Check for updates

DOI: 10.1111/risa.13911

ORIGINAL ARTICLE

Improving fire risk communication between authorities and micro-entrepreneurs: A mental models study of Ghanaian central market fires

Frank Nyame-Asiamah[1] | **Bismark Yeboah Boasu**[2] | **Peter Kawalek**[3] | **Daniel Buor**[4]

[1]Leicester Castle Business School, De Montfort University, Leicester, England

[2]Department of Geography, SD Dombo University of Business and Integrated Development Studies, Wa, Ghana

[3]Centre for Information Management, School of Business and Economics, Loughborough University, Loughborough, England

[4]Department of Geography and Rural Development, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

Correspondence
Frank Nyame-Asiamah, Leicester Castle Business School, De Montfort University, Leicester, LE1 9BH, England.
Frank.nyame-asiamah@dmu.ac.uk or
Frank.Nyameasiamah2@mail.dcu.ie

Abstract

This study conceptualizes how fire management authorities can empower nonexpert public to participate in fire risk communication processes and increase their own responsibilities for managing fire preventive, protective and recovery processes effectively. Drawing narratives from 10 disaster management experts working at government institutions and nine micro-entrepreneurs operating self-sustaining businesses in different merchandized lines in Ghana, we analyzed the data thematically and explored new insights on mental models to generate a two-way fire risk communication model. The findings suggest that fire management authorities planned fire disasters at the strategic level, collaborated with multiple stakeholders, disseminated information through many risk communication methods, and utilized their capabilities to manage fire at the various stages of fire risk communication, but the outcomes were poor. The micro-entrepreneurs sought to improve fire management outcomes through attitude change, law enforcement actions, strengthened security and better public trust building. The study has implications for policymakers, governments, and risk communication authorities of developing countries to strengthen their fire disaster policies to minimize commercial fire incidents and address the damaging effects of fire on people's livelihoods, businesses, properties, and environments. Our proposed two-way fire risk communication model is a new theoretical lens for experts and the nonexpert public to assess each other's beliefs about risk information and manage fire risk communication effectively at all stages.

KEYWORDS

disaster management, fire risk communication, Ghana, mental models, policy, two-way communication

1 | INTRODUCTION

With 45,000 stores and stalls, Kumasi Central Market in Ghana is the largest in West Africa and provides all kinds of merchandize for buyers. Frequent fires cause danger to human life, and ruin property and livelihoods. Ten-year trend data from the Ghana National Fire Service (GNFS) reveals an alarming socioeconomic and environmental problem, with 36 reported occurrences of fire in 2006, 88 cases in 2011, and 130 blazes in 2015. Although research has reported many serious fire incidents in several places (Chetehouna et al., 2014; Martin et al., 2009; Molina et al., 2019), Kumasi Central Market represents a critical setting for study of fire risk awareness, prevention, and management. As a nodal metropolis, Kumasi has unique geographical, economic, and social importance for thousands of micro-entrepreneurs, their international trading partners, the local community, and the Ghanaian economy.

There is no doubt that fire is vital to many aspects of human existence and to socioeconomic activities (Zaksek &

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.
© 2022 The Authors. *Risk Analysis* published by Wiley Periodicals LLC on behalf of Society for Risk Analysis

15396924, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/risa.13911 by Test, Wiley Online Library on [30/10/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Arvai, 2004), but it can cause devastating damage to lives, properties, and environments (Anderson & Ezekoye, 2013; Tabara et al., 2003). These worrying effects of fire necessitates collective action to minimize the risk of fire outbreaks and devastations (Cutter et al., 2008; Weber et al., 2019), yet it is not a straightforward activity for fire management authorities. Existing approaches to communicating fire risks information have focused heavily on using experts' (fire management authorities') knowledge to manage fire disasters and given less account of how nonexpert public perceive, understand, and mitigate fire disaster risks (Martin et al., 2009; Zaksek & Arvai, 2004).

This traditional view adopts reactive fire management methods, advocating short-term technical solutions that apply fire extinguishers, air-tankers, and military personnel to fight fire outbreaks and maintain environmental protection (Dube, 2013; Weber et al., 2019). Such reactive methods outline what people should do or not do to put out fire by using one-way bureaucratic communication, a top-down fire risk communication process to instruct lay persons and the public about the dangers of fire (Tabara et al., 2003; Weber et al., 2019). Whereas fire risk communication refers to the exchange of fire information before, during, and after outbreaks between experts and nonexpert public and how such fire information exchange can reduce the threats and damages of fire to the (affected) public, property, and environment (Zaksek & Arvai, 2004). Prior studies contest the reliance on reactive fire risk approaches to communicate fire risk messages (Dube, 2013). Tabara et al. (2003) used empirical support from the rampant forest fires in the Mediterranean rural areas to suggest that reactive fire risk management methods rely more on past incidents to minimize future errors than anticipating risks and addressing them to prevent serious incidents. Rather than relying on reactive fire risk methods which use top-down communication processes, Tabara et al. (2003) advocate more preventive fire management methods which apply wider public engagement to plan long-term procedures for communicating and managing fire risks.

Despite the potential merits of preventive fire risk approaches, they do not fully address people's misconceptions, misinterpretation, and mistrust about fire risk communication. Weber et al. (2019) observed in a mixed methods study that some community residents of Lower Eyre Peninsula of South Australia misperceived "fire retardant" as a substance that "won't burn" rather than seeing it as something that has the ability to slow or prevent the spread of fire. Zaksek and Arvai (2004) also found that some British Columbia Forest Service's experts who planned fire preventive strategies for the local stakeholders (nonexperts) to implement did not have adequate knowledge of the wildland fires they were helping to manage when compared with the local stakeholders. The challenge is that fire guidance and preventive information provided by these experts were likely to be incomplete, inaccurate, or misrepresented (Zaksek & Arvai, 2004). These studies illustrate a lack of public confidence in the success of risk communication delivered by risk communication authorities and the way they manage fire disasters (Eriksson, 2017; Wardman, 2008).

While experts might better understand the fire benefits for enhancing biodiversity and improving quality of life, their ability to manage the potential damage to the environment, health, and material by fire is by all means a complex activity (Zaksek & Arvai, 2004). Such efforts require two-way information exchange between expert and nonexpert actors to understand and manage misconceptions about fire risk and fire risk communication (Guanquan & Jinhua, 2008). The question is: How effectively can fire management authorities exchange fire risk information with nonexpert public and address fire incidents and disasters?

Previous studies have used mental models, the representation of people's thought processes about the world around them, to explain risk communication about hazardous situations and events such as exposure, health risks, climate emergencies, and how to mitigate such risks and uncertainties (Chowdhury et al., 2012; Claassen et al., 2016; Cousin & Siegrist, 2010; Cox et al., 2003; Greven et al., 2018; Lazrus et al., 2016). Other studies advocate the need to empower local people whose livelihoods are affected by fire to be more involved in fire disaster planning that reflect their knowledge, sensitivities, and temporalities of fire management models (Breakwell, 2001; Edwards & Gill, 2016). Such inclusive views can allow the opportunity for the nonexperts to fill in experts' risk information gaps or critique experts' rationale for designing risk preventive communication processes which might not necessarily address the public awareness of risk (Chowdhury et al., 2012).

In this article, we conceptualize how fire management authorities can empower nonexpert public to participate in fire risk communication processes and increase their own responsibilities for managing fire preventive, protective, and recovery processes effectively. We utilized the narratives of the fire management authorities and nonexpert public (micro-entrepreneurs) of Kumasi Central Market in Ghana to explain how the authorities implemented fire risk communication processes and to elucidate how the micro-entrepreneurs responded to the authorities' risk communication processes. The data also helped us understand the impact of the perennial fire outbreaks on livelihoods of the micro-entrepreneurs. We then explored the narratives on mental models to provide theoretical insights into how commercial fire actors can perceive and manage fire risk information and actual incidents effectively to protect lives, property, and self-sustaining businesses. Understanding how individual micro-entrepreneurs make decisions, manage behaviour, and cope with fire incidents in the marketplace can improve the authorities' fire preventive planning and policy measures that can reduce perennial fire incidents.

In doing so, we respond to the ongoing call for researchers to conceptualize effective models for designing and implementing fire risk communication and management processes that can help authorities and public to take collective decisions to prevent and minimize risk events (Claassen et al., 2020; Greven et al., 2018; Paraskevopoulou et al., 2019;

15396924, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/risa.13911 by Test, Wiley Online Library on [30/10/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Tabara et al., 2003; Wardman, 2008; Zaksek & Arvai, 2004). We also contribute to studies that draw on mental models to explain risk communication and caution people about risk incidents and disasters (Chowdhury et al., 2012; Claassen et al., 2016; Cousin & Siegrist, 2010; Hagemann & Scholderer, 2007; Lazrus et al., 2016; Morgan et al., 2002; Whitmer et al., 2017; Zaksek & Arvai, 2004). The rest of the article is organized as follows:

First, we draw on the literature from risk communication to unveil existing risk information exchange and their challenges, and discuss how the challenges impede experts' efforts to manage disasters and risk events effectively. We then discuss mental models and its prospects for studying and managing risk events and disasters. Second, we formally introduce the research context and explain why fire outbreaks are problematic in Kumasi Central Market in Ghana and therefore provides the context for this study. Third, we describe our research methodology and methods to justify how they can address the research question. Fourth, we present and discuss our findings to illuminate fire management authorities' and micro-entrepreneurs' perceptions of how fire information can be exchanged and used between the diverse actor groups to prevent, manage, and recover fire disasters. Based on these, we set out theoretical propositions of the study to underpin our conceptualization of fire risk communication. Finally, we discuss the study's theoretical merits, highlight its implications for policy and practice, and outline its limitations and future directions.

2 | FOUNDATIONAL AND THEORETICAL LITERATURE

2.1 | Risk communication

Risk communication explains the exchange of information and attitude between experts and various actors or nonexpert public and how such interactions can be used to minimize risks and hazards to the (affected) public, property, and environment (Scheer et al., 2014; Visschers et al., 2009; Wardman, 2008). Various researchers have studied risk communication to understand how to manage public threats and disasters such as epidemic diseases in public health (Liu et al., 2018; Mabon & Kawabe, 2018), negative beliefs about flash flood warnings (Lazrus et al., 2016) and earthquake preparedness (Marti et al., 2018). Other studies have focused on public risks that arise from social behaviour and human attitudes such as cultural and religious uses of mercury (Riley et al., 2006), the threats of increasing population growth (Dawson & Johnson, 2014), and the threat of using social media (Verroen et al., 2013; Vos et al., 2018).

Aside from motivating risk reducing behavior that removes psychological stress (Liu et al., 2018), changing negative attitudes and beliefs toward risk phenomena (Mabon & Kawabe, 2018), providing assurances to the affected public (Kusumi et al., 2017), and improving corporate survivals (Wardman, 2008), risk communication presents several challenges. First, the messages that are transmitted between experts and the public are often distorted at different stages of risk communication processes because of misunderstanding of content (Lazrus et al., 2016), unfamiliarity with the methods of communication (Scheer et al., 2014), and the way different people perceive the same information differently (Johnson & Chess, 2006; Dawson & Johnson, 2014; Gutteling & De Vries, 2017). Kusumi et al. (2017) sought to minimize misperception by encouraging people to circulate their knowledge of risk (risk literacy) and risk information environment through social networks to stabilize any difference between their risk perceptions and risk talks. Their influential contribution focused on prerisk and postrisk communication stages of risk incidents, evading what happens at the "during" (actual event) stage of risk communication. Others studies have attempted to fill the insufficient risk information exchange gap at the actual time of disaster occurrences by demonstrating the usefulness of social media as a platform for circulating official information about risk (Verroen et al., 2013). Yet, Kusumi et al. (2017) insist that "interpersonal risk communication and its role in the societal responses to risk events" (p. 2305) requires further attention because risk communication is sensitive to the way people perceive and use information.

Second, apart from the misunderstood content, past studies have found further challenges that impede effective risk communication. These include a lack of time to examine risk communication thoroughly (Johnson & Chess, 2006), reluctance to communicate due to job pressures (Derks & Bakker, 2010), recipients' perceived meanings of the risk types (Gutteling & De Vries, 2017; Scheer et al., 2014; Xie et al., 2011) and cultural differences within and across agencies and professionals who manage risk communication (Riley et al., 2006). Some studies also highlight concerns about communications that fail to accommodate nonexperts' perspectives (Claassen et al., 2016), the absence of local knowledge and technical resources needed by experts for communicating and managing risk communication effectively (Covello & Sandman, 2001; Moser, 2010), and the public attitude of distrust toward policy administrators (Carlsson et al., 2012). These, together with people's incapability to access risk information (Gutteling & De Vries, 2017) and reluctance to accept the message (Visschers et al., 2009) can also obscure accurate analysis of risk communication and effective disaster management.

2.2 | Mental models

Mental models are basic structures of cognition that represent people's beliefs about themselves and the world around them, and how these assumptions influence their actions. Originating in the psychology literature (Gentner & Stevens, 2014; Johnson-Laird, 2004), this approach is the foundation for developing risk communication processes and reducing people's inaccurate assumptions about environmental risks, global warming risks, fire risks, and all kinds of hazards (Bostrom et al., 1994; Cox et al., 2003; Martin et al., 2009;

15396924, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/risa.13911 by Test, Wiley Online Library on [30/10/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Morgan et al., 2002; Zaksek & Arvai, 2004). For instance, Bostrom et al. (1994) used mental model interviews to understand people's (mis)understanding of climate change and obtain climate emergency strategies for those who design risk communications and policies for mitigating climate-related misconceptions. Essentially, mental models have been applied as a central approach in risk communication studies to explain how authorities (experts) and the public (nonexperts) can exchange risk information to minimize or foil risk events (Chowdhury et al., 2012; Cousin & Siegrist, 2010; Hagemann & Scholderer, 2007; Lazrus et al., 2016; Niewöhner et al., 2004).

At their core, much of these works trace their roots to Morgan et al.'s (2002) mental models approach which seeks to reveal how people's beliefs, values and perceptions about how hazards affect the way they receive and interpret new risk information and then behave in accordance with their cognitions in some advanced countries (Chowdhury et al., 2012; Claassen et al., 2016; Cousin & Siegrist, 2010; Lazrus et al., 2016). Although the outcomes of these studies suggest that the information exchange between experts and the public (nonexperts) is often misinterpreted, misperceived, or dismissed, the potential of using mental models to bridge these communication gaps or to mitigate the risk of health, exposure, climate change, and environment is unveiled in all cases.

However, the capabilities of mental models are yet to be applied to commercial fire risk communication between fire management authorities and micro-entrepreneurs in developing countries to understand how people should modify their views about fire risks and manage them as a coproduction and participatory activity in order to prevent and control fire outbreaks. We explore the phenomenon of fire risk communication on mental models through our case study of Kumasi Central Market in Ghana.

3 | RESEARCH CONTEXT OF KUMASI CENTRAL MARKET

Kumasi Central Market is the largest open marketplace for the 3.49 million inhabitants of Kumasi city as per 2021 data from the Ghana Statistical Service. The city's total surface is 245 km^2. As a geographically distinct area, the market leverages its central location (see Appendix 1) to attract up to 800,000 people everyday (GOV.UK, 2019) including micro-entrepreneurs and their local and international trading partners, suppliers, customers, truck pushers, porters, and taxi drivers. The products sold at the market include agricultural materials, food items, cooking utensils, clothing, building materials, cosmetics, and electrical appliances. Some of these are highly flammable and exacerbate fire outbreaks. Excessive heat from high temperatures, combustible installation materials for buildings, faulty wiring, overloaded electrical devices, poor physical building design, and smoking also contribute to the frequent fire destruction to property, stores, assorted merchandize, and huge sums of money lost to micro-entrepreneurs who depended on the Kumasi Central Market as their sources of livelihood (Addai et al., 2016).

Although the GNFS and other disaster management authorities in the Metropolis had undertaken some preventive measures, such as communicating fire risk information publicly and educating the public to minimize the risk of fires, they had continued to find the fire disaster management challenging. Some researchers with the local knowledge of fires and risk communication argue that "risk communication and fire emergencies in Ghana often lags behind the emergency and mitigation." (Norman et al., 2015, p.168). Researchers, media, and policymakers have continued to express concerns about the persistent and devastating fire at Kumasi Central Market and other central markets in Ghana that have severe social and economic consequences (Addai et al., 2016; Twum-Barima, 2014). This setting is therefore critical for conceptualizing how to improve fire risk communication between authorities and micro-entrepreneurs.

4 | METHODS AND ANALYSIS

Following qualitative, interpretative, and thematic analysis traditions (Myers, 2009; Yin, 2014), we drew insight from mental models approach (Bostrom et al., 1994; Cousin & Siegrist, 2010; Morgan et al., 2002) to discover how people perceive information, make decisions, and behave in a novel context. We used the findings to conceptualize a fire risk communication framework in a developing country. Both qualitative design and interpretive philosophy offer the opportunity to use rich data to reveal complex and subtle meanings of research phenomenon that leads to theory advancement (Gioia et al., 2013; Myers, 2009) while thematic analysis allows qualitative data to emerge inductively into themes to support new conceptualization (Braun & Clarke, 2006; Gioia et al., 2013; Glaser & Strauss, 1967).

The study was conducted between October 2016 and May 2020 when a total number of 413 commercial fire outbreaks with varying degree of destruction occurred at Kumasi Metropolis as per the GNFS statistics. During this period, the UK Export Finance provided £70.3 million in funding for a facility to Contracta Construction UK to develop and modernize Kumasi Central Market (GOV.UK, 2019). The company reconstructed part of the market to accommodate some of the micro-entrpereneurs while efforts were being made to redevelop other sections for the remaining businesspersons. However, the ongoing fire outbreaks such as the October 2019 devastating fires destroyed items worth over GHc 100 million (about £14.4 million) and caused livelihood and financial loses to the entrepreneurs. We interviewed 10 disaster/risk management experts from six government institutions and nine micro-entrepreneurs operating self-sustaining businesses in eight different merchandized lines to capture their experiences and mental models over the period. The detailed profiles of the participant groups are provided in Tables 1A and B, respectively with anonymized names and businesses.

15396924, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/risa.13911 by Test, Wiley Online Library on [30/10/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 1A Fire risk management authorities' profile (anonymized)

Interviewee code	Risk & disaster management authorities	Position	Years of experience	Role in disaster management	Date of interview
Expert 1	Kumasi metropolitan authority (KMA) – NADMO department	Metropolitan disaster expert	5	Coordinating and managing disaster events in the Metropolis	29/04/2020
**Expert 2A **Expert 2B	Kumasi metropolitan authority (KMA) – planning department	Metropolitan planning expert A Metropolitan planning expert B	10 3	City planning, legislative, and administrative functions	30/04/2020
Expert 3	Ghana national fire service (GNFS)	Fire management expert	29	Preventing and managing undesired fires	30/04/2020
#Expert 4A #Expert 4B #Expert 4C	National disaster management organisation – Ashanti regional office	Regional disaster expert A Regional disaster expert B Regional disaster expert C	6 10 15	Coordinating and managing disaster events at the regional level	29/04/2020
Expert 5	Ghana meteorological agency (GMA)	Meteorological expert	-	Providing reliable information about climatic conditions that can cause fire	18/10/2016
Expert 6	Environmental protection agency (EPA)	Environmental protection expert	19	Planning and maintaining sustainable environments	19/10/2016
Expert 7	National commission for civic education (NCCE)	Civic education expert	7	Disseminating public information and creating fire awareness	18/10/2016

**Participants who took part in the authorities' focus group discussion 1 and #participants who took part in the focus group discussion 2.

TABLE 1B Micro-entrepreneurs' profile (anonymized)

Interviewee code	Business Name	Position	Years at the market	Main Business Activities	Date of interview
ME 1	Pet agro-chemicals store	Micro-entrepreneur 1	10	Retailing imported agricultural materials from Europe and the United States	11/03/2020
*ME 2	Amy cosmetics shop	Micro-entrepreneur 2	8	Selling imported cosmetics from China, the United Kingdom and the United States	12/03/2020
*ME 3	Dan home appliances	Micro-entrepreneur 3	26	Selling cooking utensils from China and Dubai	12/03/2020
ME 4	Tim home building	Micro-entrepreneur 4	20	Selling building materials from Ghana and China	11/03/2020
*ME 5	Don Kenteh & Garment Shop	Micro-entrepreneur 5	35	Retailing local and imported clothing from abroad	12/03/2020
ME 6	Max local & imported rice	Micro-entrepreneur 6	12	Retailing local and imported rice from abroad	11/03/2020
ME7	Ola home-used avenue	Micro-entrepreneur 7	15	Selling second-hand clothes	30/11/2016
ME8	Roy electricals	Micro-entrepreneur 8	21	Selling electrical appliances	30/11/2016
ME9	Zoe cold store	Micro-entrepreneur 9	17	Retailing chicken, mutton, and beef	30/11/2016

*Participants who took part in the focus group discussion

15396924, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/risa.13911 by Test, Wiley Online Library on [30/10/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

First, we purposively selected the experts from the government institutions whose operational activities are governed by the Local Government Act 1993 (Act 462) (Republic of Ghana, 1993) that relates to disaster information management, prevention, and recovery in Kumasi Metropolis. The selected experts with strategic responsibilities had in-depth knowledge of the activities relating to public information exchange, risk communication, and fire and/or disaster management. Second, we used a snowballing technique to invite the micro-entrepreneurs who had run their enterprises in the market for at least eight years and had lived experience of several fire outbreaks to the study. We obtained institutional clearance and participants' consents. We interviewed the participants at their workplaces lasting 40–60 min, except the experts 5, 6, and 7 who had busy work schedules and opted to provide their responses in writing after seeking their permission through the initial face-to-face meetings. To mitigate any omission of data that could potentially compromise the quality of findings as a result of this deviation from the protocol, we conducted follow-up telephone interviews with the three experts but no new information emerged to constrast the responses from other face-to-face expert interviews. All the interviews with the authorities were conducted in English while the conversations with the micro-entrepreneurs were held in both English and Twi (local language), as the two are often alternated by people with less proficient in English in Ghana. This encouraged the micro-entrepreneurs with basic formal education to articulate their experiences and mental models fully and freely without language barriers.

The interviews focused on the participants' perceptions about fire disaster risks, how fire information is exchanged, and managed between the experts and the micro-entrepreneurs to help them prevent, manage, and recover from fire incidents, and how the perceptions of one participant group (e.g., micro-entrepreneurs) could be used to address the misconceptions of the other (e.g., experts). We also elicited their views on how the experts could increase their responsibilities for fire risk communication and how the micro-entrepreneurs could be empowered to participate in the fire risk communication processes. See Appendix 2 for the detailed prompts in the interview guide. Concurrent with the one-to-one interviews, we conducted two separate focus group discussions with the experts and one additional with the micro-entrepreneurs at their work places lasting approximately 1 h. The two expert focus group interviews were participated by (i) three regional disaster experts and (ii) two metropolitan planning experts respectively, while three participants took part in the micro-entrepreneur (nonexpert) focus group discussion (see Table 1A,B). The focus group allowed us to dig deeper into participants' mental models, resolve their misconceptions, and triangulate the data. We were able to establish data saturation as the subsequent interviews with other experts or nonexperts did not yield new insights.

Inspired by risk communication and mental models studies that analyzed interviews data to generate emerging themes/concepts and proposed strategies to minimize misunderstanding of risk events (Claassen et al., 2016; Eriksson, 2017; Hamilton-Webb et al., 2019), we analyzed our data as a team and reached consensus on relevant themes that could help us address the research question. First, two of the authors (first and second) listened to the audio interviews carefully, transbribed them into text, translated the non-English versions to English, and analyzed the data following a thematic analysis approach (Braun & Clarke, 2006; Gioia et al., 2013; Glaser & Strauss, 1967). The authors compared the transcripts of each participant group including the written responses to establish common patterns and find similar statements/phrases that related to the groups' mental models about the preventive, protective, and recovery processes of fire risk communication. The aim of this pattern-matching task was to identify how the participants made decisions and behaved according to their perceived information, and what they thought could be done to reduce the rampant fire outbreaks. The other two authors (third and fourth) validated the trustworthiness of the data by comparing the statements and patterns across the two participant groups to identify inconsistencies and contradictions between authorities' and micro-entrepreneurs' perceptions and experiences about fire risk communication. The first and second authors then proceeded to code the transcripts using an open coding technique to extract statements into first-order concepts after conducting several iterative modifications and adjustments to the concepts that were relevant and surprising to our research question. These first-order concepts became generalizations across the interviews to represent how the fire management authorities and nonexpert public can collaborate to minimize fire risks and manage fire disasters. Next, the first two authors applied axial coding to group items/statements of similar characteristics from the first order concepts into second order categories of eight themes to foreground the detailed interpretation of the findings. They then aggregated the second-order categories into authorities' and micro-entrepreneurs' mental models to bind the data themes on the core principles of thematic analysis as shown in Table 2 (see Braun & Clarke, 2006 and Gioia et al., 2013).

The third and fouth authors revalidated the processes of analysis and finally, the team generated two/three word phrases from the eight second-order themes and utilized them as a basis for conceptualizing the authorities' and micro-entrepreneurs' mental models of fire risk information exchange within the context of Ghanaian central market fires. This reduction of second-order themes makes the concepts outlined in the conceptual model (Figure 1) easy to understand, apply, and replicate. These are: (i) fire disaster planning, multistakeholder collaboration, risk communication, and competence and capabilities for the authorities' aggregate themes, and (ii) improving attitude & responsibilities, law enforcement actions, addressing security concerns, and building public trust for the micro-entrepreneurs' aggregate themes. Next is the interpretation of our findings.

15396924, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/risa.13911 by Test, Wiley Online Library on [30/10/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 2 Thematic analysis

First-order concepts	Second-order categories	Aggregated themes
We undertake periodic fire safety inspections on premises that give access to the general public in the market …we therefore planned to put up the concrete type so that it becomes visible to everyone at the central market. The public is always happy to welcome fire risk information, especially the preventive measures, in advance or prior to fire outbreak.	Fire disaster planning is adequate but hampered by external factors	Authorities' mental models
The congestion and the excessive noise at the central market always hinder our efforts of communicating fire risk information to the traders [micro-entrepreneurs] at any point in time.		
We know that some of the entrepreneurs will always bring their goods to block the market streets because that is where they may easily spot buyers from their ethnic backgrounds and pull them to their stalls.		
My institution collaborates with other stakeholders to enforce laws and security; we collaborate to provide preventive and relief measures.	Fire management is a multistakeholder collaboration	
And whenever the market experiences fire outbreak almost all the stakeholders come together to control it.		
My institution usually goes to radio stations and information centres to educate the public about causes, preventive and relief strategies of fire risks and disasters … We also share informative leaflets on fire prevention and emergency support with the public, and often go to churches and mosques to create fire awareness. We dispatch fire educators to the market almost every morning to educate the traders [micro-entrepreneurs] on fire risks issues.	Risk communication is a useful public awareness tool	
The risk information that we provide … encourage some of them to sign up for fire insurance cover and make claims that enable them to recover financial or business losses after fire disasters. We render counselling services as a source of relief. We provide the fire victims with the direction as to how they can access loans from financial institutions to get back to their livelihoods.		
Our personnel are adequately competent with knowledge of fire preventive measures and their knowledge is imported to advise the public about the risk of commercial fires.	Fire management is competent and capable	
My institution responds quickly to the public's distress calls. This is because whenever information gets to us that there is fire outbreak at the central market, we rush there immediately to control the situation.		
We must avoid keeping gas cylinders, cooking, and using wooden planks for shop buildings in the market.	Fire risk management is responsible action	Micro-entrepreneurs' mental models
It is better we get qualify personnel to do all wiring and other construction works in the market making sure that enough pavements are created to reduce congestions		
The authorities need to enforce the laws and punish those who cook in the market; we sometimes report those who cook but they do not do anything about it; they are only concerned about their taxes.	Fire management is law enforcement action	
Fire management authorities, especially the KMA, have always been accusing us but I disagree; they are rather the cause. This is because they are always in the market with us and therefore witness almost all our activities. They relax the fire regulations and only expect us to take the lead in reporting the perpetrators. We don't have the mandate to punish or enforce and the bye-laws.		
It is also believed that those micro-entrepreneurs who are unable to settle their bank loans deliberately set the fire to burn their stalls but at this extends to other stalls and the entire market because there is no surveillance	Fire risk management is a security concern	
The fire is often caused by individual's deliberate actions. Poor security at the market is the cause. The market is opened in the night so any bad person can enter and set the fire…The authorities should ensure that no one is allowed to enter the market after 6pm and use radio programmes to create this awareness in the evenings.		
Sometimes, the authorities take money from the culprits, they do not take action and allow them to misbehave.	Risk communication is trusted public information but promises are unfulfilled	
The fire authorities do not give us anything except that they allow us to put up the structures again through our own means; they only come to us immediately after the fire outbreak to make promises but they will never fulfil them.		

15396924, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/risa.13911 by Test, Wiley Online Library on [30/10/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

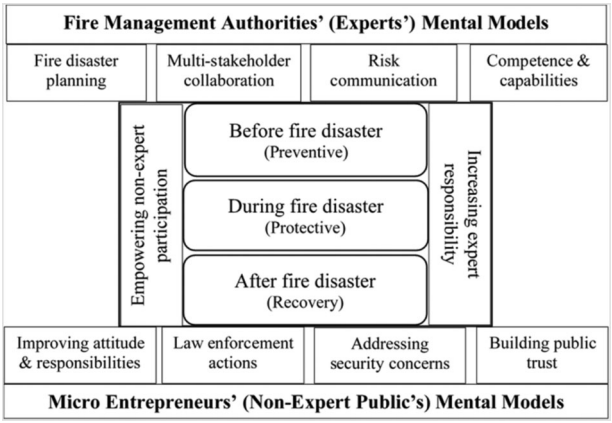


FIGURE 1 Fire risk communication (FRiC) model

5 | FINDINGS AND INTERPRETATION

5.1 | Authorities' mental models

The findings from the analysis indicate that the authorities utilized their mental models to implement and manage fire information exchange processes at the various stages of fire risk communication, focusing on four key but interrelated areas interpreted in Sections 5.1.1–5.1.4 below:

5.1.1 | Fire disaster planning is adequate but hampered by external factors

The narratives from the authorities emphasized that they used their sociocultural understanding of the public to plan and analyze the micro-entrepreneurs' attitude toward the market space usage and to navigate around the complex structures of the market stalls that often obstructed the effective fire risk disaster control (Metropolitan Planning Expert A). The Regional Disaster Expert A communicated his social-cultural knowledge of how the entrepreneurs encroached the market walkways and might block access to control fire outbreaks as follows:

> We know that some of the entrepreneurs will always bring their goods to block the market streets because that is where they may easily spot buyers from their ethnic backgrounds and pull them to the stalls.

The interpretation of the data is that the authorities would usually anticipate obstructions to fire control in the market and they might plan ahead to navigate potential barriers to market fire control. The Fire Management Expert from the GNFS focused his responses on how they had managed the challenging physical environments in the market and responded effectively to fire incidents:

> We undertake periodic fire safety inspections on premises that give access to the general public in the market …we therefore planned to put up the concrete type [of fire hydrant] so that it becomes visible to everyone at the central market. The public is always happy to welcome fire risk information, especially the preventive measures in advance or prior to fire outbreak. My institution therefore faces a little challenge in disseminating fire risk messages ahead of fire disaster in the central market.

The data suggests that the authorities planned for potential fire outbreaks and the micro-entrepreneurs and the general public were receptive to the way they delivered the pre-fire information. However, this fire disaster planning was not always effective to reduce fire incidents in the market and there were some challenges that were acknowledged by some participants (Metropolitan Planning Expert B). The Metropolitan Disaster Expert specifically indicated that the Kumasi Central Market was recently rated low for their fire disaster management processes:

> Fire disaster management scores low in the central market because of inadequate logistics support and frequent fire occurrences.

Adding to this is the blame that the micro-entrepreneurs did not always utilize the fire risk information communicated to them or report fire risk on time about ineffective outcomes of the fire information exchanges:

> The congestion and the excessive noise at the central market always hinder our efforts of communicating fire risk information to the traders [micro-entrepreneurs] at any point in time (*Civic Education Expert*).

The sense-making of this statement is that the authorities lacked effective resources to manage fire incidents and their plans and environmental understanding had not stopped the regular fire outbreaks.

5.1.2 | Fire management is a multistakeholder collaboration

The authorities recognized the involvement of many actors and different interest groups as a part of their efforts to prevent, control, and manage fire incidents and outbreak of disasters in the Metropolis. The Regional Disaster Expert C summarized his points as follows:

> My institution collaborates with other stakeholders to enforce laws and security; we collaborate to provide preventive and relief measures. And whenever the market experiences fire

15396924, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/risa.13911 by Test, Wiley Online Library on [30/10/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

> outbreak almost all the stakeholders come together to control it.

The meaning of the quote is that the authorities engaged law enforcement officers such as the police to maintain law and order in the midst of fire incidents when unscrupulous people usually attempt to loot and steal from some parts of the market. Unsurprisingly, the Metropolitan Disaster Expert added that the Mayor of the City always rushed to the market to find out things for himself even in the deep night when fire incidents occurred. Some authorities also stated that they collaborated with religious institutions to create awareness of fire risks and provide postfire support for the affected micro-entrepreneurs.

5.1.3 | Risk communication is a useful public awareness tool

The discussion with the authorities indicated that they delivered fire risk information regularly and thoughtfully to educate the public and micro-entrepreneurs on how they should prevent fires and protect themselves when there were outbreaks. The Metropolitan Disaster Expert said that they used different types of risk communication methods to disseminate fire risk information and manage fire events in the Kumasi Metropolis:

> My institution usually goes to radio stations and information centres to educate the public about causes, preventive, and relief strategies of fire risks and disasters whenever the need arises. We also share informative leaflets on fire prevention and emergency support with the public, and often go to churches and mosques to create fire awareness. Besides, we dispatch fire educators to the market almost every morning to educate the traders [micro-entrepreneurs] on fire risks issues

The Meteorological Expert added his voice to the role played by the authorities in providing fire risk messages on radio stations to attract the public attention:

> People respond to phone-in programmes at radio stations when issues involving fire outbreaks are being discussed.

The interpretation of the data signifies that the authorities used media and hands-on methods to exchange fire risk information with the public to ensure that their message was accessible and understood by the audience especially during the prefire stage. Notwithstanding this, the authorities acknowledged a lack of modern fire communication technology, poor responses from the entrepreneurs, and the noisy and crowded market environments as problems that affected effective fire risk communication (Civic Education Expert, Metropolitan Disaster Expert, and Regional Disaster Expert A).

In addition to giving warning information about fire disasters, the authorities indicated that they communicated information on fire recovery plans that could provide relief for the micro-entrepreneurs who might suffer from fire incidents. Excerpts from the Regional Disaster Expert B's comments is as follows:

> The risk information that we provide … encourage some of them to sign up for fire insurance cover and make claims that enable them to recover from financial or business losses after fire disasters. We render counselling services as a source of relief. We provide the fire victims with the direction as to how they can access loans from financial institutions to get back to their livelihoods.

The data indicate that the authorities communicated postrisk incident information to the micro-entrepreneurs to help them to recover fire disaster and improve their livelihoods.

5.1.4 | Fire management is competent and capable

Consistent with the legislative and coordinating roles of the disaster and environmental management institutions to supply human resource capacity to minimize the threats of fire in Ghana, the Regional Disaster Expert B proudly maintained that his institution had competent staff who were able to provide effective training and capacity building for fire volunteers who in turn monitored potential fire outbreaks and educated micro-entrepreneurs on fire risk in the market. His assertion was shared by the Environmental Protection Expert:

> Our personnel are adequately competent with knowledge of fire preventive measures and their knowledge is imported to advise the public about the risk of commercial fires

These articulations confirm the obligations of the fire risk information experts to provide knowledge, training, and skills required for preempting and managing undesired fires in the market centres. The authorities also held the position that they used their capabilities to react swiftly to fire emergencies as indicated by the following quote:

> My institution responds quickly to the public's distress calls. This is because whenever information gets to us that there is fire outbreak at the central market, we rush there immediately to control the situation (*Fire Management Expert*).

15396924, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/risa.13911 by Test, Wiley Online Library on [30/10/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

5.2 | Micro-entrepreneurs' mental models

The analysis of the micro-entrepreneurs' mental models indicates that they simultaneously accepted their misbehaviors as a problem of market fires and called for more responsible actions from the authorities to control the situation. They intended to empower themselves in the fire risk communication processes by suggesting attitude change, law enforcement actions, improved security, and better trust building as areas of focus for the the authorities. We interpret these in Sections 5.2.1–5.2.4 as follows.

5.2.1 | Fire risk management is responsible action

Insights from the micro-entrepreneurs sought to improve electrical installations, stalls construction, decongestion, and attitude toward fire risks in the market. Apart from seeking to call the authorities to action, they saw themselves as part of the problem and therefore ought to change their behaviour in order to minimize the risk of fire. The following are the views of a couple of them:

> It is better we get qualify personnel to do all wiring and other construction works in the market making sure that enough pavements are created to reduce congestions (Micro-entrepreneur 1)

> We must avoid keeping gas cylinders, cooking, and using wooden planks for shop buildings in the market (Micro-entrepreneur 4)

Some entrepreneurs understood the devastating economic, social, and health consequences of not taking fire measures seriously. Micro-entrepreneur 5 captioned such effects in the following quote:

> It is very distressful and a big blow to me. Imagine you have your own capital and all of a sudden you lose everything. Often some victims with high blood pressure die out of these frustrations.

The interpretation of this quote is that the entrepreneurs were fully aware of the negative impact of fire disaster, which comes to support the assumption that nonexpert public would respond to risk communication if anticipated the consequences (Claassen et al., 2016).

5.2.2 | Fire management is law enforcement action

Seeking to challenge the deep-seated views of the authorities that the rampant fires should be blamed on the micro-entrepreneurs, the electricals, and cold store entrepreneurs held the common view that the law should be rather enforced to deter and punish the offenders of fire incidents in the market. Micro-entrepreneur 5 also added the following point during the focus group discussion:

> Fire management authorities, especially the KMA, have always been accusing us but I disagree; they are rather the cause. This is because they are always in the market with us and therefore witness almost all our activities. They relax the fire regulations and only expect us to take the lead in reporting the perpetrators. We don't have the mandate to punish or to enforce the bye-laws.

This assertion suggests that authorities who held power positions to enforce fire regulations were not tackling the cause of the problem. Micro-entrepreneur 6 corroborated the claim that authorities ought to enforce the law especially when they had been informed about the wrongdoers of fire risks:

> The authorities need to enforce the laws and punish those who cook in the market; we sometimes report those who cook but they do not do anything about it; they are only concerned about their taxes.

The deeper interpretation of this quote is that in addition to highlighting some responsible thoughts on how some micro-entrepreneurs were committed to reducing fire outbreaks in the market, their activities also seem to contribute to business tax income for the country.

5.2.3 | Fire risk management is a security concern

Apart from the conversations around irresponsible behaviors like cooking in the market that often led to fire outbreaks, there were shocking perceptions that some people set off the blaze intentionally to bail themselves out of defaulted loans. Micro-entrepreneur 3 revealed this in the focus group discussion:

> It is also believed that those micro-entrepreneurs who are unable to settle their bank loans deliberately set the fire to burn their stalls but at this extends to other stalls and the entire market because there is no surveillance.

Another participant shared similar sentiments in a separate discussion as follows:

> The fire is often caused by individual's deliberate actions. Poor security at the market is the

15396924, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/risa.13911 by Test, Wiley Online Library on [30/10/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

> cause. The market is opened in the night so any bad person can enter and set the fire…The authorities should ensure that no one is allowed to enter the market after 6 p.m. and use radio programmes to create this awareness in the evenings (Micro-entrepreneur 6).

A deeper meaning of these quotations is that the security in the market could be improved to track potential offenders and possibly arrest them to prevent fire outbreaks. The data also conveys useful fire prevention knowledge for the authorities and signifies benefits of empowering the micro-entrepreneurs (nonexperts) in commercial fire risk planning and disaster management (see Edwards & Gill, 2016; Wardman, 2008; Weber et al., 2019).

5.2.4 | Risk communication is trusted public information but promises are unfulfilled

Contrary to the authorities' assertions that their fire risk messages were welcomed by the public and the micro-entrepreneurs, our discussions with these entrepreneurs exposed their distrust in authorities which required repairing to improve risk communication between the two groups. First, micro-entrepreneur 2 disclosed the following in the focus group discussion:

> Sometimes, the authorities take money from the culprits, they do not take action and allow them to misbehave.

Our reading from the above statement is that extorting money from offenders and setting them free is a corrupt practice that might underlie the entrepreneurs' mistrust in authorities. Second, micro-entrepreneur 1 extended the issue around mistrust to the authorities' failure to honor their promises to support the fire victims financially. He stated his views as follows:

> The fire authorities do not give us anything except that they allow us to put up the structures again through our own means; they only come to us immediately after the fire outbreak to make promises but they will never fulfil them.

Taking the conversation back to the earlier claim by the authorities that they helped the micro-entrepreneurs to recover financial or business losses through insurance companies, the entrepreneurs we studied further expressed their distrust in the insurance companies in the focus group discussion.

> We have realized that the insurance companies are not trustworthy; they will convince you to do it [insure your business] but when problem arises, the bureaucracy alone will put you off from getting the required benefit (Micro-entrepreneur 2).
>
> Many of us have not insured our stalls because the insurance companies do not do it for those of us operating at the central market. If we get better explanation from you today about the insurance, why not! We will do it (Micro-entrepreneur 3).

The interpretation of these statements for better postfire risk communication is to improve trust between the micro-entrepreneurs and insurance companies which goes beyond two-way communication between the authorities (experts) and the micro-entrepreneurs (nonexperts).

6 | DISCUSSION

This study aimed to conceptualize how fire management authorities can empower nonexpert public to engage in fire risk communication processes and increase their own responsibilities for managing fire preventive, protective, and recovery processes effectively. Our findings suggest that the fire management authorities used their knowledge of fire incidents and threats to plan and implement fire disaster management processes at the various stages of fire risk communication to manage (potential) fire occurrences in Kumasi Central Market. Their narratives, when explored on mental models approach, reflect the normative view of experts in communicating risk information (see Martin et al., 2009; Tabara et al., 2003) but differ from the way micro-entrepreneurs felt the frequent fire outbreaks might have been tackled. We discuss the findings and utilize the evidence to conceptualize the Fire Risk Communication (FRiC) model which explains how fire management authorities can empower nonexpert public to engage in fire risk communication processes and increase their own responsibilities for managing fire disasters effectively (Figure 1).

First, the authorities' perceptions on fire risk communication reflected how they planned fire disasters at the strategic level, collaborated with multiple stakeholders, disseminated information through many risk communication methods, and utilized their capabilities to manage fire threats and disasters at the various stages of fire risk communication. Their top-down efforts to communicating risk information and managing fire disasters, according to the fire managers, were hampered by inadequate logistics, use of outdated communication technology, congested and noisy market environment, and poor responses from the nonexpert micro-entrepreneurs. The consequences of these are frequent fire outbreaks and poor fire management outcomes which underlie the Metropolitan Disaster Expert's mental models on the market's low disaster management rating.

However, these challenges can be overcome by empowering participation of the micro-entrepreneurs in fire risk communication agendas, increasing responsibility of authorities to scan the potential for fire outbreaks in detail, and using

15396924, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/risa.13911 by Test, Wiley Online Library on [30/10/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

a better collaboration between the authorities and micro-entrepreneurs to stimulate conversations that can unfold their cognitions about the fire crises. These can help the authorities to reflect on their own (mis)conceptions about top-down risk communication planning such as using radio and megaphoned transport buses to communicate risk messages at noisy environments and resolve their inaccurate assumptions (see Chowdhury et al., 2012; Cousin & Siegrist, 2010; Morgan et al., 2002). For instance, we noted that the authorities could consider alternative times or methods of communicating risk information, to navigate the issues around excessive noise levels and crowded public areas that hindered effective use of radio and megaphoned transport buses during the peak periods. Improvising from the narratives of Micro-entrepreneur 6, one possibility is to use the radio method of communication after 07:00 p.m. when the micro-entrepreneurs have closed from work and typically when they can listen to radio at home. More anecdotally, they can use alternative media such as Facebook, Twitter, and WhatsApp (see Chowdhury et al., 2012; Verroen et al., 2013; Vos et al., 2018) to bypass the noisy and crowded conditions and to allow easier access to fire risk messages by the micro-entrepreneurs. Based on this discussion, we propose that: *The fire management authorities must collaborate with nonexpert public in fire disaster planning and empower these lay persons to identify risk communication methods that can be most effective to safeguard lives, properties and environment at the various stages of fire risk communication* (Proposition 1).

As inferred from this study, participation of micro-entrepreneurs in fire disaster decision making can encourage them to assess the risk of fire incidents from the bottom-up and to provide their understanding of practices. This is potentially a constructive, generative response to the authorities' misconception that low utilization of fire risk communications by the entrepreneurs hampers effective fire risk communication in the market. This will in turn influence the experts to communicate prefire strategies to prevent faulty electrical installation or penalize those who cook in the market, strengthen security measures especially during actual fire outbreaks to protect property and expensive merchandise against looting, and provide adequate relief packages for fire victims after fire incidents. The implications for risk communication policy design is noted in the work of Bostrom et al. (1994) where mental model interviews were used to solicit the public's views and understand how to mitigate people's misconceptions about climate change.

Discussing the findings further, we found that the micro-entrepreneurs received fire risk information from the authorities but they were not always confident in the messages. They expected the authorities to provide trusted fire risk information before fire disaster, deploy their firefighting capacity early to control fires during the actual occurrences and offer credible recovery assurances after fire disasters. However, the outcomes of these expectations had been poor largely because of unenforced bye-laws, a lack of surveillance, corrupt practices by some authorities, and irresponsible behaviors of some micro-entrepreneurs themselves. Insights on this account suggest that the micro-entrepreneurs wanted their voice and mental models to be considered for mitigating the rampant fire outbreaks in the market.

Our evaluation of the findings unveiled their desire to see changes in irresponsible behaviors that cause or compound fire disasters, enforcement of the law to deter or punish the offenders, improved security in the market to identify the perpetrators, and build strong trust between the authorities and micro-entrepreneurs themselves (see Bearth & Siegrist, 2021). Their voice aligns with existing knowledge that joint communication efforts between experts and nonexpert public yield better results that can also form the basis of evaluating their shared mental models of emergencies which can in turn be used as coordinated warnings to prevent and manage disasters (Chowdhury et al., 2012; Lazrus et al., 2016; Whitmer et al., 2017). Drawing insights from this discussion, we propose that: *Fire management authorities must increase their responsibilities for fire risk communications and take actions to change irresponsible attitude, enforce the law, strengthen security and build public trust to save lives, properties and environments at the various stages of fire risk communication* (Proposition 2).

Moving the discussion forward, we anchor the two propositions in the FRiC model to illustrate that mitigating perennial fire disasters does not just require the fire management authorities to listen to the nonexpert public nor merely to communicate fire risk information to them. It is also about empowering the participation of nonexpert public and increasing the responsibility of authorities in fire preventive, protective and recovery mechanisms for effective fire risk communication outcomes (see Chowdhury et al., 2012; Edwards & Gill, 2016). Understanding the public's (mis)conceptions about fire causes and its persistent damaging effects on livelihoods, property, and environment as witnessed through this study, necessitate effective fire laws to deter deliberate or careless behaviors that trigger fire outbreaks and arrest those who steal goods in the midst of fire occurrences. It also requires enacting fire emergency policies and building community trust to rehabilitate and provide recovery for the victims of fire after fire incidents. All these reside in the context of using appropriate fire risk communications to prevent fire; protect lives, property and environments, and recover the affected public across the three stages of fire disasters (before, during, and after), as a collective agenda toward the fire risk communication (Cutter et al., 2008; Weber et al., 2019). Our FRiC model is therefore significantly distinct from the way mental models are currently understood and applied in risk communication studies where the focus has been largely placed on erroneous beliefs between experts and the public (Cousin & Siegrist, 2010; Morgan et al., 2002) or concentrated more on public misconception of risk events (Lazrus et al., 2016).

15396924, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/risa.13911 by Test, Wiley Online Library on [30/10/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

7 | CONCLUSION

7.1 | Contribution and implications

We have explored empirical data on mental models to provide new understanding of integrating the perceptions of fire management authorities and nonexpert public to improve fire risk communication processes as both coproduction and participatory risk management activity. The uniqueness of our theoretical contribution lies in the way that the FRiC model seeks to empower engagement of nonexpert public and increase the responsibility of experts as collective mechanisms for minimizing fire outbreaks and managing fire risk information exchange at all stages of risk communication. The study introduces a fresh empirical case to support teaching of risk analysis and commercial fire disaster management which will explain how the disciplines can be studied from rampant fire disaster contexts in the near future.

The study also has immediate implications for micro-entrepreneurs running businesses in Ghana central markets and those operating similar enterprises in developing countries to use the FRiC model as practiced-based model that can help them to engage effectively in fire preventive, protective, and relief processes. This can help them to sign up for fire insurance cover, maintain their self-sustaining businesses, and instil business confidence in their local and foreign trading relationships. There is also implication for Ghanaian policymakers, risk communication authorities, and disaster management think tanks to strengthen fire disaster policies that can address commercial fire incidents and their devastating damage to people's livelihoods, businesses, properties, and environments now and the future. Such policy enrichment will likely improve social trust between the entrepreneurs and fire management authorities, strengthen public security, regulate irresponsible behaviors, and minimize corruption.

7.2 | Limitations and future research

We employed interpretivist traditions to explore the mental models of the studied risk communicators, but as reflexive researchers we accept that sentiments around empowerment can be explored through critical research and this philosophical viewpoint offers prospect for future iteration of this study (see Nyame-Asiamah & Kawalek, 2020). This study took a lengthy period to complete and some fire risk communication activities and fire incidents occurred between the first and second phases of data collection which might have affected the findings. Although care was taken to account for some implications of fire incidents and reconstruction activities at the market within this lengthy period, future iteration of the study can apply a longitudinal design to capture observational events that might impact the findings. While qualitative case studies can be generalized to other contexts that display characteristics of the original study's setting, it should be noted that the representativeness of this study's purposeful sample must be limited to the extent to which the findings can be repeated to a wider population (Myers, 2009). However, the study's propositions and our two-way FRiC model can be tested through quantitative research in future studies to allow the experts and the non-expert public to assess each other's beliefs about risk information and validate such beliefs against their own perceptions.

ACKNOWLEDGMENTS

We are grateful to the developmental feedback we received from Professor Loius Tony Cox (EiC), Professor John Besely (AE) and the anonymous reviewers that enabled us to develop this paper to its publishable form. We are also thankful to all participants of the study and to the Department of Geography and Rural Development of Kwame Nkrumah University of Science and Technology, Ghana for approving the progress of the study. We also thank De Montfort University for supporting this study and making it freely available through Open Access publishing.

ORCID

Frank Nyame-Asiamah https://orcid.org/0000-0002-6330-0751

Peter Kawalek https://orcid.org/0000-0002-6248-7745

REFERENCES

Addai, E. K., Tulashie, S. K., Annan, J. S., & Yeboah, I. (2016). Trend of fire outbreaks in Ghana and ways to prevent these incidents. *Safety and Health at Work*, *7*(4), 284–292.

Anderson, A., & Ezekoye, O. A. (2013). A comparative study assessing factors that influence home fire casualties and fatalities using state fire incident data. *Journal of Fire Protection Engineering*, *23*(1), 51–75.

Bearth, A., & Siegrist, M. (2021). The social amplification of risk framework: A normative perspective on trust?. *Risk Analysis: An International Journal*, https://doi.org/10.1111/risa.13757

Bostrom, A., Morgan, M. G., Fischhoff, B., & Read, D. (1994). What do people know about global climate change? 1. Mental models. *Risk Analysis: An International Journal*, *14*(6), 959–970.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101.

Breakwell, G. M. (2001). Mental models and social representations of hazards: The significance of identity processes. *Journal of risk research*, *4*(4), 341–351.

Carlsson, F., Daruvala, D., & Jaldell, H. (2012). Do administrators have the same priorities for risk reductions as the general public?. *Journal of Risk and Uncertainty*, *45*(1), 79–95.

Chetehouna, K., Courty, L., Garo, J. P., Viegas, D. X., & Fernandez-Pello, C. (2014). Flammability limits of biogenic volatile organic compounds emitted by fire-heated vegetation (Rosmarinus officinalis) and their potential link with accelerating forest fires in canyons: A Froude-scaling approach. *Journal of Fire Sciences*, *32*(4), 316–327.

Chowdhury, P. D., Haque, C. E., & Driedger, S. M. (2012). Public versus expert knowledge and perception of climate change-induced heat wave risk: A modified mental model approach. *Journal of Risk Research*, *15*(2), 149–168.

Claassen, L., Bostrom, A., & Timmermans, D. R. (2016). Focal points for improving communications about electromagnetic fields and health: A mental models approach. *Journal of Risk Research*, *19*(2), 246–269.

Claassen, L., Greven, F., Woudenberg, F., & Timmermans, D. (2020). 'Stay clear from the smoke': Effects of alternative public messages in case of large-scale chemical fires. *Journal of Risk Research*, *24*(11), 1426–1438.

15396924, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/risa.13911 by Test, Wiley Online Library on [30/10/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Cousin, M. E., & Siegrist, M. (2010). Risk perception of mobile communication: A mental models approach. *Journal of Risk Research*, *13*(5), 599–620.

Covello, V., & Sandman, P. M. (2001). Risk communication: Evolution and revolution. In A. Wolbarst (Ed.), *Solutions to an environment in peril* (pp. 164–178). John Hopkins University Press.

Cox, P., Niewöhner, J., Pidgeon, N., Gerrard, S., Fischhoff, B., & Riley, D. (2003). The use of mental models in chemical risk protections: Developing a generic workplace methodology. *Risk Analysis: An International Journal*, *23*, 311–324.

Cutter, S. L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., & Webb, J. (2008). A place-based model for understanding community resilience to natural disasters. *Global Environmental Change*, *18*(4), 598–606.

Dawson, I. G., & Johnson, J. E. (2014). Growing pains: How risk perception and risk communication research can help to manage the challenges of global population growth. *Risk Analysis: An International Journal*, *34*(8), 1378–1390.

Derks, D., & Bakker, A. B. (2010). The impact of e-mail communication on organizational life. *Cyberpsychology: Journal of Psychosocial Research on Cyberspace*, *4*(1), 1–14.

Dube, O. P. (2013). Challenges of wildland fire management in Botswana: Towards a community inclusive fire management approach. *Weather and Climate Extremes*, *1*, 26–41.

Edwards, A., & Gill, N. (2016). Living with landscape fire: Landholder understandings of agency, scale and control within fiery entanglements. *Environment and Planning D: Society and Space*, *34*(6), 1080–1097.

Eriksson, L. (2017). Components and drivers of long-term risk communication: Exploring the within-communicator, relational, and content dimensions in the Swedish forest context. *Organization & Environment*, *30*(2), 162–179.

Gentner, D., & Stevens, A. L. (Eds.) (2014). *Mental models*. Psychology Press.

Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013). Seeking qualitative rigor in inductive research: Notes on the Gioia methodology. *Organizational Research Methods*, *16*(1), 15–31.

Glaser, B., & Strauss, A. (1967). *The discovery of grounded theory*. Aldine de Gruyter

GOV.UK (2019). *UKEF supports UK firms to develop critical Ghanaian infrastructure*. https://www.gov.uk/government/news/ukef-supports-uk-firms-to-develop-critical-ghanaian-infrastructure

Greven, F. E., Claassen, L., Woudenberg, F., Duijm, F., & Timmermans, D. (2018). Where there's smoke, there's fire: Focal points for risk communication. *International journal of environmental health research*, *28*(3), 240–252.

Guanquan, C., & Jinhua, S. (2008). Quantitative assessment of building fire risk to life safety. *Risk Analysis: An International Journal*, *28*(3), 615–625.

Gutteling, J. M., & De Vries, P. W. (2017). Determinants of seeking and avoiding risk-related information in times of crisis. *Risk Analysis: An International Journal*, *37*(1), 27–39.

Hagemann, K., & Scholderer, J. (2007). Consumer versus expert hazard identification: A mental models study of mutation-bred rice. *Journal of Risk Research*, *10*(4), 449–464.

Hamilton-Webb, A., Naylor, R., Manning, L., & Conway, J. (2019). 'Living on the edge': Using cognitive filters to appraise experience of environmental risk. *Journal of Risk Research*, *22*(3), 303–319.

Johnson, B. B., & Chess, C. (2006). From the inside out: Environmental Agency views about communications with the public. *Risk Analysis: An International Journal*, *26*(5), 1395–1407.

Johnson-Laird, P. N. (2004). *The history of mental models* (pp. 189–222). Psychology Press.

Kusumi, T., Hirayama, R., & Kashima, Y. (2017). Risk perception and risk talk: The case of the Fukushima Daiichi nuclear radiation risk. *Risk Analysis: An International Journal*, *37*(12), 2305–2320.

Lazrus, H., Morss, R. E., Demuth, J. L., Lazo, J. K., & Bostrom, A. (2016). "Know what to do if you encounter a flash flood": Mental models analysis for improving flash flood risk communication and public decision making. *Risk Analysis: An International Journal*, *36*(2), 411–427.

Liu, Y., Hoppe, B. O., & Convertino, M. (2018). Threshold evaluation of emergency risk communication for health risks related to hazardous ambient temperature. *Risk Analysis: An International Journal*, *38*(10), 2208–2221.

Mabon, L., & Kawabe, M. (2018). Engagement on risk and uncertainty–lessons from coastal regions of Fukushima Prefecture, Japan after the 2011 nuclear disaster?. *Journal of Risk Research*, *21*(11), 1297–1312.

Marti, M., Stauffacher, M., Matthes, J., & Wiemer, S. (2018). Communicating earthquake preparedness: The influence of induced mood, perceived risk, and gain or loss frames on homeowners' attitudes toward general precautionary measures for earthquakes. *Risk Analysis: An International Journal*, *38*(4), 710–723.

Martin, W. E., Martin, I. M., & Kent, B. (2009). The role of risk perceptions in the risk mitigation process: The case of wildfire in high risk communities. *Journal of Environmental Management*, *91*(2), 489–498.

Molina, C. M., Martín, O. K., & Martín, L. G. (2019). Regional fire scenarios in Spain: Linking landscape dynamics and fire regime for wildfire risk management. *Journal of Environmental Management*, *233*, 427–439.

Morgan, M. G., Fischhoff B., Bostrom A., & Atman C. J. (2002). *Risk communication: A mental models approach*. Cambridge University Press.

Moser, S. C. (2010). Communicating climate change: History, challenges, process and future directions. *Wiley Interdisciplinary Reviews: Climate Change*, *1*(1), 31–53.

Myers, M. D. (2009). *Qualitative research in business & management*. SAGE.

Niewöhner, J., Cox, P., Gerrard, S., & Pidgeon, N. (2004). Evaluating the efficacy of a mental models approach for improving occupational chemical risk protection. *Risk Analysis: An International Journal*, *24*(2), 349–361.

Norman, I. D., Awiah, B. M., Aikins, M. K., & Binka, F. N. (2015). Review of Catastrophic Fires and Risk Communication, Ghana. *Advances in Applied Sociology*, *5*, 167–177.

Nyame-Asiamah, F., & Kawalek, P. (2020). Participating in critical discourse: A critical research study of clinicians' concerns for a Ghanaian hospital e-mail system. *Journal of Global Information Technology Management*, *23*(1), 53–75.

Paraskevopoulou, A. T., Nektarios, P. A., & Kotsiris, G. (2019). Post-fire attitudes and perceptions of people towards the landscape character and development in the rural Peloponnese, a case study of the traditional village of Leontari, Arcadia, Greece. *Journal of Environmental Management*, *241*, 567–574.

Republic of Ghana (1993). *Local Government Act, 1993 (Act 462)*. Ghana Publishing Company.

Riley, D. M., Newby, C. A., & Leal-Almeraz, T. O. (2006). Incorporating ethnographic methods in multidisciplinary approaches to risk assessment and communication: Cultural and religious uses of mercury in Latino and Caribbean communities. *Risk Analysis: An International Journal*, *26*(5), 1205–1221.

Scheer, D., Benighaus, C., Benighaus, L., Renn, O., Gold, S., Röder, B., & Böl, G. F. (2014). The distinction between risk and hazard: Understanding and use in stakeholder communication. *Risk Analysis: An International Journal*, *34*(7), 1270–1285.

Tàbara, D., Saurí, D., & Cerdan, R. (2003). Forest fire risk management and public participation in changing socioenvironmental conditions: A case study in a Mediterranean region. *Risk Analysis: An International Journal*, *23*(2), 249–260.

Twum-Barima, L. M. (2014). An assessment of the awareness of fire insurance in the informal sector: A case study of Kumasi Central Market in Ghana. *International Journal of Humanities Social Sciences and Education*, *1*(8), 41–47

Verroen, S., Gutteling, J. M., & De Vries, P. W. (2013). Enhancing self-protective behaviour: Efficacy beliefs and peer feedback in risk communication. *Risk Analysis: An International Journal*, *33*(7), 1252–1264.

Visschers, V. H., Meertens, R. M., Passchier, W. W., & De Vries, N. N. (2009). Probability information in risk communication: A review of the research literature. *Risk Analysis: An International Journal*, *29*(2), 267–287.

15396924, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/risa.13911 by Test, Wiley Online Library on [30/10/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Vos, S. C., Sutton, J., Yu, Y., Renshaw, S. L., Olson, M. K., Gibson, C. B., & Butts, C. T. (2018). Retweeting risk communication: The role of threat and efficacy. *Risk Analysis: An International Journal*, *38*(12), 2580–2598.

Wardman, J. K. (2008). The constitution of risk communication in advanced liberal societies. *Risk Analysis: An International Journal*, *28*(6), 1619–1637.

Weber, D., Moskwa, E., Robinson, G. M., Bardsley, D. K., Arnold, J., & Davenport, M. A. (2019). Are we ready for bushfire? Perceptions of residents, landowners and fire authorities on Lower Eyre Peninsula. *South Australia. Geoforum*, *107*, 99–112.

Whitmer, D. E., Sims, V. K., & Torres, M. E. (2017). Assessing mental models of emergencies through two knowledge elicitation tasks. *Human factors*, *59*(3), 357–376.

Xie, X. F., Wang, M., Zhang, R. G., Li, J., & Yu, Q. Y. (2011). The role of emotions in risk communication. *Risk Analysis: An International Journal*, *31*(3), 450–465.

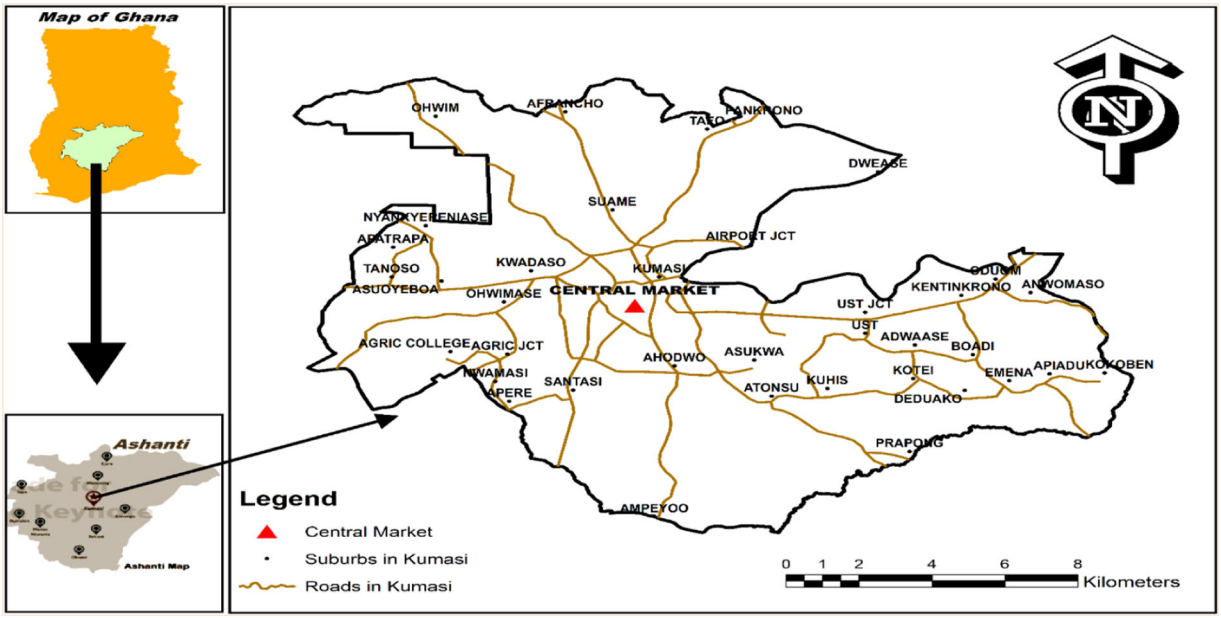
Yin, R. K. (2014). Case study research design and methods. *(5thed.)*. SAGE.

Zaksek, M., & Arvai, J. L. (2004). Toward improved communication about wildland fire: Mental models research to identify information needs for natural resource management. *Risk Analysis: An International Journal*, *24*(6), 1503–1514.

How to cite this article: Nyame-Asiamah, F., Boasu, B. Y., Kawalek, P., & Buor, D. (2022). Improving fire risk communication between authorities and micro-entrepreneurs: A mental models study of Ghanaian central market fires. *Risk Analysis*, 1–16. https://doi.org/10.1111/risa.13911

APPENDIX 1

Map of Kumasi Metropolis (*Source*: Town and Country Planning Department, Kumasi Metropolitan Assembly)



APPENDIX 2

Authorities' Interview Guide

1. **Perceptions about fire disaster risks**
   - What do you think are the causes of fire disasters that frequently hit Kumasi Metropolis?
   - How does your perception about fire disasters affect how you plan fire risk communication for the traders/micro-entrepreneurs at the Kumasi Central Market?
   - What has your institution done to manage the fire incidents at the Kumasi Central Market?
   - What more can you do to manage fire disasters and their effects at all stages of fire risk communication?
2. **Dissemination and management of fire risk information**
   - What is your general assessment on how fire risk information is communicated with the micro-entrepreneurs at the Kumasi Central Market? e.g. in the areas of accessibility, understanding, acceptability and frequency
   - Who are involved in the fire risk communications processes at the Kumasi Central Market?
   - Why are these persons involvement important?
3. **Addressing micro-entrepreneurs' misconceptions about fire risk communication**
   - What is your view on the kind of trust that the public have in your institution and its risk communication processes?

15396924, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/risa.13911 by Test, Wiley Online Library on [30/10/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

- How accurate or inaccurate is the belief they hold about your fire risk communication processes?
- How do you ensure that the micro-entrepreneurs provide accurate fire risk information to your institution and implement your fire risk communications?

4. **Increasing experts' responsibilities of fire risk communications**
   - How can you improve your capabilities to communicate fire risk information before, during and after fire outbreaks at the Kumasi Central Market?
   - How do you involve other institutions and the micro-entrepreneurs in your efforts to plan and disseminate fire risk information at the Kumasi Central Market?
   - What support do you give to micro-entrepreneurs whose businesses and livelihoods are affected by fire disasters at the Kumasi Central Market?
   - What do you consider as challenges of designing and allocating support packages for these fire victims?

Micro-Entrepreneurs' Interview Guide

1. **Perceptions about fire disaster risks**
   - What do you think are the causes of fire disasters that frequently hit Kumasi Metropolis?
   - How does your perception about fire disasters affect how you respond to fire risk communication by the fire management authorities at the Kumasi Central Market?
   - What do you think you can do to prevent fire incidents at the Kumasi Central Market?
   - What do you think the fire management authorities can do to prevent fire incidents at the Kumasi Central Market?
2. **Dissemination and management of fire risk information**
   - What is your general assessment on how fire risk information is communicated with the fire authorities at the Kumasi Central Market? e.g. in the areas of accessibility, understanding, acceptability and frequency
   - Who are currently involved in the fire risk communications processes at the Kumasi Central Market and who else do you think should be involved in managing and controlling fire disasters effectively at the Kumasi Central Market?
3. **Micro-entrepreneurs' (mis)trust in fire risk communication**
   - How accurate is the fire risk information you provide for the fire management authorities?
   - How much trust do you have in fire management authorities and the fire risk information they provide for you before, during and after fire outbreaks?
   - What can the fire management authorities do to help you improve your confidence in their risk communication processes and prevent/manage fire incidents better at the Kumasi Central Market?
4. **Empowering micro-entrepreneurs in the fire risk communication processes.**
   - What type of insurance cover do you think the entrepreneurs here must have to safeguard their businesses? How can you be supported to obtain an appropriate insurance cover?
   - What support do the fire management authorities provide for you to enable you to recover from post-fire disaster incidents? And how happy are you with the support, if you have received any?
   - How can fire outbreaks at the Kumasi Central Market be prevented?
   - How effectively do you think the fire authorities can involve you to contribute to planning and implementation of fire risk communication at all stages of fire management processes?

15396924, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/risa.13911 by Test, Wiley Online Library on [30/10/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License