Intelligent warnings: a twenty-first century approach to encouraging protective action in emergencies

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Executive summary

The Victorian approach to the delivery of public information and warnings is robust and leads the country in many respects. Despite this, when at-risk individuals do receive warnings, existing research clearly highlights they are unlikely to immediately act, and instead, will seek out further information and take time to process the information to determine whether any action is required. This verification process may include talking with family, friends, neighbours or colleagues, resulting in a delay before protective action is taken. To counteract this problem and provide communities with as much time as possible to take action, we need to minimise the likelihood of delays infiltrating our decision-making and warnings dissemination process. Artificial Intelligence (AI) and automation can help us to achieve this.

To investigate this further, a desktop review of existing literature was undertaken, supported by informal discussions and semi-structured interviews with a diverse range of academics, emergency managers and other experts across Victoria, New South Wales, Queensland and the United States. The discussions and interviews highlighted exciting opportunities to enhance our current approach through the use of AI and automation, which could be particularly helpful in enhancing the effectiveness of warnings for rapid impact emergencies, such as flash flooding and severe thunderstorms. During these types of emergencies, where community consequences are often experienced very rapidly after initial onset of the event, AI and automation can support the tailoring of language and content in warning products according to affected communities and likely consequences, minimise warning issuance delay and maximise the effectiveness of decision-making.

The investigation found these technologies are not a replacement for human decision making, however, if leveraged effectively they will enable us to better understand risk in real-time and reduce the considerable time taken to manually process intelligence and apply our pre-determined triggers and business rules. For the Victorian emergency management sector, these results suggest there is a need to prioritise investment in innovative new approaches to support the dissemination of potentially life-saving public information and warnings, whilst also supporting researchers to further understand human behaviour and decision-making upon receipt of a warning. In summary, this investigation has identified opportunities to better support communities to take protective action in a timely manner, to ensure we achieve our shared vision of safer and more resilient communities.

Introduction

The Victoria State Emergency Service (VICSES) is the control agency for flood, storm, earthquake, tsunami and landslide in Victoria. Victorian emergency management agencies, including VICSES, must issue timely, tailored and relevant warnings in response to emergencies, to inform communities and encourage protective action, in accordance with the Emergency Management Manual Victoria (EMMV), the State Emergency Response Plan (SERP), the Victorian Warnings Protocol and Joint Standard Operating Procedure (JSOP) J04.01 – Public Information and Warnings.

Following a number of significant emergencies in Victoria over the last decade, including the 2009 Black Saturday Bushfires and the 2010-11 Floods, the Victorian emergency management sector, including VICSES, has significantly enhanced the way it issues warnings to communities for a diverse range of hazards. Underpinning these changes has been the need to ensure warnings issued are in fact timely, tailored, relevant, accessible and consequence-based. Arguably, work undertaken to date has resulted in Victoria becoming a world leader in this space. Despite the significant progress made, there is considerable work required to ensure we remain at the forefront of global best practice.

Discussion

In this complex and ever-changing global environment, where the quality and scale of data and information available to emergency management agencies continues to grow, we must be at the forefront of developing and implementing innovative new approaches that enable us to transform the data and information into actionable intelligence for the benefit of community safety. We must become smarter about making the most of all available intelligence in real-time, as well as the presence of new and emerging AI and automation technologies, to better inform, warn and support our diverse communities to take protective action in emergencies. Not doing so could have catastrophic impacts.

There is a clear requirement to move beyond dashboards and platforms that simply display information, or require warnings issuers to manually type information that in many cases is not genuinely tailored to specific communities. Instead, we must implement solutions that enhance our collective ability to leverage AI and automation to inform our warning decision making processes and products in an efficient and effective manner. Whilst information systems and warning platforms have begun to address these sorts of issues, there is still significant research and groundwork required to implement enhanced systems and processes incorporating these exciting technologies, in a complex, multi-hazard warnings environment.

Upon receiving a warning, research shows that community members may initially believe the emergency will not impact them. In some instances, emergency managers may falsely believe that if a warning is issued, it will be received and actioned upon by those at risk. Trusted research to date indicates it is not this straightforward. When at-risk individuals do receive warnings, the research clearly highlights they are unlikely to immediately act, and instead, will seek out further information and take time to process the information and determine whether any action is required (Mileti & Sorensen, 1990). This may include talking with family, friends, neighbours or colleagues, resulting in a delay before protective action is taken.

Furthermore, numerous post-disaster inquiries, Royal Commissions and official reviews internationally, and across Australia, have repeatedly identified unfortunate failures in the decision-making processes of emergency managers' responsible for warnings who may have been under immense pressure at the time, or may not have all available intelligence to support effective decisions (Victorian Bushfires Royal Commission, 2009). Recurring delays in the issuing of emergency information over disparate events have also been identified and in some cases, critical emergency information was never disseminated. AI and automation can enable the longest possible lead time for the issuing of warnings containing highly tailored information.

In order to issue warnings containing highly tailored information, and with as much lead time as possible, efficient methods of intelligence collection and analysis are required. Scientists at the Queensland University of Technology have developed an Australian-first device which can be placed into floodwater to map exactly where water is flowing (Hamilton-Smith, 2018), which can assist hydrologists and technical experts to make more accurate predictions about downstream impacts ahead of time. The projected impact area could then be 'pushed', using automation, to community warnings platforms for dissemination alongside calls to action specifically tailored to the community at-risk. For example, if the projected impact area covered areas of farmland, the warnings platform would recognise the need to automatically include action statements such as 'move stock to higher ground' or might include contact details for government agencies responsible for agriculture and farming, which would only be required for warnings being issued to those specific communities.

There is no doubt that an enhancement to the impact of community warnings can be achieved through the use of AI and automation given the success other sectors have seen in this space. The intent for emergency managers is to ensure emergency we issue more genuine timely, tailored, relevant, accessible and consequence-based warnings. Reflecting on the world of aviation, we can see that the industry has taken significant steps forward in enhancing the safety of passengers on commercial airlines by increasing the use of automation throughout flights (Vartabedian & Masunaga, 2019), which has minimised the potential for human error. For Victorian emergency management agencies, in a practical sense, this might mean using these technologies to simultaneously tailor language and content in warning products according to affected communities, whilst minimising warning issuance delay. In essence, we would transform the way we disseminate potentially life-saving, critical information in emergencies by

applying our pre-determined business rules and language through automated platforms, or perhaps through development of a decision-support tools that guide our people when warning communities.

Despite the clear benefits of increased automation and the use of basic AI when issuing warnings, allowing computers to make independent decisions on content with little human oversight could evoke fears within both the emergency management sector and the general population. With the advent and rise of new technologies in people's homes, such as Google's Home and Amazon's Alexa, concerns around privacy and the role of technology in the lives of ordinary citizens are often raised. Experts have noted serious concerns about the potential for smart devices to be vulnerable to hacking (Butler, 2019), which could have all sorts of unintended consequences for individuals. This idea creates a sense of fear and distrust in technology, which could have a significant impact on the effectiveness of emergency warnings if communities become fearful that technology is directing them on how to stay safe in a flood, for example, rather than a human with intuition and years of experience. This is particularly relevant because of the importance of trust in promoting protective action when warnings are received by individuals (Victorian Bushfires Royal Commission, 2009). In this sense, it seems important to ensure that any enhancement to the technology we use to issue warnings and emergency information is focussed on augmenting and enhancing the current approach of human-led warnings, rather than replacing our people entirely.

The importance of a human or customer-centred approach to warnings is also essential when considering how to best engage with culturally and linguistically diverse (CALD) communities. In the health sector, the significance of nuance in language when conveying potentially life-saving medical information to diverse communities is well-understood and influences communications approaches, particularly in the United States, through bodies such as the Centers for Disease Control and Prevention (D. Daigle, personal communication, October 9, 2018). Interestingly, vaccine information is now available in more than 110 languages across the United States, which is crucial in empowering communities to make decisions by themselves in a bid to stay safe, which in some ways is similar to the intent of emergency management agencies when issuing warnings – to inform, empower and protect communities. However, much of this work in the health sector happens ahead of time and requires careful translation by people, rather than computers or robots. In rapid onset emergencies, for example, the time it might take a human translator to disseminate the content in 100 or more languages is unlikely to be available before impacts are felt. Nonetheless, technology does still provide opportunities to enhance our approach, whilst maintaining a focus on the individuals and communities at the other end.

The Victorian emergency management sector is already taking steps to integrate greater automation as part of the response to emergencies. In the flood context, the Victoria State Emergency Service, Department of Environment, Land Water and Planning, Melbourne Water, Bureau of Meteorology and Emergency Management Victoria are working to implement automatic Flash Flood Alerting which will not require human involvement. This project, due to progress to a trial in mid-2019, will see monitoring gauges aligned to specific triggers (determined ahead of time) push an automatic notification to community members who subscribe to the VicEmergency app, alerting them to the potential for flash flooding. Agencies, including the Victoria State Emergency Service can then expand on the initial automatic alert by disseminating a more formal warning product through human involvement, with specific calls to action based on the actual event. This, in some respects, is similar to the Victorian fire context where fire predictions from the Phoenix platform are automatically pushed across to the warnings platform (EM-COP), for warnings issuers to refer to when creating an impact area polygon to distribute alongside a warning product. Although simple, these examples demonstrate the positive steps already being undertaken in the emergency management sector to leverage technology for the benefit of community safety.

Internationally, other exciting work is taking place to enhance the way emergency management agencies and governments communicate, inform and warn communities during emergencies and disasters. In the United States, for example, the AWARN Alliance is working to explore opportunities for greater integration and automation across local emergency managers and television networks through the provision of a platform to enable warnings to be pushed directly to 'next generation' televisions (J. Lawson, personal communication, November 21, 2018). Additionally, in the research space, institutions such as the University of Georgia are partnering with service-delivery agencies including VICSES to better understand the psychological aspect of warning success, in encouraging behaviour change during emergencies. Additionally, VICSES has, for some time, partnered with the Queensland University of Technology through the Bushfire and Natural Hazards Cooperative Research Centre to develop our collective understanding of the role of trust, effective types of messaging and structures, and how alternative mediums (e.g.: video and other visuals) can aid or inhibit the success of warnings. All of these projects are, in some way, demonstrating the significant will of the sector to improve the way we operate and support communities to stay safe.

Conclusion

Bearing in mind the work already underway across our sector, there is an abundancy of options available to VICSES, and

partner agencies, to develop a smarter, technology-driven approach to support decision making and enable genuinely timely, tailored, relevant, accessible and consequence-based warnings. Ensuring our sector can learn from the considerable investment and research into artificial intelligence and automation across other industries is crucial in dealing with the community safety challenges we face. Now is the time to transform our approach to warnings in Victoria.

This investigation has enabled the researcher to develop an in-depth understanding of the issues and opportunities that exist and will act as a foundation for further discussions to ensure we can continue to provide the best information, with as much lead time as possible, to truly achieve safer and more resilient communities. This investigation has helped to ensure that we, as emergency managers, can truly meet the needs of all Victorians, supporting our desire to achieve safer and more resilient communities, through an innovative, twenty-first century approach.

Recommendations

The author makes the following recommendations:

1. The Victorian emergency management sector should prioritise investment in real-time, automated data sharing between disparate platforms, such as the Emergency Management Common Operating Picture (EM-COP) and hazard-specific applications including FloodZoom and the Bureau of Meteorology (BOM) Warnings Entry Tool (WET), to support decision-making and minimise warning issuance delay. In a practical sense, this integration might include the ability for EM-COP to digest BOM warning polygons and FloodZoom flood extents in real-time for immediate dissemination to communities.

2. The Victorian Public Information Working Group and Victorian Intelligence Capability Group should investigate development of a decision support tool, which would digest real-time data, overlay it with hazard predictions and our pre-determined business rules/triggers, outputting a suggested warning (including warning level, polygon, and key safety messages), for publishing by the relevant issuer. This tool could also benefit other aspects of response.

3. VICSES, EMV and other agencies should scope opportunities to develop a multi-agency project that would seek to develop collaborative relationships with graduates, experts and relevant institutions focussed on data and analytics, AI and robotics, enabling the sector to better leverage opportunities that AI and automation are already presenting to other like-industries, such as aviation, policing and transport.

4. VICSES and the broader emergency management sector should continue to work in partnership with the Bureau of Meteorology as part of its long-term project to review, refine and enhance its service delivery arrangements for warnings at a national level, with a particular emphasis on shifting towards truly impact-based warnings.

5. VICSES should to continue to work with the University of Georgia (UGA) to conduct a cross-national research project (US – Italy – Australia) focussed on risk communication in the context of natural disasters and emergencies.

6. VICSES should continue to work with the Queensland University of Technology and the Bushfire and Natural Hazards Cooperative Research Centre across relevant research projects considering the effectiveness of warnings and risk communication more generally, whilst advocating for greater research into the role of AI and automation in relation to the dissemination of warnings and emergency information.

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