Article

Evaluation of Operational Capability of Disaster and Emergency Management Resources Using AHP

Ke Zhang **and Jae Eun Lee**

Crisisonomy, Chungbuk National University, Chungbuk 28644, Korea
National Crisisonomy Institute, Chungbuk National University, Chungbuk 28644, Korea;
zhangke35307@naver.com

Abstract: In a world of frequent disasters, the operational capacity of disaster and emergency management resources (DEMR) is essential for risk reduction and contemporary emergency management. In this study, the effective operational capability of DEMR evaluation system is constructed form four aspects: human resources, material resources, facility resources and information technology resources. The objectives of this study were to identify the factors affecting the effective operational capability of DEMR in China and Korea, and to compare and analyze the relative importance and priority of each evaluation domain and indicator in China and Korea so as to improve the operational capacity of DEMR. Firstly, the weight of the four domains were calculated and ranked. The results show that China had the largest weight for human resources, followed by material resources, facility resources and information technology resources. Korea had the largest weight for human resources, followed by information technology resources, material resources and facility resources. Secondly, a comparative analysis of the local weight of indicators in each domain was conducted, with the greatest difference between China and Korea being in the domain of information technology resources. Finally, global weights were calculated, with the same being ranked first for decision makers, indicating that decision makers have the greatest impact on operational capability of DEMR.

Keywords: operational capability; DEMR; evaluation; AHP

1. Introduction

Despite not being a new phenomenon, globalization has been gaining momentum lately in recent years. With the movement of goods, capital, people, and ideas around the world, the world is more interconnected and interdependent than ever. On the positive side, globalization is a unifying process that connects activities, countries and resources into a complex whole, with an increasing number of governments and economies integrated into the "global community" [1]. On the negative side, this increased global activity is resulting in environmental degradation that in turn increases the frequency and intensity of disasters [2], countries around the world have inevitably faced threats from both man-made and natural disasters. These disasters are characterized by their suddenness and destructiveness, posing a serious threat to people's lives, property, and the socioeconomic development of nations. Protecting citizens' lives and properties from extreme events has been one of the top responsibilities of national governments [3]. In the face of complex and volatile disasters, countries should learn from each other and work together to improve their disaster and emergency management capabilities.

In recent years, China and South Korea (Korea) have endeavored to boost their strategic and cooperative partnership in numerous sectors, as well as promoting a high level relationship. Contemporary relations between China and Korea are characterized by extensive trading and economic relations. At the same time, in response to frequent emergencies and disasters, both countries also attach great importance to and actively promote cooperation in disaster and emergency management. The inaugural Trilateral Meeting on Disaster Management among China, Japan, and Korea was held in 2009. In July 2022, the 7th meeting was convened, where the major disaster management policies and experiences in response to increasingly frequent and severe disasters were presented. Consensus was reached on enhancing the capabilities and measures of all parties to respond to various disasters and further improve disaster management capabilities.

As a key link in disaster and emergency management, the operation of disaster and emergency management resources (DEMR) is directly related to the effectiveness of the overall disaster and emergency relief work. The operation of DEMR involves a process to find, obtain, allocate, and distribute resources to satisfy the needs that are generated by emergencies and disaster situations [4]. the effective operation during this process becomes complicated due to the suddenness, devastation, dynamic evolution, and spread of the [5-7]. It is extremely vulnerable to the influence of numerous uncontrollable factors, including people, supplies, space, time, and environment, which has a negative impact on the advancement of emergency rescue operations. In order to more accurately evaluate the DEMR and better ensure the needs of emergency and disaster relief for government departments, it is crucial to strengthen the evaluation of effective operational capability of DEMR.

So far, investigations related to disaster management, emergency response capability and disaster preparedness capability have been attracted many academics and practitioners. Meanwhile, many scholars in China and South Korea have emphasized the important role played by DEMR in the disaster and emergency management. [8] emphasized the importance of disaster management resources as a factor in disaster preparedness. [9] emphasized that emergency resource management, as a critical way of decreasing loss from natural hazards. [10] stress that early preventive measures through disaster management resources are essential to minimize disaster areas. In addition, in order to facilitate the implementation of emergency rescue, most studies also have analyzed the storage, logistics and distribution of emergency resources. [11] have developed a multivariate emergency resourcing model that considers both response times and the cost of emergency resources. [12] used the entropy-TOPSIS method to evaluate the impact of intelligent technologies on emergency resource allocation. In summary, the significance of DEMR in disaster and emergency management has been stressed by academics, who have also examined DEMR in terms of resource allocation and logistics. There hasn't been much examination of the operational capability of DEMR or only focused on one-way indicators. With few studies include the coordinated deployment of human resources and emergency facilities into the evaluation indicators. Moreover, ever since the fourth industrial revolution, information technology has been recognized as being necessary for the support of relief efforts. Highly automated technical monitoring and warning services have also been acknowledged as one of the determine of success [13]. Thus, information management capability should also be included in the evaluation index of DEMR operational capabilities.

Therefore, this study takes the operational capacity of DEMR in China and Korea as the research object. Firstly, we analyze the relevant literature and refer to the previous research results to identify the specific factors affecting the effective operational capability of DEMR from four dimensions: human resources, material resources, facility resources and information technology resources. Secondly, combining expert survey and the Analytic Hierarchical Process (AHP) methods, we refine and construct an index model to evaluate the relative importance and priority of the domains and indicators of DEMR operational capability, to compare the differences between the indicators in Korea and China, and to provide theoretical guidance for improving DEMR operational capability and collaboration between China and Korea. The objective is to reflect the level of disaster and emergency management from the perspective of operational capability of DEMR and to provide continuous support for the improvement of government's emergency and disaster management capability based on this.

2. Theoretical Background

2.1. Disaster and emergency management resources (DEMR)

DEMR is a general term for all kinds of resources which can be quickly mobilized or positively responded in a short time when the emergency event occurs. Emergency management systems require a variety of resources such as human, supplies, financial, facilities, information and technology to effectively respond to emergency event and ensure the normal operation of the system, these resources are collectively referred to as DEMR [14]. [15] defined emergency resources as a variety of important supplies, emergency response equipments and basic living supplies in emergency rescued. [16] divided emergency resources into response resources and recovery resources in terms of the characteristics of the operational course based on the response-stage and the recovery-stage emergency management pattern. [17] believed that emergency resource is important for the evacuation of people and the rescue of property. [18] emphasized that emergency resource is the important content of emergency management, which directly decide the success or failure of emergency rescue. [19] showed that emergency resource is the supplies basis of emergency management, which is the key factor to ensure effective emergency management.

The rescue of emergency events, not only include provide enough resources, but also the management of emergency resource which can make the entire emergency rescue work more orderly and improve the efficiency of the whole emergency rescue work [18]. Implementing a comprehensive resource management process helps align resource capabilities, streamline resource coordination and ensure interoperability nationwide [20]. The US Department of Homeland Security first published the National Incident Management System (NIMS) in 2004. In NIMS, emergency resource management is defined as the application of processes, procedures, and tools to coordinate the utilization of emergency resources, including personnel, teams, facilities, equipment and living supplies.

Its primary goal is to support policy makers in rationalizing limited emergency resources, minimizing damage and saving lives [21]. [22] identified emergency resource management as consisting of two important tasks, namely resource allocation and resource scheduling. The emergency resource allocation strategy should allocate the appropriate number of resources at different places as per the demand, emergency resource scheduling supports the process of resource allocation by aiding efficient scheduling of the resources for the optimal allocation. [23] divided emergency resource management into three categories: equipment, supplies, and human, and divided them into 11 collaborative functions such as life support, energy function support, facility emergency recovery, and emergency communication support, etc. [9] noted that emergency resource management is critical to disaster response and regard emergency resource management as a comprehensive process that falls centrally into resilience building.

In this paper, based on previous studies, we define emergency resource management as the process of coordinating and cooperating with various government departments and social organizations to accurately and timely deliver the needed emergency resources from the supply area to the demand area in the shortest possible time after a disaster has occurred. Meanwhile, we argue that emergency resource management encompasses all phases of disaster relief operations. The factors and demands involved in emergency resource management should be viewed in a holistic manner that covering the mobilization of people, supplies, facilities, and technology to support vulnerable groups affected by disasters.

2.2. The operational capability of DEMR

Emergency response capability evaluation is one of the major activities in emergency management. Emergency response capability is the comprehensive ability of the government to take measures to successfully mitigate the effects of disasters. In relation to disaster events, it is fundamental to identify the characterize demands of DEMR and to develop the capability of DEMR to respond to disasters [24]. However, how to evaluate the capability of DEMR has attracted a great deal of attention from government and academic circles.

In terms of government practice, the United States was the first country to carry out emergency response capacity evaluation, and the Federal Emergency Management Agency (FEMA) studied a system of Capability Assessment for Readiness in 1997, and the Department of Homeland Security first established the National Incident Management System (NIMS) in 2004, establishing a standardized approach to incident management, which includes resource management guidelines. Japan historically placed more emphasis on disaster response and recovery activities and set up an evaluation item of disaster prevention capacity of local public organizations in 2002, including nine aspects such as crisis mastery and evaluation, countermeasures to mitigate danger, rectification system, and resource management system [25]. Korea is also more advanced in researching emergency management capacity evaluation, which is conducted annually by the Ministry of Administration and Security and encompasses disaster management tasks, organizational structure, safety management system, and disaster management resource [26]. In terms of DEMR, China mainly takes the release of relevant policy and normative documents, the National People's Congress of China approved China's 14th Five-Year Plan in March 2021, pointed out that the emergency supplies guarantee evaluation system should be strengthened.

Academic research on the evaluation of emergency capabilities has primarily concentrated on emergency preparedness and emergency response capabilities, with less research on the evaluation of emergency resource management capabilities, mainly divided into the evaluation of emergency logistics capabilities, [27] constructed a public health emergency logistics capacity evaluation system and applied it to the COVID-19 events to verify the scientific nature and feasibility of the evaluation model. [28] performed an empirical study to investigate important factors on emergency logistic and performed a multi-criteria decision-making approach using AHP to prioritize important activities to improve logistic operations. However, [29] defines capability as the financial, technological, policy, institutional, leadership, and human resource capabilities that government agencies must possess in order to carry out tasks in all stages of emergencies. [30] considered DEMR capability as the cultivation and enhancement of disaster prevention and mitigation capabilities of the state or social institutions in terms of human resources, science and technology, organization, and supplies. [24] considered the DEMR capability as a function of institutional resources, human resources, policy for effective implementation, financial, and technical resources and leadership. National Incident Management System (NIMS) resource management guidance enables many organizational elements to collaborate and coordinate to systematically manage resources— personnel, teams, facilities, equipment and supplies. In summary, DEMR is a series of activities implemented to improve the efficiency of emergency rescue and reduce the adverse effects of a disaster. DEMR often requires coordination between individuals, governments, agencies, and organizations to quickly mobilize resources, enhance and introduce information technological innovations, and ensure that individuals, social organizations, and businesses in various fields support this ability.

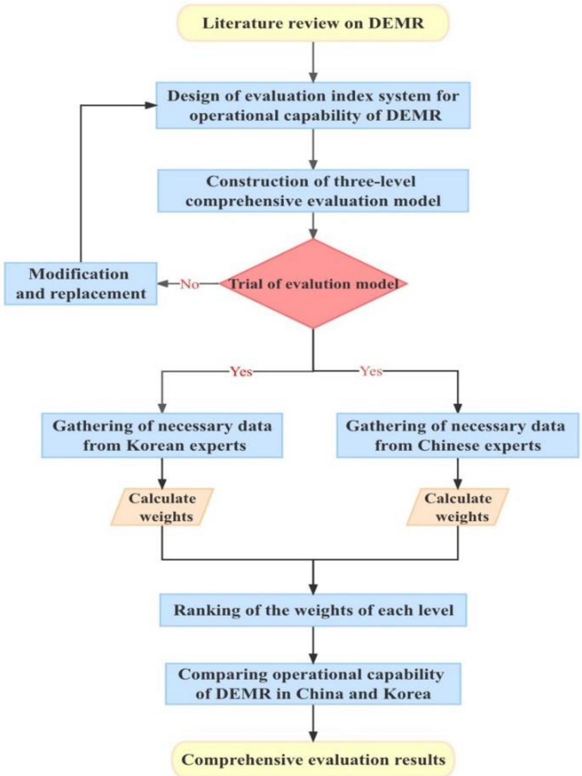
3. Methods and model

3.1. Analytic Hierarchical Process (AHP)

AHP is a multi-criteria decision-making method that combines quantitative analysis and qualitative analysis proposed by Saaty in the 1970s [31]. After systematically breaking down questions and linking and layering relevant factors, a pairwise comparison is conducted to identify the relative importance ratio between different elements, and a rank of options is compiled as reference for selecting the best solution [32]. AHP is primarily applied to decision-making problems with uncertainties and multiple evaluation criteria. This approach was adopted for a wide range of decision-making circumstances, in different fields such as government, business, industry, healthcare, quality, and education. In emergency management, the main applications are disaster preparedness, emergency response capability, resilience index, emergency supply chain risk index [8, 33-35].

This study begins with the literature review on disaster and emergency management capability and operational capability of DEMR. Evaluation index system for operational capability of DEMR has been designed and a hierarchical structure model based on hierarchical relationships was established. The researchers from China and South Korea were invited to conduct model testing to verify the completeness of the index system. After confirming the index system, suitable experts were selected to collect data. A judgement matrix was then calculated to obtain the relative weights of the evaluation indicators, and the consistency of the judgements was tested to obtain the final indicator weights for each level, and the differences between China and Korea were compared. The specific steps and process are shown in Figure1.

Figure 1. The flowchart of evaluation of DEMR operational capability



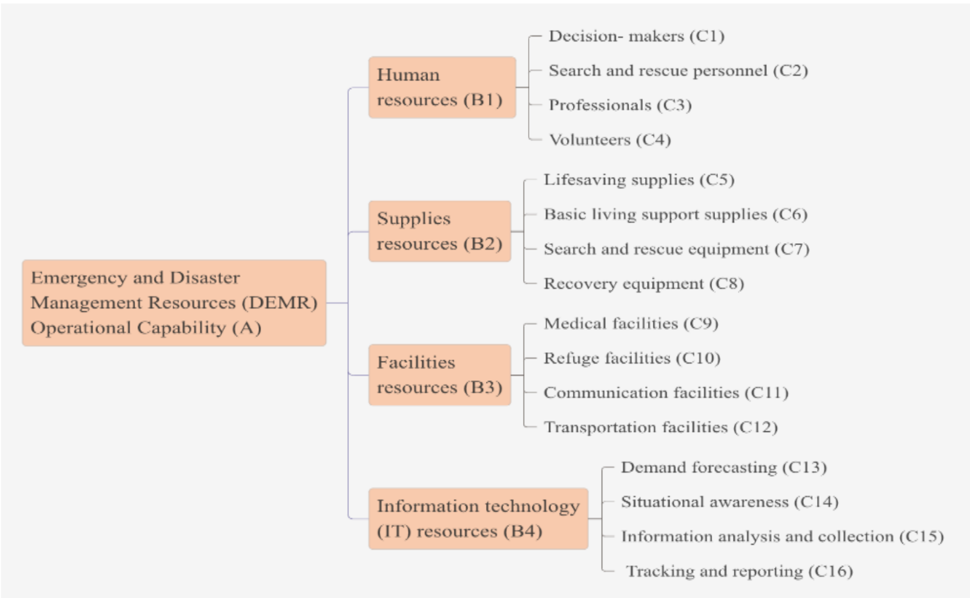
3.2. Evaluation index system and model

The evaluation index system is a combination set of two or more indexes that can effectively evaluate a specific system, with many functions such as evaluating the current situation, reflecting problems, and predicting trends [36]. There are many factors that influence the evaluation of operational capability of DEMR, and its evaluation is a multi-level, multi-indicator evaluation system that requires the inclusion of multiple factors for comprehensive analysis. Therefore, the principles of objectivity, systemic, comprehensiveness and coordination in the construction of the indicator system should be followed to effectively improve the credibility of the evaluation results [37]. Based on an extensive data research and literature review, this paper starts from the concept of DEMR, and draws on Federal Emergency Management Agency (FEMA) capability assessment for readiness, NIMS resource management guidance, and China's emergency resource guarantee planning to construct an evaluation index system. It is divided into four primary domains: human resources, supplies resources, facilities resources and information technology resources.

Firstly, human resources refer to the personnel or groups that can provide support for disaster response activities when a disaster occurs. These individuals or groups obtain special qualifications and certifications from specialized agencies or possess professional expertise and skills in disaster management. Secondly, supplies resources refer to the physical resources provided to support disaster and emergency management activities in affected areas. Thirdly, developing facilities and equipment to assist in resource management helps the responding agencies significantly reduce the number of casualties and properties damaged and destroyed as a result of disasters. Fourthly, information technology enhances resource status information flow by providing real-time data to emergency management personnel. Information technology used to support resource management include location-enabled situational awareness and demand forecasting with resource tracking that links to the entity's resource reserve.

In summary, we developed a three-level AHP evaluation model with operational capability of DEMR as the target, as shown in Figure 2. In the AHP evaluation model, the target level is DEMR operational capability (A). The evaluation domains are divided into human resources (B1), supplies resources (B2), facilities resources (B3), information technology resources (B4), and 16 tertiary evaluation indicators.

Figure 2. The evaluation model of the DEMR operational capability



3.3 Data collection

To ensure the validity of the index system, and to scientifically determine the importance and priority of the domains and indicators, this paper first tested the indicators with 10 Ph.D researchers, reworked the indicators and then, this paper issued questionnaires to 11 Korean and 11 Chinese experts in the field of disaster management, who were recommended by professors or contacted directly. They marked evaluations and choices based on their experience, knowledge and practice.

4. Analysis and results

4.1. Consistency test

In this paper, we used YAAHP software to calculate the weights for each level of indicator. In order to ensure that AHP is implemented in an effective manner, it is important to ensure consistency index [38]. In the consistency test, various researchers agree that, in general consistency ratios (CR) is acceptable up to the limit of 0.10, although there are other scholars offering a limit up to 0.20, but never more than that [39,40]. Regarding the random consistency index, [31] makes clear that the CI of a matrix of comparisons is given by $CI = (\lambda max - n)/(n - 1)$. For the random consistency index (RI), [32] has determined the values of the RI based on the number of evaluated criteria. The consistency ratio (CR) is finally calculated as follows: $CR = CI/RI$. The analysis results of the AHP model in DEMR operational capability index system in China revealed that the $CR = 0.032 < 0.1$, and DEMR operational capability index system in Korea revealed that the $CR = 0.032 < 0.1$, which meets the consistency requirement, as show in Table 1.

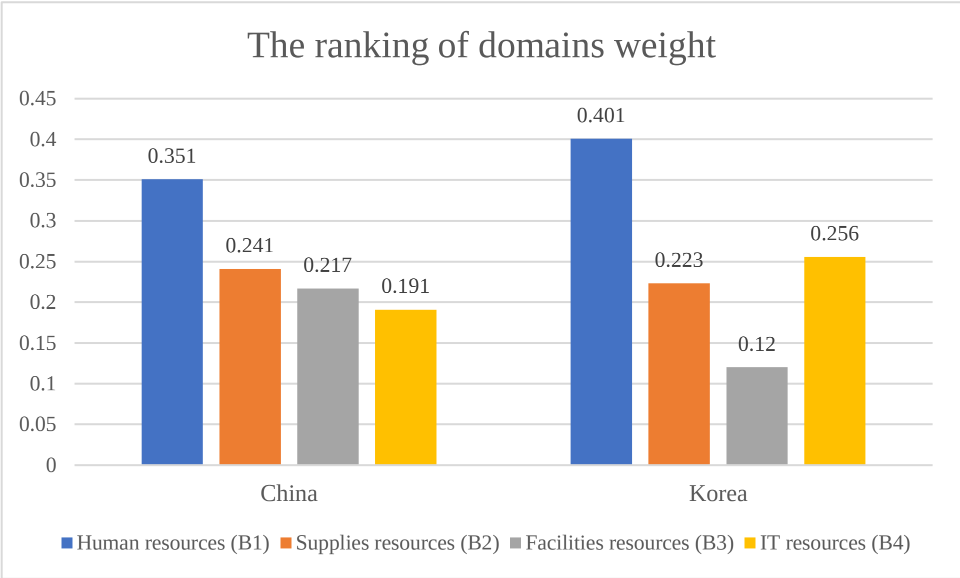
Table 1. The results of consistency test

	DEMR operational capability	human resources	supplies resources	facilities resources	IT resources
China	0.044	0.033	0.006	0.021	0.003
Korea	0.010	0.016	0.003	0.001	0.005

4.2. Local weight ranking comparison

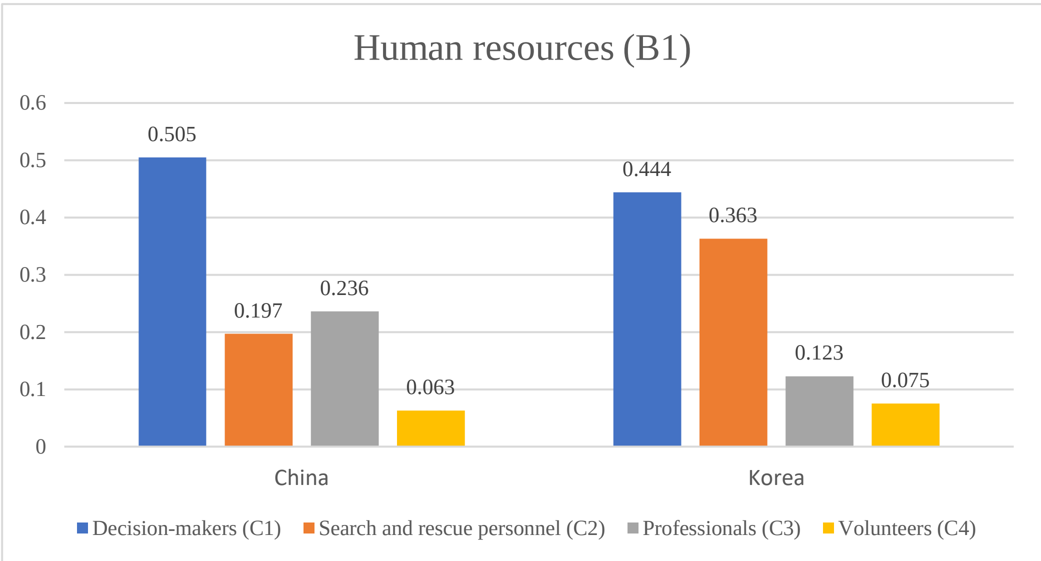
Figure 3 shows the weights of the different domains in China and Korea. In the case of China, human resources (B1) had the largest weight in the overall DRMR operational capability, followed by supplies resources (B2), facilities resources (B3), and the smallest weight by IT resources (B4). In the case of Korea, human resources (B1) continue to be the the largest weight, followed by IT resources (B4) and supplies resources (B2), and with facilities resources (B3) being the least weighted. The similarity is that human resources are considered to an important domain in operational capability of DEMR. This result was consistent with many previous studies [41,42]. The operational capability of DEMR can be improved be achieved through effective identification of relevant skilled people and mobilization of their expertise. However, IT resources, which had the smallest value in the Chinese case, ranked second in the Korean case. This means that Korea is more focused on the role of IT resources in the effective operation of DEMR. This may be due to the fact that Korea has entered the fourth industrial revolution era earlier than China and is more proficient in the use of big data, Internet of Things (IoT) and other IT resource capabilities.

Figure 3. The domains weight ranking of DEMR operational capability.



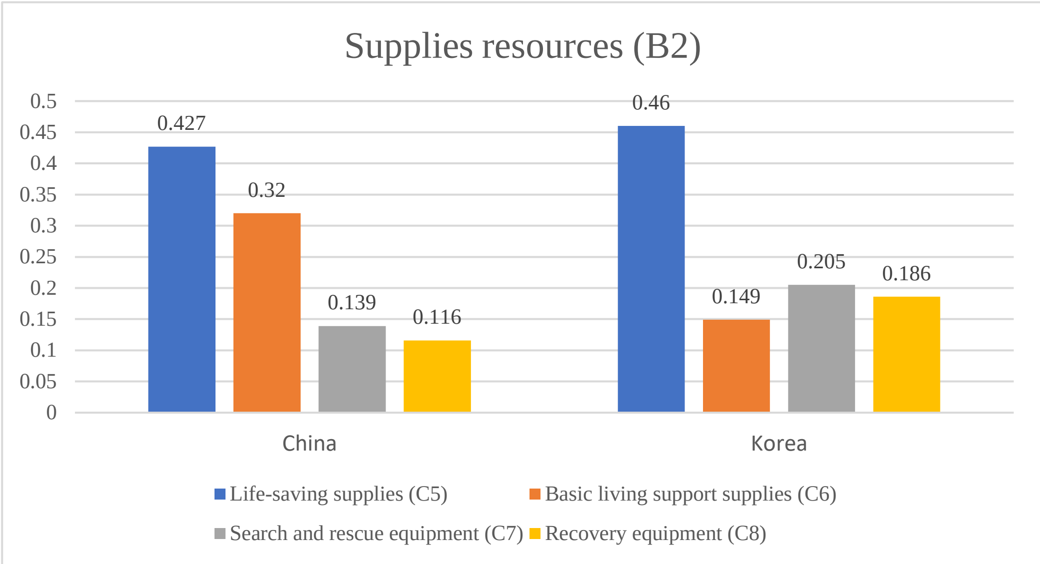
According to the judgment matrix, the relative weight ranking of the third level to the corresponding second level can be obtained separately. For human resources (B1) in China (see Figure 4), the local weight of decision makers (C1) was far more important than search and rescue personnel (C2), professionals (C3) and volunteers (C4). For human resources (B1) in Korea, decision makers (C1) received the highest local weight, followed by search and rescue personnel (C2), with both professionals (C3) and volunteers (C4) being given less weight. Thus, decision makers (C1) are the biggest influencing indicators in human resources, but volunteers (C4) received the lowest local weight.

Figure 4. The local weight ranking of human resources (B1) domain.



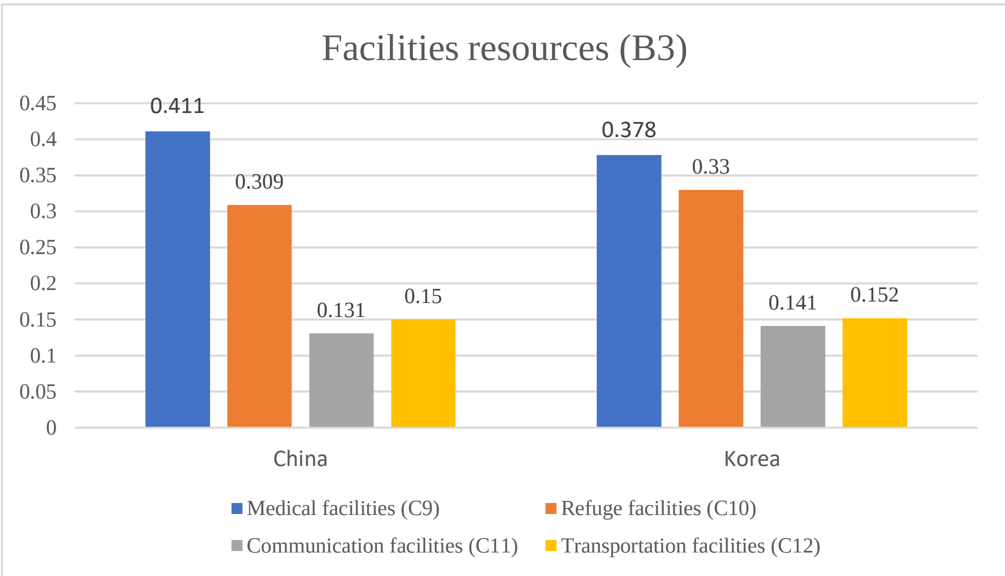
For supplies resources (B2) (see Figure 5), in the case of China, the weight of life-saving supplies (C5) was as high as 0.427 and basic living support supplies (C6) (weighted at 0.320) was also important. Additionally, search and rescue equipment (C7) and recovery equipment (C8) were 0.139 and 0.116, respectively. In the case of Korea, the local weight of life-saving supplies (C5) was much higher than that of basic life support supplies (C6), search and rescue equipment (C7) and recovery equipment (C8). This result is consistent with previous studies [43, 44], where life-saving supplies such as food and medical supplies have been the focus of victims and a priority.

Figure 5. The local weight ranking of supplies resources (B2) domain.



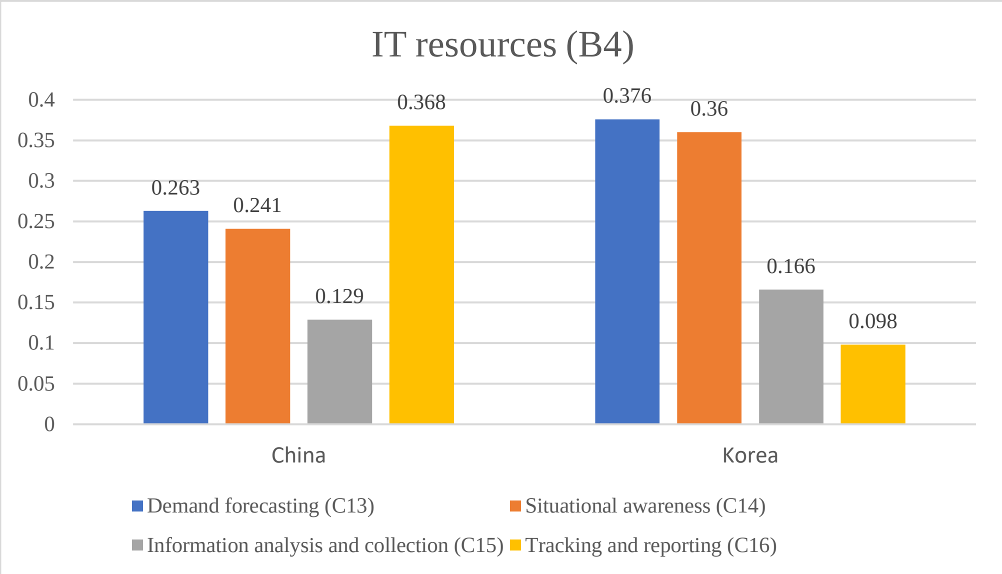
For facility resources (B3) (see Figure 6), the ranking is the same for China and Korea, with medical facilities (C9) had the largest local weight of 0.498 and 0.33., followed by refuge facilities (C10) and transportation facilities (C12), with weights of 0.309 and 0.150 for China respectively. Korea's weights are 0.330 and 0.152 respectively, and finally, communication facilities had the smallest weights of 0.131 and 0.141.

Figure 6. The local weight ranking of facilities resources (B3) domain.



For information technology (IT) resources (B4) (see Figure 7), interestingly, China and South Korea are ranked in completely different ways. In the case of China, tracking and reporting (C16) directly affects (IT) resources, with a weight of 0.368, followed by demand forecasting (C13) at 0.263 and situational awareness (C16) at 0.241, with little difference, and information analysis and collection (C15) with the smallest weight. In the case of Korea, the difference is small between demand forecasting (C13) and situational awareness (C16), with weights of 0.376 and 0.360 respectively, this means that it was difficult for the participants to determine the relative importance of two indicators due to the almost equal significance of two indicators. This was followed by information analysis and collection (C15) (0.166), and finally, tracking and reporting (C16) (0.098), which accounted for the smallest weight.

Figure 7. The local weight ranking of IT resources (B4) domain.



4.3. Global weight ranking comparison

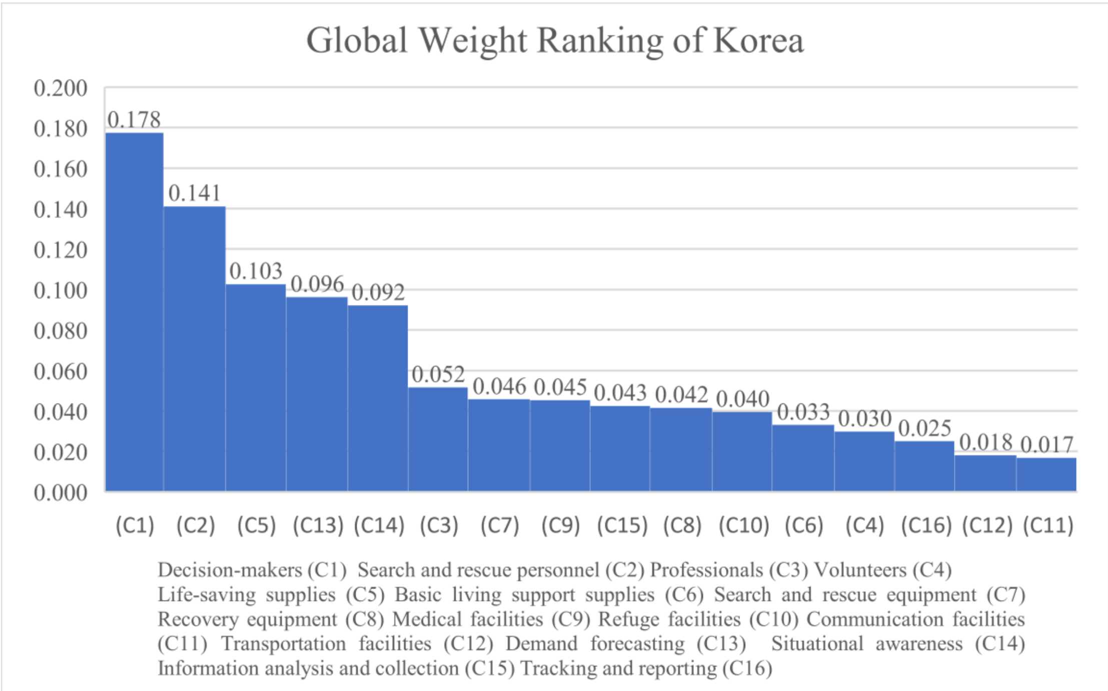
The global weight ranking is used to obtain the interaction of scheme layer to the overall target layer and scheme layer, also called the composite weight ranking or the absolute weight ranking [3]. The global weights were obtained by multiplying the weight of each domain by the local weight of sub-criteria. For instance, a global weight of decision makers (0.177) was obtained by multiplying the weight of human resources (0.351) by the local weight of it (0.505). Figure 8 shows the ranking of the global weight.

In the case of China (see Figure 8a), The top four sub-criteria factors were decision makers (0.174), life-saving supplies (0.103), medical facilities (0.089) and professionals (0.083) ranking among the top four. Next, life-support supplies (0.077) ranked fifth in the global ranking. The second least salient sub-criteria factor was information analysis and collection (0.025); and the least significant sub-criteria factor was volunteers (0.022). As discussed previously, the ability of volunteers is generally not valued in disaster relief, therefore, the results implied that volunteer had the least influence on the overall operational capability of DEMR.

In the case of Korea (see Figure 8b), the same is true in that decision makers (C) (0.177) received the highest global weighting, followed by search and rescue personnel (0.141), life-saving supplies (0.102), and demand forecasting (0.096). The difference is that professionals (0.052) ranked sixth and medical facilities (0.045) ranked eighth in the global weight ranking. The least salient sub-criteria factors were transport facilities (0.018) and communication facilities (0.017), respectively. The results show that emergency or disaster situations, often require decision makers to take crucial decisions. A more balanced and professional group of decision-makers would be a plus in terms of more quickly arriving at a decision during emergency situations [45].

Figure 8. The global weight ranking of DEMR operational capability.

(a)



(b)

5. Discussion

This study separately identifies the relative importance and priority of factors affecting the effective operation of DEMR in China and Korea, and provides a comprehensive list of influencing factors. The main characteristics presented by the results are as follows: firstly, the measurement of the evaluation domain shows that the relative importance of 'human resources' is highest in China and Korea. The difference is that China ranks fourth in terms of IT resources and Korea ranks second. This implies a greater focus on the role of IT resources in the effective operation of DEMR in Korea. It is judged that Korea is more proficient in utilizing IT resources such as Big Data and the Internet of Things, as it has entered the Fourth Industrial Revolution earlier than China. Although some Chinese scholars have found IT resources to be one of the important factors for the operational capability of DEMR [33, 46], the result of this study did not fully support their arguments. While IT has become an essential channel for posting disaster-related information since the Fourth Industrial Revolution, there has been an unsuccessful use of IT, which has ultimately led to low levels of collaboration between governments and agencies, resulting in resources not reaching disaster areas in a timely manner and leading to community destruction [47].

Secondly, looking at the results of the ranking of local weights in each evaluation domain, in terms of human resources, decision makers were ranked as the most critical factor in both China and Korea. The decision makers are generally the head of the level responsible for emergency response. Their ability to make decisions in the face of emergencies is influenced by various factors such as the personal experience, personality traits and psychological qualities. An excellent decision-maker should have the ability to lead, anticipate and be psychologically prepared for emergencies and disaster situations. At the same time, both countries have overlooked the role of volunteers in emergency and disaster management. This is largely because in most countries, emergency and disaster management relies heavily on professionals and, to varying degrees, on volunteers attached to official agencies. Those who work outside of such systems are often viewed as a nuisance or a liability, and their efforts are often undervalued [48]. Much of the literature has demonstrated that volunteers who volunteer their time, knowledge, skills and resources to help others can be a valuable and committed resource in responding to various types of disasters and emergencies [49-51]. As the first at the site of the incident, they may initiate lifesaving activities, help in evacuating victims, give emotional support, provide necessary information and offer other practical assistance [52]. In terms of supply resources, both countries regard life-in-waiting items as the most important factor. It is necessary to increase government reserves of material resources, especially life-saving materials such as food, drinking water and medical supplies, to effectively respond to emergencies and disaster situations, reduce casualties and economic losses, and guarantee sustainable social development. community or social economy [53]. In terms of facility resources, both countries consider the relative importance of medical and refuge facilities to be higher than that of transportation and communication facilities. In the process of fighting against COVID-19, many countries have noticed the importance of medical facilities. In terms of IT resources, the differences between the two countries are very significant. Location tracking technology has the greatest impact in China, but the least in Korea, where the number one ranking in information resources is demand forecasting. The difference in size between China and Korea is huge, with China being vast and in resource transportation is time consuming, with multi-modal mobile information collection terminals such as GPS and GPRS providing full mesh node positioning and real-time location tracking of rescuers [54]. At the same time, it is also necessary to increase the collection of disaster information, maintain the sensitivity of major disaster signals, improve the ability to analyze information and ensure the timely release of warning information.

Thirdly, the global weight ranking shows that China ranks higher in terms of medical facilities than Korea, ranking third in the global weight. China has a large and densely population and in the event of a disaster, especially an infectious disease such as covid-19, medical facilities are in short supply and in serious need. If a city can establish the necessary medical facilities as soon as possible after disaster, it can alleviate the disaster as soon as possible, solve the medical problems, improve patient treatment ability and ensure the safety of people's lives and health [55]. Demand forecasting and situational awareness are significantly higher in the Korean local weighting ranking than in the Chinese ranking. Precise situational awareness of the on-site information can forecast the developing trend of disasters, provide the scientific basis for the auxiliary decision-making, and effectively coordinated the direction rescue [56].

6. Conclusion

This paper used an AHP model to assess the relative importance and priority of domains and indicators affecting the operational capacity of DEMR in China and Korea respectively, and conducts a comparative analysis. The commonality between the two countries is that they both consider human resources as the most influential domain and decision-makers as the key influencing indicator. The difference is that Korea has a higher priority in terms of IT resources. Demand forecasting and situational awareness indicators in this domain also ranked higher than China's. Meanwhile, China places more stress on the value of medical facilities and professionals in operational capability of DEMR. This paper contributes to improving disaster and emergency management capabilities by evaluating the factors influencing effective DEMR operations capability from a DEMR perspective. By comparing the differences between China and Korea, cooperation in disaster management can be better promoted. However, the authors acknowledge that the research contains several limitations. Firstly, AHP studies are typically conducted with a small sample size, there is subjectivity. Secondly, as the existing literature does not provide an official definition of DEMR operational capability, the derivation of evaluation domains and indicators relies on prior research and theoretical foundations in disaster and emergency management. Therefore, in future studies, the evaluation domains and indicators should be more objective and refined to enhance the overall evaluation framework.

References

1. Kubina, M., Šulyová, D., & Vodák, J. (2021). Managing global smart cities in an era of 21st century challenges. *Sustainability*, 13(5), 2610.
2. Benson, C., & Clay, E. J. (2003). Disasters, vulnerability, and the global economy. *Building Safer Cities*, 1.
3. Oh, N. (2020). Collective decision-making for developing emergency management capabilities. *International Journal of Emergency Services*. 1-25.
4. FEMA, 2017, National Incident Management System
5. Wang, H., Ye, H., Liu, L., & Li, J. (2022). Evaluation and Obstacle Analysis of Emergency Response Capability in China. *International Journal of Environmental Research and Public Health*, 19(16), 1-25.
6. Liberatore, F., Pizarro, C., de Blas, C. S., Ortuño, M. T., & Vitoriano, B. (2013). Uncertainty in humanitarian logistics for disaster management. A review. *Decision aid models for disaster management and emergencies*, 45-74.
7. Ding, L., & Zhou, J. J. (2023). Study on food supply chain integration of epidemic outbreak based on AHP-fuzzy. In Sixth International Conference on Traffic Engineering and Transportation System (ICTETS 2022) (Vol. 12591, pp. 678-684). SPIE.
8. Zhai, L., & Lee, J. E. (2023). Analyzing the Disaster Preparedness Capability of Local Government Using AHP: Zhengzhou 7.20 Rainstorm Disaster. *International Journal of Environmental Research and Public Health*, 20(2), 1-17.
9. Miao, X., Banister, D., & Tang, Y. (2013). Embedding resilience in emergency resource management to cope with natural hazards. *Natural hazards*, 69, 1389-1404.
10. Kim, Y., Jang, D., Lee, S., & Kim, S. (2019). A critical review of disaster management resource problems based on past disaster events. *Journal of the Korean Society of Hazard Mitigation*, 19(4), 89-102.
11. Su, Z., Zhang, G., Liu, Y., Yue, F., & Jiang, J. (2016). Multiple emergency resource allocation for concurrent incidents in natural disasters. *International journal of disaster risk reduction*, 17, 199-212.
12. Ma, R., Meng, F., & Du, H. (2023). Research on Intelligent Emergency Resource Allocation Mechanism for Public Health Emergencies: A Case Study on the Prevention and Control of COVID-19 in China. *Systems*, 11(6), 300.
13. Yadav, D. K., & Barve, A. (2015). Analysis of critical success factors of humanitarian supply chain: An application of Interpretive Structural Modeling. *International journal of disaster risk reduction*, 12, 213-225.
14. Lin, D., LingJian, Z., Meng, K., & Changsheng, Y. (2011, August). Research on the evaluation of the enterprise emergency capability with the butterfly catastrophe theory. In 2011 2nd IEEE International Conference on Emergency Management and Management Sciences (pp. 29-32). IEEE.
15. Zhou., & Lian, S. (2011, March). Research on scheduling models of emergency resource. In 2011 Fourth International Conference on Intelligent Computation Technology and Automation (Vol. 1, pp. 1110-1113). IEEE.
16. Qin, J., Xing, Y., Wang, S., Wang, K., & Chaudhry, S. S. (2012). An inter-temporal resource emergency management model. *Computers & operations research*, 39(8), 1909-1918.
17. Zhang, W., Yan, X., & Yang, J. (2017). Optimized maritime emergency resource allocation under dynamic demand. *PloS one*, 12(12), e0189411.

18. Mu, J., & Liang, L. L. (2014). Multi-stage emergency resources management based on supply chain. In Applied Mechanics and Materials (Vol. 635, pp. 1780-1783). Trans Tech Publications Ltd.
19. Shao, H., Zhao, H., & Hu, F. (2012). A study on modeling and simulation engineering of emergency resources supply based on System Dynamics. *Systems Engineering Procedia*, 5, 307-312.
20. FEMA, 2021, National Incident Management System Guideline for Resource Management Preparedness
21. Wang, S. L., & Sun, B. Q. (2023). Model of multi-period emergency material allocation for large-scale sudden natural disasters in humanitarian logistics: Efficiency, effectiveness and equity. *International Journal of Disaster Risk Reduction*, 103530.
22. Choksi, M., & Zaveri, M. A. (2019). Multiobjective based resource allocation and scheduling for postdisaster management using IoT. *Wireless Communications and Mobile Computing*, 2019.
23. Kim, S. W., Lee, J., Jang, D. W., & Chon, J. J. (2018). Disaster risk assessment for the disaster resources management planning. *Journal of the Korean Society of Hazard Mitigation*, 18(2), 387-394.
24. Kusumasari, B., Alam, Q., & Siddiqui, K. (2010). Resource capability for local government in managing disaster. *Disaster Prevention and Management: An International Journal,* 19(4), 438-451.
25. Indrayani, E., & Wasistiono, S. (2021). The role of community protection institution in disaster management at West Java, Indonesia. *Jàmbá: Journal of Disaster Risk Studies*, 13(1), 1-10.
26. Kim, Y. H, Kim, S. J., and Lee, Ji Ho. (2020). A Study on Improving Disaster Management Evaluation Based on the PUFA Meta Evaluation Model. *J. Korean Soc. Hazard Mitig*, 20(1), 101-110.
27. Zhang, Y., Ding, Q., & Liu, J. B. (2022). Performance evaluation of emergency logistics capability for public health emergencies: perspective of COVID-19. *International Journal of Logistics Research and Applications*, 25(12), 1509-1522.
28. Feizollahi, S., Shirmohammadi, A., & Kahreh, Z. (2012). Investigation the requirements of supply and distribution emergency logistics management and categorization its sub-criteria using AHP: a case study. *Management Science Letters*, 2(7), 2335-2340.
29. Cigler, B. A. (2007). The "big questions" of Katrina and the 2005 great flood of New Orleans. *Public Administration Review*, 67, 64-76.
30. Liu, Z., Ma, R., & Wang, H. (2022). Assessing urban resilience to public health disaster using the rough analytic hierarchy process method: A regional study in China. *Journal of Safety Science and Resilience*, 3(2), 93-104.
31. Saaty, R. W. (1987). The analytic hierarchy process—what it is and how it is used. *Mathematical modelling*, 9(3-5), 161-176.
32. Saaty, T. L. (2008). Decision making with the analytic hierarchy process. *International journal of services sciences*, 1(1), 83-98.
33. Manca, D., & Brambilla, S. (2011). A methodology based on the Analytic Hierarchy Process for the quantitative assessment of emergency preparedness and response in road tunnels. *Transport Policy*, 18(5), 657-664.
34. Orencio, P. M., & Fujii, M. (2013). A localized disaster-resilience index to assess coastal communities based on an analytic hierarchy process (AHP). *International Journal of Disaster Risk Reduction*, 3, 62-75.
35. Chukwuka, O. J., Ren, J., Wang, J., & Paraskevadakis, D. (2023). A comprehensive research on analyzing risk factors in emergency supply chains. *Journal of Humanitarian Logistics and Supply Chain Management.*
36. Wood, E., Sanders, M., & Frazier, T. (2021). The practical use of social vulnerability indicators in disaster management. *International Journal of Disaster Risk Reduction*, 63, 1-14.
37. Ravago, M. L. V., Mapa, C. D. S., Aycardo, A. G., & Abrigo, M. R. (2020). Localized disaster risk management index for the Philippines: Is your municipality ready for the next disaster?. *International Journal of Disaster Risk Reduction*, 51, 101913.
38. Khatwani, G., & Kar, A. K. (2017). Improving the Cosine Consistency Index for the analytic hierarchy process for solving multicriteria decision making problems. *Applied computing and informatics*, 13(2), 118-129.
39. Cox, A. M., Alwang, J., & Johnson, T. G. (2000). Local preferences for economic development outcomes: analytical hierarchy procedure. *Growth and Change*, 31(3), 341-366.
40. Canco, I., Kruja, D., & Iancu, T. (2021). AHP, a reliable method for quality decision making: A case study in business. *Sustainability*, 13(24), 1-14.
41. Doyle, E. E., Becker, J. S., Neely, D. P., Johnston, D. M., & Pepperell, B. (2015). Knowledge transfer between communities, practitioners, and researchers: A case study for community resilience in Wellington, New Zealand. *Australasian Journal of Disaster and Trauma Studies*, 19(2), 55-66.
42. Sun, X., Chang-Richards, A. Y., Kleinsman, T., & Innes, A. (2021). Improving human resource mobilisation for post-disaster recovery: A New Zealand case study. *International Journal of Disaster Risk Reduction*, 52, 1-10.
43. Malawani, A. D., Nurmandi, A., Purnomo, E. P., & Rahman, T. (2020). Social media in aid of post disaster management. *Transforming Government: People, Process and Policy*, 14(2), 237-260.
44. Kotani, H., Yokomatsu, M., & Ito, H. (2020). Potential of a shopping street to serve as a food distribution center and an evacuation shelter during disasters: Case study of Kobe, Japan. *International Journal of Disaster Risk Reduction*, 44, 1-16.
45. Kapucu, N., & Garayev, V. (2011). Collaborative decision-making in emergency and disaster management. *International Journal of Public Administration*, 34(6), 366-375.
46. Zhu, X., Zhang, G., & Sun, B. (2019). A comprehensive literature review of the demand forecasting methods of emergency resources from the perspective of artificial intelligence. *Natural Hazards*, 97, 65-82.
47. Abid, S. K., Sulaiman, N., Wei, C. S., & Nazir, U. (2021, June). Building resilient future: Information technology and disaster management-a Malaysian perspective. In IOP Conference Series: Earth and Environmental Science (Vol. 795, No. 1, p. 012026). IOP Publishing.

48. Whittaker, J., McLennan, B., & Handmer, J. (2015). A review of informal volunteerism in emergencies and disasters: Definition, opportunities and challenges. *International journal of disaster risk reduction*, 13, 358-368.
49. Helsloot, I. and Ruitenberg, A. (2004), "Citizen response to disasters: a survey of literature and some practical implications", *Journal of Contingencies and Crisis Management*, 12(3): 98-111.
50. Scanlon, J., Helsloot, I. and Groenendaal, J. (2014), "Putting it all together: integrating ordinary people into emergency response", International Journal of Mass Emergencies and Disasters, 32(1): 43-63.
51. Simpson, N.C. and Hancock, P.G. (2009), "Fifty years of operational research and emergency response", Journal of the Operational Research Society, 60(S11): 26-139.
52. Skar, M., Sydnes, M., & Sydnes, A. K. (2016). Integrating unorganized volunteers in emergency response management: A case study. International Journal of Emergency Services.
53. Zhang, Y. L., & Chen, L. (2016). Emergency materials reserve of government for natural disasters. *Natural Hazards*, 81, 41-54.
54. Ji, Z., & Anwen, Q. (2010, November). The application of internet of things (IOT) in emergency management system in China. In 2010 IEEE International Conference on Technologies for Homeland Security (HST) (pp. 139-142). IEEE.
55. Liu, J., Li, Y., Li, Y., Zibo, C., Lian, X., & Zhang, Y. (2022). Location optimization of emergency medical facilities for public health emergencies in megacities based on genetic algorithm. *Engineering, Construction and Architectural Management*. 29(7): 1-27.
56. O'Brien, A., Read, G. J., & Salmon, P. M. (2020). Situation Awareness in multi-agency emergency response: Models, methods and applications. *International Journal of Disaster Risk Reduction*, 48, 1-11.