The Journal for Transdisciplinary Research in Southern Africa
ISSN: (Online) 2415-2005, (Print) 1817-4434

Optimising knowledge management practices for improved collaboration in disaster response

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Dates:
Received: 03 Oct. 2024
Accepted: 06 Jan. 2025
Published: 18 Mar. 2025

How to cite this article:
Matekenya T, Ruhode E. Optimising knowledge management practices for improved collaboration in disaster response. J transdiscipl res S Afr. 2025;21(1), a1509. https://doi.org/10.4102/td.v21i1.1509

Disaster response operations are inherently complex, requiring effective collaboration between various stakeholders, including government agencies, non-governmental organisations, first responders and local communities. However, these operations are often hindered by fragmented communication, siloed information and inefficiencies in knowledge sharing. This study explores the optimisation of knowledge management (KM) practices to enhance collaboration in disaster response, adopting a transdisciplinary approach that integrates insights from natural, social, economic and technological systems. Drawing on data that were collected from Zimbabwe's Department of Civil Protection and the Civil Protection Committees, the study used thematic analysis to identify key KM strategies, including the development of a single knowledge repository, investment in local indigenous knowledge for early warning systems, capacity building, use of technologies and fostering a knowledge culture. Implementing these strategies can enhance collaboration, streamline communication and lead to more effective disaster response and management.

Transdisciplinary contribution: The findings provide actionable insights for practitioners and organisations aiming to optimise disaster response capabilities through effective KM.

Keywords: knowledge management; disaster response; coordination; collaboration; information sharing; situational awareness; lessons learned.

Introduction

Every year, the world faces numerous disasters that threaten human security and well-being.[1,2] Responding effectively to these disasters is a substantial challenge for most nations.[3] This challenge arises from the need for a critical mass of individuals and organisations, such as the army, police, fire and non-governmental organisations (NGOs), to coordinate their efforts in disaster recovery programmes. Designing solutions for social phenomena such as natural disasters requires a transdisciplinary approach.[4] Such an approach goes beyond traditional disciplinary boundaries to foster holistic solutions, emphasising collaboration among various sectors. These problems often lie at the intersection of natural, social and technical systems.[5] Effective coordination and information sharing are crucial for successful disaster response, as they facilitate the timely exchange of pertinent information between citizens and responders and among the responding entities.[4] This speeds up the restoration of normalcy and maximises a nation's response capacity.[5] This notion was supported by Usuda et al.,[6] who argue that disaster information should be effectively shared and unified so that each emergency responder can quickly and efficiently respond to the disaster. However, the current state of information coordination and collaboration among responders often leads to overlapping initiatives, extensive resource mismanagement and, ultimately, the loss of lives and livelihoods.[4] High levels of coordination and collaboration among emergency responders are necessary for efficient logistical processes to aid transport, procurement and warehousing.[7] Nonetheless, achieving coordination in emergency response is complex and demanding, mainly because of time pressure and urgency.[8] In disaster situations, the ability of responders to quickly react to a crisis depends on the quality and nature of information at their disposal and the extent to which they understand the current situation.[9] Coordination has been identified as a critical factor in effective responses to large-scale crises and disasters, emphasising improved knowledge management (KM) strategies to enhance coordination and collaboration in disaster response efforts.

This article argues that KM, because of its transdisciplinary nature, can provide the interconnectedness of these diverse organisations and expertise responsible for responding to disasters and assisting affected communities. Oktari et al.[2] point out that because of a lack of coordination and collaboration in disaster management (DM), disaster knowledge and experience

remain at an individual and institutional level. Thus, information on DM strategies is fragmented. This situation negatively affects the responsiveness of organisations to disaster, leading to 'reinventing the wheel' in projects and programme management. Knowledge management within the DM context focusses on availing the correct knowledge to the right people in the exact place at the proper time. The key tenets of KM are capturing, storing, sharing and leveraging diverse forms of disaster knowledge.[2] This knowledge can be tacit, explicit, context-specific or experiential. Therefore, KM in a transdisciplinary context involving various actors presents a possible environment for addressing the discussed limitations mentioned in this article. The purpose of this article is to recommend key KM strategies that can be used to improve the effectiveness of disaster response in Zimbabwe. This is because natural disasters, such as cyclones, cholera outbreaks, flooding and droughts among others have become recurrent and more destructive in Zimbabwe.

Related literature

The transdisciplinarity of knowledge management in disaster management

Transdisciplinarity in disaster response is essential because of the complex and multifaceted nature of disasters. Firstly, studies of KM in DM are an integration of diverse disciplines. Knowledge from psychology, sociology and communication studies helps understand human behaviour during disasters, risk perception and community engagement.[10,11] Inputs from civil engineering (e.g. earthquake-resistant structures), geographic information systems and data analytics are crucial for predicting, mitigating, and responding to disasters. Takewaki et al.[12] and Leaning et al.[13] contend that public health and medical sciences play a key role in managing disaster-related injuries, disease outbreaks and mental health challenges. Climate change, geography and environmental science contribute to understanding natural disasters such as floods, droughts and wildfires.[14,15,16] Secondly, DM requires collaboration across governments, NGOs, private sector organisations, local communities and international agencies.[17] Each stakeholder contributes specific expertise, creating a comprehensive approach to managing disaster risks and recovery. Response to coronavirus disease 2019 (COVID-19) is a clear example where collaboration between epidemiologists, public health experts, data scientists and policymakers allowed for more efficient knowledge sharing (KS) and crisis management. Thirdly, natural disasters are complex systems that affect multiple sectors simultaneously. Thus, addressing this complexity requires integrating knowledge from different disciplines to develop adaptive, flexible and sustainable management practices. Knowledge management in this context often includes integrating real-time data, historical knowledge and community practices to anticipate disasters and coordinate a rapid, effective response. Fourthly, a transdisciplinary approach also values indigenous and local knowledge systems, which have long contributed to resilience in the face of natural hazards. In many parts of the world, indigenous communities have a deep-rooted knowledge of their environment, passed down through generations. Knowledge management systems that capture this knowledge have proven to enhance disaster resilience, particularly in the context of climate change and ecosystem management. The integration of non-academic or non-technical knowledge, such as indigenous knowledge (IK) or community experiences is a key aspect of transdisciplinarity.[18] For example, in Bangladesh, NGOs employ a transdisciplinary approach that integrates local wisdom with scientific methods to improve DM and community resilience, particularly in cyclone-prone areas like Gabura.[19] They conduct training sessions on traditional practices, such as elevated housing and survival tactics, and scientific strategies, ensuring that DM is culturally relevant by involving community members in planning. As a result, communities become more prepared for cyclones, leading to reduced risks and enhanced long-term development. Lastly, legal frameworks, governance structures and political science are crucial in DM. These areas contribute to designing policy tools, regulations and international agreements that coordinate disaster response and recovery efforts.[19]

Knowledge management in disaster coordination and response

According to Haddow et al.,[20] KM is the effort expended to systematically find, organise and make available a company's intellectual capital and foster a culture of continuous learning and KS so that organisational activities build on what is already known. Knowledge management's focus goes beyond mere data accumulation and retention. It pertains to guaranteeing that appropriate information that is relevant, complete and in the correct format, is accessible to the correct individuals when needed to facilitate ease of application. This highlights the importance of knowledge application rather than just knowledge creation in decision-making, communication and coordination during emergencies. Because of the evolving nature of a disaster, KM becomes a key facet in improving the responsiveness to environmental changes.[21] This view is supported by Santoro et al.[22] who argue that KM should be at the centre of crisis management. Knowledge management facilitates situational awareness (SA) and, thus, minimises the impact of disasters.[2] Through the use of knowledge management systems (KMS), organisations can collect, organise and disseminate accurate and up-to-date crisis-related information comprising data related to the resources available, affected areas and best practices for handling similar situations. Knowledge management supports decision-making because the KM tools provide valuable insights and lessons learned from past crises. This knowledge enables the responders to make informed decisions based on evidence and experience that helps them timeously generate problem-solving plans. Responders use tacit knowledge in the form of expertise to allow them to select the best possible action for the most effective outcome.[23] In DM process, common factors that lead to organisations investing in KM include fragmented

knowledge, organisational silos, a reactive culture, a lack of standardisation, institutional memory loss and information overload.

Accountability for disaster information involves various stakeholders, including government agencies, emergency services, meteorological organisations, local governments, NGOs, community leaders, the private sector, media, academia and international bodies, all of which must work together to provide accurate and timely information. According to Tomé et al.,[23] these stakeholders should accurately document the crisis decisions, providing justifications for the decisions taken throughout. These documented decisions then act as institutional memory, a frame of reference for others managing the crisis and a checkpoint for cognitive biases.[23] This process helps capture lessons learned from the response effort allowing for continuous improvement. It helps diffuse best practices within the organisation and, thus, enables the organisation to solve problems quickly. Knowledge management is essential for organisations to make better decisions and improve disaster response and coordination.[24] It facilitates the building of organisational memory, reducing the chances of 'reinventing the wheel'. However, for effective disaster response, a centralised disaster repository is essential, allowing users to access information from a single point and reducing time wasted searching multiple sources. To make robust SA, more robust communication, coordination and collaboration, it is crucial to understand the KM strategies, initiatives and techniques that support seamless communication solutions for enhancing SA in disaster response.[25] Knowledge management initiatives or KM strategies are efforts undertaken by organisations to efficiently manage and make use of their knowledge resources.[26] They enable an organisation to convert data and information into relevant knowledge that will meet the objectives of the organisation.[27] Knowledge management plays a pivotal role in facilitating effective and efficient disaster response.

Transdisciplinary knowledge management in practice: The Sendai framework

The Sendai Framework for Disaster Risk Reduction (DRR) (2015–2030) is a United Nations initiative which emphasises the need for a people-centred, all-hazards approach to DRR. It calls for the integration of knowledge from various disciplines, ranging from scientific data on hazards to IK of risks to build resilient communities. It has been implemented globally, influencing policies and practices across diverse countries and regions. Its comprehensive approach to DRR emphasises the need for cooperation, community engagement and resilience-building in the face of increasing disaster risks. Various United Nations agencies, including the United Nations Development Programme and the International Federation of Red Cross and Red Crescent Societies, have used the Sendai Framework to guide their DRR initiatives worldwide.

Japan has used the Sendai Framework to strengthen its disaster resilience, particularly following the Great East Japan Earthquake in 2011. Indonesia has integrated the Sendai Framework into its national DM strategy, focussing on risk reduction and community engagement. The country has also developed DRR action plans that align with the framework. The European Union has adopted the Sendai Framework within its civil protection (CP) policies, aiming to improve cooperation and coordination among member states in DM. South Africa has aligned its DRR policies with the Sendai Framework, focussing on enhancing community resilience and integrating DRR into its national development plan. Another success story is that of the Philippines which has actively implemented the Sendai Framework through various initiatives aimed at community-based disaster risk management, particularly given the country's vulnerability to natural disasters. The Sendai Framework has influenced the United States of America's national disaster preparedness strategies, including the National Preparedness Goal and the Federal Emergency Management Agency initiatives. Powered by the Sendai Framework, several other countries, including Japan and New Zealand, have set up knowledge hubs that collect and disseminate data from past disasters, helping other regions learn from their experiences. These hubs serve as repositories of transdisciplinary knowledge, bringing together scientific research, government policies and local experiences.

Theoretical framework

Consistent with the transdisciplinary nature of disaster response approaches, Oktari et al.[2] view the implementation of KM from three perspectives which are information technology (IT), people and processes. These three perspectives by Oktari et al.[2] formed the theoretical framework for this study.

People-centred

This perspective acknowledges that knowledge resides within people's interactions and experiences. The transdisciplinary component of social sciences finds relevance in this context where people hold the tacit knowledge that is critical in knowledge creation. According to this paradigm, knowledge transfer between external partners and within the organisation is the main objective of KM.[2] This perspective, thus, prioritises the role of individuals in the process of managing knowledge. Knowledge management initiatives under this perspective include encouraging the creation of communities of practices, storytelling sessions, feedback loops, knowledge sharing platforms, training and development programmes, cross-functional teams, exit interviews and knowledge capture, and fostering a culture of KS, collaboration and continuous learning. Interpersonal open communication is strongly valued, and the significance of capturing tacit knowledge is recognised. This perspective can lead to increased problem-solving and innovation.

Technology-centred

Drawing from computer science, IT and information systems disciplines, this group believes that IT systems can encode, store, transmit and process knowledge. Thus, IT becomes crucial in managing knowledge.[2] Information technology plays a key role in retrieving the varieties of tacit and explicit information and knowledge that is embodied in systems.[27] The focus is leveraging technological solutions to facilitate knowledge storage, retrieval and dissemination. The emphasis is on KM's use of various platforms, software tools and systems. Priority is given to automation, digitisation and efficient information retrieval. The technology perspective often involves the implementation of knowledge repositories, collaborative tools, artificial intelligence and machine learning, content management systems, social media and networking tools, data analytics and visualisation tools, knowledge mapping software, as well as e-learning platforms among others. The benefits of this perspective include the facilitation of remote collaboration and communication, the automation of routine KM tasks, and the efficient storage and retrieval of a large volume of information. However, Ganapathy et al.[25] argue that KM solutions concentrating only on technologies have partially succeeded because an overemphasis on technology can neglect KM's human and social aspects. The technology perspective requires ongoing updates and maintenance to remain effective. In addition, this perspective might not effectively capture tacit knowledge.[28] This indicates that technology alone may be insufficient for capturing the unspoken, intuitive and experiential knowledge that individuals possess. It underscores the necessity of human interaction, socialisation and collaboration to fully acquire and utilise this type of knowledge within an organisation.

Process-centred

This perspective emphasises creating efficient and structured processes for capturing, organising and sharing knowledge within an organisation. Operations management, business management and organisational management are the main disciplines from which knowledge of process-centred implementation is drawn. Priority is given to creating a seamless information flow across the organisation.[29] Emphasis is placed on standardised workflows and procedures for KM. This involves developing documentation systems, standard operating systems, continuous improvement frameworks, knowledge audits, cross-functional process teams, lessons learned systems, workflow automation tools, feedback and evaluation mechanisms, integrated KM and training and development on processes, among others. The process-centred perspective supports better monitoring and tracking of knowledge-related processes, facilitates quick access to relevant information and enhances consistency in KM but overlooks the social and human aspects of KS. The standardisation can also lead to rigid structures that may not accommodate creativity and flexibility. It also requires continuous updates to accommodate changing needs. However, flexibility and versatility are essential elements in DM because of the unpredictable nature of disasters, which vary in scale, type and impact. Knowledge management processes must be adaptable to quickly accommodate changes and effectively respond to unforeseen circumstances. This adaptability is crucial for integrating diverse knowledge from multiple stakeholders and promoting cross-disciplinary collaboration. Additionally, real-time information sharing is vital, requiring agile processes that can handle rapid data influxes and ensure accessibility.

Research methods and design

Data collection

This study adopted a case study approach using Zimbabwe's Department of Civil Protection (DCP). In Zimbabwe, CP uses a multi-sectoral approach, which is supported by the Civil Protection Committees (CPC) at the national, provincial and district levels. The DCP exists only at the national level, and at the provincial level, it is represented by the Provincial CPC and chaired by the Secretary for Provincial Affairs and Devolution (SPAD). At the district level, the DCP is represented by the District CPC and chaired by the District Development Coordinator (DDC). The population for the study encompassed a diverse range of stakeholders involved in CP in Zimbabwe. Members of the DCP constituted the primary population, as they are directly responsible for managing CP issues and possess firsthand knowledge of existing coordination mechanisms and collaboration practices. Additionally, representatives from various government line ministries and organisations that constitute the CPC were included because of their expertise and involvement in disaster response efforts. Communities also constitute the population as they are the ones affected and respond first during disasters. Furthermore, experts in CP, including disaster academics, KM and IT specialists, contributed valuable knowledge regarding potential improvements in coordination practices as well as NGOs. Thus, a multi-stage sampling technique was adopted in this study in which the researcher combined purposive and convenience sampling. The researcher initially identified the categories of responders who would answer the research questions, based on their relevant roles and expertise (purposive). Leaders of the DCP were chosen for their critical role in disaster response coordination in Zimbabwe. Members of the CPC, specifically, the DDCs and SPAD, were included because of their involvement in coordinating responses to hydrological hazards. Experts were identified through an extensive search for academics who have published works on disaster coordination, information sharing and KM, ensuring the research reflected current best practices. The study focussed on the response to cyclone Idai, thus those organisations that participated in responding to cyclone Idai were purposively selected. Additionally, the research engaged with the community in Manicaland, the province most affected by the cyclone, to gain insights into the local impacts and the effectiveness of the response measures. Thus, the researcher first purposively identified and selected participants based on the criteria mentioned in the article. In the second stage, the researcher sent requests for

participation letters to the purposively selected individuals or organisations. Follow-ups were made but only those parties who responded and agreed to participate were included in the final sample (convenience sampling). Data were collected until saturation was achieved. A total of 26 interviews were conducted: six interviews with DCP and CPC members, 12 interviews with NGOs and seven interviews with experts (two DM academics, two KM experts, and three IT experts). Lastly, a focus group was done with a community made up of eight members. Data collection was conducted until saturation was reached, which is defined as the point at which no new themes or insights emerged from the interviews. The primary method of data collection was interviews administered by the researcher.

Data analysis

Data were analysed through thematic analysis using a framework approach for analysis, using both deductive and inductive reasoning, with ATLAS.ti.24 as the tool which was employed. Thematic analysis is a method for identifying, analysing and reporting patterns (themes) within data. The researchers read each script three times to ensure an in-depth familiarisation with and understanding of the data and the key themes. This initial coding helped the researcher obtain a general data overview. The coding scheme was developed using a hybrid approach in order to remain open to themes which were developed from the theoretical framework adopted in the study. Several codes stood out as highly grounded. Code groundedness represents the number of times the code was applied in the entire data set. On KM strategies that the DCP should adopt, technology was highly grounded at 42 groundings, people-related equally grounded at 42 groundings and processes were at 38 groundings.

Ethical considerations

Ethical clearance to conduct this study was obtained from Cape Peninsula University of Technology and the Faculty of Informatics and Design Research Ethics Committee (reference no.: 220315787/2021/13).

Results

Findings are clustered into broad themes which are: people-centred strategies, technology-centred strategies and process-centred strategies. These are presented in Table 1:

- *People-centred*: These strategies focus on prioritising the needs, rights and active participation of affected communities. These strategies recognise that individuals and communities are not just passive recipients of aid, but active agents who have valuable knowledge, skills and resources that can contribute to the response and recovery process. People-centred strategies ensure community participation, promote human rights principles and enhance local capacities and resilience as well as foster inclusive decision-making.
- *Technology-centred*: These strategies focus on using advanced technology to enhance the effectiveness, speed and coordination of disaster relief efforts. These strategies leverage the power of digital tools, data analytics, communication platforms and other technological innovations to improve decision-making, resource distribution and the overall response to disasters. Technology-centred strategies in disaster response often aim to improve data collection and situation awareness, enhance communication and coordination, as well as improve decision-making with data analytics.
- *Process-centred*: These strategies focus on optimising the procedures, workflows and systems that govern the entire DM cycle. These strategies prioritise the organisation, coordination and continuous improvement

TABLE 1: Mapping perspectives to participant responses.

Perspective	Text extract	Analysis of text
People-centred	'Let's incorporate IK-based EWS by making use of locally available resources using local knowledge that we understand and then we can just borrow a few things from outside', (DRO3)	The findings indicate the need for emergency responders to adopt a people-centred perspective to enhance their effectiveness during disasters through IK-EWS, training, partnerships, storytelling and fostering a knowledge culture. All respondents emphasised the need for EWS to consider the unique local context of the community or area, including the ecological, geographical and social factors influencing disaster risk.
Technology-centred	'Creating a single repository of information where whatever piece you might find elsewhere, you also find it in that central location, so that everybody has got like a one-stop shop for all the information to a particular humanitarian emergency', (DRO1)	The findings across all the groups of respondents highlighted that the DCP should invest in technologies that would assist in DM and response. The CPC members emphasised the use of technologies for EW that will improve the reliability and accuracy of disaster predictions for triggering response efforts. The NGOs and experts stressed the need for technologies that help in gathering, storing, processing and sharing disaster data. The findings from the study indicated that the DCP can enhance its ability to create, share and utilise disaster knowledge effectively by integrating various technologies across the KM cycle. Information technology experts revealed that technologies can be used effectively for knowledge creation and capture, storage, processing and analysis, sharing and distribution.
Process-centred	'There is need to review our *CP Act*. Disasters that used to be there in the 80s are now a bit different. E.g., we now have artisanal miners who are poisoning the water bodies and that means we need to take a different approach, when you have a disaster of this nature, this is how you are supposed to react' (Expert- DMA2)	There was a general convergence of perspectives and all responder groups revealed the need for robust governance structures that are enabled by legislative frameworks and clear policies, specifically revising the current *CP Act*. The experts revealed that for DCP to become more effective, certain policies and instruments need to be in place. These include revising the current *CP Act* to enhance the role of local authorities, limiting the political powers of certain politicians, when a disaster should be declared and creating a KM policy, a Data Protection policy and a DM Response policy. The findings revealed that the current *CP Act* (enacted during the 1980s) is no longer fit for purpose because it is outdated and ill-equipped to deal with modern-day crises such as climate change, cyclones, cholera outbreaks, flooding and droughts.

KM, knowledge management; DCP, Department of Civil Protection; CPC, Civil Protection Committees; IK, indigenous knowledge; EWS, early warning systems; EW, early warning; NGO, non-governmental organisation; DM, disaster management; CP, civil protection; DRO, Disaster Response Organisation; DMA, Disaster Management Academic.

of the processes involved in responding to disasters. The goal is to enhance the efficiency, effectiveness and accountability of disaster response efforts through well-defined, standardised and flexible operational procedures. Process-centred strategies emphasise the standardisation of procedures and protocols, defining roles and responsibilities as well as continuous monitoring, evaluation and adaptation.

Discussion

People

Indigenous knowledge is a unique, context-specific and place-based form of knowledge that can provide insights about a village, ward and district[30] to aid in disaster preparedness and response. Practically, the DCP can leverage this practice by integrating the IK-based EWS with the scientific EWS which will yield several benefits for improving disaster coordination in Zimbabwe. The findings revealed that communities possess a wealth of knowledge that the DCP can tap into to improve the overall coordination of disaster. This knowledge includes subtle changes in the environment such as weather patterns, animal behaviour or natural indicators of impending disasters in their areas. Thus, the DCP should facilitate the development of indigenous knowledge for early warning systems (IK-EWS) at a local level to enable timely and relevant alerts that resonate with affected communities. The IK holders in communities should be identified and interviewed for issues that have been time-tested and adapted to the local conditions. They should be involved in designing and operating homegrown EWS to ensure that alerts are culturally relevant, contextually appropriate and more likely to be heeded. Each local authority should keep an IK database of the most recurring disasters in that area that would foster intergenerational learning and KS and improve community resilience. There is growing empirical evidence from various cultural and geographical contexts that highlights the need for IK-based EWS for improving disaster response and management.[31,32,33] Studies have shown that early warning (EW) indicators, such as weather patterns, animal behaviour and environmental cues, can provide predictive information that complements scientific EWS. Prior research has shown the need for IK and formal knowledge systems and how this practice has led to effective and comprehensive EW and response mechanisms.[31] This finding aligns with these empirical findings. However, some researchers have highlighted challenges associated with this approach. Because of power dynamics, difficulties in validating the IK, cultural differences and resource constraints, there can be challenges in integrating IK and formal knowledge.[31] To integrate IK into the scientific EWS, there is a need for DCP to facilitate the systematic collection and validation of the IK for every district, stratified according to wards and villages.

Technology

Findings from the study stress the need for the development of a comprehensive KMS that serves as a centralised, secure and scalable platform that enables disaster data collection and acquisition, storage, analysis dissemination and transfer. This platform should act as a source for evidence-based decision-making for all disaster response stakeholders. The platform should also capture lessons learned from previous disasters and any other relevant disaster-related information. The diverse data and information should be seamlessly aggregated and consolidated into the centralised disaster knowledge repository. The KMS should employ a multifaceted approach to data acquisition and capture. It should integrate real-time inputs from various sources and employ multilingual capabilities. The KMS should incorporate advanced data mining and analytical capabilities to allow for the extraction of meaningful insights and patterns from the data to assist stakeholders in making data-driven decisions regarding disaster preparedness and response.

The need for IT adoption in managing disaster knowledge and improving emergency response is well supported by empirical evidence in various contexts. These studies have consistently pointed out the positive impact of IT on enabling the systematic capture, storage, analysis and sharing of disaster information. This practice has ultimately led to effective coordination and response operations.[2,23,34,35,36,37,38] Previous studies have consistently highlighted the importance that strategic deployment of IT plays in knowledge capturing, storage, analysis and sharing. However, some prior studies stressed the need for organisations to focus on all three perspectives of KM, that is, people, processes and technology. They argue that by focussing on technology, the outcomes of the interventions are not as effective. This view dovetails with Tomé et al.[23] who also discovered that a crisis is solved by using both IT and teaching the responders competency in the right processes. These views concur with Edwards[39] who argues that without thinking about the way people, organisations and IT operate, any implementation of a KM's initiatives are at best risky and at worst doomed to failure.

Processes

From a theoretical perspective, the findings on the need for clear governance structures anchor on theories on knowledge governance.[40,41] They conform to previous empirical evidence that underscored the need to formalise KM practices by establishing strong governance structures.[36,42] Prior research has shown how poor leadership coordination, lack of clear policies and standard operating procedures have hindered the effective flow of knowledge and application during disaster response.[43] Other empirical studies, however, have demonstrated the value of legislative frameworks that mandate joint training and exercises[36] that involve unorganised volunteers in the response operation.[44] However, some studies have discovered that overly bureaucratic or rigid governance structures can hinder the adaptability and agility required during disaster response.[45] Thus, there is a need to balance formal governance mechanisms with operational flexibility.[46]

Key recommendations

The need for a holistic approach

A key recommendation is the adoption of holistic KM strategies in line with the transdisciplinary nature of the DM phenomenon. A holistic approach to KM emphasises that effective management cannot depend solely on one aspect: people, processes or technology. Instead, it requires a synergistic integration of all three to cultivate a sustainable knowledge ecosystem that improves disaster coordination and collaboration. This integration involves aligning people, processes and technology with the organisation's strategic goals, ensuring relevance and application of knowledge. It also incorporates change management principles to address the human elements of technology adoption and process changes. Disaster response is a highly complex, dynamic and multi-stakeholder process that involves various challenges, such as fragmented information, rapid decision-making and unpredictable environments. A holistic approach ensures that all facets of KM, namely, people, processes and technology are optimised to work together seamlessly. This approach would ensure that in each village, risk management teams are formed at the ward level. The risk management teams should consist of members who transcend traditional disciplinary boundaries by integrating village residents with diverse skills and knowledge. Such diverse compositions are essential for developing comprehensive strategies for disaster preparedness, response, recovery and mitigation. These village structures would then coordinate with all other stakeholders including various levels as CPC members. This transdisciplinary approach emphasises collaboration among these diverse stakeholders, fostering a holistic understanding of complex disaster scenarios and promoting innovative solutions that address the multifaceted nature of disasters.

Technology

The DCP should house a comprehensive centralised repository of disaster-related information gathered from multiple sources. This can be achieved through web scraping, extracting data from organisational websites, using Application Programming Interfaces and data connectors for seamless integration of disaster data from internal systems and crowdsourcing, designing standardised templates for consistent data submission, and employing natural language processing and machine learning techniques to identify, extract and classify relevant information from unstructured data sources. The database should include a comprehensive list of potential hazards, information on vulnerable populations and critical infrastructure, and records of past disasters detailing their impacts and responses, historical weather data, maps of hazard zones and resources, relevant scientific studies and documentation of local disaster preparedness practices. Additionally, it should capture narratives from community members about previous disasters and a list of all NGOs and government agencies operating in the areas among others. It should provide a system for community feedback, outline methods for disseminating disaster-related information, detail EWS, and establish protocols for regular updates and efficient data sharing among stakeholders. This transdisciplinary approach ensures that DM strategies can be more effective, culturally relevant and adaptable to the unique needs of communities, ultimately leading to improved resilience and preparedness in the face of disasters.

People

The DCP should invest in capacity-building initiatives, training all stakeholders involved in disaster response including Members of Parliament to ensure that there is a shared understanding of disaster response management. They should have partnerships with various stakeholders, such as the private sector, academia, and regional and international organisations. This practice enhances collaborative action, shared understanding, collective resilience and, ultimately, the effectiveness of disaster coordination and the response effort. The communication channels and collaborative platforms established through partnerships can facilitate the swift flow of disaster information and also help in leveraging each stakeholder's unique capabilities and resources, leading to effective disaster response efforts. The DCP should also foster a knowledge-based culture that focusses on cultivating employees' behaviour and mindsets as well as structural arrangements to facilitate KS, integration and application.

Processes

The DCP should incorporate a systematic approach to disaster knowledge identification, capture and acquisition, storage and retrieval, disaster knowledge transfer and sharing, dissemination and collaboration. This creates a disaster knowledge infrastructure that can be used to improve the proactiveness of the disaster coordinating organ, efficient resource allocation and decision-making and, hence, the overall effectiveness of the response operation. The success of KM processes relies not only on technological solutions but also on creating an enabling environment. Findings indicate that a bureaucratic CP structure leads to slow decision-making, while a centralised system hinders effective disaster KM. A hybrid approach is recommended, combining centralised decision-making at the national level with district-level autonomy to address local needs. This involves establishing CP offices at provincial and district levels, staffed by dedicated personnel to analyse local disaster data and cater to specific conditions. To enhance decentralised decision-making, the DCP should strengthen local structures and engage knowledgeable volunteers in each village to provide insights on risks and vulnerabilities. This decentralisation will enable more responsive disaster responses. The DCP should set up district Emergency Operating Centres (EOCs) at the provincial and district levels staffed by people solely responsible for CP issues. At the village level, the EOCs should be established to address microscale climatic conditions that are challenging to comprehend for those not situated within the district. The EOCs will integrate data collected from both Indigenous

Knowledge Systems (IKS) and scientific sources, facilitating collaboration between diverse forms of expertise and cultural perspectives. This integration fosters a more holistic understanding of disaster risks and responses, as indigenous communities frequently provide valuable insights into local ecosystems, historical patterns and traditional practices that can enhance scientific methods. These EOCs should have robust data management capabilities. Additionally, the organisational structure should include knowledge-related positions, such as chief knowledge officers and data analysts, to meet the DCP's knowledge needs. Strong governance mechanisms are essential to support KM processes, and DM authorities should prioritise developing these frameworks. Effective leadership is needed to enforce policies and monitoring metrics as well as strong governance mechanisms to clarify ownership, accountability and responsibility that promotes a culture of KS. Legislation should mandate the acquisition, storage and sharing of critical knowledge assets. The DCP should also focus on capacity building to ensure all stakeholders are aligned and equipped to fulfil their roles effectively.

Implications for theory and practice

The community of scholarship will find relevance in the transdisciplinary nature of this study. This article recognises the integration of knowledge systems which is consistent with transdisciplinary approaches. Firstly, this is because disasters are complex phenomena and no individual or discipline has all the necessary expertise to respond to them. Additionally, a robust framework for managing knowledge encompassing people, processes and technology is vital for the systematic collection and dissemination of information, enabling informed decision-making and timely responses. This fosters a more holistic understanding of disaster phenomena and enhances theoretical frameworks by incorporating multiple perspectives. Secondly, the intersection of various disciplines necessitates the development of new theoretical frameworks that can account for the complexity of disasters. These frameworks must incorporate social, cultural, environmental and technological dimensions to better explain how knowledge is generated, shared and utilised in disaster contexts. Thirdly, the transdisciplinary nature of KM in DM emphasises the dynamic processes of knowledge creation and exchange. This aligns closely with the Sendai Framework which advocates for a holistic approach to disaster risk management that recognises the diverse factors influencing knowledge generation, sharing and utilisation. Furthermore, the transdisciplinary nature of KM in DM reflects the Sendai Framework's emphasis on collaborative and dynamic processes of knowledge creation and exchange, ultimately enhancing resilience and preparedness in disaster contexts.

The EOC at the district level serves as a critical hub for DM providing a centralised location for coordinating emergency response efforts and housing a comprehensive database of disaster-related information specific to the district. This centralised database should include data on vulnerabilities, historical disaster events, resources and response plans, enabling efficient access to vital information during emergencies. The district EOC plays a pivotal role in collecting and analysing local disaster data, which is then communicated to the Provincial EOC, creating a seamless flow of information that supports decision-making at higher levels of governance. To ensure effective governance and management of these central repositories, clear protocols must be established. This includes designated roles for data management personnel, regular training on data entry and analysis, and standardised procedures for data updates and dissemination. Additionally, DCP members should oversee the operations of the EOC. This collaborative framework not only enhances the functionality of the EOC but also fosters a culture of shared responsibility and resilience within the community. Practically, the establishment of a centralised repository of disaster-related information will facilitate the institutionalisation of tacit knowledge. Recognising and valuing IK systems empowers communities, allowing them to take an active role in disaster preparedness and response. This fosters resilience and encourages the adoption of culturally relevant practices that enhance community capacity.

Conclusion

In conclusion, the data suggest that the DCP can greatly improve its effectiveness through the implementation of various technological tools and advanced data analytics. The findings also underscore the need for a centralised knowledge repository to ensure swift and coordinated responses. Additionally, the review and updating of relevant policies and legislation, such as the *CP Act*, are crucial for modernising disaster response efforts. Overall, prioritising the integration of technology, enhancing communication and collaboration, and implementing appropriate governance policies and restructuring strategies are essential for improving DM at all levels. However, the insights gained underscore the need for an integrated approach to KM that focusses on all perspectives of people, processes and technology. Thus, response organisations must prioritise the integration of these KM practices to enhance their preparedness and responsiveness.

Acknowledgements

The authors would like to thank the Cape Peninsula University of Technology for the financial assistance and access to research facilities that have been instrumental in enabling the successful completion of this article. The authors are deeply grateful to all the organisations and individual representatives who generously left their busy schedules to attend interviews and share their time, experiences and insight. Without their contributions, this study would not have been possible. This article is based on the first author's doctoral thesis entitled 'A knowledge management framework for improving emergency and crisis response in Zimbabwe' towards the degree of Doctor of ICT in the Information Technology Department, Faculty of Informatics

and Design Cape Peninsula University of Technology, South Africa in August 2024, with supervisor Prof. Ephias Ruhode.

Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Authors' contributions

T.M. contributed to the conceptualisation, data collection, analysis and writing of the article. E.R. is the co-author and supervisor that provided essential guidance throughout the research process, contributed to the critical revision of the article and ensured that the research adhered to academic standards.

Funding information

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Data availability

The data that support the findings of this study are available from the corresponding author, T.M. upon reasonable request.

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