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A Literature Review on Social Innovation and Community Flood Preparedness in Alignment with SFDRR and SDG: Recommendations for Dam Failure Flood Risk Management

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ABSTRACT

In response to the escalating challenges posed by climate change, the United Nations (UN) proactively formulated the Sendai Framework for Disaster Risk Reduction (SFDRR-2015-2030) as a comprehensive strategy for disaster risk management (DRM). This framework delineates four priority action objectives, seven global targets, and a set of guiding principles aimed at mitigating the impact of disasters. Notably, each of the seven SFDRR targets is intricately linked with the Sustainable Development Goals (SDG-2030). Given that natural disasters, such as floods, continue to hinder a country's social and economic progress, achieving long-term development becomes challenging. Both frameworks prioritize initiating and investing in innovation, involving all of society's stakeholders, to build a risk-informed and people-centered disaster-resilient society. However, a research gap exists regarding the relationship between Social Innovation (SI) and disaster risk preparedness. To address this, the present study conducts an in-depth literature review and content analysis focused on SI and flood preparedness. The study also aims to offer strategic recommendations for adopting SI to improve preparedness against dam-related flood risks, aligning with SFDRR targets and SDGs-2030. The study's findings are valuable for academia, policymakers, flood risk management agencies, at-risk communities, and stakeholders. By shedding light on the role of SI in flood risk preparedness, the research contributes to existing knowledge and enhances understanding of SI in the context of disaster risk management.

1. INTRODUCTION

The mitigation of natural and man-made hazards has played an essential role in aligning the Sustainable Development Goals (SDGs) with the Sendai Framework for Disaster Risk Reduction (SFDRR) [1], with the ultimate goal of achieving the 17 SDGs that are derived from 169 global goals [2]. While the SFDRR does not possess legal enforceability over UN member states, the act of reporting on advancements remains a voluntary endeavor [3]. It is suggested that the state should adopt and implement the prescribed guidelines of SFDRR based on their perspectives [4]. Malaysia, like other UN member states, places significant emphasis on the SFDRR when formulating effective policies, guidelines, and programs to address and prepare for disaster risks [3]. Given the focus of SFDRR on disaster management initiatives encompassing various types of hazards, it is noteworthy to acknowledge the integrated community-based disaster risk management (ICBDM) efforts in Malaysia. Specifically, the ICBDM in Malaysia directs its attention towards the occurrence of dam-related floods, which are infrequent but possess the potential for devastating consequences that surpass those resulting from typical floods. Considering global warming and climate change, it is imperative for a nation to possess the capability to effectively manage a multitude of hazards that may arise from the failure of dams or the occurrence of consecutive events, thereby resulting in a dire situation with regards to dam safety. Implementing efficient risk mitigation strategies can achieve this [2].

The objectives of this study are twofold: firstly, to conduct a comprehensive literature review and content analysis on the Social Innovation and flood risk preparedness and secondly, to propose recommendations for integrating Social Innovation (SI) to improve dam-related flood risk preparedness to achieve SFDRR targets and SDGs.

1.1 SI and SFDRR

To achieve its targets, SFDRR focused on the increasing role of science and technology as well as the involvement of the private sector. For instance, to attain priority 1, i.e., to understand disaster risk, the expected outcome is to assess the current state of data, scientific knowledge, and technical availability on disaster risk reduction and fill the gaps with new knowledge.; and the critical action is to enhance the access to environmentally sound technology, local knowledge, and inclusive innovation and promote community engagement in data collection. For this, United Nations International

Strategy for Disaster Risk Reduction (UNISDR) advocates harnessing the power of community-based innovation practices for community mobilization [5].

Priority 3 refers to the importance of public and private investment, private cooperation, and business resilience to promote innovation [1]. To realize almost all the goals, targets, and priorities of action, SFDRR advocates a scientific and people-centered approach with the involvement of both state and local authorities, stakeholders including all-off-society engagement and partnership, paying particular attention to the poor people who are disproportionately affected, incorporation of indigenous knowledge to scientific knowledge [6]. In January 2016, the UNISDR Science and Technology Partnership launched the Science and Technology Road Map to 2030 at the Geneva UNISDR Science and Technology Conference. This initiative aims to promote and facilitate the use of science and technology in decision-making for Disaster Risk Reduction (DRR) [5]. Besides technical innovation, community-based innovation is prioritized for integrating local information in disaster management decision-making [5].

While the term "innovation" appears 12 times in the SFDRR, it predominantly refers to technical and scientific innovation. For the implementation of SFDRR through "science and inclusive innovation," the potential benefits of SI by involving stakeholders from all segments of society. This perspective is also supported by Shaw et al. [7], noting that SFDRR underscores the increasing use of science, technology, and innovation by scientists and a wide range of stakeholders, including governments, non-governmental organizations (NGOs), and the private sector. They highlight the contemporary shift in innovation towards co-designing solutions tailored to the specific needs of vulnerable communities and other stakeholders, diverging from past approaches that primarily focused on identifying causes and offering general solutions.

Some of the past studies have employed SI to attain the objectives of the SFDRR. For instance, Trejo-Rangel et al. [6] assessed how social innovations can contribute to the development of public policies aimed at reducing risks and enhancing resilience to floods. This evaluation sought to establish a virtual platform for collaboration among student innovators and mission-driven entrepreneurs in fields such as architecture, engineering, and disaster management, fostering the development of innovative solutions for addressing future disasters. The Social Innovation Online Hackathon (SIOH) 2020 was initiated through collaboration between Resilience Innovation Knowledge Academy (RIKA) India, Indo-Japan Laboratory (Keio University, Japan), and four cooperating universities [8]. However, studies specifically focusing on SI in the context of DRR remain limited [6, 9, 10].

1.2 SI in the context of flood risk preparation

From the dawn of human civilizations to the contemporary era, societal progress and transformations have been driven by various innovations. SI, a concept gaining significant attention, is defined by Mulgan [11] as innovative activities and services meeting social needs, often diffused through organizations primarily dedicated to serving society. SI is characterized as a response to social challenges, seeking enduring results for social welfare across organizational boundaries and jurisdictions [12], often involving the voluntary commitment of civil society actors [13]. SI can manifest in three types: grassroots, responding to social demands and vulnerable groups; broader level, addressing societal challenges; and systemic, aiming for fundamental changes in attitudes, values, and organizational structures [14].

Conversely, community preparedness is a crucial aspect of DRM, highlighted as priority 4 in the SFDRR. Preparedness, as defined by Guru and Santha [15], encompasses the knowledge and capabilities developed by various entities, including governments, response and recovery organizations, communities, and individuals, to anticipate, respond to, and recover from the impacts of disasters. Community involvement is indispensable for enhancing preparedness against floods, as evidenced by community-based strategies employed in Japan and England originating from grassroots levels [16]. Inclusivity and collaboration across society, irrespective of age, gender, or cultural perspectives, are imperative for fostering innovative approaches in DRR and developing comprehensive, tailored policy frameworks [15]. Beyond technological advancements, the integration of a broader societal perspective, termed "Society Innovation" (SI), involving all stakeholders united by the common goal of developing sustainable DRR solutions, can lead to more enduring outcomes.

Several studies, such as Trejo-Rangel et al. [6], have addressed the role of SI in improving flood preparedness, identifying SI measures for prevention and preparedness in a small city. Other studies, like the studies of Kelly and Kelly [17] and Canwat [18], have highlighted the potential of SI initiatives to enhance disaster preparedness. While interest in SIs is growing among academics and policymakers, there remains limited knowledge about actors and implementations of SIs [19].

1.3 SI and flood risk preparedness to achieve the targets and goals of SFDRR and SDG

In February 2017, the UN adopted a set of indicators to gauge the progress of each of the seven targets outlined in the SFDRR. These indicators enable countries to assess their endeavors in mitigating disaster losses by 2030, encompassing aspects such as fatalities, affected individuals, economic losses, and damage to vital infrastructure like water systems, transportation networks, telecommunications, educational institutions, and medical facilities. As the SDGs were formulated shortly after the SFDRR, these indicators were devised to facilitate the monitoring of advancements toward the pertinent targets of the SDGs. The discernible connection between the SDGs and the SFDRR can be discerned in SDG11 and SDG13. SDG11 endeavors to foster the sustainability of urban areas and communities, while SDG13 addresses climate change and its repercussions by empowering individuals to become more resilient and adaptive through enhanced knowledge of hazards [20]. The mutually reinforcing nature of achieving the SFDRR targets in order to realize the SDGs, particularly in terms of poverty reduction, is widely acknowledged [21, 22]. Nevertheless, our understanding of the specific SDGs that existing Sendai Indicators (SIs) already address remains limited.

Consequently, bolstering preparedness for flood risks through SIs can assist a nation in attaining the targets outlined in the SFDRR and the SDGs.

2. RESEARCH METHODS

This article utilized qualitative research methodologies to achieve its dual research objectives. In this paper, in addressing the main research objective, how existing literature discusses SI as a means of increasing disaster risk preparedness especially flood risk preparedness; the study employed Systematic Literature Review (SLR) to identify pertinent academic literature. Subsequently, utilizing the findings and discussions from the SLR, this study employed content analysis of existing literature on the management of flood risks caused by dam failures to offer recommendations for enhancing the preparedness of Malaysia in dealing with the risks associated with dam failure-induced floods.

SLR search techniques entail conducting a comprehensive search of applicable scientific databases and sources with the purpose of identifying and selecting primary studies for review. Researchers employ specific keywords and search criteria to retrieve relevant papers [23, 24]. The selected papers are subsequently analysed for their quality, and data extraction and synthesis are carried out to derive meaningful insights and conclusions.

The example of using a combination of SLR and content analysis can be found in previous scholarly literature as a noteworthy approach. For instance, Fasihi et al. [25] conducted an exhaustive literature review and scientific mapping of flood and drought literature. Khirfan et al. [26] contributed to the scholarly discourse by utilizing SLR techniques and content analysis to undertake a comprehensive literature review on the subject of stream daylighting. In a parallel vein, Habibi Rad et al. [27] delved into the application and contribution of Industry 4.0 in DRM.

The SLR searching techniques were strategically deployed, encompassing searches across prominent academic databases such as Google Scholar, Science Direct, and Scopus. The specified keywords employed in the search included "Social innovation," "Flood disaster," "Preparedness," and "Management." Considering the variations in searching protocols across these databases different search string was used to search titles, abstract and full text as shown in Table 1.

The study utilized rigorous inclusion and exclusion criteria outlined in Table 2, restricting the search to English-language articles published between January 2013 and December 2023. Exclusion criteria considered factors like relevance, quality, and duplication. Abstracts and conclusions were initially screened, and duplicates were identified through unique coding and manual detection. Thirteen (13) articles were selected through electronic tracking, manual review, and email communication among authors. All authors independently assessed eligibility, collected data, and evaluated bias and quality. This meticulous process aimed to ensure the study's relevance and currency. The selected articles' goals, methods, results, and recommendations were thoroughly examined for further research efforts. To analyse the data the study used thematic content analysis to describe the findings based on their pattern. The overview of SLR is depicted on the Figure 1.

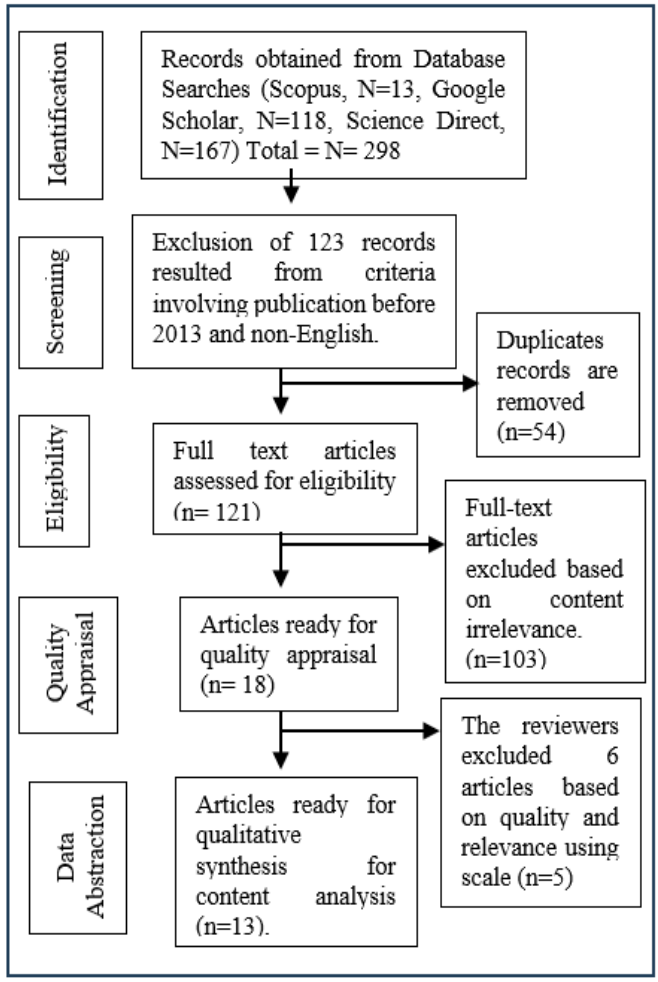

Figure 1. The overview of SLR process

Table 1. Search terms

Database	Search Terms
Google Scholar	"Social innovation" AND "flood disaster" AND "preparedness" AND “management”
Scopus	TITLE-ABS-KEY ("Social innovation" AND flood OR disaster) AND "preparedness" AND "management"
Science Direct	("Social innovation" AND flood OR disaster) AND "preparedness" AND “management"

Table 2. The exclusion and inclusion criteria for the SLR

Criteria	Inclusion	Exclusion
Timeline	2013-2023	<2013
Document type	Article Journal, conference paper	Chapter in books, Books series and books
Language	English	Non-English
Content	SI, flood risk preparedness or natural disaster preparedness	Articles not related to SI, flood or natural disaster preparedness

3. RESULTS AND DISCUSSION

SI in increasing flood risk preparation among high-risk communities. The literature review, comprising an examination of 13 articles delineated in Table 3, spans across various scholarly sources, including journals, commentaries, and working papers, all of which contribute to the discourse on SI in the context of flood risk management.

Figures 2 and 3 illustrate number of studies included in this section for content analysis based on 'publication year' and 'country.' Evidently, SI has emerged as a salient theme within the academic literature on DRM.

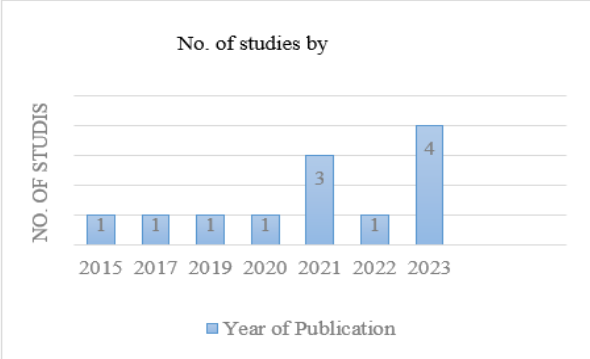

Figure 2. Number of studies included in the review based on "year of publication"

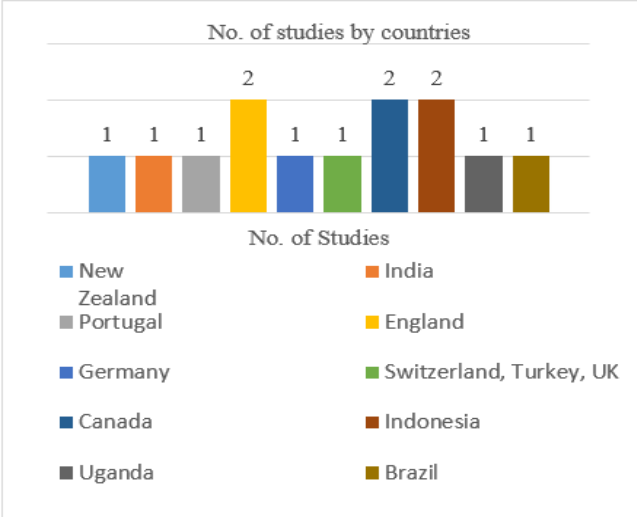

Figure 3. Number of studies included in the review based on "country of publication"

The following section discusses the principal findings derived from content analysis, encompassing SI actions or initiatives, the actors involved in SI within the domain of flood risk management, drivers or incentives of SI, the role of SI in flood risk communication, and its integration into the early warning system.

Table 3. Content view of the selected articles

No.	Journal Title	Objectives	Method	Findings
1	Social innovation Hackathon for driving innovation in DRR [8]	To introduce SIOH as a tool of multi-disciplinary collaboration to develop innovative solutions for innovation DRR	- Virtual platform - Duration: two and a half months, - Four stages: ideation; maturation; tangible phototype; and marketing strategy	Skills such as problem-solving, entrepreneurship, application development, time management, interpersonal & leadership
2	Incorporating SI in the elaboration of disaster risk mitigation policies [6]	To analyze what SI and how SI initiatives nurtures risk mitigation public policy to increase flood resilience in small cities	- Survey - A seminar with serious gaming activities was arranged to share the survey results to identify, discuss and formulate implementation pathways for the SI actions	Survey result explored using 10 SI initiatives to avoid and reduce disaster risk
3	Make-a-thon: A blueprint for SDG-driven innovation [28]	To build a blueprint for collaborative innovation to enable interested organizations and individuals to replicate it in their own contexts	- A collaborative innovation marathon initiative created by university, firms, philanthropic and NGO's as a main actor - Engagement with SDGs-related contexts and by applying technology to iterative prototyping	Blueprint of collaborative innovation with proper structure to empower other organizations and individuals that want to take part in the SI movement to. achieving the SDGs
4	The SI potential of ICT-enabled citizen observatories to increase eParticipation in local flood risk management [29]	To analyze the potential of SI by ICT-enabled citizen observatories to increase eParticipation in local flood risk management	Two case studies	Citizen observatories do not necessarily mean that residents will participate more actively in flood risk management or that stakeholder communication will improve
5	Spontaneous volunteers and the flood disaster 2021 in Germany: Development of SI in flood risk management [14]	To know the challenges and potentials of developing SVs as SI in flood risk management	Online survey (n = 2636)	Preplanning of useful concepts considering safety aspects, ICT utilization, foster mutual respect between SVs and authorities and supporting sense of community

				are the key results for development of SI
6	Exploring the micro-foundations of dynamic capabilities for SI in a humanitarian aid supply network setting [30]	Explores the micro-foundations of the DCs needed for SI in a humanitarian aid context	Content analysis (combined analysis of secondary data, semi-structured interviews, and the meeting notes)	(i) Early anticipation of needs (ii) Building capacity, supply network service provision, collaboration with logistics service providers, local partner engagement, building trust, and reconciliation (iii) Coordination and adaptability
7	A serious role-playing game as a pedagogical innovation to strengthen flood resilience [31]	To develop strategy as an educational and engagement tool enabling individuals in universities, governments, the private sectors, and more at both local and national levels to better understand how the complexity of flooding requires an adaptable multipronged approach	Commentary	The flood resilience challenge (FRC) gaming incorporates both social and responsible innovation which can also be used to enhance. awareness, preparedness, and responses to disasters
8	SI in effective flood risk communication [32]	1) Examine gaps public's understanding of flood risk, flood-related climate change, and managed adaptation; and 2) Examine effective ways of communicating	- Interview - Workshop - Rapid evidence assessment	How SI can break down result in a more cohesive communication of flood risk, to bridge academia, practice and policy to effect change and empower communities to prepare against disaster
9	Lead user method vs. innovation contest - An empirical comparison of two open innovation methodologies for identifying SI for flood resilience in Indonesia [33]	To compare the costs and benefits of two. Open innovation tools for identifying SI: an innovation contest and the lead user method	Working paper	Lead user method scores significantly higher in overall quality as well as regarding use value, feasibility, degree of elaboration, and social impact
10	Looking for a needle in a haystack: How to search for bottom-up social innovations that solve complex humanitarian problems [34]	To explore an effective theory-guided bottom-up innovation search process for the real-life humanitarian problem of recurring floods in Indonesia	Procedural action research	Theory-guided bottom-up search process (lead user method) of SI is superior to non-theory-guided (bottom-up) SI process
11	Readiness assessment in flood risk management and climate adaptation: A mechanism for SI? [17]	To discuss the development and initial trials of a readiness assessment methodology and to examine how and to what extent this approach to readiness assessment can be considered an example of SI	Readiness could be assessed at different levels - for individuals, within particular groups or organizations, and for a wider community	Shows 'on the ground" SI is essential yet insufficient in relation to the size of the difficulties posed by climate change, changes in national (and worldwide)
12	Social innovations and drivers in flood early warning systems: A community-based transboundary perspective from Elegu flood plain in Northern Uganda [18]	Social innovations and drivers in the community-based transboundary flood early warning systems in the Ugandan context	Interview	It produces three SI: new inter-community relations, new community-local resource relations, and new housing and bedding structures
13	Integrating volunteering cultures in New Zealand's multi-hazard environment [35]	To identify approaches how formal and informal volunteering can be integrated in community resilience-building activities against local hazards	Review paper	This research offers some insights that would contribute to community resilience. And recognizes the use of SI of formal and informal volunteer organization

3.1 SI actions or initiatives

In order to foster innovation within DRM, Dabral et al. [8] introduced a SI tool known as the SIOH. This tool employed a four-step multidisciplinary collaboration process, conducted over a virtual platform spanning two and a half months. The four-step process encompassed ideation, maturation, tangible prototype development, and the utilization of a marketing strategy. The outcomes of the Hackathon were multifaceted, including the acquisition of skills such as problem-solving, entrepreneurship, application development, and effective time management.

Trejo-Rangel et al. [6] delve into the exploration of how SI actions can contribute to nurturing risk mitigation public policies, specifically aimed at enhancing flood resilience in a small city in Brazil. Utilizing a survey methodology, the research elucidates on prioritizing ten SI actions for DRM. The survey participants proposed and ranked actions encompassing prevention plans, conservation and restoration of natural areas, risk area tours, engagement of children and youth, evacuation plans, mapping of vulnerable areas, community monitoring of the river, communication of

mitigation measures, and the implementation of a community-led rainfall monitoring system [6].

Soares et al. [28] engaged in building a blueprint for collaborative innovation through a Make-a thon as an SI tool to achieve SDGs, which provides proper structure to enable individuals and organizations to customize it in their context. Wehn and Evers [29] assessed ICT enables citizen observatory's potential to increase e-participation in local flood risk management. However, the results show that the increase in participation is not directly linked with it. Bier et al. [14] explored the preplanning of practical concepts considering safety aspects, ICT utilization, fostering mutual respect between Spontaneous Volunteers (SV) and authorities, and supporting a sense of community as vital factors for developing SI through SVs. Grant et al. [35] also addressed the necessity to participation of informal volunteers or self-organized volunteers in readiness and reduction activities in case of local hazard as a form of SI.

SI innovation can be applied in a disaster-related humanitarian aid context, another crucial aspect of flood risk management. Tabaklar et al. [30] suggested SI in micro-foundations of dynamic capabilities in the humanitarian aid context:

1. Early anticipation of needs in disaster-affected areas and lessons-learned exercises.
2. Capacity building, supply network service provision, collaboration with logistics service providers, local partner engagement, building trust, and reconciliation.
3. Coordination and adaptability [30].

Gaming, such as a serious role-playing game to enhance understanding of flood, can also be used as SI to raise flood risk awareness and preparedness [31]. Trejo-Rangel et al. [6] also arranged a seminar with serious gaming activity to identify, discuss, and formulate the SI actions implementation pathways. Henderson et al. [32] suggested that SI can result in a more cohesive communication of flood risk to enhance their awareness and preparedness. The disaster risk readiness assessment tools can also be a form of SI initiatives. Hence, SI initiatives in flood risk management can include a diverse set of actions and initiatives, which are listed in Figure 4.

3.2 Actors in the SI process

The identified sectors proposed by participants of the Heckathon for involvement in managing disaster risk were ranked as follows: municipal government (civil defense), state government, social entities (population), federal government, educational institutions, non-governmental organizations (NGOs, civil societies), private institutions (businesses), academic institutions (university research institutions), and religious institutions [6]. Additionally, Spontaneous Volunteers (SV) play a significant role, defined as grassroots types of SI [14]. As the risk of disasters increases, there is a growing need to integrate and develop the role of SVs in disaster risk reduction and mitigation activities. Bier et al. discuss the challenges and potentials of developing SVs as SI in flood risk management, emphasizing the preplanning of concepts such as safety considerations, utilization of information and communication technology (ICT), fostering mutual respect between SVs and authorities, and supporting a sense of community [14].

Furthermore, SI initiatives can also be in the form of multidisciplinary collaboration aimed at developing solutions aligned with social needs [8]. Notably, collaborative innovations such as "Make-a-thon" necessitate partnerships involving universities, firms, philanthropic organizations, and NGOs as pivotal actors. These collaborations are instrumental in empowering diverse organizations and individuals to replicate such initiatives in varied contexts [28]. However, based on the review of the selected articles, the potential actors involved in SI for flood risk management activities are succinctly summarized in Figure 5.

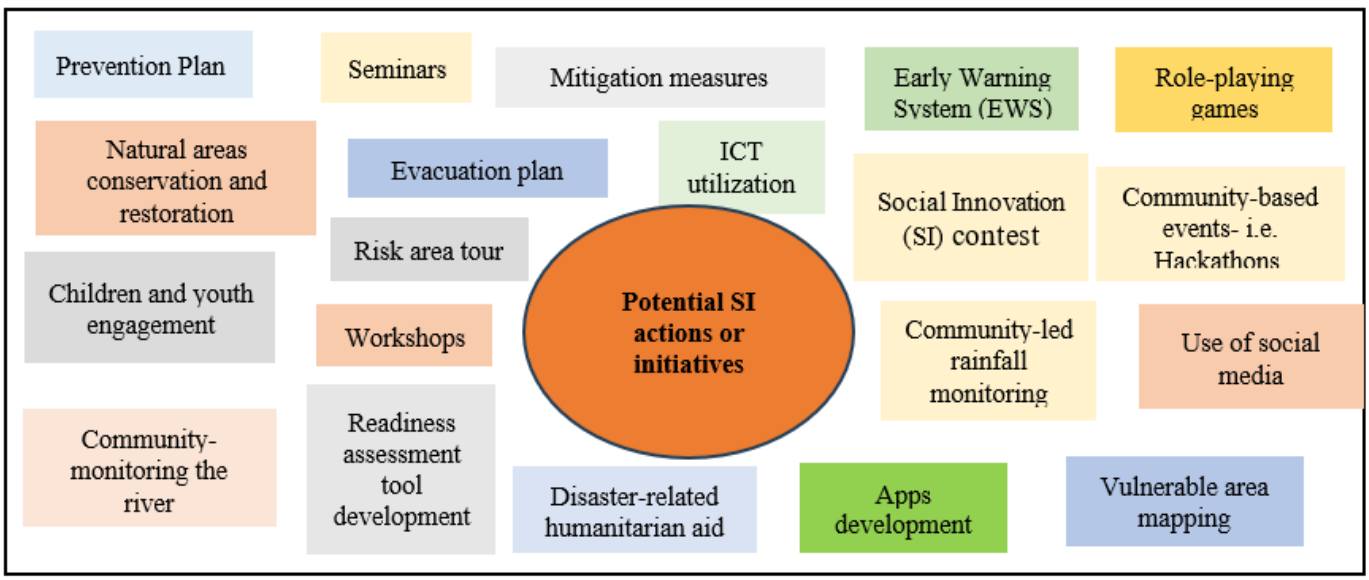

Figure 4. Potential SI actions or initiatives

-government, municipal govt., civil defense, state government, educational institute (school, college, universities), social (population), non-governmental organization (NGOs), civil societies, private firms, philanthropic organizations, businesses, academic institutions, religious institutions, spontaneous volunteers, individuals, logistics partners, community.

Figure 5. Potential actors in SI

4. RECOMMENDATION FOR DAM FAILURE FLOOD PREPAREDNESS

4.1 SI in flood risk communication and early warning system (EWS) to increase dam failure flood preparedness

A critical challenge identified in community-based dam-related flood risk reduction is the lack of awareness and knowledge about dam failure flood risk and its consequences. Past studies have consistently advocated for risk communication with community participation [2, 36-38] and the implementation of community-based early warning systems [37-39] to enhance community members' preparedness and capacity to face potential dam-related flood disasters in the future. This aligns with the priorities outlined in the SFDRR, particularly Priority 1 (understanding of risk) and Priority 4 (enhancing preparedness and developing early warning systems).

Based on the findings of SLR and further examination of past studies through content analysis reveals that SI tools and EWS tools can significantly contribute to risk communication within vulnerable communities. SI can manifest as incremental, institutional, or disruptive innovations, with incremental SIs involving the development of newer tools and techniques for monitoring and communicating flood risks [18]. An illustrative example of incremental SI is a telemetric system providing real-time early warnings, offering sufficient lead time for disaster preparedness [18]. SI in EWS is often characterized as a bottom-up and people-centered approach, involving the beneficiaries in the entire development process [40].

A people-centered early warning system (PEWS), as articulated by Guru and Santha [15], aims to empower individuals and communities at risk to take timely and appropriate actions to minimize personal harm, loss of life, and property and environmental damage. PEWS comprises four essential elements: risk knowledge, risk monitoring and warning service, risk communication, and dissemination, and response qualification. Community-based EWS encompasses diverse tools and techniques developed for and by local communities to disseminate real-time flood warnings [41]. In Malaysia, such a program implemented in SK Telanok in Cameron Highland aims to empower students in school communities with knowledge on applying life safety measures during emergencies [41]. Bringing all the dam surrounding areas under such initiatives will make the vulnerable communities more aware and prepared for facing any future dam incident with minimum losses. Therefore, SI in risk communication and community-based early warning systems (CBEWS), developed for and with community members and stakeholders, stands as a valuable tool to enhance dam failure flood risk preparedness in Malaysia.

5. CONCLUSIONS

Priority Action 3 of the SFDRR emphasizes the enhancement of disaster preparedness to facilitate effective response, minimizing losses and expediting recovery and rehabilitation. A key objective of SFDRR is the inclusive involvement of all societal stakeholders, with a specific emphasis on engaging the scientific and innovative communities in DRM. Additionally, SFDRR prioritizes scientific and technological innovation in disaster risk reduction activities. Reviewing past studies on disaster preparedness reveals that some studies have incorporated the idea of engaging all societal stakeholders to integrate SI in DRM activities. Despite the emerging nature of SI in DRM initiatives, further studies are needed to precisely understand its implications. Recognizing the gap in past research and aligning with SFDRR priorities, this study conducted a comprehensive literature review and content analysis to explore how SI can contribute to improving flood preparation in Malaysia and how SI initiatives can enhance dam-related flood risk preparation to meet SFDRR targets and SDGs.

Content analysis of the literature highlights those past studies recommend addressing knowledge, awareness, and divergence in the scientific and local community's perception of dam failure floods and their consequences as major driving factors for preparedness. Strategies such as risk communication with community participation, proper training through education drills and awareness programs, and an EWS can help reduce knowledge gaps and increase awareness and preparedness, aligning with SFDRR priority actions and targets. Malaysia is already implementing such measures in the context of dam-related flood risk management.

Regarding SI concerning flood risk preparedness, the content analysis reveals potential actors, initiatives, and actions. Potential SI actions include prevention plans, conservation and restoration of natural areas, risk area tours, children and youth engagement, evacuation plans, vulnerable areas mapping, community monitoring of rivers, communication of mitigation measures, and community-led rainfall monitoring. Initiatives encompass seminars, workshops, gaming, application development, hackathons, make-a-thon, role-playing games, early warning systems, readiness assessment tools, social media utilization, SI contests, and ICT utilization. Potential actors in SI initiatives for flood risk management involve various entities such as government agencies, municipal governments, civil defense, state governments, educational institutes, social communities, non-governmental organizations (NGOs), civil societies, private firms, philanthropic organizations, businesses, academic institutions, religious institutions, spontaneous volunteers, individuals, logistics partners, and the community.

The content analysis also suggests that adopting SI initiatives supporting bottom-up participation in flood risk management can enhance flood risk preparation. Recommended SI initiatives for improving dam-related flood risk preparation include developing tools and ideas for risk communication, a PEWS, and preparedness-assessment tools. Collaborative efforts involving community members and SI actors, such as spontaneous volunteers, NGOs, and educational institutions, can result in tailored solutions to

mitigate dam-related flood disasters with minimal losses. In absence of abundant literature on dam related floods, the study's findings are limited to common flood risk management literature. Despite this, we anticipate that the findings are anticipated to contribute to the existing literature on DRM, particularly in the context of flood and dam-related disasters. Policymakers can gain insights into utilizing SI to improve preparedness against potential flood disasters, aligning with SFDRR and SDG targets.

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REFERENCES

[1] United Nations. (2015). Sendai framework for disaster risk reduction 2015-2030. Resolution adopted by the General Assembly on 3 June 2015. https://www.undrr.org/implementing-sendaiframework/what-sendai-framework.

[2] Shahrim, M.F., Harun, A.N., Anuar, A.N., Razak, K.A. (2019). Disaster risk management for dam safety in Malaysia: Strengthening governance, risk communication and community resilience. Proceeding Book, 2: 44.

[3] Norizan, N.Z.A., Hassan, N., Yusoff, M.M. (2021). Strengthening flood resilient development in Malaysia through integration of flood risk reduction measures in local plans. Land Use Policy, 102: 105178. https://doi.org/10.1016/j.landusepol.2020.105178

[4] Mavhura, E., Manyangadze, T., Mudavanhu, C., Pedzisai, E. (2022). An assessment of riparian communities' preparedness to flood risk: The case of Mbire communities in Zimbabwe. GeoJournal, 87(3): 1671-1693. https://doi.org/10.1007/s10708-020-10329-7

[5] Fakhruddin, S. (2016). UNISDR Science and Technology Conference on the Implementation of the Sendai Framework for Disaster Risk Reduction 2015-2030.

[6] Trejo-Rangel, M.A., Marchezini, V., Rodriguez, D. A., et al. (2023). Incorporating social innovations in the elaboration of disaster risk mitigation policies. International Journal of Disaster Risk Reduction, 84: 103450. https://doi.org/10.1016/j.ijdrr.2022.103450

[7] Shaw, R., Izumi, T., Shiwaku, K. (2018). 1- Science and technology in disaster risk reduction in Asia: Post-Sendai developments. In Science and Technology in Disaster Risk Reduction in Asia. Academic Press, pp. 3-16. https://doi.org/10.1016/B978-0-12-812711-7.00001-8

[8] Dabral, A., Bajwa, S., Shioyama, S., Chatterjee, R., Shaw, R. (2021). Social innovation Hackathon for driving innovation in disaster risk reduction (DRR). IDRiM Journal, 11(1): 64-82. https://doi.org/10.5595/001c.28876

[9] Thaler, T., Seebauer, S. (2019). Bottom-up citizen initiatives in natural hazard management: Why they appear and what they can do? Environmental Science & Policy, 94: 101-111. https://doi.org/10.1016/j.envsci.2018.12.012

[10] Izumi, T., Shaw, R., Djalante, R., Ishiwatari, M., Komino, T. (2019). Disaster risk reduction and innovations. Progress in Disaster Science, 2: 100033. https://doi.org/10.1016/j.pdisas.2019.100033

[11] Mulgan, G. (2006). The process of social innovation. Innovations, 1(2): 145-162.

[12] Voorberg, W.H., Bekkers, V.J., Tummers, L.G. (2015). A systematic review of co-creation and co-production: Embarking on the social innovation journey. Public Management Review, 17(9): 1333-1357. https://doi.org/10.1080/14719037.2014.930505

[13] Ludvig, A., Wilding, M., Thorogood, A., Weiss, G. (2018). Social innovation in the welsh woodlands: Community based forestry as collective third-sector engagement. Forest Policy and Economics, 95: 18-25. https://doi.org/10.1016/j.forpol.2018.07.004

[14] Bier, M., Fathi, R., Stephan, C., Kahl, A., Fiedrich, F., Fekete, A. (2023). Spontaneous volunteers and the flood disaster 2021 in Germany: Development of social innovations in flood risk management. Journal of Flood Risk Management, 1-20. https://doi.org/10.1111/jfr3.12933

[15] Guru, B., Santha, S.D. (2013). People-centred early warning systems and disaster risk reduction. https://www.undrr.org/publication/people-centred-early-warning-systems-and-disaster-risk-reduction.

[16] Sharma, R. (2021). Community based flood risk management: Local knowledge and actor's involvement approach from lower Karnali river basin of Nepal. Journal of Geoscience and Environment Protection, 9(6): 35-65. https://doi.org/10.4236/gep.2021.96003

[17] Kelly, R., Kelly, U. (2023). Readiness assessment in flood risk management and climate adaptation: A mechanism for social innovation? Journal of Flood Risk Management, e12915. https://doi.org/10.1111/jfr3.12915

[18] Canwat, V. (2023). Social innovations and drivers in flood early warning systems: A community-based transboundary perspective from Elegu flood plain in Northern Uganda. Journal of Flood Risk Management, e12930. https://doi.org/10.1111/jfr3.12930

[19] Eichler, G.M., Schwarz, E.J. (2019). What sustainable development goals do social innovations address? A systematic review and content analysis of social innovation literature. Sustainability, 11(2): 522. https://doi.org/10.3390/su11020522

[20] Bhuiyan, T.R., Er, A.C., Lim, C.S., Muhamad, N., Bakar, A.A., Pereira, J.J. (2022). Disaster loss indicators for reporting to DesInventar Sendai and enabling rapid monetary valuation in Malaysia. Weather and Climate Extremes, 37: 100488. https://doi.org/10.1016/j.wace.2022.100488

[21] Cremin, E., O'Connor, J., Banerjee, S., et al. (2023). Aligning the global delta risk index with SDG and SFDRR global frameworks to assess risk to socio-ecological systems in river deltas. Sustainability Science, 1-21. https://doi.org/10.1007/s11625-023-01295-3

[22] Kelman, I. (2015). Climate change and the Sendai framework for disaster risk reduction. International Journal of Disaster Risk Science, 6: 117-127.

https://doi.org/10.1007/s13753-015-0046-5
[23] Safi, A., Singh, S. (2023). A systematic literature review on phishing website detection techniques. Journal of King Saud University-Computer and Information Sciences, 35(2): 590-611. https://doi.org/10.1016/j.jksuci.2023.01.004
[24] ul Husnain, A., Mokhtar, N., Mohamed Shah, N., Dahari, M., Iwahashi, M. (2023). A systematic literature review (SLR) on autonomous path planning of unmanned aerial vehicles. Drones, 7(2): 118. https://doi.org/10.3390/drones7020118
[25] Fasihi, S., Lim, W.Z., Wu, W., Proverbs, D. (2021). Systematic review of flood and drought literature based on science mapping and content analysis. Water, 13(19): 2788. https://doi.org/10.3390/w13192788
[26] Khirfan, L., Mohtat, N., Peck, M. (2020). A systematic literature review and content analysis combination to "shed some light" on stream daylighting (Deculverting). Water Security, 10: 100067. https://doi.org/10.1016/j.wasec.2020.100067
[27] Habibi Rad, M., Mojtahedi, M., Ostwald, M.J. (2021). Industry 4.0, disaster risk management and infrastructure resilience: A systematic review and bibliometric analysis. Buildings, 11(9): 411. https://doi.org/10.3390/BUILDINGS11090411
[28] Soares, M.A., Silva, G.A., Silva, T.F. (2020). Make-a-thon: A blueprint for SDG-driven innovation. In ISPIM Conference Proceedings. Virtual: The International Society for Professional Innovation Management (ISPIM), pp. 1-16.
[29] Wehn, U., Evers, J. (2015). The social innovation potential of ICT-enabled citizen observatories to increase eParticipation in local flood risk management. Technology in Society, 42: 187-198. https://doi.org/10.1016/j.techsoc.2015.05.002
[30] Tabaklar, T., Sorkun, M.F., Yurt, O., Yu, W. (2021). Exploring the microfoundations of dynamic capabilities for social innovation in a humanitarian aid supply network setting. Industrial Marketing Management, 96: 147-162. https://doi.org/10.1016/j.indmarman.2021.04.012
[31] Bogdan, E., Cottar, S. (2022). A serious role-playing game as a pedagogical Innovation to strengthen flood resilience. IEEE Technology and Society Magazine, 41(3): 98-100. https://doi.org/10.1109/MTS.2022.3197124
[32] Henderson, F., Helwig, K., Teedon, P., Beier, S. (2021). Social innovation in effective flood risk communication. In International Social Innovation Research Conference. https://www.isirc2021milano.com/.
[33] Goeldner, M., Kruse, D.J., Herstatt, C. (2017). Lead user method vs. innovation contest–An empirical comparison of two open innovation methodologies for identifying social innovation for flood resilience in Indonesia. Technology and Innovation Management, Hamburg University of Technology, Working Paper, (101). http://hdl.handle.net/10419/172256.
[34] Kruse, D.J., Goeldner, M., Eling, K., Herstatt, C. (2019). Looking for a needle in a haystack: How to search for bottom-up social innovations that solve complex humanitarian problems. Journal of Product Innovation Management, 36(6): 671-694. https://doi.org/10.1111/jpim.12507
[35] Grant, A., Hart, M., Langer, E.R. (2019). Integrating volunteering cultures in New Zealand's multi-hazard environment. The Australian Journal of Emergency Management, 34(3): 52-59. https://doi.org/10.3316/ielapa.576752064171651
[36] Mehta, A.M., Weeks, C.S., Tyquin, E. (2020). Towards preparedness for dam failure: An evidence base for risk communication for downstream communities. International Journal of Disaster Risk Reduction, 50: 101820. https://doi.org/10.1016/j.ijdrr.2020.101820
[37] Muda, R.S., Tukiman, I., Khidzir, A.B.M., Ibrahim, A.I.N., Hussain, M.R., Rabe, N., Abdul Razad, A.Z. (2020). Building capacity through school based engagement on dam safety program in cameron highlands. In ICDSME 2019: Proceedings of the 1st International Conference on Dam Safety Management and Engineering, Springer Singapore, pp. 51-63. https://doi.org/10.1007/978-981-15-1971-0_6
[38] Muda, R.S., Tukiman, I., Amin, M.F.M., Hussain, M.R.M., Khidzir, A.B.M. (2020). Dam related disaster framework for emergency preparedness. Planning Malaysia, 18(4): 352-364. https://doi.org/10.21837/pm.v18i14.837
[39] Ghazali, A., Thiruchelvam, S., Muda, R.S., et al. (2018). Development of community-based early warning system (CBEWS) in enhancing community preparedness for dam-related disasters in Malaysia. ASM Science Journal, 11(2): 117.
[40] Baudoin, M.A., Henly-Shepard, S., Fernando, N., Sitati, A., Zommers, Z. (2016). From top-down to "community-centric" approaches to early warning systems: Exploring pathways to improve disaster risk reduction through community participation. International Journal of Disaster Risk Science, 7: 163-174. https://doi.org/10.1007/s13753-016-0085-6
[41] Muda, R.S., Tukiman, I., Sarkawi, A.A., Amin, M.F.M., Khidzir, A.B.M. (2019). Community preparedness for disaster risk reduction from Islamic perspectives in promoting DAM disaster management. South East Asia Journal of Contemporary Business, Economics and Law, 20(6): 1-76. https://doi.org/10.18178/ijesd.2021.12.9.1350