the Facebook health communication strategy shifted from a *divergent discussion* on a range of themes, mainly disseminating "*General Health Information*" to more "*theme-based strategic communication,*" influencing individual and community decisions on a scaled-down range of health issues. In particular, over 65% of the discussion was focused on crisis communication to control the COVID-19 pandemic.

At the early stage of the pandemic (P2 period), the majority of Facebook public health communication focused on pandemic control to assist in creating *crisis-related SSA* in three areas *1) mitigating measures and behavioural health interventions, 2) event-based surveillance*, and *3) COVID-19 information literacy*.

Mitigating Measures and Behavioural Health Interventions

The majority (32%) of public health communication on Facebook during the first four months of 2020 was intended to control the COVID-19 pandemic by *encouraging informed decision-making and behavioural health interventions*. Over 17% of the total posts *promoting good personal hygiene* habits (e.g., social or physical distancing, staying at home, and self-isolate) and explaining the *new restrictions and roles* were other *behavioural health intervention* themes.

Risk Communication and Surveillance

Facebook was also used to inform the public about the *current state* and the *risk* of the COVID-19 pandemic. Over 18% of Facebook posts disseminated information about the number and location of new cases to *enhance public preparedness and response*.

COVID-19 Information Literacy

The Australian public health agencies used Facebook to *increase public awareness about the pandemic* and respond to Facebook users' questions (9.1% of total posts). For instance, 3.8% of messages provided information on COVID-19 symptoms and 2.1% about the tests. *An "Audience targeting"* strategy was also used to support audiences with specific information needs (e.g., CALD community and pregnant women.)

The communication type changed from a one-way approach of transmitting health information from the agency to the public to a two-way approach that engaged the public during the crisis. In this sense, we observed that Facebook users not only shared their questions and concerns but also they increased the range and reach of government risk and crisis communication by sharing messages and notifying (tagging) other users in the comment area under the posts. This approach shifted and expanded the risk communication from "*agency-to-public control*" to "*user-to-user control*."

While the new pattern of communication promoted crisis-related SSA for the public, it also posed risks to public health awareness, as detailed below.

Communication Undermining- the Impact of Bifurcation on SSA

During the COVID-19 pandemic, public health communication on Facebook was dominated by pandemic-related discussions, leaving little space for other important health-related topics. As a consequence, Australia encountered new challenges, such as changes in healthcare-seeking

behaviour patterns, as many people became hesitant to visit healthcare settings when it was necessary (Sutherland et al., 2020). For instance, Scott and Edmonds (2020) reported that Australians have delayed or are avoiding lifesaving medical tests during COVID-19.

Furthermore, the COVID-19 pandemic in early 2020 and its consequences, such as widespread movement restrictions, social distancing measures, physical isolation, or 'lockdowns,' impacted Australian mental health and overall well-being ("Mental health services in Australia," 2021). However, in 2020, Facebook communication for supporting Australian mental health issues reduced (from 8.9 % to 4%) during the onset of the pandemic.

In 2019, around 3% of public health agencies' Facebook posts were devoted to minorities and Indigenous community health-related issues. During the COVID-19 pandemic, this communication effort was redirected to the Australian migrant and linguistically diverse communities to control the impact of returned international travelers on the spread of infections and to assist linguistically diverse communities in accessing health information. We observed the health concerns of minorities and Australian Indigenous communities received less attention on the channel during the pandemic, while at the same time, these vulnerable groups faced increased challenges in accessing healthcare services and information (Yashadhana et al., 2020). Social problems historically undermine the pandemic response within these communities, particularly the "Indigenous community" that, compared to non-indigenous Australians, has higher health risk factors and more vulnerability during health crises like pandemics (AIHW, 2018).

Disseminating comprehensive and up-to-date information, including topics related to mental health and Indigenous community health, through social media channels of Federal, NSW, and VIC agencies is essential for promoting public situational awareness. This can help manage the pandemic and promote overall community health.

Fractal

Fractal, a term coined by Benoit Mandelbrot in the late 1970s, is another tenet of chaos theory and is defined as a qualitative measurement of "*the relative degree of complexity of an object*" (Murphy, 1996, p. 100). Fractals replace quantitative measures when they become flawed yardsticks to describe the world (Eldridge et al., 1996).

In the context of crisis communication, the audience standpoint and measuring tools play an essential role in understanding the object and subject of communication. The COVID-19 pandemic presented a massive information crisis that significantly impacted the public's perception of the situation. For instance, studies showed that the inconsistent messaging to the public to change social behaviour to limit the spread of COVID-19, such as initially recommending not wearing face masks in public and then a few weeks later asking people to 'mask up,' created a wide-ranging public reaction to the posting of, what was deemed to be a controversial issue during the pandemic (Feng et al., 2020; Malecki et al., 2020). As a result, health agencies faced a challenging task in generating SSA during this time.

Public health officials stressed social distancing and discouraged panic buying during the early stages of the pandemic. However, these messages were sometimes met with an unexpected and undesirable response from the public, indicating a potential disconnect between the perspectives of health agencies and the audience.

We conclude that at the early stage of COVID-19, the agencies (i.e., Federal, NSW, VIC) and individuals (actors) had different viewpoints (measures or fractals), i.e., situational awareness about the pandemic, that in turn influenced their actions and responses. While the early stage of a

health crisis is critical for creating situational awareness and managing the pandemic, inconsistent and unpredictable communications hinder SSA, resulting in unsynchronised responses.

Strange Attractors

Strange attractors are fundamental points when a complex system starts to emerge from bifurcation back to order and regular operation, enabling communications patterns to move from bifurcation and find a new order through self-organisation principles. Strange attractors can include family cultures, common values, or organising principles that help a system rebuild after a disaster (Freimuth, 2006; Sellnow et al. (2002).

Likewise, we observed that as the COVID-19 pandemic evolved in Australia, the Federal, State, and Territory governments applied health restrictions to slow the spread of the virus. These public health orders, i.e., new mandatory restrictions, mainly included behavioural modification messaging such as social distancing and personal hygiene. As we discussed, *mitigating measures and behavioural health* messages were widely broadcast through Facebook, facilitating the move from bifurcation to a new state of normal. However, considering the unstable nature of the COVID-19 outbreak and its control, there was little time for dialogue and health promotion activities grounded in traditional health or crisis communications (Holmes, 2008) and creating SSA. The contrast between behavioural intervention messaging and outcome (i.e., public pandemic behaviour) led to *a change in the tone of messages around SSA*. We observed that the crisis communication strategy shifted from *advising* the public on disease prevention behaviours to *enforcing* new laws and broadcasting law enforcement messages in response to inconsistent and erratic pandemic social behaviour. Therefore, intervention communications around social behaviour modification *consisted of initial guidance but then moved to enforcement messaging* to

deal with a *perceived breakdown in SSA by public health agencies*, which *wrested control of the situation from the general public to the public health agencies.*

Self-Organisation

Self-organisation is a state where a new form of overall order arises from interactions between elements of an initially disordered system. According to chaos theory, a radical system fluctuation or chaos is necessary for transformation and renewal, and systemic collapse is a prelude to systemic rebuilding. Because at the time that we write this paper, the pandemic is not over, we still do not have a clear understanding of "*living with COVID-19.*" How the social, economic, and communication systems will emerge from the pandemic is still in progress; however, there is evidence that we are rebounding to the "*new normality*," as well as modifying communications patterns to return a balance of control to the general public that is more in keeping with accepted public health policy. The communication system has to move to a new state that can effectively support the creation of SSA and simultaneously accommodate diverse users' information needs.

Research Findings and Discussion

Effective social media communication during a crisis like COVID-19 requires a well-planned and strategic approach. The complex nature of social media makes it sensitive to initial conditions, meaning that the emergence of a crisis can quickly destabilize the communication system. As a result, the behaviour of the system becomes unpredictable and challenging to control. Understanding the potential changes in system behaviour resulting from a crisis such as the COVID-19 pandemic can help response agencies develop an effective crisis communication plan for establishing trusted SSA.

The way information is communicated (such as link types) and the information itself (link content, such as Facebook posts) are critical factors that significantly influence the development of SSA during a crisis (Seppänen et al., 2013). Our investigation focused on the official link created by Facebook between crisis response agencies (Federal, NSW, VIC) and the public. We analyzed both the link type and content of Facebook communications to develop SSA before and during the initial stage of the COVID-19 pandemic by health agencies. Our research revealed a significant shift in communication patterns following the emergence of the COVID-19 pandemic in early 2020. We have framed this shift through the lens of Chaos Theory to describe how the pandemic has triggered a profound alteration in communication dynamics. We observed communication bifurcation, leading to a radical change in communication content and a shift in the way information was communicated.

The communication system's parameters, including content, velocity, variety, and approach, underwent gradual changes, leading to a qualitative transformation in its dynamics. As a result, new patterns emerged, and existing ones disappeared. COVID-19 changed how public health agencies communicated on Facebook and how crisis-triggered situational awareness became a priority. Therefore, pandemic emergence and dynamics should influence social media public health communication strategies.

We revealed the characteristics of emerged crisis communication system during the COVID-19 pandemic, which assisted the agencies (i.e., Federal, NSW, VIC) in creating SSA for the public. The new system involved *1) a higher level of engagement from both agencies and the public with increased volume and velocity of information exchanged. 2) the communication strategy shifted from diverse public health discussions to topic-based and targeted audience communication relevant to decision-makers. 3) The communication strategy also turned from one-way*

communication and transmission of information from the agencies to the public to "listening to the audience" and creating a path for two-way communication.

In this sense, secondary communication and "*user-to-user control*" risk communication emerged as valuable tactics for expanding and influencing SSA. The "*user-to-user control*" risk communication identified in this study is an example of convergent user behaviour facilitated by social media characteristics that can amplify critical agency messaging and SSA during the onset of a crisis.

On the downside, the communication bifurcation also hampered the creation of adequate situational awareness. We highlighted that the emergence of a public health crisis and its butterfly effect could "swamp" and block communication themes on other important health issues central to the creation of SSA, which can result in further health impacts (cascading effect).

As the system remains sensitive to a new crisis, the results of this study assist public health agencies in modifying their social media communication strategies to fit the stages or 'waves' of a crisis that may reduce communication pattern sensitivity to an initial impact of an extreme event and facilitate moving from *bifurcation to self-organisation*. For instance, combining crisis-related information with other health-related topics in one post can support diverse audience information needs and create trusted public SSA. Applying concepts from chaos theory allowed us to explain the changes that occurred in a specific component of the complex system, i.e., social media communication, and how it affected the overall system behaviour.

Our study makes a scholarly contribution to the better application of communication technologies, in particular, social media as an IS artifact in public health communication and the creation of SSA. Our study further assists practitioners who are, as Elbanna et al. (2019) highlighted, facing

challenges regarding information quality, speed of dissemination, and content and positioning of the message when using social media such as Facebook.

Further work is needed to understand changes to communications for situational awareness during the recovery and resilience-building phases of the pandemic. In addition, research on the content of public comments on health agency Facebook posts would also expand our understanding of health communication by and between individual Facebook users.

As the next stage in our research, we have arranged in-depth interviews with public health agencies (i.e., Federal, NSW, VIC) communication managers and users. These interviews will further contextualize our study and add insights to the interpretive elements of this research.

Chapter 5 Social Media Public Health Communication Disruption and Transformation:

Community Engagement and Secondary Crisis Communication

This chapter continues the analysis of the Australian public health agencies' Facebook communication and extends the understanding of the way that the agencies used Facebook (communication link) and their approach to communication with the public. I also highlight the change in the organisations approach due to the emergence of the COVID-19 pandemic. To better understand the communication, I further look at the channel audience and public engagements in crisis communication. I investigate the secondary crisis communication during the COVID-19 crisis from January to December 2020, revealing the factors that influence the public decision to share information from reliable sources.
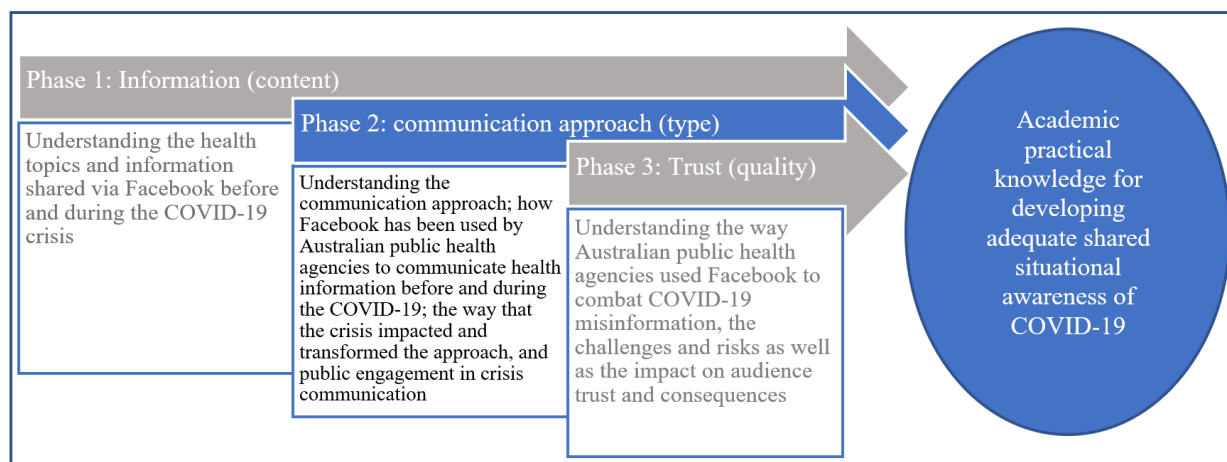
Figure 18 Study Process Map- Phase Two; understanding the communication

The next section is the manuscript of the full research paper, preprinted and ready to submit to a conference in the field of IS; the complete list of authors: Maryam Shahbazi & Deborah Bunker.

I designed the study, collected and analyzed the data, and wrote the first draft. My co-author supervised my work and contributed to the revisions of the manuscript; she kindly permitted me to use this as a component of this thesis.

Social Media Public Health Communication Disruption and Transformation: Community Engagement and Secondary Crisis Communication

Abstract

Effective crisis communication is critical to crisis management success. This study investigates Facebook public health crisis communication during the COVID-19 pandemic, uncovers the way that the event impacts communication, and identifies the factors that influence secondary crisis communication and content sharing. This case study shows that Australian public health communication on Facebook was firstly disrupted by COVID-19 and then transformed to cope with the dynamics of the crisis and resulting information needs. Enlightened by Sandman's risk model, our study further investigates *secondary crisis communication* during the COVID-19 pandemic highlighting the role of users' emotions in content sharing during the crisis. Our analysis revealed that sentiments of online social media posts, particularly users' expressions of "anger" feelings, are a strong driver for content sharing during the crisis. This study contributes to the existing body of knowledge about social media adoption for crisis communication and assists crisis response agencies in expanding the reach of their messages to broader communities.

Keywords: social media, crisis communication, public health communication, COVID-19 pandemic, secondary crisis communication

Introduction

Information technology plays an important role in assisting people and organisations through various disaster stages, e.g., disaster response websites (Chou et al., 2014), reducing or alleviating the impacts of information flow impediments (Day et al., 2009), assisting in coordination mechanism (Leidner et al., 2009), inter-organizational information sharing (Wakolbinger et al., 2013). Information technologies remained the main means of social interaction during the COVID-19 pandemic (PAHO, 2020). During the pandemic, governments and industry have used ICT to reorganize, innovate and adapt to quickly changing pandemic conditions (Lee, Malcein, & Kim, 2021; Zaman et al., 2020).

Social media platforms like Facebook have played a critical role in the COVID-19 pandemic, aiding emergency and crisis communication between health agencies and the general public (Raamkumar, Tan, & Wee, 2020). These platforms have been used by public health organisions around the world to disseminate health information, educate the public, raise awareness, and communicate critical health interventions (Lee & Smith, 2022; Stellefson et al., 2020). Social media has spawned self-help communities and empowered the community in crisis, for instance, requesting help or responding to pleas for help through these platforms (Leong et al., 2015). People access and share crisis information online during a crisis like the COVID-19 pandemic enhancing the reach of messages and crisis communication. The widespread usage of social media during the COVID-19 pandemic generated the phenomena of the pandemic's "digital infodemic" (Banerjee & Meena, 2021).

A challenge of social media crisis communication, which is yet to be met, is understanding how the public shares information (secondary crisis communication) perceived from reliable sources

during a crisis. Understanding the factors that affect crisis communication behaviours assists emergency management agencies in developing effective crisis communication strategies for managing both local and global hazards in a digital context (Bunker et al., 2019).

The importance of the pandemic as a global crisis event, the relatively short time for an effective response, and the devastation caused by the event make the COVID-19 pandemic an essential case study for Information Systems research (Sein, 2020). This paper focuses on *secondary crisis communication* in the context of the COVID-19 pandemic and investigates the factors that influence Facebook users sharing behaviours during the crisis. The study's findings lend preliminary credence to the social media adoption for crisis communication and content-sharing subjects. Drawing from the literature on social media crisis communication, the Slovic (1987) risk model, and emotion psychology, this study examines the role of users' *emotions*, *perception of risk,* and *information load*, in *secondary crisis communication* during the COVID-19 crisis indexed by *information sharing* behaviours.

Our case study investigates the use of Facebook by Australian public health agencies' and their audience during the COVID-19 outbreak. This paper first shows *how public health Facebook communication patterns experienced 1) initial crisis impact, 2) continuous change, and 3) self-organisation*. We further focus on *community engagement in social media public health communication*, investigating the factors that impact *secondary crisis communication and Facebook users' information-sharing behaviours*. This study is among the first to investigate the effect of *risk perceptions*, *users' emotions,* and *increased load of information* and compare the extent of the influence on *sharing behaviour*, which assists with developing timely and efficient risk communication. By expanding on Slovic's risk perception model, our study contributes to the literature on social media adoption for crisis communication and the IS field at large.

Studies investigating social media users' sharing behaviours mainly focused on the relationship between content characteristics and sharing behaviour, mainly used the Twitter dataset and have focused on tweet contents, twitterer characteristics, and Twitter features (Son et al., 2019). Facebook data has also been investigated to reveal the interaction between the types and content of the post and users' reactions or engagements, providing insight into how different types of posts gain users' attention and motivation to interact (Syn, 2021). However, we found no study focused on understanding the role of users' *emotions, perception of risk,* and *information load* in *secondary crisis communication* and content-sharing behaviour on Facebook in the context of the COVID-19 crisis. The COVID-19 pandemic created a crisis that was not experienced in earlier times as a global phenomenon with far-reaching consequences as in the present context (Nandy, 2022), and Facebook informs and connects people and has been wildly used by Australian public health organisations and communities, creating shared situational awareness during the crisis (Bunker et al., 2022).

Our work is timely and important; the COVID-19 pandemic has made it clear that we need to build resilience in ways that save lives and livelihoods. The pandemic has also given people amazing experiences and shown people's dark sides and weaknesses in many different ways. There is a lot of uncertainty about how the pandemic will spread and how long it will last, as well as about how often global pandemics will happen. This, along with massively depressed economies and high economic uncertainty, makes it hard to predict how the world will change after the pandemic. It seems clear that the important role of digital technologies gives Information Systems (IS) scholars a great chance to help build resilience to pandemics and extreme events, which is an essential need (Rai, 2020). Studies on crisis communication have traditionally focused on sustaining and restoring the image and trust of commercial organisations to minimize financial and reputational

loss (Barton, 1994; Civelek, Çemberci, & Eralp, 2016; Sturges, 1994). While government agencies are of particular interest since they have a critical role in planning, communicating, and controlling large-scale societal crises, there is limited knowledge of crisis communication from the perspective of public organisations (Olsson, 2014). Our study fills the gap and provides an in-depth understanding of government agencies' social media crisis communication during the COVID-19 pandemic.

Since Facebook is the most widely used social media platform in Australia, we investigate how public health agencies and their audiences utilise it. Instead of doing survey research, which is popular in the field of media studies, we analysed the connections between our explanatory and outcome variables using data we gathered from Facebook.

Our work differs significantly from past studies in critical respects. Firstly, we analyse a large sample of Facebook posts reflecting on two years of official public health communication. Furthermore, we explicitly investigate users' online behaviours, and Facebook Emojis represent users feeling about the content rather than self-report measurements of what users feel about the information. By applying Sandman (1989) risk model in the COVID-19 crisis communication study, we add to the tiny pool of studies focusing on social media users' content-sharing behaviours when the crisis information is supplied by government agencies.

This paper begins by reviewing the literature on social media crisis communication focusing on users' content sharing. We then outline the study's theoretical underpinning, research methodology, dataset, and analysis. Our study concludes with general observations, findings, and suggestions for public health social media communication strategies. This study assists crisis response agencies in considering more precise and tailored social media strategies for crisis

communications and public engagement, which is crucial to decreasing the burden of a public health crisis.

<center>**Literature Review**</center>

Social Media Crisis Communications

The persistent COVID-19 pandemic demonstrated that the international community was not ready to deal with such emergent pandemics (Tambo et al., 2021). In this respect, the COVID-19 issue has never more starkly shown the significance of global and local community engagement and risk communication. The World Health Organisation has identified this as one of the most important takeaways from the most significant public health events of the 21st century (Tambo et al., 2021). As local responses to global risks become more prevalent, there is a pressing need for risk communication that actively includes communities as active players in the process of identifying, assessing, and mitigating threats (Khan et al., 2022).

Seeger (2002) recognised the importance of communication in crisis management and response, which serves various essential functions before, during, and after a crisis. During an emergency, the public increasingly turns to social media for immediate and in-depth crisis information (Jang & Baek, 2019), which supports sense-giving, making, and breaking (Mirbabaie et al., 2020) to reduce uncertainty and gain a sense of personal control over the situation (Lin et al., 2016). The public's response to disasters such as earthquakes, floods, bushfires, terrorist attacks, and the COVID-19 pandemic has been transformed as a result of digitally enabled disaster response through the adoption and use of social media (Ali et al., 2022; Bunker et al., 2015; Mirbabaie et al., 2020; Shahbazi et al., 2018; Tim et al., 2017). In times of crisis, social media, directly and

indirectly, impact the at-risk population's situational awareness (Son et al., 2019). Therefore, the use of social media in health crisis management and policy creation is essential (Lin et al., 2016).

The integration of social media communications for monitoring and controlling public health crises like pandemics has created new opportunities for health agencies and governments (Avery, 2017; Guidry et al., 2017), as well as new challenges such as dispelling rumors and dealing with the emergence of vaccine refusal online collective behaviour (Baines et al., 2021; Tran et al., 2022).

Social media is defined as a group of Internet-based applications that have been built on the ideological and technological foundations of Web 2.0. These applications have facilitated the creation and exchange of user-generated content (Kaplan & Haenlein, 2010). Social Media platforms have been recognised as an appropriate communication channel to transmit health information to a large number of people and promote public health awareness (Lyson et al., 2019; Thackeray et al., 2012). Access to information, citizen communication, outreach to communities, and government openness are all bolstered by the use of social media in government. Some of the roles that government social media platforms play, such as facilitating "need to know" information sharing, are difficult to do using traditional media (Kim et al., 2015; Park et al., 2016). Public health systems worldwide have adopted social media to broadcast health information, engage the public and increase awareness, communicate essential health interventions, and serve as a vital surveillance tool (Kass-Hout & Alhinnawi, 2013; Lyson et al., 2019; Stellefson et al., 2020).

The COVID-19 Pandemic and Public Health Crisis Communication

WHO identified the novel coronavirus (the COVID-19 disease) in December 2019 when the Wuhan Municipal Health Commission, China, reported a cluster of cases of pneumonia in Wuhan,

Hubei Province. On 30 January 2020, the WHO declared a public health emergency of international concern due to the spread of COVID-19 and the severe global threat it presented. The pandemic created a period of a severe global health crisis that impacted various aspects of social and personal life (Barnes, 2020; Venkatesh, 2020).

Many nations have felt the effects of COVID-19 on their economies and daily lives. By the end of August 2021, snap lockdowns in Australia had wreaked havoc on the country's mental health and cost the economy billions of dollars (Lathouris, 2021). Risk communication and community engagement are essential to the success of responses to a public health crisis, as was learned during important public health events of the 21st century, such as the epidemics of SARS, MERS, influenza A (H1N1), and Ebola virus disease. However, there are always new communication risks during a public health emergency. The COVID-19 pandemic poses a serious threat to the efficiency of public health services and the clarity of their communication with the public, creating an "information crisis" (Xie et al., 2020). The breakdown in communication can result in a loss of credibility, reputation, money, and even life. There are always new things to learn, but there are also things we can do now that we know would be effective. There is a call to action for leaders to make *risk communication* and *community engagement* a priority in health emergency preparedness and response (WHO, 2020b). Lim and Nakazato (2020) defined risk communication as an interactive process by which individuals, groups, and all stakeholders in a community exchange information and opinions about an emerging or potential risk to human health or the environment to make more informed decisions about their well-being during a crisis. In this regard, social media platforms, such as Facebook and Twitter, have played an important role during the COVID-19 pandemic, assisting health agencies in crisis communication and the public in accessing event-related information (Wang et al., 2021). For instance, government agencies (e.g., local, state, and

federal public health agencies) use social media to communicate during the COVID-19 crisis (DePaula et al., 2022).

Social media play various roles across the pandemic–response continuum, including tracking contagion, transmission, surveillance, vaccination, disease control, and treatment (Schillinger et al., 2020). During the COVID-19 pandemic, social media, like Facebook, swiftly emerged as a critical means of disseminating and consuming information (Wang et al., 2021). In the early stages of the pandemic, the general public developed a shared understanding of the event by exchanging information on microblogging platforms like Facebook and Twitter (Zheng et al., 2020). Due to limited public activities during the COVID-19 lockdowns, these platforms became the primary source of crisis-related information (Irawan, 2022). As a result of the COVID-19 pandemic, attention is now focused on ways to improve public health and risk communication practices.

COVID-19 crisis communication on social media engages the public, influences their behaviour and ability to cope with risk, builds trust and real-time engagement, and motivates the public to take action (Al-Dmour et al., 2020; Lu, Li, & Qian, 2021; Oh, Lee, & Han, 2020). According to the "Australian Health Management Plan for Pandemic Influenza" 2019) "*Communication with the public, through the media and other sources, will shape the public perception of risk and the way in which the public is engaged in measures to address the pandemic* (p 54)."

Crisis communication has been studied in many different contexts; however, the COVID-19 pandemic and the communications disruption it has caused in the era of social media are unique. Our study broadens the scope of our current knowledge in this area.

Social Media Crisis Communication and Users' Engagement

Integrating social media channels in emergency communication has changed the traditional pathway for the flow of information from emergency organisations to the public (Simon, Goldberg, & Adini, 2015). Utilizing the media, including social media, to engage a broad population in health decision-making processes is strongly suggested for government organisations (WHO, 2019).

Digital technology and social media platforms change the peace of crisis communication and influence mainstream news coverage. Without the filtering influence of journalists, information about a crisis can rapidly spread to millions of people, and communities can actively participate in the crisis response via two-way communication (Pan, Pan, & Leidner, 2012; Veil et al., 2011). Social media has made it possible to fulfill the informational, emotional, and organisational needs of those directly impacted, ensuring effective communication during times of crisis and empowering communities when responding to crises (Islam et al., 2022; Leong et al., 2015). Governments that engage the public in public policy discussions increase public awareness and promote transparent decision-making (Chen et al., 2020). Hence, it is important for government organisations to understand how to best leverage social media to engage the public during times of crisis.

While there is no agreed-upon definition of "engagement" in the context of social media, the term is commonly understood to refer to a multi-faceted concept that includes a wide range of emotional reactions and actions. The "like" button, for instance, can be used as a shorthand for a variety of reactions, such as approval or agreement with a post (Dessart et al., 2015), entertainment and enjoyment (Lee et al., 2016), or compliance and conformance with social standards or norms (Chin et al., 2015). The premise of the engagement perspective is that a highly engaged audience is more likely to respond to social media material. Attentive audiences learn about the subject matter, stay

actively engaged, and have continuous, real-time discussions with the organisation and other stakeholders (Jiang et al., 2016). In this sense, there is a growing need to quantify what is known as engagement on social media as both internal and external audiences become increasingly active participants (Paine, 2011). Communication scholars such as Agostino (2013) and Lovejoy et al. (2012) use stakeholder (i.e., social media users) engagement as a crucial indicator for assessing the performance of their campaigns and establishing links between stakeholder engagement and positive results. Understanding the factors that impact users' engagement in social media communication during the pandemic assists in improving the effectiveness of social media in crisis management.

Secondary Crisis Communication During the COVID-19 Pandemic

As the novel coronavirus spread worldwide, an increasing amount of public panic was evident on the Internet. Widespread use of social media enabled the public to discuss and seek information on emerging infectious diseases like COVID-19. To stay on top of current COVID-19 concerns, such as status, medical advice, immunisation, and policy implementations, government and public health organisations need to use social media (Kothari et al., 2022; Slavik et al., 2021). Houston et al. (2015) explained that during a disaster response organisations disseminate warnings via social media sites like Facebook so that all social media followers will receive the warnings. Social media followers can repost (i.e., share) the content and propagate the warnings through online social networks. The shared information may be more readily believed since most people rely on their personal connections as a heuristic to minimise cognitive effort (Garrett, 2011; Metzger et al., 2010).

People establish their individual thoughts, attitudes, and beliefs in response to a crisis by sharing information about it on social media, but they also participate in a collective activity in response

to the event (Chatfield et al., 2012). As social media enabled people to share information, it has also increased the spread of false content in the health ecosystem (Waszak et al., 2018) and distracted shared situational awareness (Bunker, 2020). Since infodemic and the spread of misinformation became a crucial problem during the COVID-19 pandemic (Rai, 2020; Rocha et al., 2021), the focus of studies (for example, Apuke & Omar (2021); Pennycook et al., (2020)) on social media secondary crisis communication and social media users' intention to share information, are mainly on the spread of misinformation and fake news. Furthermore, these studies have been conducted in the UK and the US; hence, Duffy et al. (2020) encouraged researchers to investigate other national contexts.

Our study has investigated the factors that impact Facebook 'users' sharing behaviours when Australian public health official sources create content. Given that internet users are more likely to share COVID-19-related information from dubious sources on social media than from trusted sources (Mian & Khan, 2020; Oh et al., 2013), it is critical to reveal the factors that influence a users' decision to share content from reliable sources such as official online health channels.

Social media information sharing (rebroadcasting) studies have mostly been conducted in marketing because understanding the drivers of rebroadcasting activities is very important in disseminating marketing communications about brands on social media (Zhang et al., 2017). In this domain, several studies showed that users' emotions considerably influence online content sharing (Berger & Milkman, 2012; Dafonte-Gómez, 2014; Guadagno et al., 2013; Teixeira, 2012).

Social psychology studies investigated the characteristics of the content to understand the factors that shape sharing behaviour in other domains. Peters et al. (2009) showed emotions (e.g., interest, joy, disgust, surprise, and contempt) could enhance the communicability of *social information*. Similar studies (Heath et al., 2001; Luminet et al., 2000) showed content that evokes strong

feelings (like disgust) would be shared more frequently. In this sense, not only different feelings may influence sharing behaviour differently, but also intensity of the emotion plays a significant role (Tellis et al., 2019; Wihbey, 2014). For instance, emotions with a high arousal level, like anxiety or humour, encourage sharing more than those with a low arousal level, like grief or happiness (Berger, 2010; Berger, 2011).

In social media settings, research showed positive or negative sentiments of content are significantly associated with sharing behaviour. These studies were conducted in the context of political communication on Twitter (Stieglitz & Dang-Xuan, 2013; Weismueller et al., 2022), disaster-relevant information sharing in a Twitter-like environment (Chen & Sakamoto), and sharing video messages on YouTube (Rubenking, 2019).

Studies investigating the psychological effects of social media usage showed that Facebook content influences users' emotions and emotional reactions (Lin & Utz, 2015; Mauri et al., 2011; Steers et al., 2014; Tandoc Jr et al., 2015). These platforms also facilitated public emotion sharing (Vermeulen et al., 2018). While social media public health communication during the COVID-19 crisis drew significant attention from researchers, we found no study that investigated the factors (e.g., social media users' emotions, perception of risk and velocity of information) that influence sharing verified content in the context of the COVID-19 crisis; thus, we conducted this study to fill the gap.

Our study further investigates the factors that influence a *social media follower's* decision to share crisis information from public health official channels. According to Jin and Liu (2010), social media followers receive crisis information from social media *content creators*. In this study, *social media followers* are users who follow *Australian public health agencies'* (*content creators*) *Facebook pages* to receive information, and they can share it with other users. Sharing information

by those impacted by a crisis is an important factor in crisis management that can increase information dissemination during the crisis. It also helps users move from being passive observers or victims to becoming actors during a crisis and to feel empowered and involved in the emergency response (Wendling et al., 2013). We investigate the factors that impact social media followers' choice to share content published by reliable content *creators*, i.e., Australian public health agencies.

Theoretical Underpinning and Research Model

Risk communication aims to motivate the target audience to take the necessary precautions. Enlightened by the Sandman (1987) risk model, the *perception of hazard* and *outrage* are two main components that affect public risk assessments and acceptability (Sandman, 1989) that influence their response to the risk. Accordingly, this study attempts to understand how public assessments and understanding of crisis influence users' content-sharing behaviour on Facebook. In the context of the COVID-19 pandemic, the *hazard* can be inferred as the number of people exposed, infected, and unwell. With this foundation, we investigate how public crisis communication reacts to the hazard posed by COVID-19. We included the number of daily new COVID cases in our analysis to account for public *perceptions of hazards* in Australia; this approach is aligned with previous studies (e.g., Malecki et al., 2021).

Furthermore, to investigate the impact of *outrage* on secondary crisis communication and users' sharing behaviours, we utilise an emoji-based sentiment analysis of users' emotional reactions to Facebook posts during the crisis (i.e., 2020). In February 2016, Facebook introduced responses as an extension of the old " Like" button. Its six alternatives (Like, Love, Haha, Wow, Sad, and Angry) are represented by slightly altered versions of numerous well-established Unicode Emojis, and they allow for a more nuanced statement of how people feel regarding a message. Studies showed sentiment analysis of online content could be improved by utilising emoticons and emojis as a cue, with accuracy increasing from 60% to 75% compared to using the linguistic text alone (Hogenboom et al., 2013; Hu et al., 2013). Tian et al. (2017) suggest that Facebook emojis and reactions are a good data source for investigating indicators of user emotional attitudes; we, therefore, assumed emojis express the user's emotional state (e.g., outrage), indicating the user's feeling about the content.

Social media users' content sharing does not necessarily aid in crisis management. We witnessed that during the COVID-19 pandemic, social media content has been shared more from unreliable sources than science-based evidence or fact-checking (Pulido et al., 2020), enhancing the spread of misinformation and fake news, which damaged social response to the crisis, altering governments' countermeasures, and created significant concern for society (Bermes, 2021; Buchanan, 2020; Kim et al., 2019).

The literature suggests that "information overload" and "infodemic" diminish social media's ability to discriminate content based on quality, which plays a crucial part in disseminating misinformation and fake news related to COVID-19 (Laato et al., 2020). We do not know, however, how the volume of information on official social media channels affects content sharing.

The initial analysis of this study presented in the previous chapter Showed that Australian public health organisations radically increased their use of Facebook as COVID-19 emerged in 2020; however, there is limited knowledge to understand whether the increase in the number of messages presents significant value to the emergency response. Hence, we included the number of messages as an indicator of *crisis information load* in our research model to address this gap.
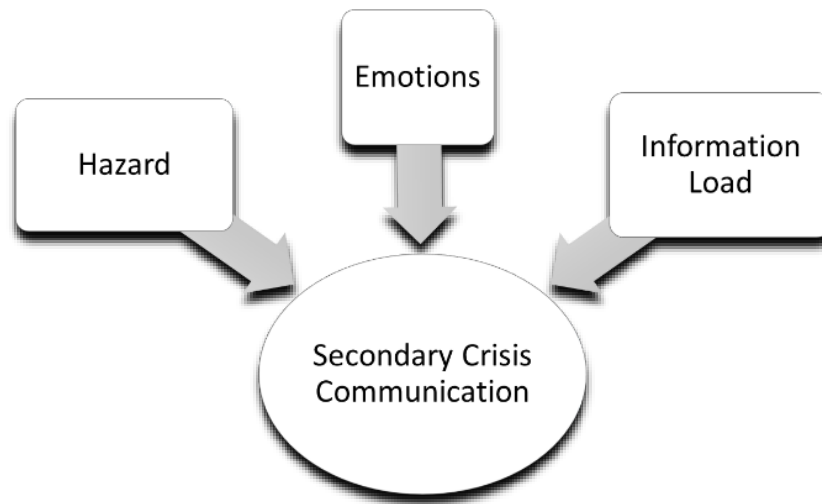
Figure 19 Research Model-Investigating Information Sharing Behaviours in Social Media Communication During the Crisis

Figure 19 highlights our research model, which investigates the influence of three factors, *hazard*, *outage*, and *information load*, on Facebook users' information-sharing behaviours during the COVID-19 crisis when official sources provide the information.

In this research, the theory provides a useful framework for guiding the overall direction and goal of the study. It provides a conceptual framework and assists us in defining a set of assumptions to describe and comprehend the relation between the concepts. It is crucial to note, however, that despite the use of a theory, this study takes an inductive approach.

Inductive reasoning is a bottom-up strategy that assists us entails gathering and analysing specific observations or evidence in order to the creation of new knowledge or theories. We start by analyzing empirical facts and progressing to more abstract and comprehensive conclusions. In this respect, our research can still be termed inductive because it is based on data gathering and analysis to arrive at new insights or understandings.

The application of a theory in this research serves as a lens through which data is collected and evaluated, but the ultimate goal is to develop new theories based on the findings. Using a theory to frame our research provides a firm foundation and focus for exploration.

Research Approach, Dataset, and Analysis

Social media is an umbrella term that covers a vast array of different platforms and technologies such as Microblogging Services, Social Networking Sites, Collaborative Web Maps, Wikis, and Media Content Sharing platforms (Kane et al., 2014). The Australian government recognises social media, such as Facebook, as an official channel of communication that supports public health organizations. Our case study investigates the Australian public health official communication on Facebook as an example of social media platform use. Facebook declared in October 2012 that it had attained one billion monthly active users. This arguably makes it the world's largest media organisation, second only to Google's group of services in terms of daily global audience size and participation (Rieder, 2013). We focus on Facebook as it is the most dominant social networking service in Australia (Government, 2016), with over 16 million users by December 2019. Approximately half of the Australian population logs into Facebook on a daily basis (Correll, 2020; Facebook, 2020).

This research adopted a case study methodology suits to examine a phenomenon in its natural setting (Benbasat, Goldstein, & Mead, 1987). The method is well-suited to this type of exploratory research and to explain the phenomena (Siggelkow, 2007; Yin, 1981). We analysed the content of the Facebook posts published by Australian public health agencies over two years (2019 and 2020) to reveal the communication patterns before and during the first year of the COVID-19 pandemic. To investigate factors that impact social media secondary crisis communication during a public health crisis, we further focused on communication in 2020. We analysed the sentiment of the

emojis to understand the users' emotions towards the messages. We finally uncovered the relationship between different emotions, the perception of hazard, and the information load with content-sharing during the first year of the crisis.

Dataset

Our original dataset contains Facebook posts published by Australian health agencies (i.e., NSW Health, VIC Health, and the Federal Government's Facebook channels) from January 2017 until December 2020 and their linked reactions and comments, which we collected using a self-developed Python app. Table 1 provides information about the dataset.

Although this study focuses on public health Facebook communication during COVID-19, we first examined a broader window of temporal data from 2017 to 2020 to better understand the usual operation of the channel and the changes caused by the pandemic's development in 2020.

Table 11 Facebook Dataset From 2017 to 2020

Year	NSW Health				Victorian Department of Health				Australian Government Department of Health			
	posts	Comments	like	Share	posts	Comments	like	Share	posts	Comments	like	Share
2017	188	2872	13112	2764	282	729	5583	1340	570	1372	9296	2842
2018	400	11725	27520	3284	325	1719	2762	1084	597	770	9551	1468
2019	499	29422	27351	3597	507	895	7407	1723	598	879	6631	138
2020	1731	200763	708321	351458	1061	53414	190058	125449	1727	140128	257829	933873

Previous studies have considered social media *comments*, *likes*, and *shares* as the three dimensions of user engagement (Brubaker & Wilson, 2018; Kim & Yang, 2017). Correspondingly, in this study, the number of posts and their linked reactions (i.e., comments, likes, and shares) represents the organisation and their followers' engagement in Facebook public health communication from 2017 to 2020. Table 11 shows that when COVID-19 reached Australia in early 2020, public health

Facebook communication radically changed in terms of the volume of posts. For instance, in 2020, the number of posts published by the agencies increased three times compared to its average over the past three years, from 2017 to 2019. These posts have been shared by the community (public) at least 200 times more than the average of the previous three years, remarkably expanding the reach of crisis messages to their social networks and community. This has motivated us to look further into the details of public engagement in social media communication concerning the factors that may impact social media content sharing and secondary communication during a crisis.

We narrowed down our analysis and looked at the content of posts published by the organisations over two years, from January 2019 until December 2020. This assisted us in understanding the communication patterns before (from 1 January to the end of December 2019) and during the public health crisis (from January to December 2020). Ultimately, we looked at the secondary communication and users' engagement in Facebook communication during the crisis (from January to December 2020).

Analysis and Results

In order to understand the public health organisational social media communication approach and the impact of the crisis on public health communication strategy, i.e., communication approach, we analysed the content of posts published by three (NSW, VIC, and Federal Government) Australian public health agencies from January 2019 to December 2020. Content analysis is a "systematic and replicable" analysis of messages (Riffe & Lacy, 1998) that has been broadly used in health communication research to analyse the content of health messages published in the media (Manganello & Blake, 2010). It is an effective technique for understanding a collection of behaviours across a data set of traditional and Web-based communication (Kim & Kuljis, 2010).

In social media communication, content-related features are important factors that drive information diffusion (Stieglitz & Dang-Xuan, 2013). We conducted a qualitative content analysis of a random sample of 1383 posts (across 2019 and 2020) and identified the most dominant public health Facebook communication themes reported in our previous study (unpublished manuscript by Shahbazi et al., 2023; i.e., chapter 4). Table 12 presents a summary of the communication themes.

Table 12 Public Health Communication Themes

	Public Health Communication Themes
1	Alcohol and drug consumption
2	Infectious disease (e.g., Measles, Influenza) and control (e.g., medicine and vaccine)
3	Behavioural Health Intervention
4	Mental health support
5	Australian bushfires
6	Minorities' (e.g., indigenous community) health
7	COVID-19 related communication[15]

Qualitative analysis of the post content assisted us in extracting the most appropriate keywords (parts) that exclusively represented each theme. We used a self-developed python app to detect these keywords from the content of 6123 posts published by health agencies from January 2019 to December 2020.

We furthermore extracted the distribution of communication topics in the Facebook posts published by the agencies before the COVID-19 outbreak (i.e., during 2019) and during the first year of the pandemic in Australia (i.e., 2020). Both authors reviewed a random sample of almost

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[15] We distinguished this category from other infectious disease to maintain the focus of the study on Covid-19 communication

2000 posts (or the part of a post) in almost perfect agreement to ensure coding reliability comparing human and computer coding. We will later explain the transformation in the communication patterns, highlighting the change in health communications before and during the COVID-19 pandemic.

The send phase of this study investigated Facebook users' information-sharing behaviours identifying factors that impact secondary communication during the COVID-19 crisis.

Information Sharing Behaviour: Impact of Outrage, Hazard, and Message Volume

To understand Facebook users' communication behaviours during the COVID-19 crisis, we analysed users' reactions (e.g., Shares and Emojis) to public health messages posted during the crisis (i.e., in 2020). Emojis, graphic symbols that depict facial expressions, have become increasingly common in social media posts to express the user's emotional state (Tian et al., 2017). Facebook posts published by the health agencies during 2020 were shared 252192 times by users and have received extensive public attention, as highlighted in Table 11. Not surprisingly, all the first 100 highly shared posts addressed the COVID-19 pandemic, but interestingly, 97 posts out of the first 100 included live videos. As previously discussed, social media followers' information-sharing reaches the extent of communication and enhances secondary crisis communication. Stieglitz and Dang-Xuan (2013) stated cognitive processes, such as attention to a Facebook post, is influenced by *emotion* that leads to behavioural response, such as liking, sharing, and commenting. We use Emoji-based sentiment analysis and classifiers to gain insights into Facebook users' emotions toward the posts. In addition to the standard "Like" button, Facebook offers the "LOVE," "HAHA," "WOW," "SAD," and "ANGRY" reactions, which allow users to express a wider range of non-verbal emotions in response to a post (Tran et al.). Examining different Emojies assist us in distinguishing the strength of the influence each emotion may have on users' sharing decision.

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Our data-driven method combines the sequence of a wide range of factors in a single statistical framework with the purpose of analyzing these factors jointly to identify the impact of each one on a user's information-sharing. Our approach is based on multiple regression modeling, where *emotion*, *perception of hazard,* and *information load* are treated as predictors, and the users' sharing behaviour is treated as the response. Each emotional reaction ("LIKE," "LOVE," "HAHA," "WOW," "SAD," and "ANGRY) is treated as independent of all other reactions. We tested the interdependency between the independent variables by representing the correlation structure over the set of 8 factors; 6 emotional reactions, presented in Table 13, as well as the number of posts, i.e., information load, and the reported daily new cases of COVID-19 in Australia as an indicator of hazard.

Table 13 The Number of Emotional Reactions (Facebook Emojis) to the Facebook Posts Published by Case Health Agencies During 2020

LIKE	LOVE	WOW	HAHA	ANGRY	SAD
546512	36087	11723	16393	7606	26051

We adopted a simple yet effective approach for constructing the network, where we first compute pairwise Pearson correlation coefficients for all pairs of emotional reactions and then connect two nodes with an edge labeled by their correlation coefficient. In other words, labels in the network set the weight of each edge to the absolute value of the correlation coefficient. Each edge weight represents the strength of the correlation between the two nodes. The constructed network may contain a couple of subnetworks within which nodes are typically densely connected. However, we exploit the full information in the constructed network to increase the power of our model by measuring how all given emotional reactions jointly influence the level of post-sharings. The network construction and all of its concomitant data management and further detailed analysis

were performed using Python 3.8 and SPSS 27 such that every coupled coefficient pair in the constructed network corresponds to the extracted values of the corresponding two columns in the same row of the dataset.

In order to maintain the validity of the analysis, we ran histograms over all the variables along with inspecting a scatterplot for each independent variable versus the dependent variable (post-sharing) to confirm that each predictor has a linear relation with the dependent variable and its population variance does not fluctuate in any systematic way. After this, we proceeded by fitting the model to the data. The next section presents the research findings, followed by a discussion and our conclusion.

Research Findings

We first investigated the distribution of public health communication categories over two years (from 2019 to 2020) to understand the public health Facebook communication approach before and during the COVID-19 outbreak. Figure 20 illustrates the keyword patterns in public health agency Facebook posts and changes to this over the two years.
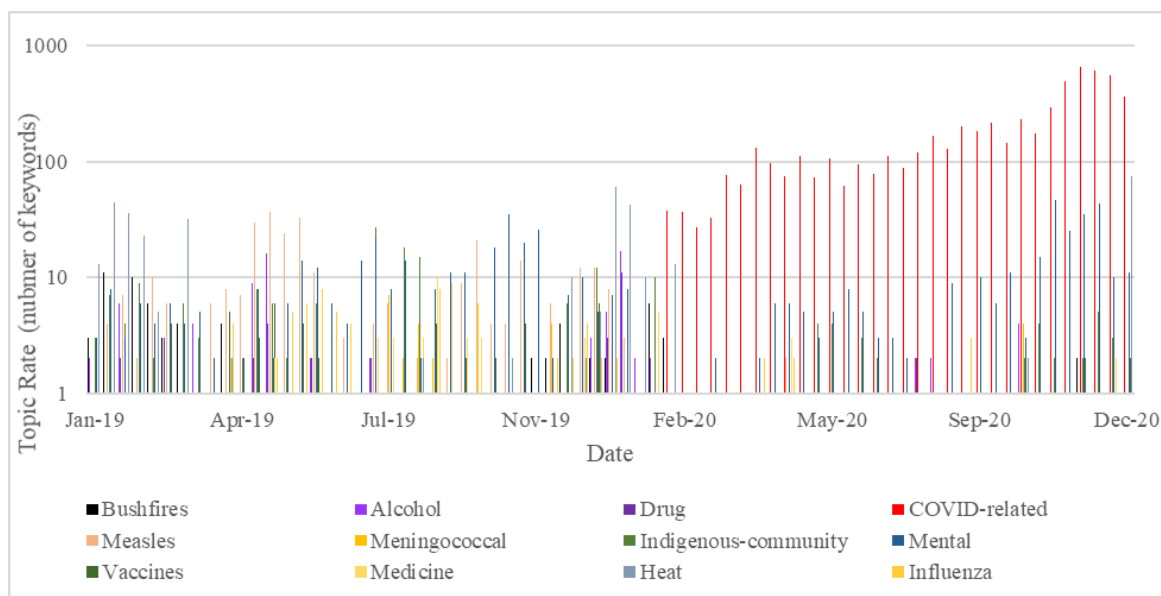
Figure 20 Health Theme Pattern-Distributions of Facebook Posts: 2019 and 2020

Figure 20 shows that in 2019 Australian public health agencies communicated a diverse range of health issues using their Facebook channels. The channel was mainly used to broadcast information to large groups of people rather than to foster genuine two-way dialogue and interaction; however, social media platforms are designed to facilitate dialogue between social agents; this observation is aligned with Heldman et al. (2013) study.

In early 2020, when COVID-19 entered Australia, the communication pattern changed in two areas; the velocity of communication and the approach to achieving objectives. In this sense, public health Facebook became more active and broadcast a high volume of messages to the public, also moving from a diverse range of health-related topics to a focus on specific pandemic-related topics. The Facebook health communication strategy shifted from a "general health information" *source* to a more "*topic-focused*" crisis communication *channel*. The emergence of the public health crisis, i.e., the COVID-19 pandemic, not only increased the organisations' activity on Facebook but also ratcheted up public engagement. The channel facilitated *dialogue* between government agencies

and the public that, as explained by Choli and Kuss (2021), is more effective in managing the COVID-19 crisis.

By the end of 2020, as the pandemic unfolded, communications settled into new patterns, addressing more *divergent information content* (more attention being paid to indigenous communities' health challenges and alcohol and drug addiction-related discussions) while remaining focused on specific COVID-19 information. Additionally, the channel maintained a high volume of activity in communicating health messages; hence, the new communication pattern is more effective in terms of information velocity and variety. Furthermore, during 2020, the uncertain nature of COVID-19 impacted the consistency and sometimes the accuracy of the information (Bunker et al., 2022). For instance, we observed inconsistency in organisations' advice on the use of facemasks for the general public. All mentioned factors influence users' information consumption and raise the possibility of information overload (Datta et al., 2021).

In the second part of this study, we investigated the secondary crisis communication examining factors that influence the followers of the Facebook channels to share content during the crisis (i.e., in 2020). We investigated the influence of explanatory variables, (1) perception of hazard (the reported new cases of COVID-19), (2) users' emotions (outrage), and (3) the number of posts (information load), on information sharing to better understand the factors influence secondary crisis communication on Facebook.

Table 14. Model Summary (Dependent Variable: post-sharing)

Model	R Square	R Square Change	F	Std. Error of the Estimate
1	.387	.387	299.360	3540.91482
2	.491	.105	175.413	3228.33318
3	.551	.059	147.968	3038.31585
4	.564	.014	116.955	2996.01922
5	.573	.009	96.670	2970.09412
6	.578	.005	81.939	2957.35872
7	.583	.005	71.471	2944.11959

1. Predictors: angry
2. Predictors: angry, like
3. Predictors: angry, like, wow
4. Predictors: angry, like, wow, love
5. Predictors: angry, like, wow, love, New cases
6. Predictors: angry, like, wow, love, New cases, message
7. Predictors: angry, like, wow, love, New cases, message, sad

Table 14 reports our model summary, the model's overall fit, and the relative contribution of influential factors to the total number of post-sharing. The model highlights the significance of the relative contribution of users' emotions, particularly ANGER, LIKE, and WOW, the predictors, which together account for 55.1% of the variability in content-sharing behaviour.

User feeling of anger as an independent variable can explain 38.7% of the variability of content sharing. Notably, the number of "HAHA" Emojis (in which users express laughter) did not effectively contribute to users' sharing behaviours. This result confirmed the impact of *outrage* on secondary crisis communication and users' information sharing on Facebook.

Furthermore, Table 4 shows the number of new COVID-19 cases (perception of *hazard*) and the volume of messages (information load) both contribute to the explanation of content-sharing, albeit to a lesser extent than users' emotions (*outrage*).

Conclusion and Discussion

Social media platforms like Facebook enable risk communication in ways that are notably different from the traditional centralised control and the usual one-way flow of risk messages and information from health officials to the public.

Social media adoption in public health communication allows for two-way symmetrical communication with the public and stakeholders. Effective use of social media for crisis communications requires a deeper understanding of the current presence of the medium in public health crisis communication. This can assist agencies in developing more effective communications policies and strategies for the future.

Our study investigated Australian public health communication on Facebook and the COVID-19 pandemic disruption to this. The results showed COVID-19 emergence disrupted Facebook communications and consequently transformed public health social media communication. There is evidence that public health communication is rebounding to a "*new normality*" to fit with the dynamic of the pandemic and Facebook user information needs.

The new pattern of communication we observed in late 2020 highlights that public health agencies were now addressing more usual communication content and themes while still focusing on managing the COVID-19 crisis. For instance, more attention was being paid to indigenous communities' health challenges and alcohol and drug addiction-related discussions that were resurfacing. These public health agency Facebook communications' reached a new level of stability, including *a higher level of communication engagement* and *well-adjusted discussion threads* that reflect the *new "normal"* communications patterns.

As Facebook communications settle into these new patterns, however, they may lose their newly acquired coherence if a new crisis emerges, where the subsequent disruption may undermine the diversity of the public health audience and their information needs. For instance, as we are writing this paper, Australia is experiencing an east coast 1-in-100-year flood event, which is causing catastrophic impacts to lives, livelihoods, and properties in Queensland and NSW. This event is disrupting and dominating social media communications across the country.

Furthermore, our results suggest that *secondary communication* and Facebook users' information-sharing behaviour during the pandemic are strongly driven by *outrage*, while the perception of *hazards* and the *information* load (volume of messages) are weaker drivers of public engagement in a public health crisis and risk communication. As a result, we suggest that the *nature of a crisis* and its *emergent characteristics (e.g., the level of unpredictability and fast-moving)* , and *public emotions* toward the situation should be considered as determining factors in designing policies for effective social media crisis communication for public engagement. Considering how crisis characteristics such as amplitude, magnitude, geographic area, containment potential, etc., impact crisis communications (Bunker & Smith, 2009), understanding underlying communication patterns and their causes during different crisis scenarios has the potential to assist agencies in the improvement of social media crisis communication strategies through the creation of tailored social media policies and adoption frameworks.

Our contribution rests not only on highlighting the impact of the crisis on Facebook's official health communication but also on revealing factors that influence *secondary crisis communication* and *content sharing* during the pandemic.

Secondary crisis communication results in the passive reception of crisis-related information, which is a crucial aspect of the public's information-seeking behaviour during a crisis. Austin et

al. (2012) showed that people are more likely to read links to crisis coverage posted by friends via Facebook than by visiting the original news sources. In this sense, the results of this study can assist crisis response agencies in expanding the reach of their messages and combating the spread of misinformation during a crisis.

Further research is required to explain the complexity and impact of pandemic characteristics (other than infection rates) on public health agency Facebook communications patterns to better understand communications during the pandemic's recovery and resilience-building phases. Characteristics to consider might include tailored and targeted communication strategies for behavioural and mental health advice, long-term health impacts, and other pandemic disease responses.

Chapter 6 As Time Goes By: Temporal Characteristics of Social Media and Information

Objective-Subjective Tensions in Crisis Communication

In the previous two chapters, I investigated the information (content) shared by Australian public health agencies before and during the COVID-19 pandemic via their official Facebook channel. I revealed the normal operational approach in public health Facebook communication and the change in the organizational approach due to the emergence of the COVID-19 pandemic in early 2020. I highlighted how an external force like a crisis (i.e., the COVID-19 pandemic) could disrupt the coherence of the social media communication system and how the system transforms to cope with the crisis and audience information needs.

I highlighted the massive rise in social media communication during the COVID-19 crisis. Hence, I further narrowed my analysis to focus on crisis communication and Facebook public health communication during 2020. In this sense, I investigated public engagement in public health crisis communication and revealed the factors that influence their decision to share information and, in consequence, influence the extent of the reach of public health messages during the COVID-19 crisis.

Secondary communication is important in crisis communication. In chapters 4 and 5, I showed how the phenomena could effectively expand the reach of reliable crisis information during the event and contribute to forming adequate shared situational awareness.

This chapter looks at the concept of trust as an important factor for fluent communication, which influences adequate shared situational awareness (Seppänen et al., 2013). People refuse to share their information and knowledge without trust, even though the content is accessible and the link also is available (Virrantaus, Mäkelä, & Demšar, 2009).
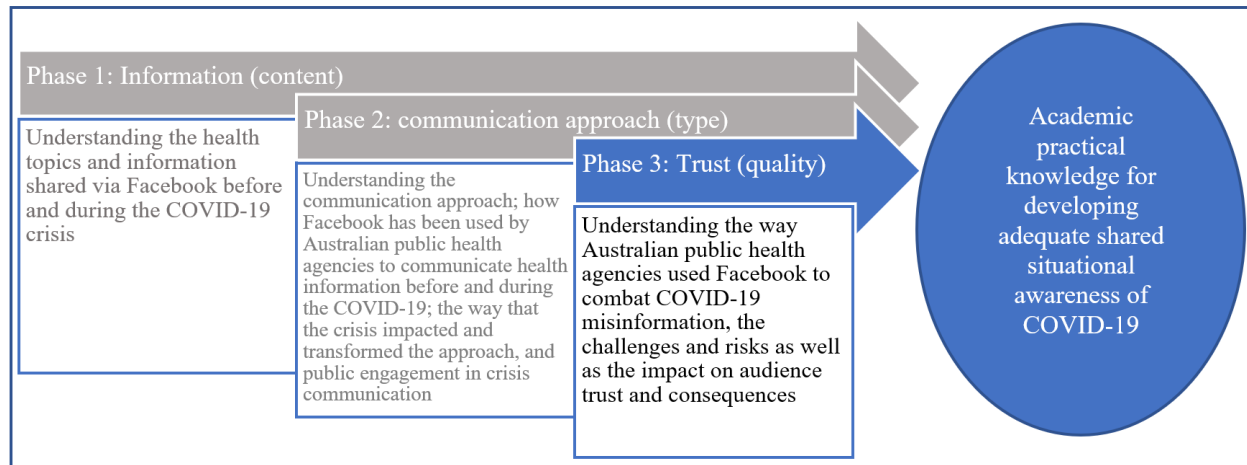
Figure 21 Study Process Map- phase Three; understanding the trust

Trust affects the quality of the communication channel (link), information sharing, and interaction. In a complex and dynamic emergency environment, the availability, reliability, and temporal accuracy of information by building trust among actors (Seppänen et al., 2013). Hence, public health agencies need to understand better how they can build trust with their audience to improve crisis communication and shared situational awareness.

I conducted this phase of the study to understand the elements that comprise trust in official public health social media channels and the consequence. Understanding the elements that trust comprises assists in developing trust systematically. As I investigated the communication on the official public health Facebook channel, the assumption is a level of trust exists between *actors*, the agencies, and their audience. However, as I show in this chapter, there are situations that impact the channel audience's trust and, consequently, hinder adequate shared situational awareness during a crisis.

Although individuals, teams, technologies, and social and technical systems like social media and inter-organizational networks can be trusted, only individuals can trust (Blomqvist, 2002; Sydow, 1998) and believe that the object of trust acts in accordance with their expectations (Cummings & Bromiley, 1996).

Trust is not a fixed state of mind but rather is task-, situation-, and context-dependent (Blomqvist, 2002). Trust can be studied from different points of view; in this study, my concern is *individual expectations* and understanding those factors that affect the development of trust in social media crisis communication.

Social media facilitated emergency communication and public access to information during a crisis; however, it also exacerbated the infodemic of misinformation. This first section of this chapter investigates how local public health organisations use Facebook to share the worldwide fight against COVID-19 misinformation and create effective shared situational awareness. I further focused on the information that can "age" and become misinformation over time. In an evolving crisis scenario, it is crucial to consider that situational awareness and knowledge develop over time, and information and advice may change in response to the dynamic situation. Consequently, previously accurate information can become outdated, leading to the potential for misinformation. The accessibility of information through official channels plays a role in this context. If outdated information is still accessible through trusted sources such as the government public health Facebook channel, it can contribute to spreading misinformation. Therefore, ensuring the availability and accessibility of accurate information through official channels is important for preventing the dissemination of false information during a crisis.

As Time Goes By: Temporal Characteristics of Social Media and Information Objective-Subjective Tensions in Crisis Communication

Abstract

Social media communication is integral to framing an effective crisis response but is generally impacted by high volumes and an overload of information and misinformation, i.e., infodemic conditions. The social media connection content (i.e., information) and connection type (i.e., communications strategies) that are shared between actors (e.g., emergency response organisations and the public) underpins the development of trusted shared situational awareness for effective crisis management. This study investigates how local public health organisations use Facebook to mitigate COVID-19 misinformation and create effective trusted shared situational awareness. We show how the nature of the event and social media temporal characteristics can create information objective-subjective tensions and create misinformation on public health social media channels. This undermines an agreed and accurate representation of reality that is expected of trusted, shared situational awareness. We conclude that developing communications strategies to manage information objective-subjective tensions becomes especially important during an evolving crisis scenario where situational awareness and knowledge are developed over time, and information and advice may change in response to a changing crisis condition.

Keywords: social media, crisis communication, infodemic, trust, misinformation, health communication.

Introduction

Widespread social media use has exacerbated infodemics, defined as a rapid spread of all kinds of information, including misleading or false information (misinformation) in digital and physical environments during an epidemic (WHO, 2022). Even though the word "infodemiology" was coined in 2002 (Eysenbach, 2002), concerns about the digital spread of misinformation have been present since the World Wide Web was first launched (Eysenbach, 2020). Misinformation spread globally alongside the COVID-19 pandemic on social networks, e.g., Twitter, Facebook, TikTok, and other social media platforms, which became a major concern for societies (Bermes, 2021; Buchanan, 2020). The infodemic phenomenon is influenced and fragmented social response impacted the efficiency of government countermeasures and resulted in the pandemic's acceleration (Kim et al., 2019).

Information technologies such as social media platforms became a critical means of social interaction during the COVID-19 pandemic (PAHO, 2020). Social media use in the initial stages and during the COVID-19 outbreak resulted in the generation of a vast amount of information (both accurate and inaccurate), creating an infodemic not seen in previous viral epidemics like SARS and MERS. The COVID-19 infodemic disseminated information, misinformation, and rumors with a range, reach, velocity, and volume, which complicated the pandemic response, creating confusion and distrust among the public as well as risks to public health, hampering effective crisis management ("UN tackles 'infodemic' of misinformation and cybercrime in COVID-19 crisis," 2020).

Official and trusted social media channels, including those located on Facebook, Weibo, Instagram, Twitter, LinkedIn, Pinterest, and official public health agency websites, were also actively used to provide timely and accurate information to mitigate infodemic and misinformation

impacts. However, the flood of misinformation countered by a flood of corrective information caused public confusion about which sources of information were reliable (Agley & Xiao, 2021). This problem contributed to the destruction of mental model alignment, i.e., public trust in shared situational awareness (Bunker, 2020), and resulted in worldwide panic and fear (Vaezi & Javanmard, 2020).

Boell (2017) discusses the *Four Stances of Information,* which encompass the physical, objective, subject-centred, and sociocultural perspectives of information depiction. Each stance is underpinned by assumptions regarding information existence in the world, the condition for that existence, data (definition), knowledge (definition), signs, human beings (as creators, interpreters, and appropriators), social context, technology use, and relevance to IS research.

As mental model alignment (Bunker, 2020) is essential for the creation of trusted shared situational awareness, the development of an objective stance of information and its underlying assumptions for use in crisis communications is a critical factor. Information and communication solutions in this space must "*be researched as an objectively existing artifact, with a particular interest in the accuracy of representations enabled or captured by IT artifacts-p11*" (Boell, 2017). Given that it can be argued that social media, as an IT artifact, is subject-centred in its underlying information systems assumptions (Bunker, 2020), this presents us with a *stance tension* in the IT artifact where an information objective-subjective divide must be bridged for effective infodemic solutions.

It is here that we turn to Seppänen et al. (2013), who highlight the importance of shared understanding of situational awareness for emergency response and which identifies the critical factors that affect the formation of shared situation awareness 1) information, 2) communication, and 3) trust.
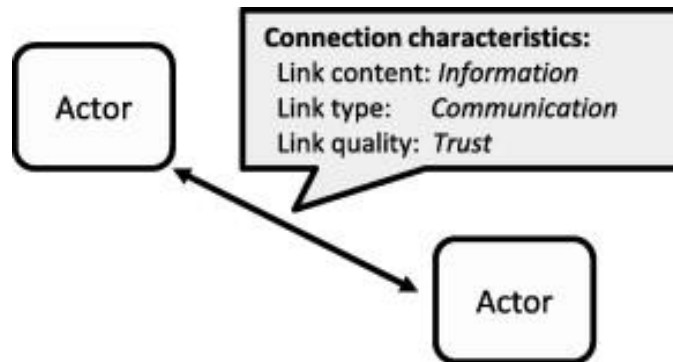
Figure 22 Information, communication, and trust affect the formation of shared situational awareness for emergency response, source; Seppänen et al. (2013)

As shown in Figure 22, the connection between actors via content (information), type (communication), and quality (trustworthiness) are all key elements in creating shared situational awareness during a crisis. However, processing high volumes of information communicated through social media platforms is problematic for emergency response agencies because it is difficult to authenticate the trustworthiness of actors to establish the accuracy and relevance of the information itself (Ehnis & Bunker, 2020). This presents us with an information objective-subjective tension in the *condition of existence*, where information needs to be both 'a representation of reality but also 'meaningful and relevant to a human being.' As we have seen in the pandemic infodemic, social media is effective at providing subject-centred meaningful, and relevant information but is not well suited to providing an objective representation of reality due to its underlying algorithmic design, which reinforces individual subjective perspectives.

This study intends to bridge the information objective-subjective divide by utilising Seppänen et al., and their approach (Seppänen et al., 2013) to determine how the spread of misinformation on social media, i.e., Facebook affects the formation of trusted shared situation awareness. Within our study, we investigate *how local health organisations in Australia, at state levels, use social media,*

i.e., Facebook content (information) and type (communication strategies) to mitigate COVID-19
misinformation propagation and how this knowledge might be used to enhance the development
of the quality of shared situational awareness (trust).

Our study reveals the factors that should be considered in creating the *content (information) and*
type (strategies) of official social media crisis communication to bridge the information objective-
subjective divide that fuels infodemics.

The COVID-19 pandemic and the disruption it has produced in the age of social media is
remarkable. The COVID-19 infodemic is a current and urgent information systems problem, which
requires an effective solution, so our research is timely. Furthermore, our analysis has revealed
how the nature of the event leads to the creation and spread of misinformation in a previously
unidentified manner. Emergency management agencies such as public health agencies can use our
results as a first step in the development of effective crisis communication strategies to fight an
infodemic in a digital context.

Background - Social Media Crisis Communication

Our social connections, individual and collective activities, and dominant attitudes are all
influenced by social media (Bunker et al., 2019). During crises, the public's interest in using social
media increases (Mirbabaie et al., 2020). People seek timely and unfiltered information during a
crisis or an emergency to raise their concerns and express sentiments (Bunker et al., 2017;
Shahbazi et al., 2018). They also use these platforms to determine disaster magnitude, check in
with family and friends, maintain a sense of community, seek and express physical and emotional
support, and make sense of an event (Fraustino et al., 2017; Mirbabaie et al., 2018).

Although social media platforms are well-known as crisis communication tools, information is also created, catalysed, and distributed by these channels due to their nature and characteristics (Apuke & Tunca, 2018). These platforms provide an enormous opportunity for "fake news" and "misinformation" to reach a mass audience (Tandoc Jr et al., 2018).

For instance, the propagation of vast amounts of accurate or inaccurate COVID-19 related messages during the pandemic was remarkably confusing and misleading for an uninformed public (Ashrafi-rizi & Kazempour, 2020a). Social media amplified misinformation, disinformation, and unverifiable content at an alarming rate that hampered effective crisis communication about the pandemic (Kouzy et al., 2020). To counteract this situation and mitigate the risks associated with misinformation propagation, the WHO Information Network for Epidemics (EPI-WIN) was launched by the WHO risk communication team as a new information platform to share timely, tailored, accurate, and relevant information with target audiences (WHO, 2021a). Furthermore, government and health officials provided daily updates on the virus's growth and information on how to guard against it (Rao et al., 2020).

The urgent need to conduct information systems research on social media infodemics has been highlighted by the research community (Baines & Elliott, 2020), who highlighted that the term "*misinformation*" is unclear and imprecise. Baines and Elliott (2020) introduced a taxonomy of false information examining the communicator's intention to deceive, the message and its embodied proposition.

Research on a COVID-19 information typology (Ashrafi-Rizi & Kazempour, 2020b) highlighted that our understanding of risks associated with the crisis and knowledge of the situation influence the type of information created and disseminated via social media. While technology allows information to be coded, transformed, stored, and transmitted at high speeds (Flender, 2016), the

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uncertainty and temporality of crisis-related information can cause crucial problems. Crisis decision-making follows the rhythm of knowledge production in which phases of *'known,' 'partly-known,' 'not-yet-known,' 'will-be-known,' 'unable-to-know' and 'unable-ever-to-know'* differ; this is because assessments of uncertainties and risks change constantly. From time to time, decisions must precede what is not yet known, but the decisions must be able to be reversed or corrected if the assumptions prove to be wrong.

Due to the legislative constraints and responsibilities of crisis management agencies such as health agencies, it is difficult to coordinate their decisions with the daily updated crisis information, so the 'epistemic constellation' forms a complex system that needs constant reassessment of previous situational perceptions and decisions (Wang, A. et al., 2022). Correspondingly, we argue that the temporal and uncertain nature of advice and crisis communications in the COVID-19 outbreak are also significant drivers of misinformation production and the resulting infodemic.

At the same time, we understand that if government agencies fail to establish an early and regular flow of factual and trusted information in their crisis communications, this could *result in the proliferation of rumors, misinformation, and information overload to 'fill the gap' and drastically accelerate the effects of a crisis as it impacts social behaviour* (Mirbabaie et al., 2020). Hence, further understanding of governmental crisis communication strategies is required to treat the resulting infodemic effectively. To date, researchers and government health authorities are still seeking 'treatments' for the infodemic of misinformation and the general information overload caused by social media communications.

Our study focuses on developing an understanding of social media use for combating misinformation and increasing shared situational awareness during a crisis by studying the COVID-19 pandemic as an example, examining information posted by a trusted public health

authority on their Facebook channel during the early days of the pandemic; and analysing communications strategies involved in those posts.

To align with prior studies (Pennycook et al., 2020; Velichety & Shrivastava, 2022), we focus on *falsehood* and *ambiguity* to identify misinformation in our data-cleaning process. We define falsehood as the degree to which a piece of news/information concerning a real-world event is perceived to be false and ambiguity as the level of uncertainty about a piece of information's truthfulness. We also identify, define, and classify the information typologies used to combat misinformation and explore how the organisational response to deal with misinformation and the nature of the event influenced the pandemic response. Our study is the first phase of a larger study that investigates how health agencies' use of Facebook during the pandemic affected public trust in health officials, their communications channels, and trusted shared situational awareness.

This paper is structured as follows. We first summarise the crisis communications literature, which deals with the COVID-19 pandemic, to outline the problem. Next, we explain the research approach and dataset and outline our findings and discussion. Our paper concludes by providing insights and an immediate recommendation to assist public crisis managers and decision-makers in improving their social media communication policies and practices to enhance shared situational awareness.

Crisis Communications and the COVID-19 Pandemic

The Role of Misinformation

The term *infodemic* has been defined by the World Health Organisation (WHO, 2020a) as an overabundance of information about a (public health-related) crisis, some accurate and some not, in digital and physical environments that complicates the problem-solving process. The lack of a readily available solution to the COVID-19 pandemic and a lack of relevant clinical data to support successful public health communications stifled information-sharing efforts. As a result, information systems worldwide were failing to provide timely and accurate information allowing the COVID-19 infodemic to flourish and disseminate false information (Flender, 2016). Researchers intended to identify a COVID-19 crisis-related information topology and define different types of false information (Ashrafi-Rizi & Kazempour, 2020b).

Misinformation has been defined as false, inaccurate, or misleading information intentionally disseminated to or not to deceive (regardless of intent to mislead). Misinformation denotes falsehoods or distorted information, which means any information that does not directly reflect the generally accepted 'true' state of the world can be considered misinformation (Zhou & Zhang, 2007).

Disinformation, instead, is a subset of misinformation and refers to false information *deliberately disseminated* to confuse or manipulate people. An infodemic may be fuelled by deliberate attempts to spread misinformation to undermine public confidence in disaster response which can be used to advance alternative agendas of individuals or groups. Therefore, in an emergency, people struggle to find trustworthy information and reliable guidance when they need it.

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The infodemic of COVID-19 misinformation can be classified into four major thematic areas, including (1) the cause and source of the disease and virus; (2) the symptoms and patterns of transmission; (3) existing treatments, cures, and prophylactics; (4) the outcome of interventions by health authorities and organisations (WHO, 2020a).

Some examples of this misinformation from RMIT ABC Fact Check[16] include:

- "Bill Gates would use COVID-19 vaccines to track people" (FactCheck.org – 14 April 2020) CoronaCheck #66;
- "COVID-19 vaccines are 'in violation of all 10 of the Nuremberg Codes'" CoronaCheck #66;
- "people vaccinated against COVID-19 can "shed" the virus and infect those around them" CoronaCheck #64;
- "masks are "useless" and "actively damaging to individual health and social wellbeing"" CoronaCheck #62;
- "Xi Jinping invented the lockdown" CoronaCheck #61;
- "PCR tests are unable to distinguish between the flu and COVID-19" CoronaCheck #76; and
- "50% of animals in Australian COVID-19 vaccine trials died" CoronaCheck #73.

Mian and Khan (2020) reported that unverified sources of COVID-19 related information on social media were prevalent and even more popular compared to reliable sources like official online health channels among internet users. For instance, some false claims like "*the virus cannot survive in the hot weather*", or "*taking a high dose of chloroquine medication can protect you*", and "*consuming large quantities of ginger and garlic can prevent the virus from going viral*" were spreading faster than the virus itself. Therefore, it is essential and timely to understand how the spread of misinformation impacts effective crisis communication and the creation of shared situational awareness.

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[16] https://www.abc.net.au/news/factcheck/

Infodemics and Crisis Response

> "*We're not just fighting an epidemic; we're fighting an infodemic[17]*"
> Tedros Adhanom Ghebreyesus, Director-General of the WHO

The spread of misinformation during crisis like an infectious disease epidemic can inhibit crisis response and hamper risk communication efforts by undermining the trust and credibility of the information source (Glik, 2007). For example, the effect of misinformation about the preventative impact of white vinegar on the spread of disease caused a dramatic increase in the price of vinegar and panic buying during the 2003 pneumonia scare in China (Rosling & Rosling, 2003).

Misinformation spread has also impacted the management of the COVID-19 pandemic. For instance, even though scientists condemned and attempted to dispel the rumour that 5G lowers the immune system and helps COVID-19 to be more readily transmitted, mobile phone masts were still set on fire by an enraged public in Birmingham and Merseyside in early April 2020 (Schraer & Lawrie, 2020). Likewise, scientists emphasised that the Malaria drug, hydroxychloroquine, should not be used to treat coronavirus, but the infodemic of misinformation around the effectiveness of this drug as a COVID-19 treatment triggered its overuse and a shortage of the medicine in pharmacies.

"The spread of misinformation during an outbreak event and the fear and uncertainty of the situation can weaken the national and global response, encourage nativist narratives, and provide opportunities for those who may seek to take advantage of this moment to deepen social divisions"; said Melissa Fleming[18]. Correspondingly, public health decision-makers need to find a way to mitigate this issue. Pennycook et al. (2020) stated that people share misinformation about COVID-

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[17] WHO Director-General Tedros Adhanom Ghebreyesus at Munich Security Conference, 15 February 2020
[18] Melissa Fleming is Under-Secretary-General for Global Communications, taking up her functions as of 1 September 2019.

19 because they fail to think about the trustworthiness of the information source, and they suggest that pushing people to think about the source and accuracy of information may improve their choices about what to share on social media. As a result, social media providers like Twitter, Facebook, and Weibo can decide to censor actors who spread misinformation; however, they cannot stop conspiracy theorists, liars, and trolls (Garrett, 2020). Furthermore, public health organisations employ information and communication technology (ICT)-enabled channels like Facebook to combat the infodemic of COVID-19 misinformation.

Adhanom Ghebreyesus, *Director-General of the WHO*, believed that in the COVID-19 crisis, fake news spread faster and easier than the virus itself. Zarocostas (2020) investigated how health officials responded to the infodemic during the pandemic outbreak to ensure people were informed to act appropriately to control the disease or mitigate its impact. WHO was at the forefront of the battle against the pandemic and was also fighting against the spread of misinformation. WHO communications teams in six regional offices included social media personnel, risk communications consultants, and communications officers. WHO's Information Network for Epidemics (EPI-WIN) provides access to regular updates on accurate and easy-to-understand information on public health events and outbreaks such as the COVID-19 pandemic. A technical risk communications team and their colleagues working at WHO's Information Network for Epidemics (EPI-WIN) closely interact with Facebook, Twitter, Pinterest, Tencent, TikTok, and Chinese social media platforms to provide them with evidence-based answers to public concerns, address rumors and misinformation about COVID-19, as well as to supply timely information.

WHO has launched various messaging services in several languages and interactive chatbots by partnering with WhatsApp, Facebook, and Rakuten Viber to communicate with billions of people worldwide in their local language. WHO and the International Telecommunication Union (ITU),

supported by UNICEF, requested that all worldwide telecommunication companies send text messages to billions of people who do not have access to online information to help save lives from COVID-19.

Alongside these services, the UN uses all available channels, including social media and radio, to counter misinformation and rumors; for instance, the organization's 59 UN Information Centres fight disinformation in local languages.

The UN formed a rapid response team to overcome a surge of misinformation by sharing facts and science-based evidence and is tackling the spread of misinformation by (1) producing and propagating facts and reliable information through various communication channels, (2) partnering with businesses, (3) working with media and journalists, (4) mobilising civil society to respond to the COVID-19 crisis, and (5) speaking out for rights of global citizens ("UN tackles 'infodemic' of misinformation and cybercrime in COVID-19 crisis," 2020).

Priority COVID-19 communications actions for many governments around the world included (a) advising social media companies on removing contentious pandemic content (e.g., India); (b) creating special units to combat misinformation (e.g., UK, EU); and (c) criminalising malicious coronavirus deception concerning public health measures (e.g., South Africa, Hungary) (Radu, 2020). It is noted that governments worldwide take various actions to counter misinformation, many of which have yet to be proven effective.

Misinformation and Public Trust

During a public health crisis, public health officials are responsible for providing trustworthy information; however, there has been little research on how the public reacts when their expectations for such information are not met. Jang and Baek (2019) showed less credible information from public health organisations resulted in increased use of interpersonal networks, online news, and social media to obtain health crisis-related information. COVID-19 is spreading throughout an increasingly interconnected globe in which people are maintaining connectivity using global digital social networks, such as Facebook, to enable their interaction and information sharing about the virus (Limaye et al., 2020).

During the COVID-19 pandemic, the public trust in information sources and confidence in institutions determined public response to the health measures and defined public health decisions, e.g., willingness to take up vaccines (De Freitas et al., 2021). In contrast, misinformation and mistrust contributed to the hesitancy and rejection of vaccinations (Rodriguez-Morales & Franco, 2021). In circumstances where trust in the government is critical to crisis response, communication content, type, and quality are critical factors in managing a crisis. Fletcher et al. (2020) showed public trust in information about coronavirus provided by the UK government decreased during the pandemic. The erosion of trust in public institutions and health crisis information drove the government in Italy (i.e., the Ministry of Health) to use Facebook to fight misinformation (Lovari, 2020). Our study investigates Australian public health (communication) strategies against misinformation, develops a better understanding of the factors that impact (information) content of governmental communication, to enhance social media communication capabilities in creating quality shared situational awareness (trust) during a public health crisis.

Research Approach

Our study seeks to better understand:

- How do local health organisations in Australia, at state levels, use social media (i.e., Facebook) content (information) and type (communication strategies) to mitigate COVID-19 misinformation propagation? (RQ1)
- How can this knowledge help to improve the development of shared situational awareness during crisis events? (RQ2)

We develop our understanding through an analysis of Australian public health agency Facebook pages by exploring post content and related public comments that were published during the early stage of the pandemic. Our analysis looked at NSW Health and the Victorian Department of Health's official Facebook communications. New South Wales (NSW) and Victoria (VIC) are two of Australia's most populous states that also reported the highest number of COVID-19 cases during the first four months of the outbreak (3,045 and 1,366 patients, respectively). The NSW Public Health System is also the largest public health system in Australia. Facebook pages are one of the official channels that agencies use for public health communication. Our qualitative exploratory study allowed us to focus on the nature and content of public health agency Facebook communications during the early stages of the COVID-19 pandemic. Our approach is appropriate for exploratory research (Siggelkow, 2007), allowing us to uncover operational processes (Gephart Jr, 2004) that are tight to the context under study aiming at the development of findings to the 'how' question (Pan & Tan, 2011).

We randomly sampled 765 posts and their linked public comments published from 1 January to the end of April 2020 on the NSW and VIC of Health agency Facebook pages[19]. This four-month sampling window allowed us to study communications around two major events; 1) the start of

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[19] https://www.facebook.com/NewSouthWalesHealth & https://www.facebook.com/VicGovDH

the pandemic in Australia in late January 2020 and 2) the first COVID-19 peak in March/April 2020, affecting all states and territories (AIHW, 2021). We utilised a general inductive research approach (Thomas, 2003) that provided an efficient way of analysing qualitative data. After a close reading of the post content, we removed posts that provided facts, news, or information that had been scientifically accepted at the time of the post. To achieve this, we conducted a thematic analysis, and unlocked insights in the data to code posts. This assisted us to "*condense extensive and varied raw text data into a brief, summary format*" and "*establish clear links between the research objectives and the findings derived from the raw data-p2*" (Thomas, 2003).

Finally, we further analysed the post content and manually selected 29 posts that addressed the uncertainty or unreliability of COVID-19 related information available on social media or other sources/channels of communication. We selected these posts because they address the four major thematic areas[20] of the COVID-19 misinformation outlined in "*Coronavirus Disease 2019 (COVID-19) Situation Report–85* ". By doing this, we investigated how local public health organisations, employed social media to combat misinformation. Our study methodology could be further employed for similar or more complex examples of crisis communication.

Subsequently, the content of the posts was read several times to identify themes and categories, i.e., open coding. The posts were read by researchers individually, and the coding frame was developed after group discussion sessions. The posts were reread again and recategorized according to the agreed coding structure, then abstracted into a higher logical level, which, after further discussion, were conceptualised into final themes. Major themes emerged through rigorous

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[20] 1) the cause and origin of the virus and disease; 2) the symptoms and patterns of transmission; 3) the treatments, prophylactics, and cures that are available; and 4) the effectiveness and impact of interventions by health authorities or other institutions.

and systematic reading and coding of post content. The themes were developed to address the research questions.

We also observed a new phenomenon during the process; the old posts containing obsolete information contradicted subsequent new 'current' knowledge, which could be considered misinformation. Consequently, a new code, i.e., *Contradictory Information*, emerged, and the coding frame was slightly changed. All posts were then reread according to the new structure. The new theme, i.e., *contradictory information*, was a significant insight and finding as 1) this directly undermines the connection between content and type undermining the trustworthiness of the source and consequently trust in the shared situational awareness, and 2) the phenomenon has not been reported in the literature. This finding revealed a new factor shaped by the temporary nature of the crisis-related information that directly impacts social media content, and thus situational awareness quality and, therefore, public trust in the official channel. Crisis response agencies should carefully consider this knowledge to improve the development of shared situational awareness during crisis events.

Findings and Discussion

Our coding revealed three official *information typologies,* i.e., misinformation, counter-information, and myth-busting information. These information typologies are described as (1) *contradictory information*, (2) *countering fabricated information*, and (3) *myth-busting cynical information*.

Our analysis also revealed how social media *communication strategies* could spread and combat misinformation about COVID-19. Public health agencies used different strategies to fight the infodemic of misinformation using Facebook. Our analysis indicates that official posts to the

health agency Facebook channels: (1) *contained the propagation of misinformation by posting counter-information, or 'corrections'* of these imprecise posts, as well as (2) *mitigated the infodemic by posting 'myth-busting' information* related to general rumors and inaccuracies about COVID-19. However, public health agency posts also *accelerated the infodemic of misinformation* through posting imprecise information, which, as it 'aged' then became misinformation.

We now explain our findings in detail.

Connections - Information Topologies and Communication Strategies

How do local health organisations in Australia, at state levels, use social media (i.e., Facebook) content (information) and type (communication strategies) to mitigate COVID-19 misinformation propagation? (RQ1)

Contradictory Information – Infodemic Acceleration.

Public health agencies used Facebook extensively to inform the public about the outbreak; however, the uncertain nature of COVID-19 impacted the consistency and sometimes the accuracy of the information that was broadcast on the channel. The organisations posted accurate information (to the best of their knowledge at the time), and then as the outbreak changed and new scientific evidence emerged, new information was published that conflicted with previous posts. Earlier posts of information and advice, therefore, became outmoded and inaccurate as the pandemic evolved. This resulted in the information and advice in later posts contradicting that which was contained in the earlier posts. Contradictory information can be recognised as misleading/fabricated information if it is still accessible on the Facebook channel. For instance, a short video with the caption: "Should I wear a facemask to protect myself from novel coronavirus?

No. Unless you are a health professional [21] " was published (in February 2020) to inform the audience that at that time, they did not need to wear facemasks in public. The video was watched 244K times and received 304 likes and 115 comments by July 2021 after our data collection frame. However, another post (in July 2020) contradicted the previous February post, "*We strongly recommend wearing a face mask in situations where social distancing is not possible*" [22] This post received 486 comments and was shared 502 times by other users. At the time we were writing this paper (i.e., July 2021), the initial post was still available to the public on the channel.

Countering Fabricated Information – Infodemic Containment

From the early stages of the outbreak in Australia (i.e., January 2020), the agencies used their Facebook channel to contain the infodemic of misinformation about COVID-19. In this sense, publishing relevant information based on scientific evidence was a strategy. In doing so, the agencies published accurate, relevant, and timely information on COVID-19 to increase public situational awareness. For instance, the agencies published posts to address the rumors, and misleading information about the cures and treatment for COVID-19, e.g., "*NSW Health is aware of people self-medicating to treat COVID-19 or using medications in an attempt to prevent COVID-19 disease[23]*." The spread of fabricated information created a substantial life-threatening risk to public health as well as made managing the crisis more complex. This information typology and communication strategy also included posts to increase public awareness about the existence and spread of misinformation, including disinformation (i.e., information intentionally disseminated to mislead audiences). This containment strategy aims to improve both individual

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[21] https://www.facebook.com/watch/?v=620993142046514
[22] https://www.facebook.com/NewSouthWalesHealth/photos/a.232420926957256/1349360065263331
[23] https://www.facebook.com/NewSouthWalesHealth/photos/a.232420926957256/1254334428099229/

health literacy and community risk awareness regarding misinformation threats, e.g., "*NSW Health has been made aware of a social media post that is being widely circulated warning people to …there is no such entity as the "Department of Diseasology Parramatta[24].*"

Mythbusting Cynical Information - Infodemic Mitigation.

When disputed or imprecise information was circulated between people on social media or other sources, the health agency posted information with a tag that there was insufficient evidence on the accuracy of the information. This was done to provide some yet-to-be-confirmed information to the public to address the uncertain nature of the COVID-19 outbreak. It must be remembered that COVID-19 at this stage was a newly emerging disease and that there was a great deal of uncertainty regarding the evolution and spread of the pandemic. The health agencies admitted to the uncertain nature of some information in their posts, e.g., "*According to World Health Organization (WHO) it's not certain how long the virus that causes COVID-19 survives on surfaces,…[25],*" or "*… people gain immunity to the virus, but because it is a new virus, we don't know how long…[26].*[11]"

Managing Objective-Subjective Information Tensions

How can this knowledge help to improve the development of shared situational awareness during crisis events? (RQ 2)

The spread of misinformation has been an increasing challenge in managing crises since the development of social media facilitated mass communication. The infodemic of COVID-19 information and related misinformation has created a significant threat to public health and

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[24] https://www.facebook.com/NewSouthWalesHealth/photos/a.232420926957256/1211158705750135/
[25] https://www.facebook.com/225158094350206/posts/1234523503413655/
[26] https://www.facebook.com/NewSouthWalesHealth/photos/a.232420926957256/1280092618856743/

significant challenges for health systems. We investigated how misinformation impacted official health agencies' Facebook communication with the public on the NSW and VIC Health Facebook pages during the COVID-19 outbreak from January to April 2020.

This study revealed that the use of social media, i.e., Facebook for emergency and crisis communication, assisted public health agencies in mitigating the infodemic by 1) posting counter information or corrections of these imprecise posts and 2) posting myth-busting information related to general rumors and inaccuracies about COVID-19 by providing scientific information to increase community health literacy. However, on the downside, it accelerated the infodemic through the posting of imprecise information due to the uncertain and changing nature of the event, which, as it 'aged,' became misinformation. Identifying that the very communications strategies in use to counter the infodemic were, in fact, contributing to it highlights the necessity of developing alternative, or at least, other supplementary strategies.

It is recommended that government agencies should develop communications strategies that focus on information *objective-subjective tensions* to better accommodate and deal with variations in advice to the public over time. Changing crisis conditions and impacts, e.g., knowledge of the virus and its effects, access to services, government funding, vaccines and RATS, community support and leadership, social dislocation, and mental health outcomes, etc., as well as digital public health and safety literacy are all risk factors in infodemic generation. It is in the interest of both government and platform providers to carefully develop and utilise platforms in a way that manages objective-subjective tensions to retain and enhance trusted shared situational awareness effectively.

As a starting point, we would suggest that the content of old posts on social media crisis communications pages need to be regularly reviewed and backward audited to detect and eliminate

misinformation before it has a chance to impact public response to health advice and confidence in trusted sources of information. There is also scope to be more proactive by closely monitoring changing crisis conditions and probable impacts to better anticipate possible niche communications strategies to specific audiences. These strategies may also be useful for shaping convergence behaviours in some crisis event conditions (Bunker, Mirbabaie, & Stieglitz, 2017).

Conclusions and Recommendations

The inconsistency that is created over time between the information contained within posts can undermine shared and trusted situational awareness, the channel users' understanding, and expectations of trusted sources, i.e., the health agency.

While trust, credibility, consistency, timeliness, and reliability are essential characteristics for effective, persuasive health communication, we observed that the unpredictable and changing nature of the COVID-19 outbreak, as well as social media temporal characteristics, facilitated information aging resulting in the spread of inconsistent and inaccurate information. This had the potential to undermine public confidence in agencies and trusted COVID-19 situational awareness.

In the context of our study, the connection type, i.e., Facebook, facilitated the dissemination of information, but the unpredictable nature of the event, as it unfolded, increased the possibility and damage caused by the infodemic of misinformation.

From our study, we conclude that social media has significant advantages when it comes to infodemic containment and mitigation by health agencies, but it can also accelerate the size and velocity of an infodemic as information ages and becomes inconsistent. Disseminating timely information during a crisis is necessary to produce accurate situational awareness at any given point in time. The COVID-19 pandemic, however, was a very uncertain and changing situation in

its early stages. This fuelled informational objective-subjective tensions as the temporal characteristics of a crisis, i.e., uncertainty and change over time, presented challenges for using social media channels for crisis communications.

While these channels are effective broadcast mechanisms for current situational awareness and advice, they also retain and enable the interrogation of changing communications over time without an accompanying reflection of the changing situation at each point in time when the information is posted.

As we have seen in our study, aging social media information has the potential to become inconsistent and inaccurate, which can then accelerate an infodemic and consume valuable resources required to contain and mitigate it. It can also directly undermine communication quality, i.e., trusted sources. More research is required to better understand this problem and to develop more effective social media policies and applications for crisis communications.

Our research also calls into question the definition of trusted situational awareness and how information is defined and communicated during crisis and emergency circumstances.

Future Research

We know that the public places trust in official information sources like health agencies when it comes to assessing crisis situational awareness (Bermes, 2021); however, in this study we observed that social media information and communications strategies had been involved in disseminating contradictory information. As a next stage, we call for information systems studies investigating situational awareness development on other social media platforms, e.g., Twitter and Instagram, as these platforms target different audiences and may require different treatments of objective-

subjective tensions of information, its impact on communication strategy and quality in developing

trusted shared situational awareness.

Chapter 7 Social Media Trust: Fighting Misinformation in the Time of Crisis

The previous chapter examined "how the use of social media, i.e., Facebook, by public health officials in fighting against misinformation during an extreme event, i.e., COVID-19". This chapter comprehends the learning from the previous chapter by studying the way that the organizational use of social media to combat COVID-19 misinformation impacted public trust in health authorities and information". This case study analyses the content and sentiment of public comments linked to the Australian public health agencies' posts that were published on their Facebook pages to manage infodemic and mitigate misinformation. This study revealed the elements that affect public trust in information and the agencies' channel, therefore, hampering communication fluency and shared situational awareness. As Figure 23 shows, this chapter also contributes to the body of knowledge in the area of *social media trust and shared situational awareness during a crisis.*
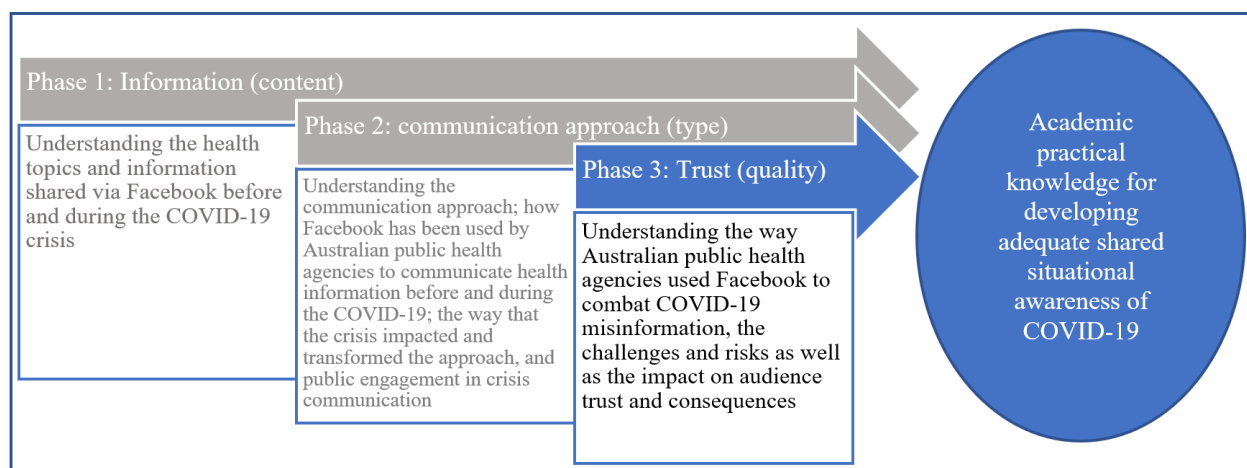

Figure 23 Study process map- phase three; understanding the trust

The manuscript has been submitted to the *International Journal of Information Management (IJIM)* and is under the second round of review. The authors's list included: Maryam Shahbazi and Deborah Bunker. My supervisor, Prof. Bunker, the co-author of this work, kindly allowed me to use the manuscript as part of my thesis.

Social Media Trust: Fighting Misinformation in the Time of Crisis

Abstract

During a crisis like the Covid-19 pandemic, the infodemic and the spread of misinformation compromised Shared Situational Awareness (SSA) and hindered crisis response. The use of social media platforms by response agencies to combat misinformation and create SSA for the public has become widespread. However, the associated risks and shortcomings are not well understood.

This study examines the use of social media (i.e., Facebook) by Australian public health agencies to combat COVID-19 misinformation during the early stage of the COVID-19 pandemic. While the value of these platforms for creating SSA during the crisis is evident, built upon Seppänen et al. (2013) SSA model, we revealed that the agencies' approach to using social media for crisis communication could damage SSA by undermining the public's trust in health authorities and information. This case study analysed the content and sentiment of communication on Australian public health agencies' Facebook pages. We conducted field interviews with agency members to supplement our findings. This study contributes to IS and communication fields by 1) *revealing how social media can be used by authorities to communicate crisis information and combat misinformation during a crisis, 2) identifying the risks and shortfalls of adopting social media for crisis communication, and highlighting the factors that can affect public trust in information and agencies' channels*. We proposed ways to build the trust necessary for managing misinformation through social media communication.

Keywords social media, crisis communication, misinformation, trust, health communication, infodemic

Introduction

Social media, with billions of users, has provided a new way for effective mass communication during the COVID-19 crisis. However, the widespread use of social media during the COVID-19 pandemic highlights the phenomenon of the "digital infodemic" which accompanied the pandemic (Banerjee & Meena, 2021). The explosion of information, including false or misleading information in digital and physical environments, known as an infodemic (WHO, 2022), creates dissonant mental models and impacts shared situational awareness (SSA) and effective crisis management (Bunker, 2020). In this circumstance, obtaining trusted situational awareness for all stakeholders, including those directly impacted, official crisis management and response agencies, and the general public, is a significant communicative difficulty during a crisis (Steensen et al., 2018).

The COVID-19 crisis was plagued by the spread of misinformation and fake news, which undermined trusted shared situational awareness. To combat this, public health agencies turned to social media platforms such as Facebook to communicate crisis-related information, combat misinformation, and create public SSA (Bunker et al., 2022). However, despite the widespread use of social media for crisis communication, we still lack a clear understanding of the associated risks and shortfalls, as well as the best practices for adopting this medium.

Accordingly, this qualitative case study examines how public health agencies utilise social media platforms to combat misinformation during a significant public health crisis, i.e., the COVID-19 pandemic, and explores associated risks, shortcomings, and advice for improvements.

We answer two research questions:

1) How did Australian public health agencies use Facebook to communicate information about COVID-19 misinformation during the pandemic?
2) How did this create trusted shared situational awareness (SSA) to support public health decision-making?

The results of this study assist public health agencies in enhancing their social media communication strategies for combating misinformation and creating SSA during a crisis.

Situational awareness is defined as the ability to recognise and understand the aspects of the environment in terms of time and place, comprehend their meaning, and predict their future condition (Endsley et al., 2003). *Shared awareness* is "*the perception of the elements in the environment within a volume of time and space, comprehension of their meaning, and the projection of their status in the near future* (Endsley, 1988, p.97). Shared situational awareness during a crisis enables actors to interact effectively in dynamic and complicated contexts (Endsley, 1995). Seppänen et al., 2013 furthermore highlight the importance of SSA for effective decision-making during emergencies, explaining that *information (link content), communication (link type), and trust (link quality)* influence formation of SSA in a SAR (Search and Rescue) organisation. There is, however, a gap in understanding the complex relationships between these factors and their impact on the development of SSA among the public during a crisis. This gap in knowledge is important to address because effective communication as the development of SSA is crucial for public decision-making and successful emergency response.

Building on the Seppänen et al. (2013) model (see Figure 24– below), this paper explores how Australian public health agencies utilise social media (*link type*) to communicate crisis-related information *(link content)* to combat misinformation and create trusted SSA (*link quality*) for the public during the early stage of the COVID-19 pandemic. We investigate the extent to which SSA is shaped and how the organisational use of social media, i.e., Facebook, affects *trust* between actors (the public and the agencies) as well as the quality and fluency of communication.
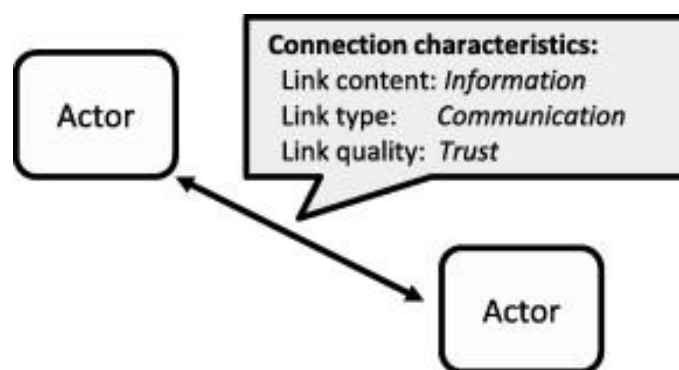

Figure 24 Information, Communication, and Trust Affecting the Formation of SSA in an Actor-Network, retrieved from; Seppänen et al. (2013)

To achieve the study objectives, we first analysed the content of the posts *(link content)* published by Australian public health agencies to address COVID-19 misinformation. Secondly, we

conducted field interviews with informants to gain a better understanding of the agencies' approach to using the platform *(link type)*. Finally, we analysed the content of comments linked to the posts to identify key relevant attributes that contribute to the public's trust in information and source during times of crisis (*link quality*). By triangulating data from various sources, we were able to gain valuable insights into social media communication to combat COVID-19 misinformation and the formation of trusted SSA for the public during the crisis.

Our study is timely and critical. During a health crisis like the COVID-19 pandemic, social media can spread disinformation and undermine trust in institutions and the healthcare system as a whole (Llewellyn, 2020). As COVID-19 vaccinations are rolled out globally, there is growing concern over the role of trust, belief in conspiracy theories, and social media misinformation on vaccine hesitancy. Studies have shown distrust in the government has caused vaccine hesitancy (Jennings et al., 2021; Schernhammer et al., 2022). Bunker (2020) called for further research to build on the trust in government and their crisis management institutions and other powerful actors in crisis management communications.

The results of this study assist health authorities in understanding the risks and benefits of adopting social media to manage the impact of the infodemic and the spread of misinformation during a crisis. The results of this study contribute to developing public health crisis communication policies aiming at reducing the risks and increasing effectiveness.

Literature Review

Social media is crucial during crises for timely information and community-building (Bunker et al., 2017; Elbanna et al., 2019; Ridhwan & Hargreaves, 2021; Shahbazi et al., 2018). It enables rapid dissemination of new information and scientific findings (Bunker et al., 2019; González-

Padilla & Tortolero-Blanco, 2020), improves public protection (Wiederhold, 2020), but also amplifies misinformation (Apuke & Tunca, 2018). Effective communication on social media is vital in public health crises (Slavik et al., 2021), and organizations have utilized technology to adapt their responses to COVID-19 (Siau & Han, 2020; Wade & Shan, 2020; Yang et al., 2020).

COVID-19 Infodemic and Misinformation

The World Health Organisation (WHO) has defined the term "*infodemic*" as an oversupply of information about a crisis in digital and physical contexts, some correct and some not, which affects problem-solving (WHO, 2020). "Infodemiology" had its origins in 2002; however, the current widespread use of the World Wide Web has raised concerns about the harm caused by the spread of false information (Eysenbach, 2002, 2020).

The proliferation of social media has accelerated the spread of misinformation during the COVID-19 pandemic, damaging situational awareness, social response, and government countermeasures and causing widespread concern in society (Bermes, 2021; Buchanan, 2020; Bunker et al., 2022; Kim et al., 2019). **Error! Reference source not found.***Table 15* highlights the paradoxical roles social media plays during the COVID-19 pandemic.

Table 15 The Ways That Social Media Supported or Hampered Managing the COVID-19 Crisis

Study	The Positive Role of Social Media in COVID-19
Almotawa & Aljabri (2020); Al-Dmour et al. (2020); Alvarez-Galvez et al. (2021)	Increase public awareness, improving knowledge awareness and compliance with health recommendations among their users.
Jiang et al. (2021); Kudchadkar & Carroll (2020); Kearsley & Duffy (2020)	Facilitate information sharing and access to the key data, rapid knowledge dissemination across geographical boundaries
Ghalavand et al. (2022); Chereka et al. (2022)	Rapid knowledge sharing and collaboration between health professionals
Taylor et al. (2022); Zhang et al. (2020)	Understanding people's emotions and shed light on psychology, public health, and economic challenges during COVID-19.
Lu et al. 2021); Tsoy et al. (2021)	Social media influence people's emotions, perception of risk, attitudes, collaboration, and interaction behaviours toward the crisis.
Karami et al. (2021); Han et al., 2020; Lyu et al. (2022); Boon-Itt & Skunkan (2020)	Enhancement of understanding of public opinion regarding COVID-19, e.g., vaccine
Van Slyke et al. (2021; Lakamana et al. (2022); Zolbanin et al. (2021)	Pandemic surveillance and prediction
Limaye et al., 2020); Bunker et al., (2022)	Maintaining connectivity and forming public trust; facilitating good faith political expression and discourse
Thelwall & Thelwall (2020); Cauberghe et al. (2021); Hamilton et al. (2020)	Social support, e.g., helping the public to cope with social isolation
Study	The Negative Role of Social Media in COVID-19
Valika et al. (2020); Pang 2021); Mohammed et al. 2021; Fan & Smith 2021); Jiang 2022)	Information overload[27] and variability in practice cause confusion and affect the ability to respond adequately. Cause social media fatigue also reduces health fact-checking. Negative impact on public well-being during the COVID-19 pandemic.
Bermes (2021); Pool et al. 2021); Li et al., (2020); Badell-Grau et al. (2020);	Spread of misinformation, disinformation, and conspiracy theories that create confusion, fear, anxiety, and mistrust in response organisations. Negative behavioural responses in consumers, e.g., irrational panic buying. Accelerate anti-

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[27] *Information overload is described as a circumstance in which there is an abundance of information but insufficient information-processing capabilities (Schick et al., 1990).*

Hotez (2021); Tandoc Jr et al. (2018); Kouzy et al. (2020)	science activities and hinder the implementation of the best public health policies.
Depoux et al. (2020); Radwan et al. 2020; Ahmad & Murad (2020)	Exelated panic and fear transmission impact their mental health and psychological well-being.
Wong et al. (2021); Wang & Zhou, (2022)	Spread of a high volume of low-quality, contradictory, and not verified information that caused anxiety and fostered distrust of credible health information
Bayer et al. (2019); Molter & DiResta (2020); Kelso & Altinay (2022)	Sharing propaganda or sponsored content. Manipulate public opinion and their decisions, e.g., creates genuine insecurity, such as the COVID-19 vaccine hesitancy. Misleading public opinion on political parties or the government's pandemic response. Pandemic-themed commercials

Misinformation is described as purposely disseminating false, inaccurate, or misleading information with the intent to deceive or not to deceive. Falsehoods or distorted information are defined as misinformation, which includes any information that does not directly reflect the "actual" status of the world (Zhou & Zhang, 2007).

The spread of COVID-19 misinformation can be broken down into four major categories: (1) the cause and source of the disease and virus; (2) the symptoms and patterns of transmission; (3) available treatments, cures, and prophylactics; and (4) the outcome of health authorities' and organisations' interventions (WHO, 2020).

COVID-19 misinformation fueled by stigma, rumors, and conspiracy theories can empose public anxiety or psychological distress (Ruiz-Frutos et al., 2020; Sallam et al., 2020); feelings of fear, uncertainty, and panic (Fernández-Torres et al., 2021; Schmidt et al., 2020; Talwar et al., 2020); and attacks against health professionals and persons of Asian heritage (Usher et al., 2020).

Although social media platforms have taken steps to limit the circulation of false information about health, such as labeling or removing posts containing misleading information (Kearney et al., 2020), the profound impact of misinformation on public health crisis response underscores the

need for a deeper understanding of COVID-19 misinformation. Appropriate and effective approaches are required to combat the infodemic and mitigate the negative effects of misinformation.

While many studies have focused on the direct effects of misinformation on the public, as we have reviewed in Table 2, our research takes a different approach. We examined how public health social media communication aimed at combating COVID-19 misinformation impacts public trust in information and official communication channels and, as a result, shared situational awareness. Our research holds significant importance as we strive to support public health agencies in enhancing their crisis communication through social media and fostering public trust in authoritative sources of health information. However, the study conducted by Mian and Khan (2020) highlights a disconcerting trend wherein unreliable sources of COVID-19-related content on social media are prevalent and, alarmingly, gaining more popularity than trusted sources such as official online health channels.

Social Media Official Use During COVID-19

Although social media platforms have enabled the infodemic and the dissemination of misinformation about COVID-19 (Cinelli et al., 2020; Zhou et al., 2021), these platforms have also been utilized by governments and health officials to combat the spread of misinformation and the infodemic (Rao et al., 2020). A wide range of official and trusted social media channels have been employed to deliver timely and accurate information to dissipate the effects (Parviainen, 2020). For instance, Liu et al. (2022) highlighted how official Chinese social media accounts serve as a significant source of information during the pandemic, playing a crucial role in influencing the infodemic by increasing social support and reducing information cascades among citizens.

Health officials globally have used social media to respond to both the COVID-19 pandemic and the infodemic by; *explaining health guidelines*, *measures, and governmental instructions,*

promoting science-based knowledge and falsehood correction, engaging the public, communicating the risk and status of the pandemic, and sharing health information (Kim et al., 2021; Liao et al., 2020; Mheidly & Fares, 2020; Rufai & Bunce, 2020; Sutton et al., 2020). Despite all these efforts, the abundance of accurate and inaccurate COVID-19 related information has caused confusion and misled the public (Ashrafi-rizi & Kazempour, 2020), leaving them uncertain about which sources of information are reliable (Agley & Xiao, 2021). Consequently, Pulido et al. (2020) study showed the public is uncertain about which sources of information are reliable, negatively impacting their response to the pandemic.

There is still much to be learned about the best practices for utilizing social media in crisis communication, as well as the potential risks and limitations that come with its use. For instance, a study by Bunker et al. (2022) found that during the COVID-19 pandemic in Australia, official social media health communication inadvertently contributed to the spread of misinformation by retaining outdated information on their channel. Our research investigated the way that Australian public health agencies utilized Facebook to combat COVID-19 misinformation and identified the risks that may impact the quality of communication and SSA during the crisis.

Official Response to the COVID-19 Misinformation and Trust

In mid-February 2020, the World Health Organisation issued a warning, declaring that the new coronavirus pandemic was accompanied by an 'infodemic' and widespread misinformation (WHO, 2020). The COVID-19 misinformation, particularly in the form of rumors and conspiracy theories, has been found to have a negative impact on public trust, potentially leading to a lack of compliance with public health recommendations (Zhong et al., 2020). As the COVID-19 pandemic spreads, the importance of public trust in healthcare institutions and providers has become

increasingly apparent. However, misinformation and rumors about the virus and its treatment have the potential to erode this trust, leading to a lack of compliance with public health guidelines and potentially exacerbating the spread of the virus (Gallotti et al., 2020).

Fletcher et al. (2020) also found that public trust in official information about Coronavirus dropped during the pandemic. This loss of trust can result in a lack of compliance with public health guidelines and potentially exacerbate the spread of the virus, leading to an even more significant public health crisis. Additionally, people's trust in information sources and confidence in institutions played a role in public health decisions (De Freitas et al., 2021), and misinformation and mistrust could lead to undesired social behaviour, such as vaccine hesitancy or refusal (Rodriguez-Morales & Franco, 2021). Hence, Governments worldwide are fighting misinformation and rebuilding public trust in public institutions. The government's social media response to COVID-19 misinformation enhanced citizens' trust in government and strengthened citizens' trust in government (Mansoor, 2021). Hence, government agencies such as the Italian Ministry of Health have turned to Facebook to achieve this goal (Lovari, 2020).

Still, the findings from a study by Jang and Baek (2019) shed light on a concerning trend. It was discovered that the credibility of information disseminated by public health organizations had experienced a decline. This decline has consequently led to a rise in individuals relying on personal networks, internet news, and social media as alternative sources for health crisis-related information.

Our study addressed a thin and unexplored area, seeking to understand which communication attributes may impact public trust in official social media channels when the agencies use these platforms to combat misinformation during a crisis like the COVID-19 pandemic. By delving into

this narrow yet crucial gap, we aimed to investigate the risks and limitations of using social media to combat misinformation, reveal factors impacting public trust, and offer insights for effective crisis communication and trusted sources of information.

Crisis Communication for Shared Situational Awareness

Crisis communication is an ongoing process of creating shared meaning between and among communities, groups, agencies, and individuals within the ecological context of the crisis to prepare them for threats while responding and reducing harm to lives and livelihoods (Sellnow & Seeger, 2021). The swiftness and reach of government communication interventions and how communities receive, comprehend, and act upon the information provided by health authorities and governments play a significant role in creating SSA and effectively managing a crisis such as the COVID-19 outbreak (Hyland-Wood et al., 2021).

In this sense, scholars such as Liu and Fraustino (2014) called for more studies on "how the public makes meaning during a crisis," i.e., situational awareness and Bunker (2020) underlined the importance of understanding the trust in government agencies' communication and SSA during a crisis.

Built upon previous literature on the development of Shared Situational Awareness (SSA) for crisis management (Ödlund, 2010; Virrantaus et al., 2009; Waugh Jr & Streib, 2006), Seppänen et al. (2013) explained creating an adequate SSA between crisis actors requires "*fluent communication*" where "*common concepts are used, trust exists and relevant information can be accessed easily*- p1". Seppänen et al. (2013) identified three factors that influence adequate SSA: link content (information), link type (communication), and link quality (trust), as shown in Figure 24.

Although our study took an inductive approach, it is important to acknowledge the significant contribution of Seppänen et al. 2013 model (Figure 24) in shaping our study and providing an initial

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theoretical lens. Seppänen et al., 2013 focused on communication within an inter-organizational context to create SSA for emergency response teams. This model served as a valuable framework for constructing our initial theoretical framework as we explored communication, information content, and the establishment of trusted shared situational awareness between emergency response agencies and the public. Building upon this model, we extended our study to examine the development of trusted SSA between public health agencies and the public, which is crucial for effective crisis response.

Our study seeks to build on and extend Seppänen et al., 2013 to better understand "how did Australian public health agencies use Facebook to communicate (link type) information (link content) about COVID-19 during the pandemic?" And "how did this create trusted (link quality) shared situational awareness (SSA) to support public health decision-making?"

The rest of this paper is structured to outline the research methodology and dataset and present the study findings. Our paper concludes by providing insights and an immediate recommendation to assist public health decision-makers in improving their social media communication policies and practices.

Research Approach, Dataset, and Analysis

In late January 2020, the first case of COVID-19 was identified in Australia. Cases rapidly increased to over 6500, with over 80 deaths in only three months.

The Australian government operates in a complex multijurisdictional network involving federal, state, and territorial authorities. Our analysis focused on the Facebook communications of the health agencies in New South Wales and Victoria, the most populous states with the highest number of COVID-19 cases during the initial four months of the outbreak in 2020. Facebook emerged as the primary communication channel for these agencies, given its large number of followers and popularity among the public.

We conducted an in-depth qualitative (case) study of the agency's public Facebook page, exploring the content of discussion threads that occurred during the early stages of the pandemic and targeted misinformation. We used the case study research methodology since it is ideal for exploratory research of this nature (Siggelkow, 2007). The use of qualitative methods allowed this study to identify operational processes that are deeply embedded in their contexts, enabling the investigation of the "how" question as recommended in the relevant literature (Gephart Jr, 2004; Pan & Tan, 2011; Walsham, 1993). We drive the extension of Sepparnen et al. (2013) inductively, which is one of the most useful applications of exploratory case studies, as highlighted by Eisenhardt (1989).

We collected and analysed our primary data in three phases: 1) during the early stages of the study, we analyzed the content of posts published by health agencies on their Facebook page aimed at combating COVID-19 misinformation to gain insights into the agencies' Facebook communication pattern and approach (*link content*). We then conducted field interviews with the health agencies' member informants (W Lawrence, 2014), such as communication managers of the agencies who were responsible for administering their Facebook pages, formulating communication strategies, and making decisions regarding public outreach (*link type*). We gained further insights into the agencies' communication strategies and decision-making approaches to build trusted SSA for public health decision-making (*link quality*).

The outcomes of the first two stages of this study served as a "sensitizing device" (Klein & Myers, 1999) to inform the subsequent data collection and analysis. We analysed the content of comments replied to the Facebook posts to understand the efficacy of their communication strategies in using Facebook to combat misinformation (*link quality*). Through this process, we gained insights into the ways in which audience trust can be shaped through official Facebook communication and impacts

communication outcomes. Reaching an acceptable level of confidence in our analysis enabled us to make meaningful contributions to theory and practice.

Our analysis of social media communication texts focuses on interpreting and understanding the meaning of the content of text data, developing themes directly from the text data. Coding and theme development are the outcomes of the analytic process where two coders' are trained to code the data in the same way rather than a starting point as it is guided by (Clarke & Braun, 2013; Terry et al., 2017).

We employed the thematic analysis approach to analyse the Facebook dataset (posts and comments) and adhered to the requirements for rigorous analysis as outlined by Braun & Clarke (2006). Our coding process was conducted with equal attention to each data item, emphasizing a comprehensive approach over anecdotal evidence. We ensured coherence, consistency, and distinctiveness by cross-checking relevant extracts within each theme and against the original data set. Our analysis went beyond descriptive interpretations, aiming to provide depth and understanding of the topic. Both authors actively engaged in the research process, dedicating sufficient time to each phase. Our analysis was interpretive rather than relying solely on emerging themes, and thematic analysis was chosen as an appropriate method for studying both traditional and Web-based communication content. Figure 25 summarises the three phases of this study in the form of a conceptual framework.
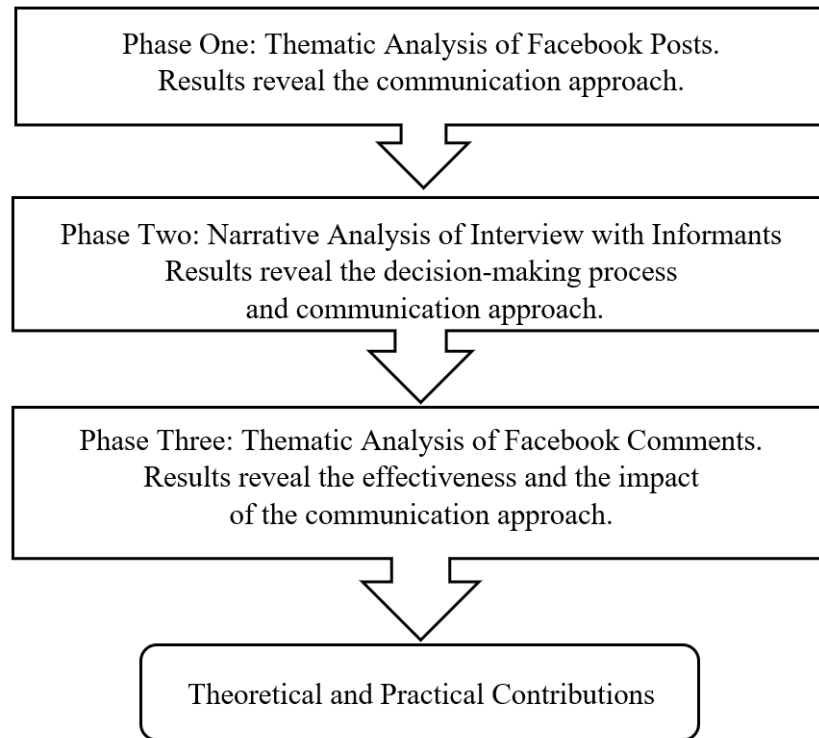
Figure 25 Conceptual Model for Analysis

Phase One- Thematic analysis of Facebook posts

We used a self-developed Python app and collected a random sample of 765 posts and their linked comments published from 1 January to the end of April 2020 on the NSW[28] and VIC[29] Department of Health Facebook page. Table 16 presents a summary of our initial Facebook dataset.

Table 16 Summary of Facebook Dataset

Public Health Organisation	Number of Posts	Number of Comments
NSW Health	431	13990
Victorian Department of Health	334	247
Total	765	14237

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[28] *https://www.facebook.com/NewSouthWalesHealth/*
[29] *https://www.facebook.com/VicGovDH*

This four-month sampling window allows us to cover two major events; 1) the start of the pandemic in Australia in late January 2020 and 2) the first COVID-19 peak in March/April 2020, affecting all states and territories (AIHM 2021). Following the general inductive approach (Thomas, 2003), which provides an efficient means of analyzing qualitative data, we carefully reviewed the content of all posts and removed any that presented facts, news, or information that had been scientifically accepted by the time of writing this work (August 2021). Subsequently, both authors jointly reviewed the posts and reached an agreement on the data-cleaning process.

Applying the general inductive approach assists us to "*condense extensive and varied raw text data into a brief, summary format*" and "*establish clear links between the research objectives and the findings derived from the raw data*" (Thomas, 2003, p.2).

As our study aims to specifically investigate the official utilization of Facebook to combat misinformation, we employed a targeted approach in selecting the data for analysis. Manually, we handpicked a total of 29 posts from the available pool of content, focusing specifically on those that addressed the uncertainties or unreliabilities associated with COVID-related information circulating through social media or other communication channels. By narrowing our data sampling in this manner, we aimed to delve deeper into the strategies employed by official sources to tackle misinformation and enhance public understanding during the ongoing pandemic.

These posts have been chosen because they focused on the four major thematic areas of the COVID-19 infodemic where there is misinformation and people look for trustworthy information according to the "Coronavirus Disease 2019 (COVID-19) Situation Report–85 "(WHO, 2020). Table 17 offers a sample of the posts published by Australian health agencies to address misinformation within each respective area.

Table 17 Four Major Thematic Areas of the COVID-19 Infodemic according to WHO (2020), and samples of posts published to address each area

COVID-19 Infodemic Major Thematic Area	Sampler
The cause and origin of the virus and disease	• *NSW Health has been made aware of a social media post that is being widely circulated warning people not to consume certain foods or visit certain locations in Sydney.*
Covid-19 symptoms and transmission patterns	• *Coronavirus does not last very long on surfaces, therefore, imported products or mail do not pose a risk of transmission.*
Available treatments, prophylactics, and cures	• *PrEP is effective in preventing HIV when taken as prescribed. But it does not protect against COVID-19. Get the facts on PrEP, HIV drugs and COVID-19: […]*
Effectiveness and impact of interventions by health authorities or other institutions	• *Should I wear a facemask to protect myself from the novel Coronavirus? No. Unless you are a health professional.*

We investigated how local public health organisations, e.g., state health, employed social media to combat misinformation in line with the WHO strategy.

Aligned with prior studies (Pennycook et al., 2020; Velichety & Shrivastava, 2022), we first identified, defined, and classified the information typologies used to combat misinformation.

In this sense, the content of the posts was read several times to identify themes and categories, i.e., open coding. The posts were read by this paper's authors individually, and the coding frame was developed after group discussion sessions. The posts were reread again and recategorised according to the agreed structure, then constructed into a higher logical level, which, after further discussion, were conceptualised into final themes. Through rigorous and systematic reading and coding of the posts' content, major themes emerged. The themes were designed to address the research question, "*how Australian public health agencies used Facebook to combat the infodemic of misinformation.*"

Phase Two- Field Interviews with Member Informants

The results of the first phase of the study revealed the organisational approach in targeting COVID-19 misinformation. However, according to Walsham (1995), there is a risk that we only observed what the theory suggests, stifling possible new difficulties and paths of exploration. In interpretive research, it is preferable to maintain a high level of openness to field data and a willingness to revise early assumptions and beliefs. This leads to an iterative data collection and analysis process.

In this regard, we have conducted nineteen one-on-one semi-structured interviews (one-hour average time for each interview) with informants from the health agencies that we investigated their Facebook activities in this study. The participants were recruited via snowball sampling and virtual one-on-one interviews conducted via Zoom[30]. The aims of the interviews were; to 1) enhance our understanding of the topic, 2) closely monitor and understand the scope and the extent of the problem, 3) understand organisational approach in using Facebook to combat COVID-19 misinformation, and 4) learn from the expert's tactical knowledge and experience and finally maintaining the pragmatic approach of this study. All participants but one (i.e., the Crisis Management expert) were working in the critical roles relevant to the study, including the director of public health COVID-19 communication, COVID-19 Social Media Manager, Multicultural Health Team Leader, Director of […] Local Health District and, a member of the Aboriginal community. The informants' professions allowed them to be active in social media public health decision-making, and public health communication, and they possessed exceptional academic and hands-on relevant knowledge (experts in the field).

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[30] *https://zoom.us/*

We collected informants' (public health communication team) narratives about their experiences managing communication during the pandemic to better understand the organisational approach and informants' opinions on using social media by government agencies to manage COVID-19 misinformation. In the sphere of literary theory, the narrative was first defined by Barthes and Duisit (1975) as any kind of speech. Scholars in the field of organisational studies have since expanded on this sweeping definition of narratives. Collecting tales in the field can bridge the gap between individual interpretations and concerted action. The study of IT-enabled organisational change benefits greatly from this narrowed focus (Czarniawska, 2004).

We used narrative analysis as this study is interested in the public health communication teams' stories about their experience using Facebook as an official communication channel to manage COVID-19 misinformation.

Phase Three- Facebook Comments Thematic Analysis

In the final stage of the study, we looked at the public response in the form of comments to Facebook posts published by agencies to combat misinformation (we analysed their content in the first stage of this study).

We randomly retrieved a sample of 387 comments that were linked to our final sample of posts analysed in phase one and applied the same thematic analysis and coding process to investigate and highlight the public reaction to the Facebook posts. Our analysis of the comments focused on understanding the impact of the public health organisational approach to use Facebook to combat COVID-19 misinformation on public trust and the consequences, revealing influential factors and suggesting ways for improvement.

Findings and Discussion

In this section, we present our findings from the different phases of analysis conducted during the study. We will also provide a detailed explanation of how the findings from each phase supported us in obtaining a comprehensive insight into the investigated topic, which in turn, aided us in building theory.

Facebook Posts Communication Themes

Our analysis of the content of Facebook posts revealed the public health officials' approach to using Facebook to combat misinformation. The results of the first stage of this study (Bunker et al., 2022) indicated that the agencies attempted to contain the misinformation by (1) posting counter-information, or "corrections" of these imprecise posts, as well as (2) posting "myth-busting" information related to general rumors and inaccuracies about COVID-19.

We further explain the approach referring to the types of messaging and the goal expected to be achieved by each approach.

Contradictory Information – Infodemic Acceleration

Australian public health agencies, such as NSW Health and VIC Health, extensively utilized Facebook to inform the public during the COVID-19 outbreak. However, due to the evolving nature of the pandemic, the information posted on the platform sometimes lacked consistency and accuracy. As new scientific evidence emerged and the outbreak evolved, earlier posts became outdated and conflicting with later information. This resulted in contradictory advice and information being shared.

Contradictory information can be recognised as misleading/fabricated information if it is still accessible on the Facebook channel. For instance, a short video with the caption: "*Should I wear*

a facemask to protect myself from novel coronavirus? No. Unless you are a health professional[31] " was published (in February 2020) to inform the audience that <u>at that time,</u> they did not need to wear facemasks in public. The video was watched 244K times and received 304 likes and 115 comments by July 2021. However, subsequent information (in July 2020) contradicted the previous February post, *".... We strongly recommend wearing a face mask in situations where social distancing is not possible...[32]"*. This post was shared many times by Facebook users. As of the time we were writing this paper (i.e., July 2021), the initial post was still available to the public on the channel.

Countering Fabricated Information – Infodemic Containment

During the early stages of the COVID-19 outbreak in Australia (January 2020), public health agencies effectively utilized their Facebook channels to combat misinformation. They publish accurate and timely information based on scientific evidence to enhance public situational awareness about COVID-19. For instance, the agencies published posts to address the rumors and misleading information about the cures and treatment for COVID-19 (e.g.," *NSW Health is aware of people self-medicating to treat COVID-19 or using medications in an attempt to prevent COVID-19 disease*….[33]"). The spread of fabricated information has created a substantial life-threatening risk to public health as well as made managing the crisis more complex. This communication theme also includes posts to increase public awareness about the existence and spread of misinformation, including disinformation (i.e., information intentionally disseminated to mislead audiences). This containment approach aims to improve both individual health literacy and community risk awareness regarding misinformation threats (e.g., "*NSW Health has been*

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[31] *https://www.facebook.com/watch/?v=620993142046514*
[32] *https://www.facebook.com/NewSouthWalesHealth/photos/a.232420926957256/1349360065263331*
[33] *https://www.facebook.com/NewSouthWalesHealth/photos/a.232420926957256/1254334428099229/*

made aware of a social media post that is being widely circulated warning people to … there is no such entity as the "Department of Diseasology Parramatta"…[34]".)

Mythbusting Cynical Information - Mitigation

When disputed or imprecise information was circulated among people on social media or other sources, the health agency posted information with a tag that there was insufficient evidence of the accuracy of the information. This was done to provide some *yet-to-be-confirmed* information to the public in order to address the uncertain nature of the COVID-19 outbreak. It must be remembered that COVID-19 at this stage was a newly emerging disease and that there was a great deal of uncertainty regarding the evolution and spread of the epidemic. The health agencies admitted to the uncertain nature of some information in their posts, e.g., "*According to World Health Organization (WHO) it's not certain how long the virus that causes COVID-19 survives on surfaces,…,[35]*" or "*… people gain immunity to the virus, but because it is a new virus, we don't know how long….[36]*"

Field Interviews with Member Informants

We collected informants' narratives by conducting six one-on-one semi-structured interviews. The interview sessions were guided by pre-determined and broad questions. We removed all identifiable information upon the recorded data being transcribed to ethics requirements, while in discussing the results, we occasionally used "*direct quote*" sentences from interviewees to support our findings.

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[34] *https://www.facebook.com/NewSouthWalesHealth/photos/a.232420926957256/1211158705750135/*
[35] *https://www.facebook.com/225158094350206/posts/1234523503413655/*
[36] *https://www.facebook.com/NewSouthWalesHealth/photos/a.232420926957256/1280092618856743/*

The COVID-19 crisis was "*showing that social media has to be a part of public health, and it has to be integrated,*" the director of the COVID-19 communication team stated.

The informants highlighted the extent and impact of the misinformation propagation during the pandemic and also the importance of social media in both amplifying and solving the problem. They stated social media "*potentially could be a wonderful source of information*" while it facilitated the spread of misinformation that impacts managing the crisis. An informant highlighted the importance of the information source in mitigating the impact of misinformation; they stated that public health agencies "*have to get them to critically think and use information from trustworthy sources*" as they are "*getting information from elsewhere.*"

Regarding the public health organisational communication approach, the interviewees revealed that agencies' communication teams include content developers and moderators who "*are very aware of what's going on day to day*" to create content for the agency's social media channels. Then to verify the trustworthiness of the content, the agencies use their' public health team to check the content and to "*make sure it's factually correct.*" The director of COVID-19 communication was responsible for all posts' final approval.

The agencies' communication team also audits and filters the content of the comments to manage the spread of misinformation. The filtering includes an automatic profanity filter, and also they filter the comments that spread misinformation *"if someone is spreading misinformation or disinformation, it's immediately hidden; well, when I say immediately, I mean when we moderate it because often the community moderates themselves, but if it isn't [we will moderate the comments]."* When the team moderates the comments, they may also address the misinformation in comments by responding to the content and providing accurate information about the topic "*but*

if they keep arguing with comments, we will just hide the whole chain." The team may also block an audience's access to the page if they continually spread misinformation "*and it seems to be on purposeful.*" In response to the question asking the extent of filtering, the communication manager stated: "*I have a lot of trust in my team to understand the threshold.*"

As we discussed in previous findings, the content can still age, impacting the information's trustworthiness as well as contradicting the new information that undermines the audience's trust. In our conversations with informants, we found no policy is currently in place to combat this issue.

The interviewees also referred to the content of the comments linked to the posts as reflective information on the performance of these social media management tactics and the impact of the message. The public health communication team uses the content of the comments posted by the public to understand the public response to the crisis communication approach. The sentiments in the public responses (i.e., comments) were taken into account as an evaluation means; "*our evaluation is more on sentiment and reading between the lines.*" Accordingly, we analysed the content of the Facebook comments to understand how the agencies' efforts in using social media to combat misinformation impacted public trust.

To summarise, we have identified the important steps taken by the communication team to effectively manage *information* and *communication* on their Facebook channel to combat misinformation. These steps include:

1. Identifying User Information Needs: Analysing and understanding the events to determine the users' information requirements during the crisis.
2. Identifying Misinformation and Rumors: Monitoring and analysing online and offline content to identify and refute any misinformation and rumors being spread.

3. Ensuring the Trustworthiness of Sources: Verifying the credibility and reliability of sources before sharing any information to combat misinformation.

4. Controlling Comments: Controlling and filtering comments to prevent the spread of misinformation, rumors, and inappropriate content. This includes utilising filters to flag potentially harmful comments, responding to comments and providing accurate information, deleting comments, and sometimes blocking the user.

5. Evaluation, Feedback, and Process Improvement.

Related Comments - Infodemic and Public Concerns

Facebook incorporates dialogic communication between members, including individuals and organisations, within an online community (e.g., the NSW or VIC Heath Facebook page). Studies show that during a crisis, the public reaches out to social media platforms to access timely event-related information as well as to raise their concerns and express sentiments (Shahbazi et al., 2018). We, therefore, examined the public response to the three Facebook post typologies to better understand how misinformation propagation, containment, and mitigation efforts impact official public health social media communication, in this case, via Facebook. We randomly selected and analysed 387 comments made by users on the posts analysed in phase one, which enabled us to examine public responses and sentiments.

Through our analysis, we observed that users utilized *tags* to notify their friends and connections in the content of the comments, which ultimately drew attention to the posts. Tags also increase the visibility of the post to the tagged person's friends or followers, which can lead to more engagement and interaction. This finding emphasised the crucial role of social media platforms, particularly Facebook, in enabling secondary communication and expanding the reach of information to the audience, especially in the midst of a public health crisis.

We also argue that users who notified others about the information had confidence and trust in the information and the source. Hence, they have communicated this information with their friends and family to increase their awareness about the health threat.

Figure 26**Error! Reference source not found.** shows the types of public reactions observed (by Themes) in our analysis of comments. It should be noted that a comment could be included in more than one communication theme if it meets the characteristics of that theme.
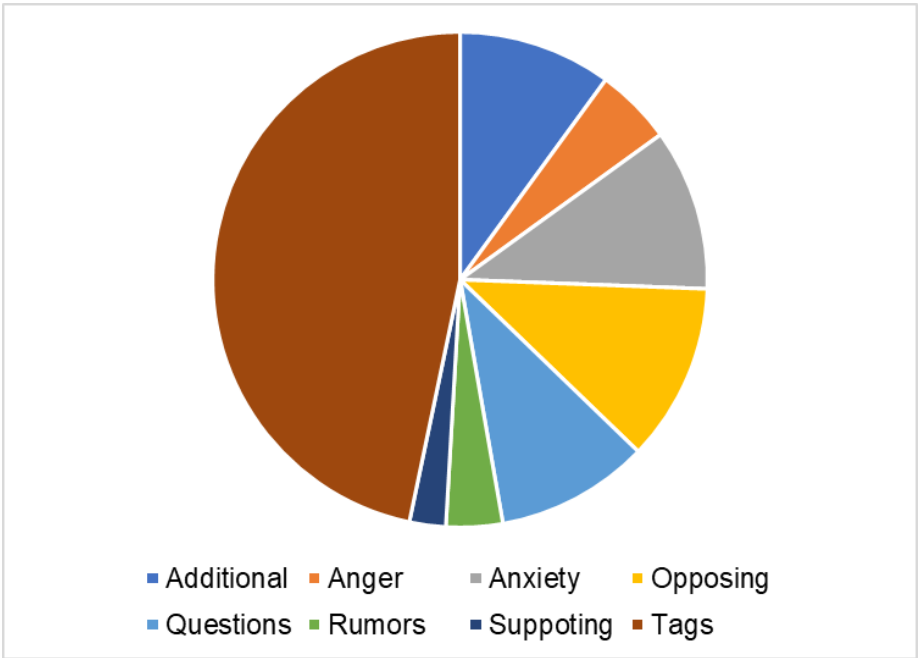
Figure 26 Thematic Analysis of the Facebook Comments

The majority of comments were directly related to the content of the original posts, and we categorise them as follows:

Error! Reference source not found. *Figure 26* shows that Facebook users used the comment section to share "*Additional*" information about the content discussed in the original post. Furthermore, users asked questions and sought further clarification by posting their inquiries in the comment section, which we identified as "*Questions*".

Some comments contradicted the original post's content or criticised the government or health agency, i.e., "*Opposing*," while only a few comments showed appreciation of them, i.e., "*Supporting*".

In our analysis, we also identified keywords that are commonly associated with emotions such as anger or irritation (e.g., Shame, Stupid, Idiots, etc.). Among the emotional reactions we observed in the data, expressing "*Anger*" was the most prevalent, followed by an expression of "*Anxiety*." We found that the content of comments reflected users' feelings of fear or concern about the situation, indicating a strong sense of worry or apprehension among the audience.

As part of our analysis, we identified comments that contained information that lacked scientific evidence or was classified as misinformation. These types of comments were categorized as "*Rumors*." However, we later discovered that the organization's communication team utilized automatic and manual filtering to screen and remove such comments.

We know that the general public tends to trust official information sources like health agencies when it comes to assessing crisis situational awareness (Bunker, 2020); however, we observed users criticising and questioning the messages published by the health agency on their Facebook channels. As Seppänen et al. (2013) highlighted, to effectively create SSA, it is imperative to consider the quality of the links, i.e., the level of trust, between actors. Therefore, we conducted a thorough analysis of the comments to gain a deeper understanding of the degree to which the organization's endeavors to combat disinformation have led to the development and sustenance of public trust. In this regard, we identified shortcomings that may have impacted audience trust and the overall SSA. Analysing the content of the comments revealed various factors that influenced public trust in information and the sources (institutions), including:

Lack of Sufficient Information

One crucial factor that had an impact on public trust in the agency was the insufficient information provided in their messages or posts. For instance, when addressing rumors about the location of new cases or the extent of the pandemic in different communities, the agencies failed to provide the precise location of the cases. As a result, the audience began to question the authenticity and communication efficiency of the agencies, e.g., "*Can the suburbs of confirmed cases be publicised? ... The public deserves more information.*" The comments revealed that in such cases, the audience would look to other sources for information when the agency failed to provide the detailed information they needed.

Nuance Language

The use of imprecise sentences in communicating the messages harmed public trust in information. For instance, in a post, "*According to World Health Organization (WHO) it's not certain how long the virus that causes COVID-19 survives on surfaces, but it seems to behave like other coronaviruses...*[37]", the agency used "*seems*" to express the uncertainty about the information that caused audience questioning the authenticity of the information. However, in another post [38], "*There is evidence that people gain immunity to the virus, but because it is a new virus, we don't know how long you are immune for,*" the agency directly communicated the reason for uncertainty about the matter, (i.e., *because it is a new virus*) which avoided the use of imprecise language from the prior scenario. In this sense, we argue that the crisis's unknown nature resulted in uncertainty

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[37] Post ID 225158094350206-1091484391200530
[38] Post ID 225158094350206_1280092645523407

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in scientific solutions; however, the way to share the uncertain information with the public further impacted public trust in information.

Inconsistent Messaging

Inconsistent messaging and, in particular, the dissemination of contradictory information damaged audience trust in the information, particularly when the information was not aligned with their health knowledge. For instance, there were published posts advising against wearing masks in public, which garnered comments reflecting public resistance and refusal, e.g., "So stupid this. *As there are plenty of inconsiderate people who cough and sneeze who don't cover their mouth and nose. So the best way for me to filter those airborne particles is to wear a face mask* 😷."

Inconsistent Policies

Inconsistent policies caused mistrust in information and its source. For instance, the health agency announced the virus would not survive on surfaces, and the use of imported products was safe, while users argued they experienced a delay in receiving imported products and cargo because the package had been delayed for examination in COVID-19 quarantine.

Misinformation and Fake News

As previous studies had also identified, we found that users' trust in information was considerably impacted by the infodemic of misinformation that caused confusion and anger, e.g., "*People are confused on the information given out by the pm*".

Past Failures

The Government's past failure in managing the pandemic impacted the trust in the institution (source) and also in the information. The Ruby Princess cruise ship incident[39] that accelerated the coronavirus outbreak in Australia is an example of a failure that impacted trust that was highlighted in the Facebook comments (e.g., "*Please Explain About the Ruby Princess ??? Shame Shame Shame …*) to doubt the information source and the communications channel.

When public trust in social media public health crisis communication is weakened, it can have a negative impact on public resilience. Social media users become confused, skeptical, or even resistant to the information being shared, which can lead to a lack of compliance with recommended health and safety measures. This can further exacerbate the crisis and make it more difficult for individuals and communities to recover. We observed that the erosion of users' trust in official health social media communication resulted in the following:

- **Psychological distress,** including public anxiety, fear, confusion, and anger.
- **Public dissent** as a result of disappointment in the governmental approach to managing the pandemic.
- **Communication fatigue** leads to seeking information from unreliable sources like the internet, family, and friends, increasing the risk of exposure to misinformation.

Psychological distress, public dissent, and communication fatigue can all contribute to the erosion of public resilience in the face of a crisis like the COVID-19 pandemic. The psychological impact of the crisis can lead to anxiety, fear, confusion, and anger among the public, which can further undermine their ability to cope and adapt to the situation.

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[39] *https://www.bbc.com/news/world-australia-53802816*

Additionally, public dissatisfaction with the government's response to the pandemic can erode trust in authorities and reduce confidence in the ability of institutions to manage the crisis effectively. This can contribute to feelings of hopelessness among the public, further weakening their resilience.

Communication fatigue, which is a feeling of being overwhelmed or exhausted by the constant flow of information, can also lead individuals to seek out alternative sources of information that may be unreliable, leading to exposure to misinformation. This can contribute to confusion, skepticism, and distrust, which can further undermine resilience and hinder efforts to respond to the crisis effectively.

All of these factors can contribute to the deterioration of public response, making it more difficult for individuals and communities to cope with the ongoing challenges of the pandemic. Therefore, it is important for public health authorities and other trusted sources to provide clear, accurate, and consistent information, engage with the public in transparent and empathetic ways, and work to rebuild trust and confidence in their ability to manage the crisis effectively. By doing so, they can help to support and strengthen public resilience in the face of adversity. The study provides valuable insights into the role of communication and information in shaping public perceptions of the crisis and how they impact trust in official sources. By revealing the factors that impact trust in official communication, the study provides a roadmap for public health authorities and other trusted sources to improve their communication strategies and rebuild trust with the public. This, in turn, can help to strengthen shared situational awareness and support more effective crisis response efforts.

Discussion

Theoretical Contributions and Implications

This study enhances our understanding of the intricate connections between information, communication, trust, and shared situational awareness during a crisis. It offers practical insights to enhance crisis communication strategies and support resilience-building efforts. When communication breaks down, or trust is lost, shared situational awareness diminishes, resulting in fragmented and ineffective public responses that worsen the crisis's impact. This creates a cycle of mistrust, anxiety, and confusion that further weakens public resilience. By comprehending the factors that influence trust and contribute to shared situational awareness, crisis communicators can improve their messaging strategies and cultivate stronger relationships with the public, ultimately fostering resilience and mitigating the negative consequences of crises. Therefore, research examining the interplay between information, communication, trust, and shared situational awareness is crucial for developing effective crisis communication strategies and promoting public resilience.

We investigated how Australian public health agencies use Facebook to combat COVID-19 misinformation. Analyzing Facebook communication on the NSW and VIC Health pages and conducting interviews with their communication teams, we applied the Seppänen et al. (2013) theory of developing shared situational awareness for emergency management. Our study extended this model and contributed to the development of effective crisis communication strategies that enhance public trust and situational awareness during a pandemic like COVID-19.
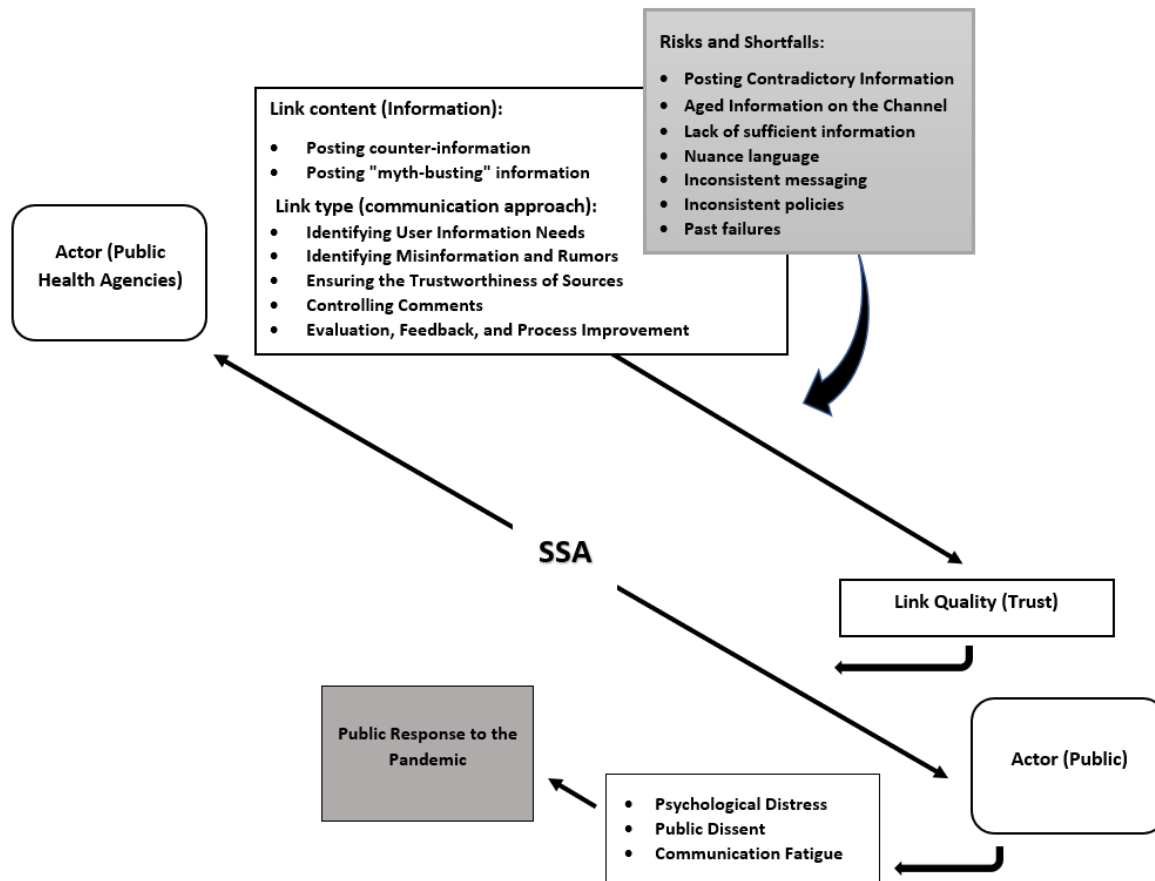
Figure 27 Conceptual Model for Developing Trusted Shared Situational Awareness for Public Health Crisis Management

Figure 27 conceptualises the use of Facebook by health agencies, which involves addressing misinformation through the "dissemination of corrective information" and "myth-busting" content related to COVID-19 rumors and inaccuracies. The model also acknowledges the risks that may impact the quality of the link and, as a consequence, the trust in SSA, for instance, potential unintended consequences of posting imprecise information that can contribute to the spread of misinformation over time. The absence of a policy to address the risks and shortfalls undermines public confidence in the agency, hinders the shared situational awareness, and impacts the public's response to official health messages, as evidenced by comments on agency posts, e.g., *"... and you expect us to believe a Government Department."*

Insufficient information, nuanced language, inconsistent messages, inconsistent policies, and past government failures were found to contribute to the erosion of public trust and hinder situational awareness during a public health crisis. Health officials have a responsibility to provide accurate information, yet there is limited research on how the public reacts when their expectations are not met in terms of information provision.

Our analysis of public comments on the health agency's Facebook pages revealed that the platform is perceived as a trustworthy source of information by a majority of the audience, who also felt confident enough to share the information with their network. Additionally, users also contributed additional relevant information in the comment section, improving communication. However, we also found that users expressed feelings of anxiety and anger in their comments, which can be attributed to the communication shortfalls discussed earlier. For instance, users argued and opposed official advice about the initial posts that recommended not using a facemask in public (e.g., "*So stupid this. As there are plenty of inconsiderate people who cough and sneeze who don't cover their mouth and nose...[40]*"), precisely as those were not aligned with their general health knowledge. Facebook users also use the channel to raise questions that reflect their doubts or concerns about the content of the health agency posts.

In the early stage of the COVID-19 pandemic, the comment space also created an opportunity to spread new misinformation and rumors relevant or irrelevant to the issue discussed in the original post. However, the agency adopted an extensive automated and manual filtering approach to reduce the risk. We suggest additional efforts to develop an appropriate communications filtering protocol considering the risks identified in this study and the audience's need for freedom of speech and being heard. Learning from COVID-19 assists agencies in developing this protocol, reducing

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[40] *Comments ID 1218770771655595_1220504884815517*

the overreliance on human judgment and the risk of human error, and also enhancing the consistency and efficiency of communication in future events.

Implications for practice

Our analysis suggests that it would be beneficial for health agencies to establish a policy that addresses the issue of imprecise information on social media platforms during times of crisis. This policy could include guidelines on how to handle uncertain or rapidly changing information, as well as protocols for reviewing and fact-checking information before it is posted to social media channels.

Additionally, the policy could incorporate regular reviews and updates to ensure that the information being posted remains accurate and up-to-date. By establishing such a policy, health agencies can demonstrate their commitment to providing reliable and trustworthy information to the public, which can ultimately help to build and maintain public trust and confidence in the agency and its messaging.

Furthermore, public health organisations can learn from these findings to update their policies concerning:

- Increase transparency: Health agencies should aim to be transparent and offer the public timely and accurate information. This can be accomplished by delivering regular status updates and being transparent about what is known and unknown. This can also help to address inconsistencies in messaging that are a natural consequence of the unpredictable nature of the crisis and evolving knowledge. Agencies should ensure that their communications are consistent across different stages of the crisis. If there is inconsistency, agencies should

acknowledge it in the content and explain the reason. This can serve to clear up confusion and boost public trust.

- Use simple language: Health organizations should avoid using vague or ambiguous words or phrases, as well as words that convey multiple meanings. Instead, they should provide definitive statements to ensure clarity in their communication with the public.

- Recognise uncertainty: Agencies should be open about the crisis's uncertainties and avoid making definitive assertions and increase users' awareness about the temporary nature of information in the content.

- Engage the public: Health agencies should engage the public and respond to their concerns and queries.

- Evaluate and update policies: Health authorities should evaluate their policies and procedures on a regular basis to ensure that they are effective and responsive to public needs. During a public health crisis, this can serve to create trust and boost situational awareness.

Understanding the resistance and scepticism towards health messages and arguments expressed in the comments section can also be a valuable source of information for health agencies. This information can provide insight into the impact and risks of an infodemic and the spread of misinformation, and may be particularly relevant for addressing issues such as vaccine hesitancy in Australia and globally. Therefore, analyzing and noting this resistance should be considered a critical component of any research study aimed at enhancing the effectiveness of public health messaging during a crisis.

Limitations and Future Research

More research is required to better understand the use of social media for fighting infodemics and misinformation and developing more effective social media policies and applications for crisis

communications. As a starting point, similar research must be conducted on other social media platforms such as Twitter, Instagram, and LinkedIn, as the platforms' audiences vary, and government agencies have also extensively utilized these channels to manage a crisis. Understanding the dynamics of all types of social media as communications channels is critical to infodemic "treatment."

Our analysis is limited to a specific geographic region and may not be generalizable to other contexts. Future research could replicate our study in diverse settings to assess the extent to which our findings hold across different cultural, social, and political contexts. In addition, future research could explore the role of macro-level communication, such as national or WHO level communication, in shaping individual and organizational communication patterns.

Also, our study was conducted during the early stages of the pandemic, and the communication strategies and challenges may have evolved over time. Finally, as with any qualitative research, the findings are subjective and may be influenced by the researchers' interpretations.

Conclusions

Our study, which examined the Facebook communication of health agencies during the early stages of the COVID-19 pandemic, highlighted the crucial role of clear and consistent communication by health agencies during public health crises. We found that social media platforms like Facebook are essential for combating misinformation and promoting accurate information to build public confidence. However, our analysis also revealed the potential impact on public trust and shared situational awareness when content creation and communication approaches fall short. To address these challenges, health agencies can adopt the recommendations from our study to improve their crisis communication strategies on social media. By taking a cautious approach and implementing effective rules, health authorities can interact with the public,

counteract misinformation, and build trust during public health crises. Moreover, our study contributed conceptual insights into the factors influencing trust in government health agencies during crises. We identified key drivers of trust, including effective communication, transparency, accountability, and competence, which enhance the theoretical understanding of trust in public health emergencies. Additionally, we developed a model that explains how information posted by health agencies on Facebook, along with their communication approaches to combat misinformation, can influence public trust and shared situational awareness during crises like the COVID-19 pandemic.

The practical implications of our findings are significant for policymakers and health agencies. They can use our research to develop evidence-based strategies that enhance public trust in government health agencies during similar crises. These recommendations can improve crisis management practices and strengthen public engagement efforts, ultimately leading to more effective responses to public health emergencies.

Chapter 8 Field Interviews, Evaluating Results, Conclusions, and Discussion

Introduction

Netnography research can be complemented with a set of interviews (Kozinets, 2019). During this study, besides workshops that facilitated the *engaged scholarship* approach to this study, I have conducted 19 one-on-one in-depth semi-structured interviews (one-hour average time for each interview) with informants from the two Australian states, NSW and VIC, that were in the scope of this study. The aims of the interviews were; to 1) enhance my understanding of the topic, 2) closely monitor and understand the scope and the extent of the pandemic, 3) understand the challenges, risks, and range of problems resulting from the pandemic, 4) understand the challenges that the pandemic posed to the public health sector 5) understand the public health agencies' approach in communicating crisis information to the community, and 6) learning from the expert's tactical knowledge and experience and finally maintaining the pragmatic approach of this study. All participants but one (i.e., the Crisis Management expert) were working in the Australian private or public health sector in different critical roles relevant to the study, including a state public health COVID-19 communication director; a state COVID-19 Social Media & Design Manager; a Multicultural Health Team Leader; a Crisis Management expert and strategist; a Director of a Local Health District; nurses; General Practitioners, Public Hospital Workers, COVID-19 epidemiologists, members of the Aboriginal community and a Public Health Assistant and community expert. Their positions closely involved them with 1) social media public health decision-making, 2) health communication, 3) patient care, and 4) developing academic and hands-on relevant knowledge (experts in the field).

The insights gained from the interviews conducted in this study contribute to a deeper understanding of the learning outcomes from the previous phases. These narratives provide

valuable perspectives that shed light on the outcomes of the earlier phases, aiding in interpreting the results and facilitating a comprehensive understanding of the topic. By incorporating the insights gained from the interviews, I enhanced my overall understanding and ensured a more holistic interpretation of the research findings.

Samplings, Interview Settings, and Data Collection

Emails and invitations were sent to participants who were qualified for this study (random sampling), which were first sent to GPs, public health managers, etc. However; this approach was not effective in recruiting study participants. The pandemic's impact on health sector jobs and other essential workers led to that most study invitees were unwilling or had no time to participate in the study. As a result, I changed the approach to participant recruitment from random sampling to snowball sampling method.

I started my interviews with a few targeted informants that I contacted via my personal LinkedIn and social media networks, and then I contacted other participants recommended by these informants, i.e., snowball sampling. Due to the COVID-19 pandemic restrictions, interviews were conducted online through Zoom[41]. The interview sessions were guided by pre-determined and broad questions selected from the range of topics available in Appendix 1- Interview questions. Fourteen interviewees consented to record the session, and I relied on the notes I took during the other five interviews. I removed all identifiable information from the recorded data being transcribed for ethics requirements.

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[41] https://zoom.us/

Analysis of Narratives

In the early stage of the study (i.e., in 2019 and early 2020), I interviewed mostly GPs, nurses, and health practitioners. The results mostly framed my approach to netnographic analysis of social media data and news on COVID-19.

In the later stage of the study, in late 2021 and early 2022, I interviewed public health communication managers and their teams to shed light on the organizational approach to public health social media communication during the crisis.

I collected informants' (public health communication team) narratives about their experiences to better understand the public health agencies' approach to the use of social media channels by government agencies to manage the COVID-19 crisis. In the sphere of literary theory, the narrative was first defined by Barthes and Duisit (1975) as any kind of speech. Scholars in the field of organisational studies have since expanded on this sweeping definition of narratives. Collecting tales in the field can bridge the gap between individual interpretations and concerted action. The study of IT-enabled organisational change benefits greatly from this focus (Czarniawska, 2004).

I used *narrative analysis* as I was interested in the public health communication teams' stories about the impact of the event on their communication strategy, i.e., communication approach and the agencies actions, as well as any resulting transformation of their communication system. I was also interested in getting feedback on the study findings in different phases of my analysis of their social media activities. This narrative analysis helped me to "connect individual experiences, stories, and actions to social events [the COVID-19 pandemic], processes, and organizational achievements", as stated by Czarniawska (1997) and cited in Wagner and Kandathil (2016).

Findings

There were learnings from the interviews I had with Australian public health agency informants, and their narratives assisted in improving the outcomes of this study. The communication system changed during the COVID-19 pandemic, and these interviews also revealed characteristics of the new communication systems that emerged after the transformation. Interestingly, the informants stated they would continue with this current approach and use what they learned during the crisis to communicate more effectively with the public. I reflected on these narratives at the very last stage of my Ph.D. when all netnographic and social media data analysis and results were finalized. Hence, I used the discussion in this chapter to validate my approach and interpret findings from my netnographic analysis of social media data. For instance, I will explain how the public health agencies' approach to understanding the social media impact on the public and the effectiveness of this approach is aligned with my study's methods. To do this, I occasionally use *"direct quotes"* sentences from interviewees.

There are arguments of factors that highlight the significance of social media channels (in this case, Facebook) as a pandemic tool. These include:

- Social media is considered an important element in managing a public health crisis like the COVID-19 pandemic. "*The public health team and public health response really understand how clever [it] can be, how targeted [it] can be, and how many people use and interact with it [social media]."* The COVID-19 pandemic showed that *"social media has to be a part of public health, and it has to be integrated; from the start, it's not."* The statement supports this study's arguments around the communication system transformation and the emergence of the new system highlighted on page **Error! Bookmark not defined.**.

- Public health agencies employ different social media (initially Facebook, Twitter, and Instagram, and as the pandemic unfolded, the agencies started using TikTok, also extending to other platforms) to reach diverse audiences (e.g., different demographics such as age groups). *"[Social media] channels have a slightly different demographic gender, age, etc., [the audience], so by being across all the channels, I think that's how we targeted [the diverse audience].* " However, the organisation's general view is that social media falls short of satisfying the agencies' audience information needs, that "*social media communication must be supplemented by other channels and cannot be left alone.*" "*So every time we [the agencies] use social media, we [the agencies] make sure that the same message is communicated in at least one other way* (e.g., offline channels).*"*

Channel Content and Validation to Communicate with Diverse Audiences:

- During the COVID-19 pandemic, the organisational approach regarding the selection of topics for their social media channels' audience was a combination of targeted and organic content in English and also developed content in other languages.

- The communication team included "*multicultural health communication services"* to assist COVID communication with the diverse Australian population. The team also has content developers and moderators who "*are very aware of what's going on day to day.*" Then to verify the trustworthiness of the content, the agency "*use a lot of our public health team to check our content*" and to "*make sure it's factually correct,*" then, there was someone responsible for the final approval for all the posts. However, as I discussed in chapter 6, page 198, the content can still age, impacting the information's trustworthiness as well as contradicting the new information which then undermines audience trust. In my conversations with informants, I have found no policy is currently in place to combat this issue.

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Communication Approach:

- The organisations used social media platforms for streaming press conferences in multiple languages as well as for the deaf community to also provide information in real-time. During the height of the pandemic, when the health authorities needed to disseminate more information, they worked with news agencies (e.g., SBS) and streamed the conferences on their social media channels in different languages.

- The agencies received voluntary support from social media influencers (termed *content creators*); they have shared the crisis messages on their channels to extend the reach of the information to their followers. In this regard, the new communication approach will be to *"integrate people within our business [e.g., doctors] onto our channels because they are our greatest advocates, so that'll be our [the agency] next step."*

- The agencies used their social media not only for streaming crisis messages but also to create a dialogue with the audience. For example, every Friday, a practitioner answered audience questions posted during the week on the channel. Also, an Instagram quiz engaged the audience to participate in conversations about the pandemic.

- The agencies also observed that community engagement in social media communication increased during the crisis. Interestingly, the agencies considered this as the outcome of communication effectiveness. Their communication team *"track[s] where [they] we've lost followers and gained followers,"* They used the number of Facebook reactions as well as the number of channel members as indicators for community engagement and communication effectiveness. That approach is aligned with and validates the approach I took in chapter five (page 145) to quantify community engagement. This approach has been used by the health agencies' social media analytic team to "evaluate " and compare the effectiveness of different

tactics that the communication team took to use social media to combat the crisis. The interviewees also referred to the content of the comments linked to the posts as reflective information on the success of these communications tactics and the impact of the message, as well as to understand the public response to the crisis management, e.g., "*we have so much negative sentiment on our channels, because of vaccinations.*" The sentiments in the public responses (i.e., comments) were also taken into account as "*engagement sometimes looks really high [but] it's quite negative.*"

- An informant stated, "*our evaluation is more on sentiment and reading between the lines,*" which is the similar approach I used in chapter 6, to understand how the agencies' efforts in using social media to combat misinformation impact public trust in the information and source.

- The agencies communication team audits and filters the content of the comments; the filtering includes an automatic profanity filter, and also they filter the comments that spread misinformation *"if someone is spreading misinformation or disinformation, it's immediately hidden; well when I say immediately, I mean when we moderate it because often the community moderates themselves, but if it isn't."* This also reflects on the limitation of social media studies that analyse the content of the comments, i.e., the same approach I used in chapter 6.

- Finally, I asked informants about the sensitivity of the communication system to the initial condition, i.e., the pandemic emergence, as highlighted in chapter Four. As discussed on page **Error! Bookmark not defined.**, at the early stage of the crisis, the communication shifted its focus to pandemic-related topics and thus undermined discussions about other important health issues and the need to meet the audience's diverse information needs. The informants did not notice this phenomenon before. However, they believe that during a crisis, their audience mostly looks for crisis information on social media. Hence their suggestion for the best action

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was to combine different topics in the crisis message, and with this, they trust that the organisation can meet audience expectations as well as stay on top of the crisis information needs.

The next section concludes the thesis and highlights the learning and contributions. I also explain the limitation of the study and ways forward for the health agencies to improve their use of social media platforms during a crisis. These conclusions are also impactful lessons for other IS researchers who are interested in social media and crisis communication studies.

Conclusions

COVID-19 stands for 'coronavirus disease 2019' caused by the New coronavirus SARS-CoV-2, which originated in China's Hubei province in December 2019. On January 25, 2020, the first confirmed case in Australia was disclosed. The World Health Organization (WHO) declared the global outbreak a Public Health Emergency of International Concern on January 30. The *Australian Prime Minister* activated the *Australian Health Sector Emergency Response Plan* for *Novel Coronavirus (COVID-19)* on February 27th, anticipating that the world would "soon enter a pandemic phase." On March 1, the Australian Government declared the first COVID-19-related fatality in Australia, and on March 2, the first confirmed incidence of 'community transmission' in Australia. On March 11, the World Health Organization proclaimed COVID-19 a pandemic, the first caused by a coronavirus. There were 118,000 cases and 4,291 deaths documented worldwide at the time.

To effectively manage a crisis, governments, organisations, communities, and people rely the majority of their decisions on *shared situational awareness* (SSA) acquired from many information sources. Hence, communication with the public during the planning and response phases of a public health crisis (e.g., diseases outbreaks) is an essential component of the emergency management and responsibility of public health agencies (e.g., The Australian Government Department of Health, State and territory government health departments, the Public and private hospitals, etc.). Referring to the growing numbers of Social media users ("Statista," 2018), these platforms have become an essential channel for agencies to reach their audience in public communication. The use of these platforms to access the event-related information and communication initiated by users became important and was vastly utilised by emergency organisations. Integration of these channels in emergency and crisis communication changed the

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traditional pathway for the flow of information from response organisations to the public (Simon, Goldberg, & Adini, 2015). They also provided a great source of information to decision-makers and assisted them in monitoring and managing the crisis. However, these low-cost and effective communication tools were less utilised by health professionals to communicate public health information (Vance, Howe, & Dellavalle, 2009).

Social media is defined as a group of Internet-based applications that have been built on the ideological and technological foundations of Web 2.0. These applications have facilitated the creation and exchange of user-generated content (Kaplan & Haenlein, 2010). The social media connection *content* (i.e., information) and connection *type* (i.e., communications approach) shared between *actors* (e.g., emergency response organisations and the public) constitute the foundation for the establishment of trustworthy *shared situational awareness* for effective crisis management.

The utility of social media in crisis management studies is broad (Alexander, 2014) and includes but is not limited to; extending emergency response public awareness (Yin et al., 2015), risk communication and the public in natural disasters such as; flood (Bruns et al., 2011), earthquake (Yates & Paquette, 2010), extreme weather condition (Goncalves et al., 2014), or managing human-made crisis such as terrorist attack (Falkheimer, 2014; Stieglitz et al., 2018), as well as community resilience (Dufty, 2012). These platforms have been utilised by health agencies such as; World Health Organization , hospitals, and health practitioners (Antheunis, Tates, & Nieboer, 2013; Eyrich, Padman, & Sweetser, 2008; McNab, 2009) to improve public health communication (Dawson, 2010; Green & Hope, 2010).

As a communications medium, Facebook has a wide reach within Australia. With over 1.6 billion daily active global users in December 2019, Facebook is Australia's most dominant social networking service (Facebook, 2019). Approximately half of the total Australian population is an

active Facebook user (Correll, 2020). In Australia, public health agencies have established Facebook pages as one of their official communications channels to provide critical health information to the general public (Australia, 2020). I investigated two years of communication (2019 and 2020) on the official Facebook pages of *NSW Health,* the *Victorian Department of Health,* and the *Australian Federal Government Department of Health* to understand the Facebook channel, i.e., communication system operation before COVID-19 and during the public health crisis, COVID-19 pandemic. Analysis of Facebook communication patterns before and at the onset of the COVID-19 pandemic provided meaningful insight into the impact of the chaotic event on public health communications in Australia and the lasting effect on communications strategies overall. I narrowed down my analysis to focus on *New South Wales* (NSW) and *Victorian* public health agencies because New South Wales and Victoria are Australia's most populous states and reported the highest number of COVID-19 cases during the first four months of the outbreak in 2020 (3,045 and 1,366 cases, respectively) when I was scoping this study. The NSW public health system is also the biggest public health system in Australia. Furthermore, the *Australian Federal Government Department of Health* develops and delivers policies and programs and advises the Australian Government on health, aged care, and sport.

This research contributes to Information Systems (IS) and crisis communications research by shedding light on various aspects of ***social media use and adoption for crisis communication, illustrating how the medium operates normally and is transformed to cope with a crisis***. I also showed how Chaos Theory could be effectively used to explain the impact of a major crisis on social media communication. Chaos Theory was used as a lens to explain the complexity and impact of the pandemic phases on government Facebook communications patterns. I examined the

context, content, and settings in which social media is used to conceptualise the relationships between crisis phases and communications transformation.

Major findings highlighted the importance of the Facebook health communication in managing the COVID-19 outbreak in Australia and have shown how this channel *enabled behavioural health interventions.*

I explained that public health agencies' Facebook communication for controlling infectious outbreaks *shifted focus from raising awareness about the importance of immunisation and vaccinations for non-COVID diseases to promoting changes to health behaviour such as washing hands and social and physical distancing.* The characteristics of Facebook as a communications medium made it possible to *reach a high-volume audience, engage with the public, and deliver this message for behavioural change*.

However, my study showed that the overall uncertainty around information provision and *"mixed messaging" may have contributed to poor communication outcomes in the early stage of the pandemic*. Consequently, I observed that the tone of Facebook *communications tone became harsher, shifting communications from advice and suggestions on positive health behaviours to messaging about the implementation of public health orders and restrictions*. As the pandemic unfolded, public health agencies' Facebook posts became more consistent, effective, and engaging (evidence of self-organising principle), which saw *Facebook communications tend to reach a new level of stability*. I further suggested a way forward for public health agency communication strategies.

Facebook platform characteristics also enabled more *effective user (i.e., individual) control of risk communication by facilitating emergent "user-to-user peer control" communication* to get

their message out and increase the range and reach of public health communications to target groups and communities. The "***user-to-user peer control***" risk communication identified in this study is an example of emergent user behaviour facilitated by social media characteristics that can amplify critical agency messaging during crises. This phenomenon can improve the effectiveness of public health communication and should be understood and considered by health agencies in developing public health communication strategies.

On the downside, my analysis highlighted that ***a chaotic event could also "swamp" and block communication on other equally important health issues*** when the study showed Australians were delaying or avoiding lifesaving medical tests during COVID-19 (Scott & Edmonds, 2020). In particular, I observed ***the health concerns of minorities and Australian indigenous communities received less attention on Facebook during the pandemic***, while at the same time, it was likely that these more vulnerable groups faced increased challenges in accessing healthcare services and information (Yashadhana et al., 2020).

My study also makes a scholarly contribution to the better application of communication technologies and, in particular, social media as an IS artifact in public health communication and crisis management. This study revealed that ***developing communications strategies to manage information objective-subjective tensions is particularly important in an evolving crisis scenario where situational awareness and knowledge are developed over time and where information and advice may change as the crisis condition evolves.***

Furthermore, this study showed that secondary crisis communication and users' information-sharing vastly expanded the reach of crisis massaging during the COVID-19 pandemic and ***outlined the elements that influence a user's decision to share reliable information from an official source and secondary crisis communication.***

Understanding the current state of public health agencies' social media presence in public health crisis communication can assist agencies to better understand and reflect on the effectiveness of their social media communications to better shape policy and strategy.

I uncovered *the ways that Australian public health organisations use Facebook to mitigate COVID-19 misinformation and create effective, trusted, shared situational awareness*. Furthermore, by analysing the content of public comments published under the health agency's Facebook posts, I revealed *how the agencies' strategies impact public trust in information and its source and the downstream consequences.*

Conducting interviews with public health members and the agencies' communications managers and teams allowed me to better understand the agencies' viewpoints and approaches to using social media for managing the COVID-19 pandemic. Narratives collected through in-depth semi-structured interviews with the members of the public health agencies assisted in developing my understanding of phenomena, evaluating the approach and findings, and enhancing conclusions.

In my previous discussion (refer to the study process model outlined in Figure 10), I emphasized the importance of the engaged scholarship approach and the active involvement of practitioners, organizational members, and academics in understanding the problem at hand and shaping appropriate solutions. Through these interviews, I gained a deeper understanding of the problem, leveraging existing knowledge and literature to formulate the solution. By actively engaging with stakeholders and drawing on their expertise, I was able to refine my understanding and develop solutions that align with the current body of knowledge.

Conclusion and Discussion, Academic and Practical Contribution

Social media platforms, such as Facebook, Instagram, and Twitter, have enhanced public health awareness and facilitated health promotion to prevent disease (Al-Dmour et al., 2020).

During a crisis, social media platforms are heavily used by the public to access event-related information and communicate with others, including officials (Ross et al., 2018; Weaver III et al., 2009), and are also utilized by emergency organisations to manage a crisis (Avery, 2017; Guidry et al., 2017). However, these platforms also created new challenges, such as disseminating rumors and misinformation and negatively influencing users' crisis response, such as vaccine refusal (Dredze, Broniatowski, & Hilyard, 2016; Kata, 2012). In general, these platforms provide a great source of information to decision-makers (e.g., infoveillance) and assist them in monitoring and managing crisis events (Eriksson, 2014; Eysenbach, 2006; Vance, Howe, & Dellavalle, 2009; Woo et al., 2016). Accordingly, *this study showed the importance and extent of the roles Facebook plays in crisis communication, including facilitating organizational response to the crisis by mediating crisis communication and broadcasting a broad range of information to a large number of diverse audiences*.

Social media platforms have been integrated with traditional public health communication channels by agencies and recognised as an appropriate communication channel to broadcast health information and reach people to promote public health awareness (Lyson et al., 2019) and health promotion (Stellefson et al., 2020). However, creating adequate shared situational awareness during an unstable situation like the COVID-19 crisis is challenging for public health agencies and governments. My research contributes to Information Systems and communications research by illustrating how a major crisis impacts social media communication, and suggesting ways to improve strategies for social media adoption for crisis communication.

The goal of this study was *to increase the knowledge in the area of social media adoption for crisis communication and to create adequate shared situational awareness*. This study significantly contributed to the field of social media adoption for crisis communication by enhancing our understanding of how social media is utilized by government health agencies, the impact of public health crises on communication systems, social media trust and misinformation, and factors influencing engagement on specific platforms like Facebook. The findings have practical implications for public health organizations in building trust, improving community engagement, and developing effective crisis communication strategies to manage future crises.

The contribution can be summarised as follows:

- Enhanced understanding of the ways in which social media are used by Australian government health agencies to manage a crisis, i.e., the COVID-19 pandemic,

The study provided an enhanced understanding of how Australian government health agencies utilize social media platforms to effectively manage crises, with a specific focus on the COVID-19 pandemic. By examining the strategies and approaches employed and the types of content shared, the study shed light on the evolving role of social media in crisis communication and the effectiveness of different approaches. This understanding can inform future crisis response plans and guide agencies in leveraging social media platforms more effectively during similar situations.

Regarding communication with diverse audiences, the study revealed that public health agencies employ various social media platforms to reach different demographics and language groups. However, the study also highlights the limitations of social media in satisfying the audience's information needs. It is suggested that social media communication should be supplemented by

other channels to ensure the effective dissemination of crucial information. This finding suggests the need for a more comprehensive and integrated approach to communication during crises.

The study explored the content and validation process employed by public health agencies to communicate with diverse audiences. It revealed that a combination of targeted and organic content in different languages is used. The agencies also involve multicultural health communication services to ensure effective communication with the diverse Australian population. However, the study points out that content can age, potentially impacting its trustworthiness and contradicting new information. The absence of policies to address this issue highlights the need for continuous evaluation and improvement in content management practices.

In terms of communication approaches, the study shows that social media platforms were utilized not only for streaming crisis messages but also for creating a dialogue with the audience. Public health agencies engaged with social media influencers and practitioners to extend the reach of information. The study underscores the importance of integrating advocates within the agencies onto social media platforms. The agencies also observed increased community engagement during the crisis and used various metrics and sentiment analysis to evaluate the effectiveness of their communication tactics. This approach aligns with the study's own evaluation of community engagement and reflects the impact of communication efforts on public trust and sentiment.

The study shed light on the filtering and moderation practices employed by public health agencies to manage comments on social media platforms. Automatic profanity filters and the removal of

misinformation highlight the challenges associated with analyzing comment content in social media studies.

- Enhanced understanding of the disruption in and transformation of the communication system caused by the public health crisis.

The study contributed to a better understanding of the disruption and transformation of the communication system during a public health crisis. By examining the impact of the pandemic on communication practices, the study revealed the shifting dynamics and challenges faced by health agencies in disseminating accurate information and managing public perceptions. This understanding can help in the development of more adaptive and resilient communication systems that can withstand and respond effectively to future crises. I explored the sensitivity of the communication system to the initial condition of the pandemic emergence. It reveals that the crisis-related focus of communication during the early stages of the crisis led to a neglect of other important health issues. The suggestion to combine different topics in crisis messages reflects an effort to address audience expectations and meet the dynamic information needs during crises.

- Improving understanding of social media trust and the generation and impact of misinformation. This knowledge assists public health organisations in building a trusted relationship with the public and improving community engagement in managing pandemics.

The study improved our understanding of social media trust and the generation and impact of misinformation. By analyzing the factors that influence trust in social media platforms and the spread of misinformation, the study provided valuable insights for public health organizations. This knowledge can assist in building a trusted relationship with the public, fostering confidence in the information shared, and combating the detrimental effects of misinformation. It also helps

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in enhancing community engagement and cooperation in managing pandemics and other public health emergencies.

- Enhanced understanding of secondary crisis communication by revealing factors that influence a Facebook user's decision to share information from official public health sources.

The study advanced our understanding of secondary crisis communication by examining the factors that influence engagement on Facebook. By identifying the key elements that drive user participation and interaction, the study provided valuable insights for health agencies in crafting effective messaging and engaging with the public on social media platforms. This understanding can contribute to the development of more targeted and impactful communication strategies, enabling agencies to address public concerns and mobilise community support during crises effectively.

COVID-19 showed us that social media should be effectively integrated into crisis management to assist the response and reduce the burden of the crisis. For instance, due to the lack of vaccines and specific therapies at the early stages of the pandemic, behavioural change health interventions became the health agencies' dominant public health focus. Facebook facilitated behaviour change messaging; however, as this study showed, the initial pandemic disruption and its butterfly effect swamped the health communication channel leaving little space for information on other important health issues. For instance, as this study showed, at the early stage of the pandemic in Australia, the public health social media channel rarely provided non-COVID related information, and thus stretched the impact that COVID-19 has had on Australians' general healthcare, e.g., Australians have delayed or avoided healthcare appointments and tests.

In this sense, crisis response organisations should carefully understand and consider the sensitivity of their complex social media communication system to the initial effect of the crisis. Managing the communication bifurcation at the early stage of the crisis can improve the effectiveness of overall communication in supporting the diversity of the audience's information needs and reduce the indirect negative impact of the crisis on the public.

I used *Chaos Theory* concepts to interpret changes in Facebook communications dynamics as the result of the pandemic disruption, identifying the sensitivity to initial conditions (butterfly effect), communication pattern breakdown (bifurcation), and new communication pattern emergence (self-organisation). I examined these concepts in terms of both changes to communication volume and topics from pre to post-pandemic periods. By netnographic analysis of Facebook data, I extracted the pattern of communication over two years, from January 2019 until December 2020, to highlight how social media communications patterns were disrupted in early 2020 as the pandemic emerged and how these patterns were then transformed over the remainder of 2020. Incorporating Chaos Theory as a lens for interpreting a netnographic study of crisis communication was a novel approach that helped me use social media data to gain essential knowledge of the phenomenon while also effectively communicating my observations through the Chaos Theory lens.

I highlighted that the initial pandemic disruption and its butterfly effect swamped the health communication channel leaving little space for other important health issues. I argue that as the communication system remains sensitive to the emergence of a new crisis, the system coherence can at any time be affected by the crisis, and then transform to cope with the dynamic information needs in the embodied interaction at different stages of the crisis. Although the communication system can approach a new self-organisation and stable state that is more effective, organisations can facilitate this shift by having an effective social media crisis communications strategy in place.

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An effective social media crisis communications strategy encompasses various elements that collectively contribute to the successful management of crisis situations. For instance, proactive monitoring of social media channels and keeping a vigilant eye on various platforms to detect any signs of a potential crisis or emerging issues can be suggested. By actively monitoring conversations and discussions on social media, organizations can identify early warning signs, assess the severity of the situation, and respond promptly to address the concerns and mitigate any negative impact.

By developing and communicating archetypical patterns of platform use and by explaining conditions and events that lead to communication outcomes, this study can assist management in developing effective social media policies and strategies.

Previous studies investigating social media applications for crisis management have mainly focused on technology and organizational benefits and are less concerned with an in-depth understanding of the event-related elements of social media communication during a crisis. In this sense, my longitudinal investigation of the communication transformation in response to the crisis movement and its consequences is novel. The contribution rests not only on *revealing the way social media contributed to the COVID-19 crisis communication but also on highlighting the situations in which social media communication was highjacked by crisis-related topics which undervalued the diversity of the audience and these information needs*.

This study applied the *engaged scholarship* method and articulated a framework (Figure 28) that can guide IS researchers to study social media and, in particular, the application of social media by public/private organisations in crisis communication.
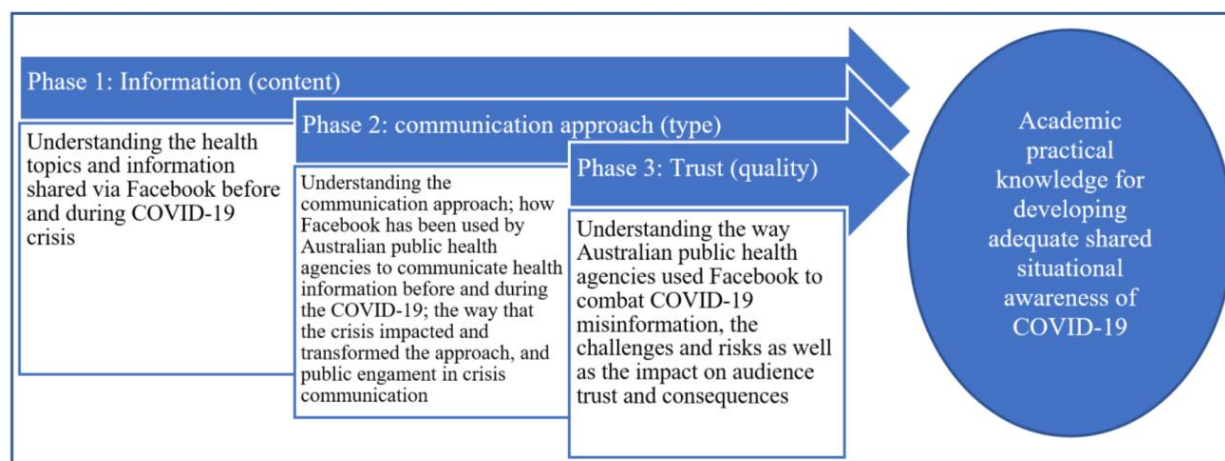
Figure 28 Conceptual Framework for studying social media crisis communication

This study filled a significant gap in the literature by focusing on the extent of the use of social media platforms by public health agencies during a crisis of this magnitude. Prior to this study, there had been limited research that specifically investigated and documented the comprehensive scope and reach of public health agencies' engagement on social media during such crises. By examining the extent of their use, this research contributes to a deeper understanding of the strategies and effectiveness of public health agencies in utilising social media platforms to disseminate crucial information, engage with the public, and address public health concerns during times of crisis. By analysing the official Facebook pages of key Australian health agencies, the research sheds light on the communication patterns before and during the pandemic. This analysis provides valuable insights into the changes and challenges faced by these agencies in adapting their communication strategies to the evolving crisis. Furthermore, the study applies Chaos Theory as a lens to understand the complexity and impact of the pandemic on government Facebook communication. This theoretical framework helps explain the initial uncertainty and mixed messaging experienced in the early stages of the crisis, as well as the subsequent shift towards more consistent and effective communication. By identifying the strengths and weaknesses of Facebook as a communication medium during the pandemic, the research highlights the

importance of social media platforms in disseminating critical health information and promoting behavioural change. It underscores the need for public health agencies to harness these platforms to reach a large audience, engage with the public, and deliver messages for behavioural interventions.

Further Studies

The findings of this study can be enhanced by further *social and community studies* to expand understanding of the phenomena from the community perspective. A community study can reveal the community's understanding and expectation of the utilisation of social media in health communication and information transmission during a crisis. It can identify the alternative, i.e., offline, channels the community uses to obtain and communicate health information during different phases of a crisis. Furthermore, the social and cultural norms that may impact the community's health and influence their use of social media for health communication can be explored further.

Limitations of the Study

While my study analysed data from before the COVID-19 pandemic to the early stages and throughout the first year of the COVID-19 pandemic, further research is required to investigate the recovery and resilience-building phases of the pandemic. This study also focused on health agencies' approaches to Facebook communication, and further research on health communication by and between individual Facebook users could enhance the knowledge in this area. Of course, other social media platforms like Instagram and Twitter play an important role in crisis communication, and they also need to be closely studied.

Like other social media studies that use social media data for analysis, my data collection and dataset are slightly influenced by the platform providers' and channels' owner filtering policies,

which can also impact communications outcomes and present us with another area of critical

research.

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Appendixes

Appendix 1- Interview questions and guide

General questions relating to NSW Health:

- *What are the decision-making processes and governance structures in public health communication? Organizational chart (i.e., structures and is it part of an overall communications department?).*

- *Who is responsible for managing the various communications channels?*

- *What are the decision-making processes and governance structures in public health crisis communication? Organizational chart (i.e., structures and is it part of an overall communications department?).*

- *Are the same people responsible for managing the various communications channels?*

- *What are health communication strategies currently being used by NSW Health to manage COVID-19 and other contagious diseases?*

- *How does NSW Health target different audiences (groups and communities) through social media communication during the pandemic?*

In your opinion:

- *What role does social media play in public health crises? Is it the main channel? How does it work with other communication channels?*

- *How do you decide what information to post on social media channels and the timing of posts?*

- *Does this dovetail with an overall communications strategy incorporating other channels e.g., TV, radio etc.?*

- *How has the COVID-19 pandemic impacted public health social media communication strategies in general?*

- *How have public health messages been created during the current COVID-19 pandemic, i.e., who has input to them?*

- *How effective was social media communication during the pandemic?*

I would also like to ask a few questions about the infodemic (an overabundance of information) and COVID-19 misinformation, for instance:

- *Have you observed an infodemic in terms of COVID-19?*

- *How has the infodemic and misinformation impacted public health communication?*

- *How has COVID-19 misinformation been addressed by public health agencies?*

Now, lastly, I would like to explain our observation of Facebook as a public health communication channel during 2021, and I would appreciate hearing your thoughts about "*how we can improve the effectiveness of social media public health crisis communication.*"

We observed the:

- Level of engagement of public health agencies with the general public on Facebook considerably increased compared to previous years.

- Initial pandemic disruption swamped the Facebook channel.

- Facebook channel was hijacked by a "crisis-related focus" that undervalues the diversity of the Facebook audience and their information needs.

- *How does NSW Health target different audiences (groups and communities) through social media communication during the pandemic? Audience*

In your opinion:

- *What role does social media play in public health crises? Is it the main channel? How does it work with other communication channels? Channel*
- *How do you decide what information to post on social media channels and the timing of posts? Message*
- *How have public health messages been created during the current COVID-19 pandemic, i.e., who has input to them? Message*
- *How has the COVID-19 pandemic impacted public health social media communication strategies in general? Pandemic impact*
- *How effective was social media communication during the pandemic? Effectiveness*

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- *Have you observed an infodemic in terms of COVID-19?*
- *How has the infodemic and misinformation impacted public health communication?*
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- Facebook channel was hijacked by a "crisis-related focus" that undervalues the diversity of the Facebook audience and their information needs.

Glossary

Term	Definition
Federal Government	Australian Federal Government Department of Health
Information and communication technology (ICT)	A diverse set of technological tools and resources used to transmit, store, create, share, or exchange information.
Information Systems (IS)	A combination of software, hardware, and telecommunication networks designed to capture relevant data, particularly within an organisation. The lack of a clear and explicit definition of IS in the literature is identified as a challenge for the field (Boell & Cecez-Kecmanovic, 2015). They highlighted the need for a clearer and more comprehensive understanding of IS through a well-defined conceptualization. Different definitions of IS can be categorised into four distinct views: the technology view, the social view, the socio-technical view, and the process view. The technology view emphasizes the technological aspects of IS, focusing on the role of information technologies. The social view highlights the sociocultural dimensions of IS, recognizing the importance of social systems and human actors. The socio-technical view underscores the interconnectedness of technology and social elements within IS. The process view emphasizes the activity-oriented nature of IS, focusing on the tasks and processes they facilitate.
NSW	New South Wales is a state on the east coast of Australia
NSW Health	The New South Wales Ministry of Health is a ministerial department of the New South Wales Government
Situational Awareness (SA)	A person's mental representation of their surroundings shapes the person's decisions and actions
The agencies	Refers to the three Australian public health agencies (Australian Federal Government Department of Health, New South Wales Health, and Victoria Health) that are the focus of this study
UNICEF	United Nations International Children's Emergency
VIC	Victoria is a state in southeast Australia
VIC Health	The Victorian Department of Health is a ministerial department of the Victorian Government
UN	The United Nations
WHO	World Health Organisation

Subject: Response to examiners' suggested correction for thesis SID 430443891

To whom it may concerns,

I am writing in response to the review of my thesis, Apandix 1 and 2. I appreciate the examinors' insightful and constructive feedback, which provided valuable guidance in refining my manuscript.

I have diligently reviewed each point of correction you suggested and have taken steps to implement these changes. Following several rounds of review, I am pleased to inform you that I have successfully addressed the requested changes under supervision of my supervisor. In particular, significant revisions were made to Chapter 4 and Chapter 7 of my thesis.

I am pleased to share that Chapter 4 has been accepted for publication (A* journal) in the Journal of Association for Information Science and Technology (JASIST), which signifies the value and contribution of this chapter to the field.

Furthermore, the initial version of Chapter 7 underwent a revision and sugested a minor revision by the International Journal of Information Management (IJIM). I have now submitted the current version for final review, and I am optimistic about its acceptance in due course. The feedback received from IJIM (A* journal) during the review process has greatly enhanced the quality and relevance of Chapter 7.

Below, I summerise the changes the examiner feedback and detailed where in the revised manuscript you can find these amendments:

Major Corrections:

Literature Review: The examiner mentioned the need for a more comprehensive literature review, particularly about SSA and the role of social media in crisis situations.

I updated the literature review chapter of thesis also chapter 4 and chapter 7 compleately revised to address the comment.

Structure and Theories: The examiner noted the lack of clear explanations about the chaos theory, and requested more justification for the selection of chaos theory.

The issue previously been raised by JASIST and were addressed in the revisions of the papar (Chapter 4), which accepted by the journal.

Methodology: The examiner had concerns about the methodology, including the lack of detail about Netnography method (chapter 4) and data set and how the data was analyzed in chapter 7.

The methods and analytical procedures were revised and now include a figure that summarises the methods across each paper (chapter 4 and 7). As I advuced, both chapters revised and the current version on the chapters received positive feedback and acceptancence from A* journals.

Outdated Information: The examiner pointed out that you referred to Google+ which was shut down in 2018.

I confirm that this comment has been addressed and a complete definition and different types of social media have been included.

Role of Social Media: The examiner wanted clearer articulation of the role of social media in crisis management.

I revised the literature review and the introduction chapter to address these comments.

One Study or Multiple Studies: The examiner wanted clarity on whether the thesis is one study divided into multiple papers or several distinct studies.

The introduction chapter and introduction to each chapter as well as the conclusion and discussion chapter have been revised to improve the flow of information and ensure a strong connection between chapters.

Minor corrections also inluded:

Consistency in Using First-Person References: I have carefully reviewed all instances where "I" and "we" were used and have amended these to ensure consistency across the thesis. These changes can be found throughout the manuscript.

Clarity in Referencing: I have made corrections to all citations as suggested. This can be seen on every page where references are cited as well as reference list. All references have been thoroughly checked and corrected as necessary.

Formatting Consistency: The formatting across chapters has been harmonized, from headings to line spacing and indentation. You can see these changes beginning from the table of contents and throughout the individual chapters.

Grammatical and Typographical Accuracy: All instances of tense inconsistencies, spelling mistakes, and punctuation errors have been corrected. These changes can be seen throughout the entire manuscript.

Semantic Corrections: I have made the suggested semantic changes to improve the readability and coherence of the thesis.

Lastly, the examiner pointed out issues with presentation, including inconsistent use of the SM acronym, missing spaces, inconsistent referencing style, and grammatical errors. I confirm that all these comments about presentation have now been addressed.

I am confident that these amendments have significantly improved the quality and readability of my thesis. I am grateful for the time and effort you will invest in reviewing my work. In the appendix 1 and 2 I included the original examinors reports and the pages that you can find the corrections in the revised version of my thesis. If there are any further suggestions or feedback, I would be more than happy to address them.

Thank you again for your invaluable input.

Best wishes,
Maryam Shahbazi,
maryam.shahbazi@sydney.edu.au

Apandix 1 Examinor 1

Major corrections (sharpen strengths and soften weaknesses)

Further exploit social media Consider expanding on the key concept "social media", and its relationships with nearby terms (page 24). Clarify the differences between social media, "regular media" (p. 29) and "traditional media" (p. 133)(page 25-26), to be able to pick up, for example, on the interview comment that "the same message is communicated in at least one other way" (p. 223). As there ought to also be a number of online alternatives to social media, consider rewriting the statement "alternative, i.e., offline, channels" (p. 237)(226). Elaborating on more functional differences would also be a valuable addition to current characterisations mostly based on technological terms (e.g. pp. 17-18, 23). Especially since you also repeatedly use the more specific term "social media platforms" (p. 4, 11, 12, etc), and also "social media services" (p. 23))(page 25-26),, without a clear distinction to just "social media". This risks unnecessarily conflating issues that could be beneficial to the research, for example in elaborating the key terms "social" and "media". After all, many see traditional media as more than for example a physical newspaper or the technology of a web site. This also might include linkages between the characteristics of social media and the research issues focused on. Questions about node symmetry/asymmetry, alternatives to the traditional distinction between sender and receiver, and distribution of power could all be valuable issues both in the early and later parts of the thesis. (page 27) For example, you talk about the importance of "information and communication initiated by users" (p. 227), but largely stay out of this in your own research where instead users' responses to information and communication initiated by agencies are focused.

Distinctions between technology and functionality could further be uncovered by expanding on the links to related terms occurring in the thesis. For example, "information and communication technology", (page 29-30) which at present is rather briefly mentioned (e.g. p. 25) rather than defined and actively used. And "information systems", a concept that could add further value beyond representing an academic discipline and a glossary definition on page 272 (page 279 the definitions from literature are included) .

Key subgroups within social media could also be useful to clarify before specific examples are used (e.g. social networking sites; p. 27 and 28 have been edited). Moreover, an overview of the relationships between key concepts of the social media context in – 2 – focus, e.g., "channel", "post", "keywords", "comment", "like", "share", etc, could be valuable given the recurring use of these concepts in the thesis (page 30).

Further exploit own perspective Consider expanding on your underlying views concerning knowledge and the world, touching on traditional research concerns of epistemology and ontology. This is especially important given your focus on key concepts such as information, misinformation, shared situational awareness, etc. For example, what do you see as central qualities of information, and in what contexts do you see it fitting to talk about information as true or false? The mentioned tension between subjective and objective raised in the thesis, could be further expanded upon in chapter 6, or perhaps returned to in chapter 8. The importance of perspective also concerns the issue of shared situational awareness. How important are the specific parties that share the awareness, and how important in the specific awareness being shared? How much is linked to a particular (valid, correct, true?) awareness originating from particular sources and communicated to a number of recipients? For example, page 6 talks about "shared situational awareness for the general public", which seems

to portray them more as a receiver and less as a creator of the situational awareness. Moreover, at times the shared aspect of situational awareness almost seems reduced to an individual's forming a combined or integrated awareness based on multiple and potentially conflicting accounts/sources. For example, consider clarifying, or at least support the statement that "To effectively manage a crisis, governments, organisations, communities, and people rely the majority of their decisions on shared situational awareness (SSA) acquired from many information sources" (p. 227). (page 70 and chapters 4, 5 & 7 edited accordingly)

Further exploit the data Consider reworking, or adding some extra analysis, to avoid drawing premature conclusions based on the numbers observed. In chapter 4, it looks like the analysis and results are mainly based on comparing percentages. For example, regarding mental health support you talk about a reduction "from 8.9% to 4%" (p. 115). However, looking at the absolute numbers from table 10 (p. 109), and adjusting for the different length of the two time periods, the number of posts on this subject seems to instead have increased, from 11.8 to 13.8 posts/month on average. If this is a valid point, also consider updating the parts of the thesis where you make use of these findings, e.g., using comments such as "received less attention" (p. 231) and "rarely provided" (p. 234). Especially when stronger expressions are used, such as "undermined" (p. 226) and "'swamp' and block communication" (p. 231). Just because "the communication shifted its focus" does not necessarily justify statements that certain discussions were undermined or blocked. (chapter 4 has been edited accordingly)

Furthermore, consider the potential impact of preconceived labels used, and if these instead could be explored through the research undertaken. For example, by already from the beginning talking about "communication strategy", it is easy for the reader to think about explicit guidelines directing the behaviour of the people involved (I have corrected it). If instead, it is more the observed output that is referred to then it might be an alternative to replace "strategies" in this context with "actions" or "behaviours". Or, at least, to comment on your use of this word, also when discussing conclusions (e.g. p. 232) to avoid possible confusion. Indeed, whether the observations are due to an explicit strategy or ad-hoc events is in itself something that could be explored. –

3 – Similarly, consider talking about "official" instead of "trusted" sources when for example referring to government sources (e.g., p. 182, 215) (I have referenced literature that government channels are trusted channel for public). Especially since the issue of trust depend on more than the source itself, as shown in the research (I talked about other factors that impact trust). Given the results it can be potentially misleading (or at least unnecessary) to use the term "reliable" in statements such as "Facebook user's decision to share reliable information from official public health sources" (p. 234 edited). In this context, "reliable" seems more of a reflection of the author's judgement, or the sender's, and not necessarily that of the Facebook user who for example reposts a message together with an angry comment or icon. Despite currently stating that local public health organisations "create effective shared situational awareness" (p. 232), it would not be unplausible to argue that the thesis instead has shown how they fail to create effective shared situational awareness (page 167). Therefore, at least consider changing the wording to "aims to create effective shared situational awareness" or something similar.

Further exploit findings To further highlight the findings of each chapter and of the thesis as a whole, be careful with mixing more forward-looking plans and methodological concerns with accounts of data, results and conclusions. This especially applies to chapter 8, which seems to have a dual ambition of covering the field interviews as well as concluding the thesis as a whole. As this chapter does not have the earlier chapters' initial "preface section", the introduction (p. 219) needs to introduce to the chapter as a whole, not only the interviews (page 228).

When reading about narrative analysis of the interviews, expectations are raised concerning details of the responses obtained, and their analysis into meaningful results. Therefore, consider including at least one direct interview quote in each of the bullet points (findings) on page 222-226 (done). In addition to highlighting results, the presentation of conclusions is equally important, especially of the thesis as a whole.

However, a large portion of the text following the heading "Conclusions and Discussion" (p. 227) bears more resemblance to a summary or an abstract of the thesis as a whole. Consider reworking or at least expand this section with more focus on things that simply could not have been written in earlier chapters. If the sentences in bold italics are meant to highlight the conclusions, these are the things that the reader expects to dominate this section of the chapter. In order to develop this section into the key part of the whole thesis that it deserves to be, consider elaborating the rather general statements now used. For example, tell us more about the "various aspects" that were shed light on (p. 229), about "how" interventions were enabled (p. 230), about the "poor outcomes" in the early stage of the pandemic (p. 230), about the "way forward" suggested (p. 230), about why managing objective-subjective tensions is "particularly important" (p. 231), about "the ways" Facebook is used to mitigate misinformation (p. 232), et cetera (i.e. each of the sentences in bold italic). Rather than summarising the thesis, this is the place for conclusions and discussion, exactly as the heading promises. Consider if the paragraph on page 233 with a sentence in bold italic has more in common with the previous highlighted conclusions. If so, consider moving it to the previous section (so that the heading regarding academic and practical contributions starts with the paragraph beginning with "Social media platforms..."). Also, in general, consider referring back to the parts of the thesis where the reader can find further details [the section revised].

Furthermore, consider rewording the four headings in chapter 8 that all include the word "Discussion" (p. 220, 222, 227, 233) to make it easier to understand what content to expect in each section (done). The final main section of the thesis, currently entitled "Conclusion and Discussion, Academic and Practical Contribution", rightfully seems to focus on contributions. However, consider elaborating the four bullet-points on page 234 with more specific statements about your contributions, e.g. in the form of examples. Not arguing their relevance, the current bullet-points do not really (242-246 edited) reveal much of – 4 – the interesting results from chapter 4-7, and could in principle have been written already in chapter 1-3 as ambitions. Consider also specifying the contents of the "framework" (done, page 245) articulated (p. 85, 236), perhaps using a figure to give an overview (not to be confused with the "study framework" outlined in figure 9 on p. 62). Further exploit the foundations Consider elaborating some general statements by supporting them with your argument and line of reasoning. Examples or follow-up details may lead the reader beyond wordings that might feel a bit vague on their own, e.g., "investigates the phenomena from different angles and reveals comprehensive knowledge" (p. 20 edited now page23), "simple yet effective" (p. 73), "provided meaningful insight" (p. 229). This also applies to statements that might benefit from additional clarifications. For example, what does it mean for a strategy to be "effective" in "an effective social media crisis communications strategy" (p. 236 addressed now page 263)? Or what "vastly" mean in "vastly expanded the reach" (p. 231 addressed now page 257), and how the study showed this. Or in what specific ways the pandemic and the disruption caused "are unique" and what "the new challenges" (p. 17 addressed now page 20) amounts to. Although everything is unique in some respect, it is still interesting to know if there are similarities perceived that can make lessons learned useful also in other contexts. In addition, especially consider elaborating statements that are categorical, e.g., "the foundation" (p. 228), or normative, e.g., "social media should be

effectively integrated" (p. 234). Foundations are also relevant when considering limitations, both in advance and following what the research has uncovered. For example, consider elaborating on possible consequences for your approach and findings following from the insight that comments are moderated by the community and the agencies (p. 225). Further exploit the research approach Consider elaborating the journey undertaken to complete the research by making more use of the research model presented (p. 73). Instead of only referring back to earlier discussion, a deeper explanation of the research process in relation to the figure would help the reader visualise how the different research activities interconnected. Also in relationship to the "study framework" outlined in figure 9 (p. 62). (These comments are due to the format of the thesis that is "by publication", I edited the manuscript to address this comment however the change in the length and visiulisations included in the papers follow the journal requirements) This becomes even more important for chapter 8 where interviews are described as having been made both at the early and the later stage of the study (p. 220-221) chapter 8 is revised. Being able to follow these details in the initial research model, or an elaboration of it, would help the reader to better relate the interviews to the other research activities (addressed on page 258). More than repeating a whole paragraph from page 203 on page 221, consider providing further details regarding the interview activities over time, such as potential differences in aims, number of respondents, and feedback received between the two stages of interviews (chapter 7). Furthermore, consider describing and arguing for characteristics of own research approach before saying method etc is appropriate for certain situations. For example, consider preceding statement that methodology is "appropriate for such exploratory research" (p. 85) with first describing the reasons for considering the research as explorative, and not only qualitative. Especially since earlier having described how the thesis "explains" (p. 20) and how theory is "used as an explanatory lens" (p. 69). (edited now page 102 and 103) Regarding the use of chaos theory, consider being more specific about the perceived benefits of using this theory. What alternatives were considered, what challenges were experienced, what was emphasised and what was downplayed by this way of dealing with complexity? Chapter 4 revised When discussing – 5 – contributions (p. 235), consider elaborating on the consequences of your use of theory, not only on the results obtained but also concerning the theory itself. Perhaps in terms of challenges with the theory or its application, or suggestions of possible improvements? Intermediate corrections (clarifications and possible misunderstandings) Consider clarifying relationships between related terms used without clear distinctions, e.g., "risk", "crisis", "emergency", "threat", "disaster" and "hazard" (p. 14, 16, 17, 19, 22, 32). Or comment on whether this perhaps does not matter that much for the present research. At least the terms "disaster" and "crisis" are described as used interchangeably in the thesis (p. 25). Consider making tables more readable by starting with the integrating column that clarify what each individual row is about. For example, the natural first column in table 1 on page 24 would be "Social media application" rather than "Study" – as also hinted by the table caption (it is the appropriate format for the journal publication so I kept that consistence through thesis). In the similar vein, consider rearranging columns also in other tables to start with the key column as indicated by the caption (the literature review columns are arranged chronologically). Consider elaborating relative judgements to make it clearer what is being compared to, e.g., "tools are less utilised" (p. 13 reference provided). Consider giving references, or arguing for, statements that might not be directly obvious to a reader, e.g., "Over 82 million individuals had been infected with COVID-19, and over 1.8 million had been killed by 31 December 2020" (p. 13) fixed, "The pandemic caused the worst worldwide economic crisis in over a century" (p. 13), "The crisis exacerbated inequalities inside and across nations" (p. 13) fixed, "These platforms engage the public, build trust and real-time engagement, and motivate the public to take action in public health emergencies" (p. 14; especially "build trust" fixed). Consider briefly explaining "netnography" when the term is first used (included on page 4 which is the first time) (p. 4, 5, 67), instead of waiting until

p. 76. Consider not using the abbreviation "SM" fixed (p. 22) before defining it. Consider clarifying the potential confusion when "this study" sometimes seems to refer to the whole thesis (e.g. p. 4, "The aim...", 219, 220, and sometimes to a part reported in an individual chapter. Consider clarifying the principles of using "I" versus "we", especially in the chapters not based on articles written together with others (i.e. all chapters except 4, 5 and 6?). (Each chapter in this thesis presents an independent yet related study, and it is important to note that the submitted or published papers have not been revised to include them in the thesis. I explained on page 25) Or, given that you at times use "I", at least clarify whom you refer to when using "we" in other chapters than 4, 5 and 6. For example, in chapter 3 you write "we followed..." and "I use..." in two paragraphs on the same page (p. 86). In chapter 7, "we" is used whereas in chapter 8, "I" is. It becomes a bit strange to read the exact same paragraph twice where the only difference is "We collected informants'..." (p. 203) versus "I collected informants'..." (p. 221). (Chapter 7 is a paper as I stated in the introduction of the Chapter) Clarify if the reference to "unpublished manuscript by Shahbazi et al., 2022" (p. 146) refers to any chapter in this thesis. If it does not, consider expanding and/or replacing it with reference to material actually included in the thesis addressed now page 167. Consider making the thesis easier to navigate. For example, show the same level of detail for all chapters in the Table of contents (pp. 7-8), and make sure chapter titles and main headings within a chapter have different indentation in the table. Also avoid inconsistencies between the table entries and actual headings (cf. second heading in chapter 8) fixed. In general, consider making the different heading levels throughout the thesis easier to distinguish, and avoid using different formats for the same heading level in separate chapters fixed (e.g., third level shown with indent in chapter 3 and trailing colon sign in chapter 8). – 6 – Consider if there ought to be a third-level heading before the bullet list starts on page 222, in a similar vein to the existing third-level headings on page 223 and 224 fixed. Consider enhancing the details in the authorship attribution statement (p. 2) with the full information now only found at the start of each chapter, including co-authors, etc. Conversely, expand the introduction of chapters 4-7 with full information on co-authors, etc. Also avoid possible misunderstandings by replacing "MS" with "manuscript" (p. 2), if that is what is meant fixed. Throughout the thesis, consider not including actual page references within the quotation marks, e.g., "a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0, and that allow the creation and exchange of User Generated Content (p. 61)" on page 23 fixed. The same applies also to footnotes detailing the internet source of a quote, which also belong outside of the quotation marks fixed (p. 178). When returning to purpose, goal or aim of work, consider referencing rather than rewriting the specific text in a similar but different way. Moreover, consider clarifying the relationship between "distinct yet interconnected research questions" (p. 20), perhaps by making use of an illustration similar to figure 9 on page 62. Minor corrections (unclear sentences or spelling mistakes) Throughout the thesis, consider referencing sources by author/source rather than title, both in text and in reference section, e.g. changing "Communicating risk in public health emergencies: a WHO guideline for emergency risk communication (ERC) policy and practice. , 2017" > "WHO, 2017" (p. 11; also remove link to private computer location in reference list, p. 243). Also "Indigenous health and wellbeing, 2020" fixed- the rest are the websites that the author is not identified and that's where I use the title of the page as it is appropriate for APA > "AIHW, 2020" (p. 112) and "Archived: WHO Timeline -COVID-19," fixed > "WHO," (p. 48). Furthermore, do not use quotes around a reference, such as in the previous case and concerning "Statista" (p. 228). Throughout the thesis, consider avoiding first names when referencing sources in text, e.g., changing "Mirbabaie, Milad, Bunker, Deborah, Stieglitz, Stefan, Marx, Julian, et al., 2020" > "Mirbabaie, Bunker, Stieglitz, Marx, & Ehnis, 2020" (pp. 12, 132), "Mirbabaie, Milad; et al., 2020" > "Mirbabaie et al., 2020" (p. 132), and "Mirbabaie, Milad, Bunker, Deborah, Stieglitz, Stefan, & Deubel, Annika, 2020" > "Mirbabaie, Bunker, Stieglitz, & Deubel, 2020" All referencing issues are fixed. (p. 188). Throughout the thesis, consider

using the same line spacing (e.g. pp. 4-5) and consistently start new paragraph with blank line, not only new line (e.g., p. 5, 31, 74, 85, 220, 236) All editing and grammar and spelling issues are fixed. Throughout the thesis, consider writing "chapter" without capital "C" except when starting a sentence fixed. Throughout the thesis, consider keeping the same grammatical tense in the same context, e.g., not suddenly switching to past tense in early chapters of the thesis fixed. For example, consider changing "six revealed" > "six reveals" (p. 5) fixed, "seven comprehended" > "seven explores" (p. 5), "results showed" > "results show" fixed (p. 6), and similar issues on pp. 18-20. fixed Throughout the thesis, consider consistent use of hyphens/dashes in chapter headings fixed. Throughout the thesis, consider consistent use of initial capital in figure captions (figures 1, 17, 20 and 22 fixed). Consider changing "behaviour change messaging" > "messaging behaviour change" (p. 5) fixed, "as the previous failures" > "as previous failures" fixed (p. 6, or further detail the specific failures implied), "need this study a" > "need a" (p. 18), "This Chapter thus introduces" > "This chapter introduces" (p. 22), fixed "2010)describes" > "2010) describes" (p. 23), "study process map-phase" > "Study process map - – 7 – phase" (p. 185), "The Authors" > "The authors" fixed (p. 185), "be completed with" > "be complemented with fixed" (p. 219), "including; a"> "including a" fixed (p. 219), "and 4) and developing" > fixed "and 4) developing" (p. 219), "workers initiated most study" > fixed "workers led to that most study" fixed (p. 220), "etc. however; this" > fixed "etc. However, this" (p. 220), "I identified other" fixed > "I contacted other" (p. 220), "These are arguments" > fixed "There are arguments" (p. 222), "also receive information" > "also provide information" fixed (p. 224), "Also, the Instagram" > "Also, an Instagram" (p. 224), " used the number" > fixed ". They used the number" (p. 224), "lessen" > "lessons" (p. 226), fixed "'Australia's" > "Australia's" (remove initial apostrophe; p. 229 fixed), "the tone of Facebook" > fixed "the Facebook" (p. 230), fixed "i.e., individuals) control" > "i.e., individual) control" (p. 231), "crisis massaging during" > "crisis messaging during" fixed (p. 231), "behavioural change health messages" > "behavioural health interventions" fixed (p. 234; to align with the term used on p. 111, 113, 114 etc), "and that thus" > "and thus" (p. 235), "overal" > "overall" (p. 235), and "resources are used" > "resources used" (p. 272). Consider removing year of birth (?) from Rosenthal, Uriel in the references (p. 258). Consider completing the reference details for Thomas (2003) in the reference section fixed (p. 261). Consider changing the definition of "Federal Government" as "Australian Federal Government Department of Health" (p. 272). Consider removing semicolons when not needed, or replace them with colons when appropriate, e.g. "to; extending" > "to extending", "as; flood" > "as: flood", "as; World" > "as World" (all on p. 228) fixed. Consider starting a new paragraph after "(Australia, 2020). fixed" on page 229. Consider avoiding mixing commas and semi colons as separators in the same list of participants (p. 219). Consider changing the web address given in footnote into a proper reference to support the statements made (p. 18). Consider correcting the author names for Green & Hope (2010) among the references (p. 247), and use correct form in the thesis (p. 30, 228).

To resolve the aforementioned comments, Chapters 8 and Discussion were revised.

Apandix 2

Examinor 2 comments

This PhD research project focuses on the information provided by public health agencies during COVID-19. The thesis is topical and addresses an important area of research.

My recommendations sit somewhere between minor and major. They require some reworking of passages, some better packaging of the thesis and clarity of theory, methods, analysis and contribution. My review is lengthier than I would usually write, but there is some repetition in my suggestions. Changes do not require an additional period of research nor result in the conclusions of the thesis being significantly altered.

The thesis is not a monograph but several papers which are top and tailed with sections. This leads to some confusion and duplication. I am not suggesting a change to this structure, however many of my comments require some rethinking on where best to make changes.

From the outset the thesis focuses on Shared Situational Awareness (SSA). Indeed, RQ1 investigates how government agencies create SSA. In my reading of the first few pages of the thesis I believe the thesis is on how public agencies use social media during crisis (i.e. Covid-19) to provide information. SSA more commonly refers to the building of SSA between actors, i.e. police, fires, paramedics, or health agencies, municipalities, etc. In this research this concept is taken to refer to public health agencies providing information to citizens (this comment now is briefly addressed in the abstract of the thesis page 5 and explained in chapter 4 and chapter 7). This information might inform citizens (or not) - in my view it is not the same as SSA. Do citizens care about "*shared* situational awareness"? Or are they just concerned with their situation? If it is the former then a stronger justification is needed and an argumentation and an extension of the term should be offered and a deeper examination of the concept is required. Another approach is to avoid using the term SSA. There is little in terms of engagement with the literature on SSA, nor is there a strong contribution to it. If SSA has evolved over the last few years to be concerned with more than the inter-organizational aspect then this should be elaborated on. ("how we understand SSA" is now explained in chapter 4 and 7. All terms are also explained),

A related (but more minor) concern is that RQ2 writes how the communication system transforms over time to main the public's information needs. Should this be "in response to the public's information needs"? The current articulation reads like the government are trying to control the conversation, which I don't think is intended. This is a straightforward change (introduction chapter and chapter 4 revised).

Overall, the introduction is well written. It is the best written section of the thesis.

A couple of minor suggestions. The introduction could more explicitly state what methods and used and what data is drawn upon. The structure of the thesis could be made more explicit with a bullet point for each chapter or a figure. This would better guide the reader through what is coming. It is easy for a reader to miss the few sentences at the end of the introduction (page 25).

Literature review

Overall this chapter covers social media and its importance well, and how it is used in crises situations but stops there. I find it a little too high level for a thesis. I was hoping that the papers would go into more detail, however they also replicate much of the same content (literature review completely revised for chapter 4 and 7 and this comment addressed there).

When moving to more theory focused journals, like the Journal of the Association Information Systems (JAIS), i.e. your paper 1, there is a need to emphasize the context less and more so the problematization (e.g., building SSA during large scale volatile contexts), what we don't know and providing a greater account of the current literature. (Chapter 4 revised in three rounds of review and the current version of now is accepted to JASIST, a tier four journal in the Business School list)

As mentioned, there is little coverage of SSA, what it is, why is it difficult to achieve and the role of social media in building it. Likewise, the reader learns little about the key actors in this space, their roles, the information they provide and how they use social media.

Given my previous comments about SSA I will leave it for the student/supervision team to consider the best way forward. However, some more detail about the key actors in this space would be helpful.

After reading the remaining chapters, it is clear to me that there is a need to better piece together elements of the thesis. In later chapters concepts such as "risk perception model", are mentioned. They come out of nowhere. A figure would help guide the reader through how all these theories fit together. In the literature review there is only a basic introduction to chaos theory. Chaos theory plays a prominent role in the literature review, but less so in the latter sections. Some more justification for its selection and use viz-a-viz other theories is required. Focusing on this chapter is the best approach to do this because the later chapters are more set in stone. (Chapter 7 received minor revision from IJIM, a tier three journal in the Business School list. Then revised and the current version addressed the examiner comments)

Some more minor comments:

- Update the social media that you refer to on page 22. Google+ was closed in 2018/2019.Wikipedia doesn't seem relevant to your study. I am not sure about Flickr. (Comment addressed and a complete definition and different types of social media been included as other examiner requested)
- Be clear that when you say that Facebook is "top" that you mean in terms of numbers of active users (unless you mean something else). (the sentence revised)
- On page 25 it is not clear why ICT is used in one sentence and then SM in the next sentence (revised). Along these lines, it is not clear why ICT is in the title of the thesis, the research clearly is on SM.
- Table 3 could be more comprehensive, also consider putting it in chronological order (done).
- When presenting a table (i.e. table 4) it is helpful to tell the reader why you are showing them the table, what is the key takeaway (done)?
- Was the Arab spring a global event (changed to extreme event)?

Chapter 3

There is reference to the use of "social media to coordinate responses to public health emergencies". I am not sure a practitioner would agree with this. Social media is an information channel, it is not used as a tool by practitioners to undertake routine or crisis coordination. Clearly you mean information provision. But this needs to be more carefully articulated throughout the thesis. I am not downplaying the role of social media, however there is a need to relate it to the right activities and be clear about its role. This applies for similar statements throughout the thesis. (I supported my arguments about the use of social media by practitioners using literature and different studies).

In chapter 3 there is some discussion of SSA but again it confuses practitioner internal operations/coordination with information provision. There is a need to be more mindful of the boundaries of the research.

The description of netnography is limited, it stays at the same level, the reader is not given a understanding of how to do netnography, the data it yields, or how it offers value over computational methods etc (page 90 edited).

Chapter 4 (the chapter revised after three rounds of review, and the current version was accepted for publication by JASIST, The revisions also addressed all comments outlined by the examiner)

This is the first of the paper chapters. See my earlier comments re SSA.

This paper is very brief and the first part seems to repeat text already covered. I would be hoping to read newer content and a deeper focus, especially for a submission to JAIS.

In this paper Chaos theory is used but the data analysis is presented as relying on inductive methods. Which is it? Perhaps a more abductive approach is being utilised, but it is not clear.

Page 117 starts with title that reads like a new paper is starting. But in fact it is just a turn from the inductive approach to using chaos theory in the same paper if I am not mistaken.

Across all chapters it is not clear how the data was analyzed, i.e. what procedures were followed. This may be common in the journals you are submitting to, however for a thesis there is a need to provide more detail. See a recommendation to address this later.

Chapter 5

This chapter introduces Slovic's risk perception model, but so far in the thesis this has not been mentioned, the same for Sandman's risk model. (I have a paper copy so I haven't used the search and find function). I don't see a strong influence of these theories in the paper (page 161 is revised to explain the theory being used as a lens to frame the study, but the approach remained inductive).

Statements like "the international community is not yet ready to deal with such emergent pandemics" may have been relevant in 2020, but in 2023 when society has overcome and learnt to live with the pandemic it is less relevant (I edited the statement and included the reference pandemics (Tambo et al., 2021)).

The findings in this paper are brief, I am not familiar with the Journal of IS so perhaps that is the style. I am not sure about some of the discussion points, is the "nature of a crisis, its characteristics and public emotions towards the situation determining factors of effect social media crisis communication"? Public emotions may reflect engagement but I am not sure what else it can show in determining an outcome (page 173 been revised).

Chapter 6

Chapter 5 is based on a paper where the student is second author. Given that the student "designed the study, collected and analyzed the data, and wrote the first draft" it is unclear why the student is second. Obviously these things happen when working in a team, a clearer clarification is needed of this situation, i.e., the first author presented it at a conference, the final version shared authorship, you went by alphabetical order etc.

Chapter 7 . (Chapter 7 received minor revision from IJIM, a tier three journal in the Business School list. Then revised and the current version addressed the examiner comments)

This chapter goes from an introductory section straight to methods and findings. The methods are not well described. For instance, a simple table of participants would have been very helpful. I struggled to clearly find the main study contributions as link to the papers – see my points below.

Overall, summary of my comments on the papers and actions

There is significant repetition of literature reviews across the chapters. I suggest that chapter 2 is significantly strengthened. By the time you receive my reviews you may already be adapting the submitted papers, so focus efforts on section 2 and the final chapter and strengthen the papers where it helps lift the individual papers.

Lack of detail about methods. Add a table that summarises the methods and analytical procedures across each paper/chapter (I am not sure where this would best fit). One thing that is not clear is if this research is one study sliced into several papers, or is it multiple studies presented as different papers? This should be clear.

Likewise, it is not clear how each paper reflects findings that are given in chapter 7, this again could be cleared up with a table.

Usually in a thesis there is a section on validity/generalizability/etc. Given that you do not have a method chapter I am not sure where this is best place. A sub section in the final chapter may be best place to cover this.

A clear contribution needs to be spelled out. What do we know now about social medial in crisis that we didn't already know? (this should be clear in the final chapter).

Presentation

As mentioned the introduction is written well, but the quality of writing is inconsistent from then onwards, below is a summary of some of the issues throughout:

There is inconsistent use of the SM acronym, missing spaces (e.g., page 23, 80) and inconsistent use of quotation mark format.

Inconsistent referencing style.

Inconsistent capitalization of headings and terms. On page 72 "we write this paper" is used, but this is a standard chapter if I am not mistaken (i.e. it should be "I").

Error!reference source not found is written on page 88 and several other pages.

Grammatical errors, such as "In this Chapter, I" (page 126).

Typos e.g., "behaviou" on page 130

(All abovementioned comments for presentation are now addressed)

Closing remarks

I hope these comments are helpful to helping the student round up their thesis whilst also doing the research justice. All the best with the changes and the papers.

Maryam Shahbazi

To Whom It May Concern,

I am Maryam Shahbazi's PhD supervisor and this email is to confirm that her PhD thesis is in a suitable format for submission to the University of Sydney library.

Regards,

Professor Deborah Bunker

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