Integrated Knowledge Management (IKM) Volume 16

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Part I. IKM and Emergency Disaster Response

1. Emergency Preparedness

1.1. Introduction

For the purpose of this volume, we define emergency disaster response in regards to four different categories of disaster: natural disasters, public health crises, acts of terrorism and radiation and chemical emergencies. [1] Natural disasters include earthquakes, hurricanes, floods, tornadoes, tsunamis, wildfires, volcanic eruptions and extreme temperatures, and these events can cause great damage to the environment, property, wildlife and human health. [2] Public health crises include epidemics, pandemics, and other disease outbreaks ranging from new influenza strains to potentially deadly diseases, as seen during the recent COVID-19 pandemic. Acts of terrorism can range from bomb threats to the threat or usage of biohazardous materials. [3] Lastly, radiation and chemical emergencies include the accidental or intentional release of radioactive materials or other toxic substances that can cause widespread damage in a specified area, as seen in the Chernobyl Accident in 1986 or the Tokyo subway nerve gas attack in 1995. [4] [5]

The year 2024 marks 45 years of emergency management for the U.S. Federal Emergency Management Agency (FEMA) and celebrates the presence and dedication of public services before, during and after an emergency disaster. [6] The rapid development of technology, such as individuals' access to smartphones during 9/11, has greatly motivated the need for applying innovative technology solutions during emergency situations. Up to this point we have understood the failures and successes of knowledge management in healthcare settings, but it's important to understand them as part of an emergency response as well. For instance, communications and knowledge sharing was critically lacking during the September 11th attacks, ultimately hampering the emergency response. The 9/11 Commission Report describes the issues with interoperability and included recommendations for better communication systems between emergency authorities. [7]

As we have previously discussed, the primary challange with the adoption of new technology and standards revolves around adapting technology to the local context and need. Addressing user understanding of technology, ensuring interoperability, and implementing data standardization - all while respecting current knowledge - are critical aspects of this overarching challenge. Integrating communication systems in all public and private spheres, and integrating social media and social services requires a strong strategy for designing and testing interfaces and interactions for usability. Promoting open data and using open-source technology to accommodate as many technical solutions is part of emloying IKM. This volume explores the level of current adoption of IKM in the existing emergency natural response system and further discusses challenges and recommendations for better practice in the near future.

1.2. Landscape of Emergency Management in the United States

FEMA was founded in 1979 by President Jimmy Carter, however federal emergency management reaches back as far as 1802 when the government needed to respond to the natural destruction of a seaport in New Hampshire. Since then, FEMA has undergone several organizational transformations and expansion of services to arrive where it is today as an agency that helps people pre, during, and post emergency. [8]

Emergency management and disaster response consists of five mission areas as defined by FEMA. These five areas include prevention, protection, mitigation, response, and recovery. These areas are part of the National Preparedness Goal which is to "...secure and resilient nation with the capabilities required across the whole community to prevent, protect against, mitigate, respond to, and recover from the threats and hazards that pose the greatest risk" [9], and includes risks such as natural disasters, disease pandemics, chemical spills, man-made disasters, and terrorist and cyber-attacks. The five mission areas are defined as follows:

1. Prevention: Prevent, avoid or stop an imminent, threatened or actual act of terrorism [10]
2. Protection: Protect our citizens, residents, visitors, and assets against the greatest threats and hazards in a manner that allows our interests, aspirations and way of life to thrive [10]
3. Mitigation: Reduce the loss of life and property by lessening the impact of future disasters [10]
4. Response: Respond quickly to save lives, protect property and the environment, and meet basic human needs in the aftermath of a catastrophic incident [10]
5. Recovery: Recover through a focus on the timely restoration, strengthening and revitalization of infrastructure, housing and a sustainable economy, as well as the health, social, cultural, historic and environmental fabric of communities affected by a catastrophic incident [10]

A simple way to think about emergency management is by breaking down a response into before, during, and after the response. In this paper we explore how IKM can play into each of these response areas.

1.3. Examples of Knowledge Management in Emergency Response

Emergency preparedness can broadly be split in pre-emergency, emergency response, and post emergency. Knowledge management and communications is critical during all stages of preparedness. In the pre-emergency timeframe, during the mitigation and preparedness stages of emergency management, knowledge management can be used to bolster training and education. For example, FEMA’s Emergency Management Institute (EMI) offers online training courses for emergency preparedness through its partnership with affiliated centers. [11] Training and education of first responders can help orient and prepare those involved once and emergency occurs, and is a core tenant of knowledge management best practices.

Another example of a national approach to emergency knowledge management is FEMA’s National Incident Management System (NIMS). NIMS is an example of a system that uses knowledge management to integrate resources across organizations by sharing and communicating compiled information. NIMS provides standardized vocabulary, systems and processes, and are large players when it comes to training and education. [12]

The National Emergency Response Information System (NERIS) is another example of system that employs interoperable data and information into an analytics platform used by the U.S. Fire Administration to support decision making. [13] Information and data from fire departments across the country in integrated into the system, and these departments can then access timely and accurate data to provide actionable intelligence.

1.4. IKM In Emergency Response

As discussed, the interoperability of data and communications is already a large part of emergency preparedness and response. IKM has a place in emergency preparedness by enhancing the ability of organizations to share and integrate critical data. Standardizing data can help improve emergency preparedness outcomes and enable the government to respond more efficiently, ultimately lessening the damage caused by an emergency. However, current standards organizations such as LOINC® and SNOMED CT® do not mention emergency preparedness, suggesting the emergency response system as a potential area for application of IKM. Furthermore, the lack of organizations that standardize emergency response terminology generates an opportunity to build a knowledge management and crowdsourcing framework for emergency preparedness.

1.4.1. The COVID-19 Pandemic and IKM

During the COVID-19 pandemic the absence of interoperable laboratory data was a challenge to response efforts. The lack of interoperable data during the pandemic showcased the inability of the government to properly estimate disease incidence and other metrics, ultimately cascading into inadequate communications and erosion in the public's trust. The Coronavirus Aid, Relief, and Economic Security (CARES) Act (P.L. 116-136) was established to require laboratories to report COVID-19 test results to the United States (U.S.) Health and Human Services (HHS) Secretary. [14] SHIELD developed the LOINC® to IVD (LIVD) mapping specifications for IVDs for SARS-CoV-2 diagnostic use, and in 2020 HHS ordered the use of LIVD test results provided to SHIELD. A study of five medical centers that used LIVD concluded there is potential for LIVD to improve semantic interoperability and data quality of LIS data. Although the benefit of LIVD is well documented, further efforts to promote its widespread use to achieve true laboratory interoperability are desirable. [15]

The pandemic also pushed forward other new technologies to help facilitate the response through the introduction and expansion of Artificial intelligence (AI). One of the main issues facing emergency responders and the public during the pandemic was the inability of policy and communications to efficiently update when new data and information was made available. Dealing with inaccurate, unreliable, and incomplete data all contributed to a flat emergency response effort. [16,17] Interoperability challenges were part of lessons learned from the COVID-19 pandemic, and fostered advacnements in AI and advanced analytics.

AI trains machines to learn from experience, taking new inputs and performing human-like tasks in logically programmed sequence with advanced analytics. As a result of rapidly developing AI, generative AI, a category of AI system that is able to produce meaningful content of its own, is known to be far superior to the traditional role of AI that primarily deals with numeric data with a limited amount of text. This generative AI has become a powerful tool to leverage existing data for enhancing data analysis and decision-making steps. Generative AI can touch on many parts of emergency response and preparedness, including optimizing resource allocation, creating alerts based on environmental scans, enhancing trainings and educational initiatives. [18]

Although AI is a powerful tool in the field of Emergency Response & Preparedness, the output of AI is solely dependent on the quality of numerical data with limited texts. Even with the existence of generative AI and its advanced outputs, public health institutions in the U.S. must navigate through a complex web of data paths with limited interoperability and data access. For example, more than a third of public health agencies were unable to access surveillance data during the COVID-19 pandemic, hampering their response. [19]

IKM can help unlock the full power of AI by ensuring data is of high quality, complete, reliable, and interoperable. [20]

1.6. Conclusion

Different institutions at the local, state, federal, national and international levels navigate through the challenge of adopting the latest technology in all shapes and forms. Simultaneously, they not only need to keep up with interoperability of their legacy systems with new systems, but also need to maintain an interoperable system with other institutions' Incident Command System (ICS).

Adopting IKM becomes an additional layer for response organizations to incorporate. Having experienced the global pandemic in recent years, the role of compliance is imperative for public safety. Enforcement in the areas of public safety and emergency planning remain crucial and requires government support to upgrade existing digital technologies. Achieving this upgrade at the local and state levels will empower and facilitate the federal level of maintaining interoperable ICS system with the latest available technology for many years to come.

The field of emergency response and preparedness is well established with many agencies and organizations serving in this space. Emergency preparedness is an important part of public health and requires a thorough management plan. In an ideal setting, emergency response systems work as well-oiled machines with complex processes and actors spanning across every field. The use of IKM in emergency preparedness and response can sharpen these processes and facilitate timely decision making and a more successful response.

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