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CRISIS COMMUNICATION DURING HEALTH CRISES: THE CASE OF CANADIAN OFFICIALS' SOCIAL MEDIA PRESENCE DURING THE COVID-19 PANDEMIC

Research in Progress

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Abstract

To effectively manage a health crisis, citizens need to have shared Situational Awareness (SA) of the crisis. This study proposes that the public draws upon shared mental models of the crisis to achieve shared SA. Declarative, procedural, and strategic knowledge bases comprise the essential aspects of shared mental models of mission-critical situations like the COVID-19 pandemic. Therefore, public officials must provide a constant flow of crisis declarative, procedural, and strategic knowledge on social media. This study investigates Canadian officials' presence on Twitter during the COVID-19 pandemic. Analyzing a dataset of 213,089 Canadian officials' tweets shows that their presence was either for health crisis management (73.26%) or crisis-related topics (46.66%). Declarative (72.03%), procedural (38.1%), and strategic knowledge (30.18%) comprised 96% of the health crisis management tweets. This study informs research and practice by analyzing the essential role of knowledge types in creating a shared SA in managing health crises.

Keywords: Crisis Management, Shared Situational Awareness, Social Media Analytics, Knowledge Types.

1 Introduction

The coronavirus disease (COVID-19) pandemic is not the first crisis in the age of Web 2.0 and social media. However, it is the biggest crisis of this era on an unprecedented and global scale. It also has features that differentiate it from most other crises. Foremost is its scale in terms of time, geography, and the affected population. Unlike other crises like natural and man-made hazards that take a short time, from minutes to days, health crises in the forms of outbreaks and epidemics happen in longer duration of time from weeks to months (Guidry et al., 2017). It has almost been two years (at the time of writing) since the pandemic started, and it is still going on. In such a situation when the pandemic necessitates people's direct access to a consistent flow of reliable information, social media come as a perfect means to fill this gap. The main body of research on social media use for crisis management, particularly the research on the authorities-to-citizens interactions, prioritizes the opportunity provided by social media for officials to directly communicate with the public on an unparalleled scale and bypass the constraints imposed by traditional media (Latonero and Shklovski, 2011, Wukich, 2015).

Furthermore, the unprecedented scale of the affected people in the COVID-19 pandemic and its consequences in emergency legislation and measurements, such as lockdowns, caused online technologies to become the favored means for citizens to access information and handle their daily lives. As a result, online technologies have become the primary choice of having social interactions (Beaunoyer et al., 2020, Wang et al., 2021). In this context, people are increasingly using social media

to seek and disseminate information on evolving topics about COVID-19 (Abd-Alrazaq et al., 2020). However, they are exposed to various questionable sources on social media (Puri et al., 2020, Cinelli et al., 2020). In such a situation, access to reliable pandemic information has to be provided to the public on social media. Recent studies have proven the public's trust in authorities' provided information (Guidry et al., 2017) and their positive effect on correcting misinformation on social media (Vraga and Bode, 2017). More importantly, in the COVID-19 pandemic, contrary to the public that is exposed to unreliable crisis information, authorities have organized access to reliable first-hand official information of the current situation and available resources, so they have a better picture of the crisis.

The most important feature, however, is the prominent role of the public in managing the pandemic. Unlike most other crises that authorities have the main and operational roles in managing the crisis; in the COVID-19 pandemic, the main operational role is on the public's shoulder. In such a crisis, authorities keep their traditional roles as leaders to manage the crisis. They identify the problem, set its boundaries, identify the solutions, and implement them in several forms, including emergency legislation and resource allocation (Eismann et al., 2018). However, the significant operational role that can ultimately influence the spread of pandemic is on citizens. They have to follow the legislation, practices, and measures to manage the pandemic.

Crisis management refers to the collective activities to manage crises (Mijović et al., 2019). Crises are any form of event that threatens individuals and communities. They require fast responses under limited information and continuously unfolding situations. Crises are often in large scales and distributed environments with high complexity, in which uncertainty and risk jump to high levels and pressures on time and resources increase tremendously (Elbanna et al., 2019, Marcus et al., 2020). Such circumstances need several prompt decisions that are often incomplete and inconsistent as they originate from different sources (Mijović et al., 2019). Therefore, stakeholders involved in managing the crisis need to develop a shared and evolving picture of the crisis (Benali and Ghomari, 2016, Santoni and Rufat, 2021). This picture has two dimensions: the situation itself and the tasks and strategies that must be done to manage it (Marcus et al., 2020). To achieve those, stakeholders need to gain shared Situational Awareness (SA). In crisis management, SA means the perception of the multifaceted circumstance of the crisis that allows stakeholders to interpret the situation and make informed decisions based on their interpretation and predict future outcomes (Trainor and Subbio, 2015).

In the setting of this problem, people are the main stakeholders in managing the crisis. As crisis leaders who want people to act wisely during the pandemic, authorities have to ensure that people have a correct shared SA. Citizens need SA to interpret their situation correctly and make informed decisions accordingly. The greater a shared SA among citizens, the more coordinated activities are in managing the pandemic. Therefore, authorities' social media presence should aim at enabling citizens to achieve shared SA. Now we refine our research question to *how authorities' and officials' presence on social media can enable citizens to achieve shared SA so the community can manage the pandemic?*

Based on the SA model (Endsley, 1995), social media analytics, and teamwork literature, this study argues that citizens need to draw upon shared mental models (Klimoski and Mohammed, 1994) of the crisis to achieve shared SA. While shared mental models describe the overall environment (the pandemic) and mechanisms that govern it, shared SA is the current and evolving dynamic understanding of the environment that helps subjects understand their current situation and predict the future states. Therefore, during pandemics, authorities should provide consistent shared mental models of the crisis on social media so citizens can achieve a shared SA by drawing upon them. We further argue that publishing information in declarative, procedural, and strategic knowledge types creates declarative, procedural, and strategic knowledge bases that comprise shared mental models of the crisis.

This study proposes a data-driven approach to analyze how authorities on social media can enable citizens to achieve a shared SA of the pandemic. For the case study of this research, we analyze Canadian authorities' Twitter presence during the COVID-19 pandemic for 13 months. We utilize this data to examine if Canadian authorities provided shared mental models of the pandemic on social media.

2 Theoretical Background

2.1 Situational Awareness

Describing SA as knowing what is going on, Endsley (1995) defines it as “the perception of the elements in the environment within a volume of space and time, the comprehension of their meaning, and the projection of their status into the near future.” SA has three levels. Perception of the elements in one’s environment deals with capturing data from the environment through all means. Comprehension of the current situation from the information gained through perception and interpreting those based on the individual’s mental models. In projection, individuals predict the situation’s outcomes in terms of the elements’ actions. It results from knowing the environment’s current state and comprehending the situation’s dynamics. The three levels of SA do not come in sequential order, but all occur virtually simultaneously. Situational assessment, the process results in SA, is a continuous dynamic process; therefore, SA is dynamic and constantly evolving (Nofi, 2000).

SA is vital for decision-makers in crisis management as it enables effective decision-making in emergency responses (Yin et al., 2012). However, SA is a separate construct and only provides the input for effective decision-making. SA is a state of knowledge and the product of situational assessment in which individuals use mental workload to acquire and maintain SA (Pew, 1994, Endsley, 1995). Experts in a field that can achieve a high level of comprehension and projection can make wrong decisions if they have incomplete or inaccurate SA (when perception is false). The opposite is also true. Decision-makers can understand the situation correctly, yet they can not make an effective decision (Endsley, 1988, Endsley, 1995, Doyle and Paton, 2018). In this scenario, although the perception is high, decision-makers’ comprehension may not be high as they do not have enough mental models of the system, which is the overall knowledge of the elements of the system and the mechanisms that govern them. Due to the complex nature of crises, having a correct SA of the crisis is a must for decision-makers. Otherwise, poor SA leads to wrong decisions that eventually cause severe consequences (Trainor and Subbio, 2015).

2.2 Shared Situational Awareness

Although having a correct SA of the crisis is necessary, it is not sufficient as successful crisis management has other factors, most notably the presence of several stakeholders in managing a crisis. Successfully managing the situation depends on coordination among all these stakeholders (Doyle and Paton, 2018). A critical task here is facilitating the coordination, communication, and collaboration between stakeholders and sharing knowledge to effectively manage the crisis (Doyle and Paton, 2018). Since crisis management is a team effort and involves several stakeholders, all team members need to have a shared understanding of the situation, i.e., shared SA. Nofi (2000) defines shared SA as “the common ‘picture’ of the mission-critical factors affecting a situation that the members of certain groups must develop to perform their duties at peak effectiveness.” In crisis management, stakeholders need shared SA to coordinate their tasks in collaboration with other stakeholders and not obstruct other stakeholders’ performance (Pogrebnyakov and Maldonado, 2018, Mijović et al., 2019).

In mission-critical situations like crisis management that require coordination between stakeholders, shared SA is achieved when team members gain shared mental models (common knowledge bases among team members). More precisely, when mission-essential overlapping portions of team members’ SA integrate into shared mental models (Nofi, 2000). Shared mental models are necessary for effective team coordination in dynamic and challenging environments with high uncertainty. Team members draw upon them to develop accurate expectations for their performance and the team members’ performance (Salas et al., 1994, Stout et al., 2011). Shared mental models assure all stakeholders solve the same problem (Orasanu, 1990). Moreover, they will cause the interactions among stakeholders to be well-coordinated (Bettenhausen and Murnighan, 1985).

Stout et al. (2011) describe mission-essential overlapping portions of knowledge as the aspects of mental models that stakeholders need to share to achieve shared mental models. Their model proposes that

declarative, procedural, and strategic knowledge bases comprise mental models that must be shared among team members. Declarative knowledge includes information about concepts and elements in the domain. They contain knowledge about the facts, rules, and relationships in the agents' environment (Stout et al., 2011). Procedural knowledge includes information about the tasks and steps that must be taken to fulfill those tasks (Stout et al., 2011, Salas et al., 1994). Finally, strategic knowledge includes information about the missions and contextual knowledge for problem-solving such as action plans, scenarios in which procedures should be implemented, and actions to be taken if proposed solutions fail (Stout et al., 2011, Salas et al., 1994). Sharing these three knowledge types creates shared mental models of the situation that assures all stakeholders they are solving the same problem and create a context in which all stakeholders can contribute efficiently (Orasanu, 1990).

2.3 Shared Situational Awareness and Social Media

Reuter et al. (2012) differentiate between four cooperation types or social media usage patterns in crises: Authorities to Citizens (A2C), Citizens to Citizens (C2C), Authorities to Authorities (A2A), and Citizens to Authorities (C2A). Theoretically, SA information could be a product of each four types. Authorities and the public both produce situational crisis information. They are also the end-users of curated crisis information enhancing SA (Imran et al., 2015). However, reviewing the literature (Reuter et al., 2018, Ogie et al., 2018, Luna and Pennock, 2018, Eismann et al., 2018, Bonaretti and Piccoli, 2018, Imran et al., 2015) reveals most of the research focuses on citizens' generated data as they are the dominant information producers on social media. Soon after the popularization of social media among the public, researchers pointed to the potential of citizen-generated data to enhance SA for decision-making in crises (Vieweg et al., 2010). Since then, a growing body of research classified as C2A has been investigating ways to extract SA information or collect and analyze this to enhance SA for decision-making (Ogie et al., 2018, Eismann et al., 2018, Imran et al., 2015).

These works use social media data to provide new methods and systems, mostly not grounded in theory, to help crisis managers in decision-making. They do not analyze SA as a construct nor distinguish between SA and shared SA. Their contribution is methods or systems that eventually enhance SA. Furthermore, as the eventual goal is enhanced SA for authorities, they look at authorities as a single unit, so there is no need for shared SA. However, several works point to creating a shared common picture of the crisis for the stakeholders and facilitating coordination (Wukich, 2015, van Gorp et al., 2015, Haataja et al., 2016). They suggest using social media capabilities to create this common picture or point to cases where organizations tried to achieve this. However, the literature has not paid much attention to shared SA as an essential construct in crisis management nor investigated how to achieve it or analyzed how this shared common picture or coordination among stakeholders can evolve in social media use. The current work builds up an argument that shared SA arising from interactions in social media is a critical factor in managing crises, such as the COVID-19 pandemic.

2.4 Conceptual Model

Seppänen et al. (2013) identify information, communication, and trust as the three requirements for forming shared SA in a network. To form a shared SA, key information elements must be identified, a communication path must be provided, and trust must be at the highest level. This study goes into the A2C category as the authorities are the source of pandemic information, and the citizens are the recipients. Public authorities' leading role and access to the most updated pandemic information make them reliable sources of crisis communication. On the other hand, the main operational role of the citizens to manage the pandemic makes them the recipient of this crisis communication. The communication path is social media due to the increasing citizens' use to seek and disseminate pandemic information. Social media also provides a direct communication path for authorities to communicate with the public on an unparalleled scale (Latonero and Shklovski, 2011, Panagiotopoulos et al., 2016). The A2C crisis interactions on social media to manage the pandemic address trust too. Authorities have

access to the most reliable pandemic information sources, and the public considers authorities reliable information sources (Guidry et al., 2017, Vraga and Bode, 2017).

Our conceptual model (Figure 1) describes enabling citizens to achieve shared SA through providing shared mental models of the situation. Authorities have to provide shared mental models of the crisis over the pandemic to enable citizens to achieve a shared SA. This model, adapted from Stout et al. (2011) model of shared mental models, describes providing shared mental models is achieved through providing three forms of knowledge to the citizens on social media. Therefore, we identify these three knowledge types, i.e., declarative, procedural, and strategic, as the key information element to form shared SA. They are also in accordance with Nofi's (2000) constituent mission-critical factors that team members must develop to perform their tasks at peak effectiveness. Declarative knowledge explains the facts about different aspects of the situation. This knowledge is necessary as it explains what the current situation is. Knowing the situation opens the way to describe the tasks and goals, the other two essential factors that citizens must develop. Strategic knowledge describes the main missions and policies to manage the pandemic. These policies provide contextual guidelines for the situation and guide citizens in understanding and selecting procedural knowledge. They are also informative enough so citizens can decide about their actions if no procedural knowledge is provided. Finally, procedural knowledge describes the tasks that citizens must do to achieve the goals mentioned in the strategic knowledge.

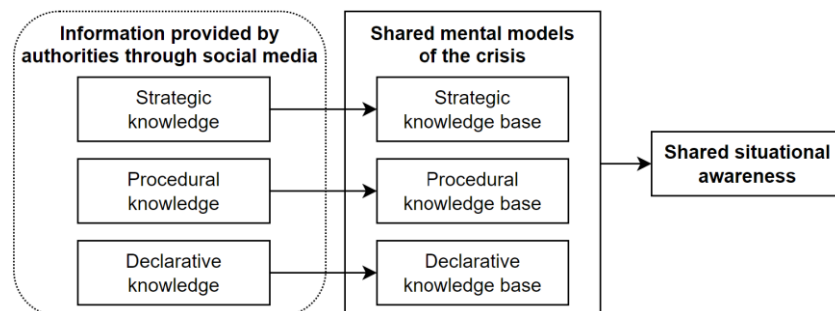


Figure 1. The conceptual model of contribution of information provided by authorities through social media to achieve shared SA in crisis management (adapted from (Stout et al., 2011)).

3 Research Design

Our list of Canadian public officials includes Twitter accounts for cities, mayors, federal officials and departments, provincial officials and departments, health services, and hospitals. First, we extracted federal and provincial officials and their departments' information from official websites and searched for their accounts on Twitter. Then, using a city list (StatisticsCanada, 2016) and a hospital list (CBCNews), we searched for city accounts, mayors, hospitals, and health networks using Twitter Application Programming Interface (API). A separate round of verification and removing inactive and private accounts resulted in 786 Twitter accounts. Next, we collected the public officials' tweets using Twitter APIs that allow access to the public accounts' most recent 3000 tweets. As the first reported COVID-19 case in Canada was on January 25, 2020 (Berry et al., 2020), we set the start date on January 1, 2020, and included 13 months of data until January 31, 2021.

We excluded tweets with languages other than English or French. Next, we used a set of terms (*covid*, *corona*, *korona*, *ncov*, *covd*, *sars*, *epidemic*, *outbreak*, *pandemic*, *épidémie*, and *pandémie*) based on the literature to identify COVID-19 tweets. This resulted in 739 official accounts with 213,089 tweets. Except for white space, we removed symbols, emojis, numbers, and non-alphanumeric characters. In addition, we normalized URLs and user mentions using common placeholders. Finally, we translated French tweets to English using Google Translate. We also lemmatized words to their dictionary form using the WordNetLemmatizer from Python Natural Language Toolkit (NLTK) (Bird et al., 2009).

The data analysis had two main phases: hashtag analysis and frequent term analysis. Since our goal was to find the main themes and subthemes in the social media presence of Canadian officials on Twitter, we started with hashtag analysis. Hashtags are community-driven conventions to categorize posts and highlight their topics (Wang et al., 2011, Godin et al., 2013) by adding a hashtag symbol (#) at the start of key terms. Wang et al. (2011) categorize hashtags into topic hashtags that identify topics, sentiment hashtags like *#kind*, or sentiment-topic hashtags like *#NursesRock*. In a preliminary analysis on the most-frequent hashtags (≥ 10 for English and ≥ 5 for French) in our data, 92.93% (1800 hashtags) were topic hashtags and 6.97% (135 hashtags) were sentiment-topic hashtags. It confirmed our approach as public officials tend to use hashtags to highlight the topics of their messages.

We used the hashtag field in the tweets' metadata to extract the hashtags. Then, we used the most frequent hashtags to identify the most common themes and topics manually. After two rounds of labeling, the authors reached a consensus for 47 fine-grained topics, i.e., subthemes, that we unanimously categorized them into 21 themes. Next, we extracted the top frequent terms up to trigrams, using the count vectorizer module from the Python Scikit-learn package (Pedregosa et al., 2011). We analyzed the top 2388 frequent terms (occurrence $\geq 3\%$) and added five new subthemes enriching the previously identified subthemes. For all the labeled terms, we searched and labeled other similar terms. This phase resulted in 21 themes, 52 subthemes, and a complete list of terms for each subtheme. We used these terms to classify tweets into predetermined subthemes. Analyzing the classification results, we excluded subthemes with low density ($< 1\%$), resulting in 8 themes and 37 subthemes. This part described the research design concisely, including all the information to replicate the study. More details of the research design are described in (Azarpanah et al., 2022).

4 Preliminary Results

Over the course of the study (from January 1, 2020, to January 31, 2021), 796,043 tweets were collected, of which 213,089 (26.77%) were about COVID-19. On average, a tweet in our data had 3.31 keywords and 2.46 subthemes. For example, the tweet: “*Stay home and get tested if you are sick or experiencing any #COVID19AB symptoms. Have a cough, fever, runny nose, shortness of breath or sore throat? It's mandatory to isolate for at least 10 days. Find out more: @URL*” by the Alberta government has eight keywords (symptom, fever, runny nose, breath, sore, isolate, stay home, and tested) that classifies the tweet into four subthemes: *Stay home*, *Self-isolation*, *Symptoms*, and *Test and trace*.

Our content analysis classifies the Canadian officials' COVID-19 tweets into eight themes and 37 subthemes (Figure 2). The themes and subthemes emerged into two main categories: Health Crisis Management (HCM) and Crisis-Related (CR). Subthemes directly dedicated to managing the COVID-19 pandemic as a health crisis, like providing safety information about COVID-19 and information about measures and practices to prevent COVID-19 propagation, were categorized as HCM. Subthemes that were not directly related to the pandemic but were affected and important enough to emerge in the top frequent hashtags and terms were categorized as CR. These themes and subthemes do not provide information on managing the pandemic as a health crisis but cover other aspects related to and affected by COVID-19. CR themes include *Economy*, *Health*, *Workers*, *Age groups*, *Schooling*, *Research*, and *Indigenous*. Full description and definition of the themes and subthemes are provided in (Azarpanah et al., 2022).

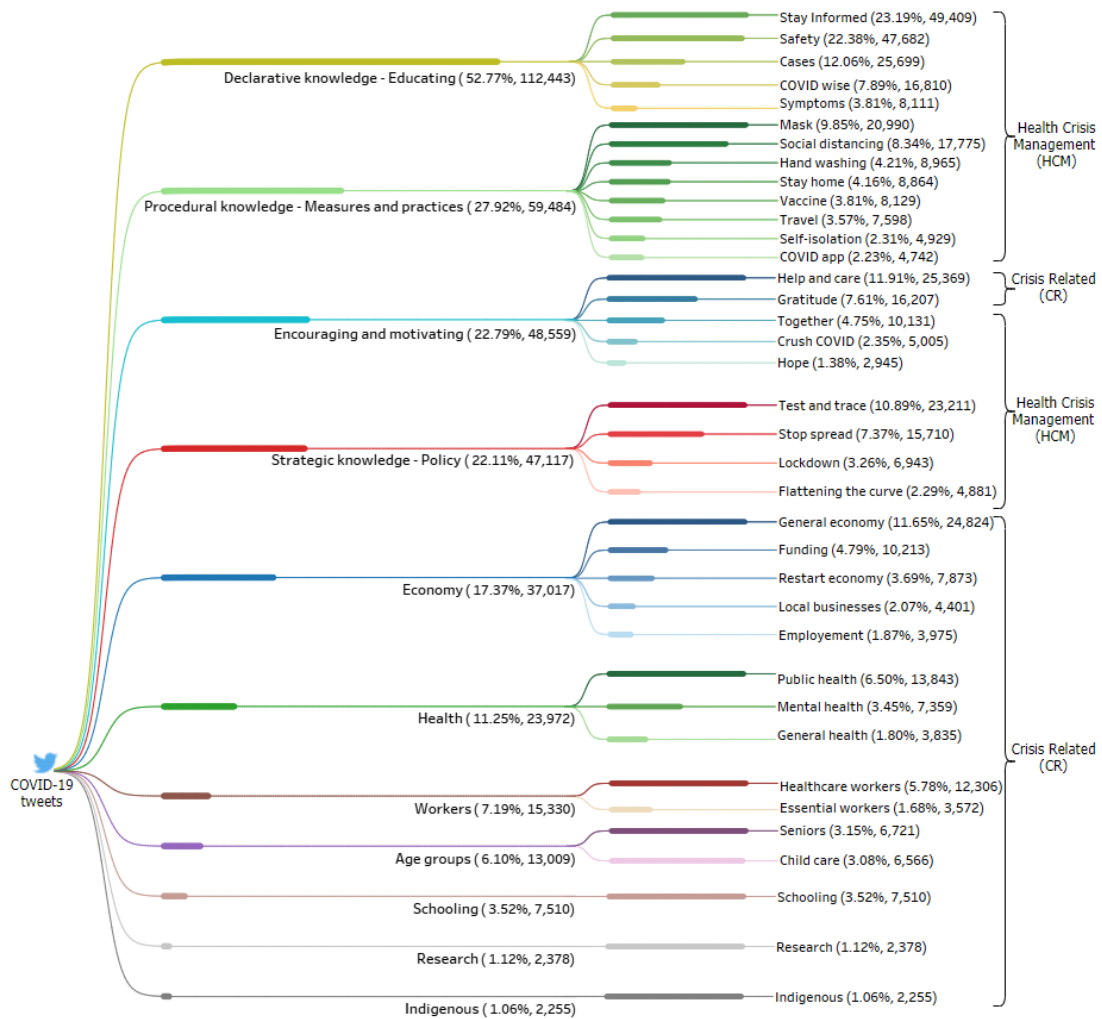


Figure 2. Emerged themes and subthemes.

Three themes, *Educating*, *Measures and practices*, and *Policy*, were categorized as HCM. Subthemes in *Educating* include messages asking people to stay informed and act wisely and providing them with basic safety information, the latest number of cases and deaths, and COVID-19 symptoms. As *Educating* subthemes provide the facts and rules governing the pandemic situation, like explaining how the virus spreads in *COVID wise*, we mapped *Educating* to declarative knowledge. Subthemes in *Measures and practices* provide eight distinctive ways to manage the pandemic, such as *Social distancing*, wearing *Mask*, and following measurements when traveling. As *Measures and practices* give information on the individuals' tasks and activities during the pandemic, we mapped *Measures and practices* to procedural knowledge. Finally, *Policy* is mapped to strategic knowledge as its policies, *Test and trace*, *Stop spread*, *Lockdown*, and *Flattening the curve*, identify the main strategies to fight the COVID-19 pandemic. *Measures and practices* subthemes include procedural knowledge at the individual level, asking people to follow specific tasks like keeping social distancing and washing their hands. Policies are the strategies taken at the community level that work as action plans to manage the pandemic. To implement policies, citizens should follow *Measures and practices*.

Analysis of the prevalence of HCM themes in COVID-19 tweets and HCM tweets (Table 1) shows that the three forms of knowledge comprise 96% (149,956) of the HCM category. Declarative knowledge (*Educating*) was the most prevalent in all COVID-19 tweets (52.77%) and the HCM category (72.03%). Next comes Procedural knowledge (*Measures and practices*), the second most prevalent theme, that

comprised 27.92% of all COVID-19 tweets and 38.1% of HCM tweets. Finally, strategic knowledge (*Policy*) constituted 22.11% of all tweets and 30.18% of the HCM category.

Category	Theme	Tweet	% of total	% of HCM
HCM	Declarative knowledge - <i>Educating</i>	112,445	52.77%	72.03%
	Procedural knowledge - <i>Measures and practices</i>	59,486	27.92%	38.10%
	<i>Encouraging and motivating</i>	16,368	7.68%	10.48%
	Strategic knowledge - <i>Policy</i>	47,118	22.11%	30.18%
	Total	156,111	73.26%	100.00%
CR		99,436	46.66%	-
Total		213,089	100.00%	-

Table 1. Themes prevalence in the HCM category.

5 Conclusion and Next Steps

To answer our research question and investigate the contribution of our model, we followed a case study approach by analyzing Canadian officials' social media presence during the COVID-19 pandemic. The content analysis revealed that 96% of HCM tweets were at least in one knowledge type. Declarative knowledge comprised up to 72% of HCM tweets, and procedural and strategic knowledge comes next with 38.1% and 30.18%, respectively. The high prevalence of the three knowledge types as they comprise 96% of the HCM tweets supports our arguments in answering the research question. To manage a health crisis that the public needs to achieve a shared SA, public officials should provide information related to declarative, procedural, and strategic knowledge on social media. These three knowledge types comprise shared mental models of the crisis that the public can draw upon to achieve a shared SA of the crisis.

Our main goal for the next steps is to analyze the effectiveness of the three knowledge types on citizens by measuring their impact on users. To measure this, we will use the citizens' engagement with the officials' posts by analyzing citizens' retweets, replies, and their replies' content to the officials' tweets. By doing so, we can measure how much officials were successful in establishing a shared SA of the pandemic. Another question that we aim to answer is analyzing the formulation of the three knowledge types in driving a better shared SA. For example, if they have to have an equal distribution or they should have different weights. We thank the anonymous reviewers that helped us to ponder on and delineate these aspects. The other two aspects that we will consider are providing knowledge types constantly and consistently. First, were Canadian authorities able to provide a constant flow of knowledge over time to maintain shared mental models of the situation? Mental models are developed as a function of training and getting experience (Nofi, 2000, Endsley, 1995, Salas et al., 1994, Stout et al., 2011). In mission-critical environments like command and control, agents constantly get trained and develop experiences to develop their team mental models. In a pandemic, a constant flow of information works as training. The new information unfolding the current situation of the pandemic, including recent statistics, goals, tasks, and strategies, will help citizens update and develop their mental models of the crisis. Second is whether Canadian authorities built consistent shared mental models of the pandemic depending on knowledge types and authority types? Answering this question is critical as the flow of information provided by authorities on social media must be consistent among different groups of authorities to reduce the propagation of contradictory information. Otherwise, it might hamper the confluence of different pieces of knowledge to evolve into shared mental models of crises. A major factor in decision-making is the degree of confidence individuals have about their SA (Endsley, 1995). The more individuals are confident in their current understanding of the situation, the more they are confident about their SA. The more consistent the propagated information, the more credible the information and its resources. Answering these questions could be learning points for the governments and public policy officials to manage health crises better.

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