

Korea, China, Japan, U.S.A., Thailand, Pakistan, Nepal, Mongolia, ADPC, and TNDR

The 16th ICCEM Program
(12th-14th December, 2022, Bangkok, Thailand & Online)

Community Disaster Resilience and Crisisonomy in the 4th Industrial Revolution Era

Date

12(Mon.) - 14(Wed.) December, 2022

Venue

Royal Orchid Sheraton Hotel & Towers, Bangkok, Thailand

Co-host Organizations

International Society for Crisis and Emergency Management (ISCEM)
Asian Disaster Preparedness Center (ADPC)
Thai Network for Disaster Resilience (TNDR)
The Korean Association for Disastronomy (KAD)
The Korean Association for Crisis and Emergency Management (KACEM)
National Crisisonomy Institute, Chungbuk National University, Korea
Institutes of Science and Development, Chinese Academy of Sciences
Institute of Emergency Management and Public Policy, Jiangsu University, China
The Center for International Education, Teikyo University of Science, Japan
Faculty of Agricultural Engineering and Technology, PMAS Arid Agriculture University Rawalindi, Pakistan
Crisis and Emergency Management: Theory and Praxis (CEM-TP)
Disaster Management Research Center, Loving Center for Disaster Victims (LCDV)
Cheongju Council for Sustainable Development
Global Crisisonomy Institute (GCI)

Sponsored by

National Research Foundation of Korea
Ministry of the Interior and Safety (MOIS)
Chungbuk National University (CBNU)
Safe Today

Supporting Journal

Journal of Safety and Crisis Management (CEMTP & ISCEM Official Journal)
Crisisonomy
Disastronomy
Korean Review of Crisis & Emergency Management
Contingencies and Crisis Management Review



International Society for Crisis and Emergency Management
Asian Disaster Preparedness Center
Thailand Network for Disaster Resilience

INVITATION

Dear Distinguished Scholars and Experts!!!

Above all, we wish everyone good health and happiness in the midst of COVID-19.

Since the 13th ICCEM was held in Kathmandu, Nepal in 2019, ISCEM has held the 14th ICCEM and the 15th ICCEM through online Youtube. Although COVID-19 has not yet completely ended, fortunately, the 16th ICCEM will be held face-to-face despite many difficulties.

Since the first ICCEM started at Chungbuk National University in Korea in 2007, ISCEM has been having discussions with many scholars and experts in Korea, China, Japan, the United States, Portugal, Switzerland, Singapore and Nepal for the academic development of crisisology.

Every year for the past 15 years, scholars and experts in the fields of crisisology and disasterology have been discourses on various topics such as crises, risks, hazards, security, and disasters from various perspectives to establish a sustainable and safe world. Now, this year, the 16th ICCEM will be held in Bangkok, Thailand, from 12 to 14 December.

Today is called the era of the 4th industrial revolution. The 4th industrial revolution is closely related to the academic development of crisisology and community disaster resilience. The era of the 4th industrial revolution is called a hyper-connected society, a super-intelligent society, and a super-converged society.

In other words, it is a society closely connected with ICT-based big data, cloud computing, artificial intelligence, robots, 3D printing, autonomous driving, Internet of Things, VR, AR, Metaverse, and SNS. This high-tech connected society certainly has risks that we must overcome, but on the other hand, it can also increase the resilience of disaster-stricken communities. In this context, The 16th International Conference on Crisis and Emergency Management will be held under the theme of "Community Disaster Resilience and Crisisology in the 4th Industrial Revolutionary Era".

We would like to ask for your interest and participation in the 16th ICCEM to make the academic development of Crisisology and a sustainable safe community.

Thank you so much for your participation and support.

Sincerely yours,

6 October, 2022

Chairs, The 16th ICCEM Organizing Committee

Executive Director Hans Guttman (ADPC), Dr. Bhichit Rattakul (TNRD, Thailand)

Members, The President Board of ISCEM

Dr. Jae Eun Lee, Dr. An Chen, Dr. Norio Okada



International Society for Crisis and Emergency Management

The 1st Day Program

12 December, 2022

Venue: Pompadour and is located on 2nd floor

■ Session 1		09:30-10:20
Moderator	Keiko Kitagawa (Seitoku University, Japan)	
Presenter	<p>Eugene Song (Chungbuk National University, Korea) Ju Ho Lee (Sehan University, Korea) Seol A Kwon (Chungbuk National University, Korea) A Study on the Effects of Infectious Disease Disaster Resilience and Social Exclusion on Disaster Overcoming Behavior: Focusing on COVID-19</p> <p>Jaruwan Phrutthayanan, Pachanat Nunthaitaweekul (Chulalongkorn University, TNDR, Thailand) Preventive Behaviors, Knowledge, Attitude, Health Belief, Knowledge Management, Social Support and Media Exposure with the Covid-19 Pandemic among to Emergency Medical Responders in Thailand</p> <p>Gyum Hun Kim (Chungbuk National University, Korea) A Study on the Advancement of the Disaster Management Resource Logistics System in the Age of the Fourth Industrial Revolution: Focusing on the Case of Private Logistics Companies</p>	
Discussants	<p>Linpei Zhai (Chungbuk National University, Korea) Gajendra Sharma (Kathmandu University, Nepal) Dong Geon Lee (Korea National University of Transportation)</p>	
Coffee Break		10:20-10:30
■ Session 2		10:30-11:20
Moderator	Eunmi Lee (Kookmin University, Korea)	
Presenter	<p>Suman Manandhar, Bijaya Krishna Shrestha, and Bishal Dev (Global Institute for Interdisciplinary Studies, Rajdevi Engineering Consultant (P)Ltd., Kathmandu, Nepal) Application of Multi Hazard Risk Assessment for the Preparation of Risk Sensitive Land Use Plan (RSLUP) Adopting DRRM: A Case Study of Lamkichuha Municipality, Far Western Province, Nepal</p> <p>Xiang Yan Jin (Chungbuk National University, Korea) Crisis Management and Communication in the Age of the Fourth Industrial Revolution in China</p> <p>Yun Jeong Cha (Chungbuk National University, Korea) The level of Awareness of Social Disaster Safety and the Necessity of Safety Education- The level of Response to Disaster and Major Accident Risk Situations</p>	

Discussants

Joon Ha Kim (KITValley, Korea)
Suman Manandhar (Global Institute for Interdisciplinary Studies, Nepal)
Bill Ho (Asian Disaster Preparedness Center)

Coffee Break**11:20-11:30****■ Session 3****11:30-12:40****Moderator**

Suman Manandhar (Global Institute for Interdisciplinary Studies, Nepal)

Presenter

Sirinon Suwanmolee (Thai Network for Disaster Resilience (TNRD), Thailand)
Pavin Jallapakdee (Forest and Sea for Life Foundation, Thailand)
Jitraporn Somyanontanakul (Mahasarakham University, Thailand)
Surangrut Jumnianpol (Mahasarakham University, Thailand)
Abhidech Tepin (Mahasarakham University, Thailand)
Kronglan Karanet (Mahasarakham University, Thailand)
Arthit Phuboonkong (Mahasarakham University, Thailand)
Stakeholder Analysis of Hydrological Hazard and Water Utilization toward the Network of Klongyan River Basin for Restoration and Conservation

Zhen Yun Jin (Chungbuk National University, Korea)
Research on the Improvement Direction of Forest Fire UAV in the Background of Climate Crisis

Xiang Nan Lin (Chungbuk National University, Korea)
Intelligent Fire Fighting of Chinese City in the Context of the Fourth Industrial Revolution

Discussants

Eunmi Lee (Kookmin University, Korea)
Hyun Soo Park (Chungbuk National University, Korea)
Sujata Shrestha (Global Institute for Interdisciplinary Studies, Nepal)

Lunch**12:40-13:40**

Opening Ceremony

(Bangkok, Thailand)

13:40-14:30

Venue: Pompadour and is located on 2nd floor

Moderator Seol A Kwon National Crisisonomy Institute, CBNU, Korea

■ Opening Address

Mr. Hans Guttman (Co-Chair, The 16th ICCEM / Executive Director, ADPC)

Dr. Sarintip Tantanee (Co-Chair, The 16th ICCEM / Vice Chairman, TNDR, Thailand)

■ Welcoming Remarks

Jae Eun Lee (Co-President, ISCEM / President, KAD / Director, NCI-CBNU, Korea)

An Chen (Co-President, ISCEM / Professor, CAS, China, Online)

■ Congratulatory Remarks

Keiko Kitagawa (Co-President, Asian Association for Crisisonomy)

Shohachi Okinaga (President, Teikyo University of Science, Japan)

Gajendra Sharma (The 13th ICCEM Chair / Kathmandu University, Nepal)

Seung-jin Maeng (President, Korean Association for Crisis and Emergency Management & CBNU)

■ MOU between NCI and TNDR I

Dr. Jae Eun Lee (Director, NCI-CBNU, Korea, Korea)

Dr. Sarintip Tantanee (Co-Chair, The 16th ICCEM / Vice Chairman, TNDR, Thailand)

■ MOU between ADPC and CCSD-Korea II

Mr. Hans Guttman (Executive Director, ADPC / Co-Chair, The 16th ICCEM)

Mr. Bill Ho (Director, Asian Disaster Preparedness Center)

Dr. Jae Eun Lee (Executive Chair, Cheongju Council for Sustainable Development, Korea)

Mr. Jong Eul Park (Director, Cheongju Council for Sustainable Development, Korea)

■ Photo Session

Coffee Break

14:30-14:40

■ Session 4: Special Lecture

14:40-15:20

Moderator **Jae Eun Lee** (Chungbuk National University, Korea)

Special Lecturer **Rory John O'Dea** (Parsons School, New York, USA)
Chronic Crisis: Only Art Can Save Us Now

Coffee Break

15:20-15:30

■ Session 5: Keynote Speeches

15:30-16:30

Moderator Dr. Sarintip Tantanee (Vice Chairman, TNRD, Thailand)

Presenter **Hans Guttman** (Asian Disaster Preparedness Center)
Localization for Sustainable Resilience

Keiko Kitagawa (Seitoku University, Japan)
Disaster Vulnerability of Both Disabled People and Evacuation Assistance Volunteers Living in Depopulated Areas

Keun Ho Ryu
(Chungbuk National University / Ton Duc Thang University / Chiang Mai University)
Healthcare Crisis: Explainable Artificial Intelligence Framework for Non-Communicable Disease Prediction

■ Session 6: Keynote Speeches

16:30-17:20

Moderator Jang Hee Lee (Chungbuk National University, Korea)

Presenter **Sarintip Tantanee** (Naresuan University, TNRD, Thailand)
University Enterprise Collaboration for Disaster Resilience in Thailand

Jae Eun Lee (Chungbuk National University, Korea)
Community Disaster Resilience Model for Sustainable Society in the Era of Climate Crisis

Gajendra Sharma (Kathmandu University, Nepal)
Review of Digital Payment Ecosystem and Associated Risks in Financial Sectors of Nepal

Bazarragchaa Duudgai (National Emergency Management Agency of Mongolia, Mongolia)
Survey on Community Earthquake Preparedness in Urban Areas of Mongolia

Coffee Break

17:20-17:30

■ Session 7: Keynote Speeches and Governance Cases

17:30-18:00

Moderator Hans Guttman (ADPC)

Presenter **Young Sik Kim** (Seowon University, Korea)
Resilient Safe Community without Disaster Hazards in Cheongju

Discussants **Bill Ho** (Asian Disaster Preparedness Center)
Seol A Kwon (Chungbuk National University, Korea)
Jang Hee Lee (Chungbuk National University, Korea)

Dinner

The 2nd Day Program

13 December, 2022

Venue: Pompadour and is located on 2nd floor

■ Session 8

09:30-10:40

Moderator	Eunmi Lee (Kookmin University, Korea)
Presenters	<p>Dong Geon Lee, Jung Hwang Shin, Mi Jung Lee, Seon Yeong Ha, and Jong-Bae Back (Korea National University of Transportation) Estimation of Risk Mitigation Rate by Item of Hierarchy of Controls Using Bayesian Networks</p> <p>Suman Manandhar, Sujata Shrestha, Dipika Das, and Uttam Babu Shrestha (Global Institute for Interdisciplinary Studies, Nepal) Approaches of Urban Vulnerable Targeting in Municipalities of Nepal: Practices and Pitfalls</p> <p>Linpei Zhai and Jae Eun Lee (Chungbuk National University, Korea) Harnessing ICT to Enhance Community Disaster Resilience: A Case Study of Employing Social Media to Zhengzhou 7.20 Rainstorm, China</p>
Discussants	<p>Sarintip Tantanee (Naresuan University, TNDR, Thailand)</p> <p>Hyun Soo Park (Chungbuk National University, Korea)</p> <p>Tapendra Bahadur Khadka (Global Institute for Interdisciplinary Studies, Nepal)</p>

Coffee Break

10:40-10:50

■ Session 9

10:50-12:00

Moderator	Gajendra Sharma (Kathmandu University, Nepal)
Speaker	<p>Seol A Kwon, Eugene Song, Jae Eun Lee, and Jee Eun Kim (Chungbuk National University, Korea) What are the effects of safety management and attendees' awareness of safety at festivals on public awareness (public collective self-esteem and national role identity)?: Focused on 2030 Busan EXPO Concert</p> <p>Suman Manandhar, Shova Shrestha, Tapendra Bahadur Khadka, and Sushmita Malla (Global Institute for Interdisciplinary Studies, Tribhuvan University, Rajdevi Engineering Consultant (P)Ltd., Kathmandu, Nepal; Saga University, Japan) Disaster Risk Reduction Interventions in Lamkichuha Municipality for Developing Risk Sensitive Land Use Plan, Nepal</p> <p>Joon Ha Kim, Tae Jung Song, and Jong Bin Kim (KITValley, Korea) Yon Soo Kim (LIG System Co., Ltd., Korea) Prototype Development of Disaster Resources Operation and Management System Considering user Convenience</p> <p>Eunsoo Park (Chungbuk National University, Korea) A Study on the Necessity of an Independent and Neutral National Crisis Management System - Focusing on the Itaewon tragedy</p>

Discussants

Jun Ho Choi (Chungbuk National University, Korea)
Jaruwan Phrutthayanan (Chulalongkorn University, TNRD, Thailand)
Hwang Woo Noh (Hanbat National University, Korea)
Wei Lu (Chungbuk National University, Korea)

Lunch**12:00-13:30****■ Session 10****13:30-14:50****Moderator**

Keiko Kitagawa (Seitoku University, Japan)

Speaker

Eunmi Lee (Kookmin University, Korea)
Why do We Need more Official Development Assistance in Crisis?— Evidence from Panel Data model Investigation

Santosh KC, Nar Bikram Thapa, Suman Manandhar, Bishnu Kumar Sinjali, and Lakpa Sherpa (Lumbini Buddhist University, Global Institute for Interdisciplinary Studies, Nepal)
Earthquake an Unpredictable Casualties, It's Scenario and Impact in Nepali Livelihood

Hyun Soo Park (Chungbuk National University, Korea)
Seol A Kwon (Hanbat National University, Korea)
A Study on Characteristics of Type of Traditional Crisis: Focusing on Accident Cases in Korean Military from 2016 to 2012

Min A Lee (Chungbuk National University, Korea; Online)
A Study on Constructing of Online Environment Strengthening Community Reliance

Discussants

Suman Manandhar (Global Institute for Interdisciplinary Studies, Nepal)
Bill Ho (Asian Disaster Preparedness Center)
Gajendra Sharma (Kathmandu University, Nepal)
Seol Hee Jung (Chungbuk National University, Korea)

Coffee Break**14:50-15:00**

■ Session 11

15:00-16:20

Moderator Tae Jung Song (KITValley, Korea)

Speaker Seol Hee Jung (Chungbuk National University, Korea)
[A Study on analysis of hyperconcentration of population in the capital region and extinction of local areas in Chungbuk province](#)

Suman Manandhar, Bijaya Krishna Shrestha, and Habendra Prasada Dev
 (Global Institute for Interdisciplinary Studies, Rajdevi Engineering Consultant (P)Ltd., Kathmandu, Nepal)
[Implementing Risk Sensitive Land Use Plan for Lamkichuha Municipality, Far Western Province, Nepal](#)

Wei Lu and Jae Eun Lee (Chungbuk National University, Korea)
[In the Era of We Media the New Trend of Government Crisis Management](#)

Jun Ho Choi (Chungbuk National University, Korea)
[A review of disaster response in the smart era: Focusing on resident evacuation](#)

Discussants Jung Hwang Shin (Korea National University of Transportation)
 Gajendra Sharma (Kathmandu University, Nepal)
 Keiko Kitagawa (Seitoku University, Japan)
 Hwang Woo Noh (Hnabat National University, Korea)

Coffee Break

16:20-16:30

■ Closing Session 12: General Meeting and Farewell

16:30-17:00

Dinner

“On-line Conference” The 1st Day Program

12 December, 2022

■ Online Session 1

09:30-10:30

Moderator	Muhammad Azam (PMAS Arid Agriculture University, Rawalpindi, Pakistan)
Presenter	<p>Juho Lee (Sehan University, Korea) Evacuation Issues and Location Factors of Shelters in the Catastrophe: Focused on the Disaster Response Base Operation Plan</p> <p>Yinghua Chen (Jiangsu University, China) Why the Stampedes Repeated Again and Again? Accident Causes and Government Emergency Ability Evaluation by QCA Case Studies</p> <p>Bo Gyeong Mun (Chungbuk National University, Korea) Effects of the 4th Industrial Revolution on the Resilience of Local Communities</p> <p>Zi Hao Li (Chungbuk National University, Korea) Crisis and Emergency Management in the Tourism Industry: Covid 19 & Theory of Communication</p>

Coffee Break

10:30-10:40

■ Online Session 2

10:40-11:50

Moderator	An Chen (Chinese Academy of Sciences, Online)
Presenter	<p>Lingli Guo (Henan Polytechnic University, China; Online) Research on the Prevention and Control Mechanism to College Internet Public Opinion</p> <p>Ke Zhang (Chungbuk National University, Korea; Online) Improving Disaster Resource Allocation in Smart Cities Based on Social Media</p> <p>Hyunjung Kim (National Disaster Management Research Institute, Korea; Online) A Preliminary Study on the Improvement of Social Disaster Response and Recovery Policy</p>

Lunch

12:00-13:00

■ Online Session 3: Keynote Speeches		13:00-14:00
Moderator	Min Sun Song (Valdosta State University, USA)	
Presenter	<p>An Chen (Chinese Academy of Sciences) Understanding the Adoption of Face Recognition Payment Technology: Expanding UTAUT Model with Perceived Risk Facets</p> <p>Muhammad Azam (PMAS Arid Agriculture University, Rawalpindi, Pakistan) Delineating Climatic Causes of Floods in 2022 in Pakistan: The Way Forward,</p> <p>Yeon Jun Kim (Chungbuk National University, Korea) A Study on the Activation of Environmental Education to Overcome the Climate Crisis and Achieve Carbon Neutrality</p>	

Coffee Break 14:00-14:10

■ Online Session 4		14:10-15:20
Moderator	Lingli Guo (Henan Polytechnic University, China)	
Presenter	<p>Muhammad Naveed Anjum (PMAS Arid Agriculture University, Rawalpindi, Pakistan; Online) Climate Change and Its impacts on the Flows of Subtropical River Basin in the Hindu-Kush Mountain, South Asia</p> <p>Woong Cheon Yoo (Chungbuk National University, Korea; Online) A Study on the Local Extinction Discourse and Crisis Management in Rural Areas: Focusing on the Local Extinction Reaction Fund</p> <p>Muhammad Jehanzeb Masud Cheema (PMAS Arid Agriculture University, Rawalpindi, Pakistan; Online) Pakistan's Water Security in Transboundary Perspective</p> <p>Min Sun Song (Valdosta State University, USA) Ki Woong Cho (Jeonbuk National University, Korea) Does Regional Competence as Resilience Matter for Response to COVID-19?</p>	

Coffee Break 15:20-15:30

■ Online Session 5

15:30-16:30

Moderator	Yinghua Chen (Jiangsu University, China)
Presenter	<p>Young Beom Kim (Chungbuk National University, Korea; Online) A Study on the Crisis Caused by Artificial Intelligence in the Era of the 4th Industrial Revolution</p> <p>Jong Hyuk Kim (Chungbuk National University, Korea; Online) A study on the direction of smart city promoted by Cheongju-si, a millennium-old city-Based on the analysis of the results of Sejong Smart City Construction and Cheongju Smart City Planning Service Results</p> <p>Dea Hoon Kang (Chungbuk National University, Korea; Online) Directions for Using the 4th Industrial Revolution Technology to Adapt to Changes in the Disaster Environment: Focusing on the Effective Reception and Processing of Deluge Emergency Calls</p>

Coffee Break

■ Online Session 6

16:40-17:40

Moderator	Muhammad Naveed Anjum (PMAS Arid Agriculture University, Rawalpindi, Pakistan)
Presenter	<p>Ran Hee Jeong (Chungbuk National University, Korea; Online) A study on the social risks of 3D printing and the harmfulness of filament materials</p> <p>Jeong Min Choi (Chungbuk National University, Korea; Online) A study on how to improve environmental problems in the Chungcheongbuk-do region using big data</p> <p>Hak Su Lee (Chungbuk National University, Korea; Online) Suggestions for Mitigating Damage from Electric Vehicle Fire</p> <p>Zeshan Waheed (PMAS Arid Agriculture University, Rawalpindi, Pakistan; Online) Projection of Future Floods in Pakistan</p> <p>Yoon Han Jung (Chungbuk National University, Korea; Online) How to Improve the Crisis Management System by Harmonizing between Objective and Subjective Risk Perception</p>

The 3rd Day Program

14 December, 2022

■ Field Workshop

10:00-18:00

ASEM Disaster Management Warehouse
: Disaster Emergency Logistics System for ASEAN: DELSA

▼ Join online Seminar Link

<https://us02web.zoom.us/j/81271449941?pwd=QW1zNGFQbIVxczBpVTc2aUtibGZnQT09>

Meeting ID 812 7144 9941
Passcode 772295

한 번의 탭으로 오디오 회의에 참가

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현지 번호 찾기

<https://us02web.zoom.us/j/81271449941?pwd=QW1zNGFQbIVxczBpVTc2aUtibGZnQT09>



International Society for Crisis and Emergency Management

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Article

A Study on Effect of Infectious Disease Disaster Resilience and Social Exclusion on Disaster Preventive Behavior: Focusing on COVID-19

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Abstract: With the outbreak of the COVID-19 in 2020, global interest in public health care has been increased rapidly. Although the primary responsibility for prevention and control of infection lies with public health and medical institutions, in a disaster situation such as the COVID-19 pandemic that requires concentration of all social capabilities, the awareness of private participation also plays a very important role. The purpose of this study was to analyze the effect of disaster resilience and social exclusion experienced in the process of responding to disasters on the intention and practice for infection prevention. The results showed that perceived barrier in outdoor activities, perceived barrier in vaccination, and perceived benefits had effect on intention for infection prevention preventive action, which in turn, affects preventive action. In addition, there were difference in preventive behavior between the low- and high-resilience groups and between low- and high-social exclusion groups. These results suggest that the level of citizen resilience and social exclusion should be considered in the development of national disaster management policies.

Keywords: Infectious Disease, Disaster, Resilience, Social Exclusion, COVID-19

1. Introduction

In recent disaster studies, disaster resilience is regarded as an important influencing factor in public disaster response behavior. The disaster resilience refers to the ability and resources to anticipate disasters, to respond to it, and to recover to the state before disaster (Kim & Park, 2019). Resilience is also applied in various social crises other than disasters. Walsh (1998) argued that every family has its own competency to cope with various stresses when faced with a crisis situation, and this is the strength that allow them to sustain in a crisis. Kim & Park (2012) observed that disaster resilience, such as social and economic resource, positive perspective, and open communication, of families experiencing disasters are important resources in overcoming disasters. In response to this observation, Lee (2018) accepted Beck (1992)'s argument that modern society has risk as a component essentially and suggested that the risk society should develop resilience and that resilience is an indispensable element not only for the present society but also for the future one. Considering that the level of disaster resilience has a positive (+) correlation with the likelihood that members of society overcome disasters and quickly return to their daily lives, and that, as mentioned above, public participation is very important in overcoming infectious disease disasters, it is clear that the disaster resilience is an important variable to study public behavior in coping with infectious disease disasters.

On the contrary, the social exclusion experienced by disaster victims, unlike disaster resilience, has a negative effect on the public's disaster response behavior. Social exclusion, a process in which resources necessary for social participation are deprived, is caused by factors such as poverty, discrimination, low educational attainment, and poor living conditions (Pierson, 2001). Kim (2020) studied the experiences of social exclusion of migrant workers in the COVID-19 crisis and reported that inequality experiences led them to social and economic isolation and had long-term negative consequences of becoming un-registered migrants. and pointed out that it has a negative impact on society as well as individual. As such, disasters have physical, mental, and economic effects on disaster victims, leading to their experiences of voluntary or involuntary social exclusion. Mutter (2020) argued that, contrary to the general prediction that the damage size due to a disaster is proportional to the scale of the disaster, it is independent of the disaster scale and is determined by social structure, absurdity, and inequality. These studies suggested that social exclusion is a factor that aggravates the damage of disaster victims quantitatively and qualitatively.

The purpose of this study was, therefore, to analyze the effect of disaster resilience and social exclusion experienced in the process of responding to disasters on the intention and practice for infection prevention. The result of this study is expected to be used as evidence for planning social countermeasures and support measures to overcome infectious disease disasters, which has been increasingly serious and considered a major future risk factor.

2. Literature Review & Hypothesis Development

2.1 Health Belief Model

Previous studies on the health belief model including Hayden (2009) and Lee et al. (2008) were reviewed. The perceived threat is difficulty and negative consequence that a disease may cause in one's life. The perceived threat has two sub-factors: The perceived severity is the degree of severity that an individual perceives for a particular disease, and perceived susceptibility is a subjective belief about the level of one's susceptibility to a particular disease.

Lee et al. (2021) reported that those who experienced disaster may experience problems in asset management, body, mind, work, and interpersonal relationships, and Song et al. (2021) stated that the public was aware of the economic or physical threat posed by infectious diseases. In addition, Lee & Kim (2011) observed that disaster victims show vulnerability to physical, household economic, and post-traumatic stress. These studies suggested that, in the event of an infectious disease disaster, the public predicts, based on their perceived susceptibility to disease, that their lives are likely to be negatively affected physically, mentally, economically and occupationally.

In this study, accordingly, perceived severity was measured as the risk level of COVID-19 to one's physical, mental, economic, and occupational life, and perceived susceptibility was measured using the contagiousness of COVID-19 and the likelihood of being infected.

2.2 Social Exclusion

Pierson(2001) considered that the social exclusion is a process in which resources necessary for social participation are deprived and is caused by factors such as poverty, discrimination, low educational attainment, and poor living conditions. Alber and Fahey (2004) observed that social exclusion is caused by the poor family support system, the weak social support system, and the lack of effort to acquire the ability to utilize resources.

Phillipson et al. (2004) reported that poverty, employment, health, and peripheral connectivity affect access to social networks. Yoo (2019) observed that elderly experience social exclusion politically, economically, and psychologically. These studies showed that

old age, poverty, unemployment, poor health, and lack of support from family and neighbors, which are characteristics of single-person households, are the main causes of social exclusion. It is assumed that single-person households experience more social exclusion in daily life than multi-person households.

2.3 Disaster Resilience

The disaster resilience refers to the ability and resources to anticipate disasters, to respond to it, and to recover to the state before disaster (Kim & Park, 2019). In several previous studies, disaster resilience has been conceptualized as the capacity of social organizations or groups to manage and recover from disasters (Kwon & Ryu, 2018; Park & Byun, 2016; Bruneau et al., 2003; Cutter et al., 2008; Klein et al., 2003; Manyena, 2006). Based on the disaster resilience at the group or organizational level analyzed by them, disaster resilience at the individual level is defined as an individual's ability to respond appropriately to disaster situations and quickly return to pre-disaster situations. Lee & Lee (2005) defined individual-level resilience as the ability to overcome severe stress or hardship encountered in life, and suggested that it is reinforced by hardships.

Since mitigation of disaster vulnerability increases the probability of returning to daily life from a disaster, reinforcement of individual disaster resilience is a very important factor in minimizing disaster damage (Yang, 2016).

2.4 Conceptual Model

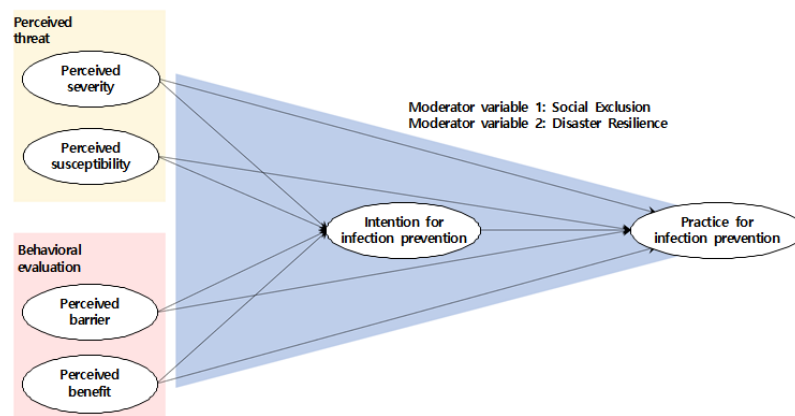


Figure 1. Conceptual Model

3. Materials and Methods

3.1 Data Collection

The data used in this study were collected for five days from Oct. 20th to 25th, 2021 by Macromill Embrain Co. Ltd., an online survey company. A structured on-line questionnaire in the form accommodating online response was distributed via e-mail to the population-proportioned samples in consideration of gender, age, and place of residence among the adult panel aged 19 years and over from the database owned by the company. The distributed online questionnaire was designed not to allow missing responses or outliers. A total of 500 questionnaires were collected and used for analysis after confirming that there were no missing responses, outliers, and duplicate responses.

3.2 Measures

3.2.1 Perceived Threat

The perceived threat was measured based on the definition from Becker (1980), Hayden (2009), and Lee et al. (2008). For the measurement of perceived severity, the objects were classified into physical, mental, economic, and occupational risks based on Lee, et al. (2021), Song, et al (2021), and Lee & Kim (2011), and the perceived severity of the impact of COVID-19 infection was measured. The perceived susceptibility was measured using the scale of Song et al. (2021) on the perceived infectivity of the COVID-19 and the possibility of one's own infection. All items were answered on a five-point likert scale, with 1 being a strong disagreement and 5 being a strong agreement.

3.2.2. Behavior for Prevention of COVID-19 Infection

The Central Disaster Management Headquarters (2021), a Korean authority, published that wearing mask, frequent hand washing, and avoidance of interpersonal contact such as social distancing are effective in preventing COVID-19 infection. Lee & Yoo (2020), Galea et al. (2020), Smith et al. (2020), and Song & Yoo (2020) commonly mentioned the above three as actions to prevent COVID-19 infection. Yoo & Song (2021) added 'avoid going outside and try at home' to the above three, whereas Xu et al. (2020) measured COVID-19 infection prevention behavior using four items measuring above three and proper coughing habits, respectively. In this study, COVID-19 infection prevention behavior was measured using three items commonly used in the preceding studies measuring COVID-19 infection prevention behavior: wearing mask, frequent hand washing, and social distancing. All items were answered on a five-point likert scale, with 1 being a strong disagreement and 5 being a strong agreement.

Table 1. Measured Variables & Items

(): Number of items

Variable		Items	Code
Perceived Threat	Perceived Severity	physical (1), mental (1), economic (1),	SV1~4
	Perceived Susceptibility	contagion (1), infection (1)	SS1~2
Behavioral Evaluation	Perceived Benefits	to wear mask (1), to wash hand (1),	BN1~6
	Perceived Barrier	vaccination barrier (2), social distancing (2), to buy & wear (2), hand washing practices and facility (2), to purchase and use and sanitizer (2),	BR1~13
Intention for Infection Prevention		social distancing (1), to wear mask (2), to wash hand (1),	PI1~6
Practice for Infection Prevention		social distancing (1), to wear mask (1), to wash hand (1)	PB1~6
Social Exclusion	Information	information of confirmed cases (1), measure to prevention infection (1)	EI1~2
	Material	public places quarantine supplies (2), financial assistance (1)	EP1~3
	Evaluation	praise(1), recognition (1)	EE1~2

Disaster Resilience	Information	institution and support polices (4), level of social distancing phase (1), status of confirmed cases (1)	RI1~6
	Economy	financial capacity to respond to damage (3), cash flow (1)	RE1~4
	Physics	response ability (1), hospital visitation (1), physical fitness (1)	RP1~3
	Emotion	depression (1), anger (1), stress (1), fear (1), scare (1)	RS1~5

3.3 Analysis

Exploratory factor analysis, reliability analysis, and confirmatory factor analysis were performed to verify the reliability of the scale, and multi-group structural equation model analysis was performed to verify the research model. The analysis programs used were SPSS 26.0 and AMOS21.0.

4. Result

4.1 Sample

Table 2 shows the demographic characteristics of the sample. Male and female accounted for 51.2% and 48.8%, respectively, of total sample. As for age, those in their 20s, 30s, 40s, 50s, and 60s accounted for 19.4%, 18.8%, 25.0%, 25.0%, and 11.8%, respectively. In terms of educational background, four year college graduation accounted for the most (51.2%), and followed by high school or less (22.8%), junior college (19.8%), and graduate school or higher (6.2%). As for the occupation, full-time workers (46.2%) accounted for the most, and was followed by housewives (14.2%). As for the residential area, the metropolitan area (52.2%) accounted for the most, and was followed by Gyeongsang area (24.0%), Jeolla area (10.6%), Chungcheong area (10.4%), and Gangwon area (2.8%). The most common monthly average household income was KRW 2-4M (33.2%) and KRW 4-6M (29.2%). Most respondents reported themselves as low-income (49.4%) or middle-class (45.0%).

Table 2. Demographic characteristics of samples.

Items		N	%	Items		N	%
Sex	Male	256	51.2	Residential Area	Metropolitan	261	52.2
	Female	244	48.8		Jeolla	53	10.6
Age	20s	97	19.4		Gyeongsang	120	24.0
	30s	94	18.8		Chngcheong	52	10.4
	40s	125	25.0		Gang-won	14	2.8
	50s	125	25.0	City Size	Large	272	54.4
	60s	59	11.8		Small & Medium	195	39.0
Education	High school	114	22.8		Rural	33	6.6
	Junior college	99	19.8		Less than KRW 2M	49	9.8
	4-year college	256	51.2		KRW 2-4M	166	33.2

	Graduate school	31	6.2	Monthly	KRW 4-6M	146	29.2
Occupation	Full-time	231	46.2	House Income	KRW 6-8M	77	15.4
	Part-time	43	8.6		More than KRW 8M	62	12.4
	Management	22	4.4		High class	4	.8
	Self-employee	37	7.4	Subjective Status	Middle class	225	45.0
	Student	29	5.8		Low class	247	49.4
	Housewife	71	14.2		Poverty	24	4.8
	Unemployed & Others	67	13.4		TOTAL	500	100

4.2 Measurement Model

The suitability of the measures was evaluated by content, convergence, and discriminant validity.

As for the content validity, it was evaluated that the model of the study was constructed based on previous studies. Convergent validity was assessed with reference to CFA indicators: chi-square distribution (χ^2/df) = 1.872, root mean square residual (RMR) = 0.033, root mean square error of approximation (RMSEA) = 0.064, goodness of fit index (GFI) = 0.927, adjusted GFI (AGFI) = 0.902, normed fit index (NFI) = 0.921, Tucker Lewis index (TLI) = 0.970, and comparative fit index (CFI) = 0.956. The standardized estimate, CR, AVE and Cronbach's α were also calculated. The standardized estimate was 0.6 or higher, and both CR and AVE of each component were 0.9 or higher. Also, Cronbach's α was found to be 0.7 or higher (Table 3). The suitability of this index is supported by Fornell and Larcker (1981). Accordingly, the measurement tool of this study was judged to have sufficient convergent validity. Finally, the inter-construct correlation coefficients and the square roots of the AVEs were compared to evaluate the adequacy of discriminant validity and the results showed that the square roots of the AVEs are higher than the inter-construct correlation coefficients, supporting discriminant validity (Nunnally, 1978). The square roots of the AVE are indicated by italic and underlined letters.

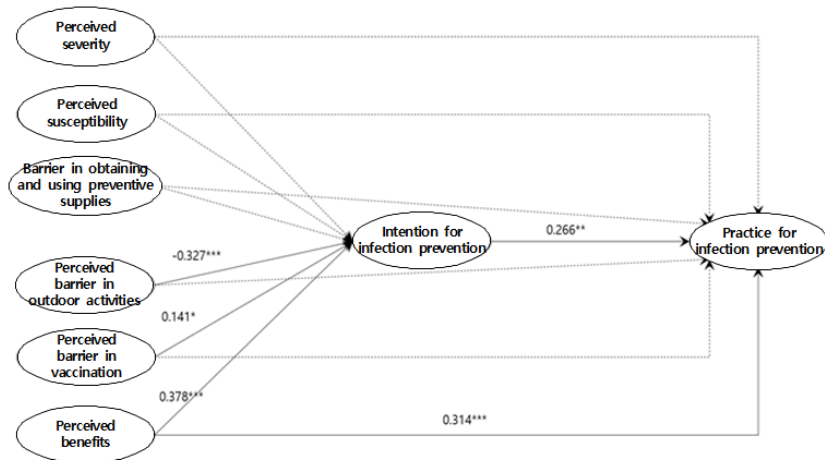
Table 3. Validity & Correlation Statistics

Variable	Cronbach's α	CR	AVE	<u>\sqrt{AVE}</u>	Correlation								
					PSe	PSu	PBOB	PBOU	PBV	PB	IIP	PIP	SE
PSe	0.759	0.776	0.543	0.737									
PSu	0.779	0.858	0.753	0.868	0.679								
PBOB	0.891	0.892	0.626	0.791	-0.035	-0.145							
PBOU	0.704	0.675	0.418	0.647	-0.184	-0.108	0.481						
PBV	0.773	0.783	0.644	0.803	-0.129	-0.063	0.591	0.528					
PB	0.747	0.867	0.766	0.875	0.546	0.600	-0.271	-0.220	-0.168				
IIP	0.772	0.852	0.659	0.812	0.455	0.485	-0.331	-0.426	-0.190	0.608			

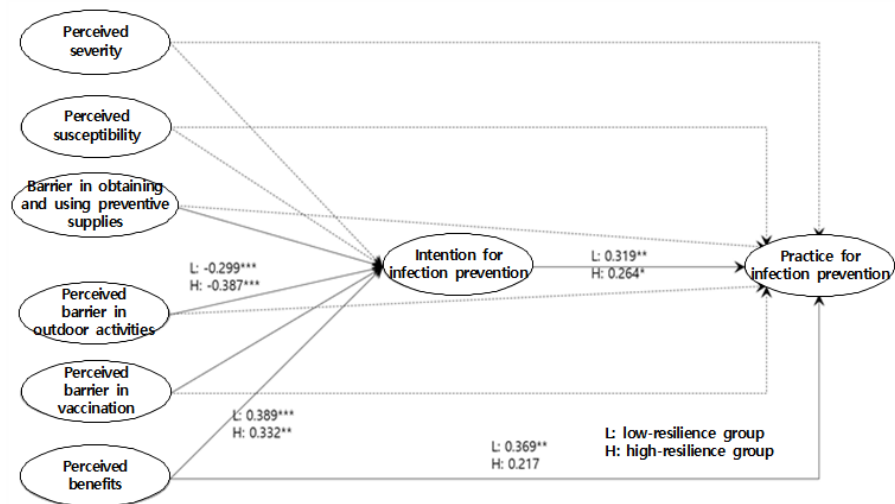
PIP	0.775	0.901	0.752	0.867	0.341	0.368	-0.258	-0.212	-0.136	0.523	0.528		
SE	0.700	0.724	0.469	0.685	-0.048	-0.075	0.504	0.364	0.439	-0.269	-0.324	-0.119	
R	0.781	0.829	0.595	0.771	0.131	0.159	-0.108	-0.091	-0.067	0.228	0.209	0.191	-0.154

Note) PSe: Perceived Severity, PSu: Perceived Susceptibility, PBOB: Perceived Barrier in Obtaining and Using Preventive Supplies, PBOU: Perceived Barrier in Outdoor Activities, PBV: Perceived Barrier in Vaccination, PB: Perceived Benefits, IIP: Intention for Infection Prevention, PIP: Practice for Infection Prevention, SE: Social Exclusion, R: Resiliency

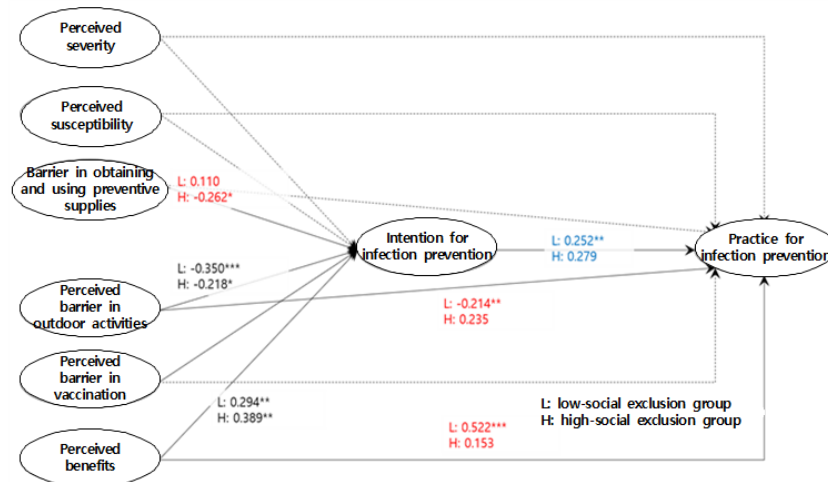
4.3 Structural Model 1



4.4 Grouping according to Disaster Resilience & Structural Model3



4.5 Grouping according to Social Exclusion & Structural Model3



5. Discussion

Since the perception and assessment of risky situations that may be experienced due to disaster, i.e., public awareness of disaster vulnerability, is based on the insecure state resulting from a disaster and disaster resilience is based on the resources available to respond to the disaster, these two variables should be considered simultaneously (Zakour and Gillespie, 2013), and, for the opposite reason, the social exclusion should be included as an important variable in the study on disaster response behavior.

Accordingly, the purpose of this study was, to analyze the effect of disaster resilience and social exclusion experienced in the process of responding to disasters on the intention and practice for infection prevention. The result of this study is expected to be used as evidence for planning social countermeasures and support measures to overcome infectious disease disasters, which has been increasingly serious and considered a major future risk factor.

The results showed that perceived barrier in outdoor activities, perceived barrier in vaccination, and perceived benefits had effect on intention for infection prevention preventive action, which in turn, affects preventive action. In particular, perceived benefits were found to have a positive effect on preventive behavior through intention for infection prevention.

In addition, there were difference in preventive behavior between the low- and high-resilience groups and between low- and high-social exclusion groups. In low-resilience group, the strength of perceived outdoor activities was higher and the perceived benefits was effected.

The low-social exclusion group was analyzed to be more active in intention for infection prevention and preventive behavior. This result suggests that motivating people's actions using disaster management policies requires consideration of the level of citizens' resilience and social exclusion.

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Reference

1. Seol A Kwon, Sang Il Ryu. 2018. Current Status of Ordinances on Disasters and Safety Management and Policy Tasks for Enhancement of Disaster Resilience Capacity of Basic Local Governments: Focusing on Urban-Rural Complex Typed Cities, *KOREAN LOCAL GOVERNMENT REVIEW*, 20(1), 25-45.
2. MIKYUNG KIM, Kim, EunJeong. 2018. Analysis of Space Planning Guidances of Temporary Shelters in terms of Universal Design for Disaster Victims in U.S. *JOURNAL OF THE KOREAN HOUSING ASSOCIATION*, 29(1), 47-57.
3. KIMYIRE, Wonik Lee. 2020. The Effects of Social Support on the Quality of Life among Disaster Victims in One-person Households. *Crisisonomy*, 16(4), 1-15.
4. Gi Geun Yang. 2016. A Strategy for Overcoming Disaster Vulnerability and Improving Resilience: Focusing on the Conceptual Integration of Disaster Vulnerability and Resilience. *Crisisonomy*, 12(9): 143-155.
5. Alber, J. and Fahey. 2004. Perception of living conditions in and enlarged Europe-Quality of Life in Europe. European Foundation of Improvement of Living and working conditions. https://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef03113en_0.pdf
6. Bruneau, M., S. E. Chang, R. T. Eguchi, G. C. Lee, T. D. O'Rourke, A. M. Reinhorn, and D. Von Winterfeldt. 2003. A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities. *Earthquake Spectra*. 19(4), 733-752.
7. Cutter, S. L., L. Barnes, M. Berry, C. Burton, E. Evans, E. Tate, and J. Webb. 2008. A Place-based Model for Understanding Community Resilience to Natural Disasters. *Global Environmental Change*. 18(4), 598-606.
8. Mutter, John C. .2015. The Disaster Profiteers: How Natural Disasters Make the Rich Richer and the Poor Even Poorer
9. Phillipson, Chris, Graham Allan and David Morgan (2004). Social networks and social exclusion: an overview of the debate, Chris Phillipson. Graham Allan and David Morgan(eds). *Social Networks and Social Exclusion: Sociological and policy perspectives*. Ashgate. Aldershot.
10. Pierson, John,. 2001. *Tackling Social Exclusion*. Routledge.
11. Zakour, Michael J., and Gillespie, David F. (2013) *Community Disaster Vulnerability: Theory, Research, and Practice*. Springer.
12. Becker, M.H.; Maiman, L.A. Strategies for Enhancing Patient Compliance. *J. Community Health* 1980, 6, 113–135.
13. Song, E.; Lee, J.-E.; Kwon, S. Effect of Public Empathy with Infection-Control Guidelines on Infection-Prevention Attitudes and Behaviors: Based on The Case of COVID-19. *Int. J. Environ. Res. Public Health* 2021, 18, 13408. <https://doi.org/10.3390/ijerph182413408>
14. Hayden, J.A. 2009. *Introduction to health behavior theory*. New York: Jones & Bartlett Publishers.
15. Byoungkwan Lee, Hyun Jung Oh, Kyung Ah Shin and Jae Young Koo. 2008. The Effect of Media Campaign as a Cue to Action on Influenza Prevention Behavior : Extending Health Belief Model. *The Korean Journal of Advertising and Public Relations*, 10(4), 108-138.
16. Jung Lim Lee and Kyun Do Kim. 2011. Variation of Vulnerability and Post-traumatic Stress Disorder of Residents Due to Oil Spill Accident of Hebei Spirit: Analysis of panel data after the accident in Sep, 2008 and Oct, 2010. *ECO*, 15(2), 269-298.
17. Lee, Song Eun, Nabin Lee, Seonyoung Yoo, Dowon Park, Kyoungsun Jeon, Tae Yeon Hwang, and Jung Hyun Lee. 2021. A Survey on the Public Perceptions of Disaster-related Mental Health Service. *Journal of Korean Neuropsychiatric Association*. 60(1): 53-60.
18. Slovic, P. and E. U. Weber. 2002. "Perception of Risk Posed by Extreme Events." in J. Applegate et al. (eds.). *Forthcoming. Regulation of 위험사회의 사회심리학 73 Toxic Substances and Hazardous Waste (Second Edition)*. Foundation Press.
19. Su-A Kim and Dong Kyun Im. 2016. Social Psychology of Risk Society: Social Psychological Determinants of Risk Perceptions. *Social Research*, 17(2), 45-75.
20. Deery, Hamish A. 2000. "Hazard and Risk Perception among Young Novice Drivers." *Journal of Safety Research* 30(4): 225-236.
21. Walsh, F. (1998), *Strengthening Family Resilience*.
22. Sohee Kim and Mee-Hyun Park. 2012. Study on Social Work Practice Strategies for Strengthening Resilience of Families in Disasters. *Journal of Social Science*, 38(3), 101-122.
23. Lee, J. E. (2018). Enhancing Disaster Resilience through Innovative Approaches for Restructuring Safe Community Governance in Korea. *Crisisonomy*, 14(3), 75-90.
24. Beck, U. (1992) *Risk Society — Towards a New Modernity*. London: Sage.
25. Kyunghak Kim and Md Golam Rabbani. 2020. Discrimination and Exclusion, and Socio-economic Impacts of COVID-19 Experienced by Bangladeshi Migrant Workers in Korea. *Journal of Diaspora Studies*, 14(2), 7-46.



Article

Preventive Behaviors, Knowledge, Attitude, Health Belief, Knowledge Management, Social Support and Media Exposure with the Covid-19 Pandemic among to Emergency Medical Responders in Thailand

: The concept paper

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Abstract: Descriptive of this study analysis are the concept paper of Preventive Behaviors, knowledge, attitude, Health Belief, Knowledge Management, Social Support and Media Exposure of medical emergency responders in Thailand during the COVID-19 pandemic situation. Which the information is derived from the review of the literature, concepts model and theories. All of the concepts had described including definitions, components, tools assessments and a review literature that related to the COVID-19 pandemic situation. The researcher selected all concepts base on disaster risk management cycle including preparedness, disaster (action), response, rehabilitation and recovery, prevention, and mitigation. The expected results achieved the new knowledge and deeply understand about concept or factors that related preventive behavioral of medical emergency responders in Thailand during the COVID-19 epidemic situation. Furthermore, the new knowledge will be based on the research study in the factors that related to preventive behavioral and developing programs or guidelines to promote emergency medical responders. In addition, the multidisciplinary volunteers' groups will be involved in the next disaster situation within every term of disaster risk management cycle.

Keywords: Preventive Behaviors; COVID-19 pandemic ; Emergency Medical Responders

1. Introduction

The situation of COVID-19 outbreak is classified as a natural disaster. The nature of a biological disaster (1) and it is a public health emergency of international concern (Public Health Emergency of International Concern: PHEIC) by WHO (World Health Organization) declares the coronavirus outbreak as a "Pandemic" (2) Impact of the covid-19 outbreak in Thailand and in global, It is broad in both health and wellness, as well as economy and society.

Emergency medical responders are personnel that provide basic emergency medical services and required a 40 hours of training in basic emergency medicine practice (3) Currently, there are 49,414 personnel. (4) Their responsibility is helping emergency patients and coordinator with the community to build a strong relationship. (5) During the COVID-19 pandemic. Medical emergency responders can be considered as the first gate of medical team as there has an important mission, including transporting infected patients with the novel coronavirus 2019 to a hospital or a field hospital. (6) While transferring process must be within a closed area inside the ambulance, there is a risk of getting infected by contact with patient droplets. Furthermore, the effect from patient illness are unable to perform their daily routine tasks and affect the family's finances. (7) With the correct and appropriate disease prevention and control behaviors, this will be a screening effective surveillance and prevention of infecting COVID-19 (8).

To reduce the spread of Covid-19 morbidity and mortality in order to perform an appropriate preventive behavior. Therefore, according to the studies and document analysis on Preventive Behaviors, knowledge, attitude, Health Belief, Knowledge Management, Social Support, and media exposures of emergency medical responders. Define that the objective is to create knowledge and a deep understanding of seven concepts by applied the disaster risk management cycle including preparedness, disaster (action), response, rehabilitation and recovery, prevention, and mitigation. Along with promote emergency medical responders, multidisciplinary volunteers' groups involved in the next disaster situation.

2. Materials and Methods

This study is a literature review and conceptual study. Likewise, the theories from master's Thesis Work Doctoral Degrees published on the Chula database (<https://www.car.chula.ac.th/>), TU Digital Collections (https://digital.library.tu.ac.th/tu_dc/frontend/), and Thai Digital Collection (<https://tdc.thailis.or.th/tdc/basic.php>). Moreover, the research articles published in Google Scholar, Scopus and PubMed databases and information from additional books. Other academic documents related to the selected concepts related to the COVID-19 prevention behaviors on emergency medical responders. With the process of collecting, analyzing, and summarize into various concepts for further utilization.

3. Results of Literature Review

From the review of research articles related to COVID-19 prevention behaviors, researcher selected seven concepts base on disaster risk management cycle including preparedness, disaster (action), response, rehabilitation and recovery, prevention and mitigation. Details are as follows.

3.1 Preventive Behaviors of COVID-19

According to the actions, activities and expressions of a medical emergency responders who works effectively to reduce the risks associated with the COVID-19 cases. In order for the patients to have good health in term of physically, mentally, emotionally, and socially. In emergency medical services, there are two types of behaviors in the pandemic situation of COVID-19: Overt Behavior and Covert Behavior. Assess tools with COVID-19-related behaviors, such as COVID-19 Behavior Questionnaire [9] with 10 topics. The result shown that the factors related to COVID-19 prevention behaviors were Knowledge, Attitude and Perceived Susceptibility, Perceived Severity, Perceived Benefits, Perceived Barriers, Social support, Media Exposure as shown in Table 1.

3.2 Knowledge about COVID-19

Refers to the knowledge obtained from learning, research, and experience on medical emergency responders. To understand the cause, incubation period, sign and symptoms

of the disease and preventing behavior in COVID-19 situation. Knowledge can be divided into 2 types: Tacit Knowledge and Explicit Knowledge [10, 11] There are a variety of tools used to assess knowledge about COVID-19, such as Knowledge Assessment Questionnaire [12]. There are 21 questions about the cause of COVID-19 including Basic Science, Transmission, Incubation Period, Symptoms, Treatment, and Prevention. The result found that Knowledge was correlated with COVID-19 prevention behaviors [13-24], as shown in Table 1.

3.3 Attitude about COVID-19

There are three types of attitudes, beliefs, feelings, thoughts, and opinions of emergency medical responders regarding to COVID-19 prevention. Which can be define as positive attitude, negative attitude, and passive attitude. In which these three types of attitudes, a person may have only one or several things and It depends on the stability of feelings, beliefs, or other values towards a person, thing, action or situation. [25] There are a variety of tools used to assess attitudes about COVID-19 such as the attitude questionnaire [17] with a total of 13 questions. Many literature found that attitudes were correlated with COVID-19 prevention behaviors [14] [17, 19] [21-24], as shown in Table 1.

3.4 Health Belief Model

Refers to a person's feelings, thoughts, perception of his or her health condition, which influences illness and care by inducing the person to have a healthy behavior, according to their thoughts and understanding. There are six elements of health belief stereotypes : Perceived Susceptibility, Perceived Severity, Perceived Benefits, Perceived Barriers, Modifying Factors and Cues to Action in Becker [26], [27] The tools of Health Beliefs Questionnaire applied to assess the health beliefs about COVID-19[28]. Perceived risk opportunities for COVID-19. Perceived severity of COVID-19. Perceived threats of COVID-19 Motivators/inducers to practice COVID-19 prevention behavior perceived benefits of preventive action COVID-19. Perceived obstacles to preventive measures against COVID-19. In total, the questionnaire contain 21 questions. [16][28-30] as shown in Table 1.

3.5 Social Support

Refers to what a medical emergency responder receives from social support, such as family members, close friends, doctors, nurses, and colleagues. The support is about favors for advise and help in the field of information, news psychological materials and equipment to affect COVID-19 prevention behaviors and social support. Likewise, it divided into 3 areas: Emotional support, Tangible support and Information support [9]. The tools used to assess social support related to COVID-19 were Social Support Behavior Questionnaire [34] consists of materials and equipment information and in terms of encouragement, a total of 14 items. The study found that social support was associated with COVID-19 prevention behaviors [9, 20, 35], and not correlated with COVID-19 prevention behaviors [28] as shown in Table 1.

3.6 Media Exposure about COVID-19

Exposure to information can be define as a medical emergency responder is exposed to information through various media to meet their own needs and motivations to support existing attitudes, beliefs, ideas, and understandings. The benefit is to build the confidence and applied in decision-making process, to solve problems and help patients in the COVID-19 situation. There are five components of communication: sender, message, channel or medium, receiver, and feedback [36]. The tool used to assess exposure information about COVID-19 and assessment questionnaire. Regarding the novel coronavirus disease 2019[37], there are 15 questions. The study found that Information exposure was

associated with COVID-19 prevention behaviors [16, 17, 20, 22, 23, 28, 38], as shown in Table 1.

4. Conclusions

From the literature review and analysis of concepts including COVID-19 Prevention Behaviors, Knowledge Theory, Attitudes, Health Belief Model, Social Support, and Media Exposure. The researcher selected all concepts base on disaster risk management cycle including preparedness, disaster (action), response, rehabilitation and recovery, prevention, and mitigation. The knowledge and a clear understanding of the concept or factors that related to preventive behavioral of medical emergency responders in Thailand during the COVID-19 pandemic situation. Lastly, the researchers developed a programs or guidelines to promote an emergency medical responder, and multidisciplinary volunteers groups involved in the next disaster situation in every term of disaster risk management cycle.

Table 1. Summarizes the results of literature reviews correlating with COVID-19 prevention behaviors.

Author, year	Factors related to COVID-19 prevention behavior							
	Knowledge	Attitude	Health Belief Model				Social support	Media Exposure
			Perceived Susceptibility	Perceived Severity	Perceived Benefits	Perceived Barriers		
Dathong, 2019 (28)	NA	NA	x	x	x	x	x	✓
Papagiannis et al., 2020 (21)	✓	✓	NA	NA	NA	NA	NA	NA
Yang et al., 2020 (22)	✓	✓	NA	NA	NA	NA	NA	✓
Buasanit, 2020 (38)	NA	NA	✓	NA	NA	NA	NA	✓
Glomjai et al., 2020 (13)	✓	NA	NA	NA	NA	NA	NA	NA
Yeunyow et al., 2021 (14)	✓	✓	NA	NA	NA	NA	NA	NA
Wongti, 2021 (9)	NA	NA	✓	x	✓	x	✓	NA
Moonti, 2021 (15)	✓	NA	x	x	✓	x	NA	NA
Thanormchayathawat et al., 2021 (39)	NA	NA	✓	x	✓	x	NA	NA
Inthacharoen et al., 2021 (16)	✓	NA	✓	✓	✓	✓	NA	✓
Phansuma et al., 2021 (17)	✓	✓	NA	NA	NA	NA	NA	✓

Author, year	Factors related to COVID-19 prevention behavior							
	Knowledge	Attitude	Health Belief Model				Social support	Media Exposure
			Perceived Susceptibility	Perceived Severity	Perceived Benefits	Perceived Barriers		
Morasakul and Puntasee, 2021 (18)	✓	NA	NA	NA	NA	NA	NA	NA
Ongarj, Ungcharoen, 2021 (19)	✓	✓	NA	NA	NA	NA	NA	NA
Sribunrueng et al., 2021 (20)	✓	NA	NA	NA	NA	NA	✓	✓
Simpong et al., 2022 (35)	NA	NA	✓	✓	x	x	✓	NA
Kor-issara-nuphob et al., 2022 (30)	NA	NA	x	x	x	x	NA	NA
Reuben et al., 2021 (23)	✓	✓	NA	NA	NA	NA	NA	✓
Dastgerdi et al., 2021 (29)	NA	NA	x	✓	✓	x	NA	NA
Alrazeeni, 2021 (24)	✓	✓	NA	NA	NA	NA	NA	NA
Kurnia et al., 2021 (40)	NA	NA	x	✓	x	x	NA	NA

: Note ✓ Factors associated with statistically significant COVID-19 prevention behaviors
 X Factors that do not correlate with COVID-19 prevention behaviors
 NA Such factors were not studied.

References

1. Panida Sangwarn. Disaster management during the COVID-19 pandemic by the Moscow Municipality in Russia. Pathumthani: Thammasat University; 2020.
2. World Health Organization. Coronavirus disease (COVID-19) pandemic: World Health Organization; 2020 [Available from: <https://www.euro.who.int/en/health-topics/health-emergencies/coronavirus-covid-19/novel-coronavirus-2019-ncov>].
3. Kritsana Sungkamuneejinda, Rungrana Chantira, Pongthorn Jantatame, Yindee Chuchan, Phakphanat Weerakhachon, Supawongsanond W. Study about of On-scene Patient Care of The Emergency Medical Responder in the Southern Region of Thailand. Princess of Naradhiwas University Journal. 2562;11(2):107-16.
4. Data Warehouse. Medical Assistant Registered in Emergency Medical Information System (ITEMS) Statistics December 31, 2021. 2021.
5. Rapeeporn Rojsaengroeng, Natchapon Sinsuwan, Kunwara Suk-iad, Kanawut Khunraksa, Praenapa Ketsiri, Jaibergban F, et al. Disaster Preparedness of Emergency Medical Responders. Thai Journal of Emergency Medicine. 2022;2(1):37-56.
6. National Institute of Emergency Medicine. Announcement of the National Institute of Emergency Medicine on Criteria, Methods and Guidelines for Special Operations Emergency Kits issued in the case of emergency patients infected with coronavirus disease 2019 (No. 4). Nonthaburi 2021.
7. Akeau Unahalekhaka. Development of A Video Media on Prevention of Emerging Respiratory Infection for First Responders. Bangkok: Thailand Science Research and Innovation (TSRI); National Institute for Emergency Medicine; 2022.

8. Chawalit Luanloy. Factors Influencing Preventive Behavior of Coronavirus Disease 2019 among People in Si Nakhon District, Sukhothai Province. *Thai Journal of Public Health and Health Education*. 2022;2(1):18-33.
9. SUPAPORN WONGTI. FACTORS ASSOCIATED WITH PREVENTIVE BEHAVIORS REGARDING CORONAVIRUS DISEASE 2019 (COVID-19) AMONG THE ELDERLY. Phitsanulok: Naresuan University; 2021.
10. Minrata Supanitchaisiri. The innovation system for extracting tacit knowledge in organization. Bangkok: Chulalongkorn University; 2560.
11. Suthiluk Lapsomboonkamol. Knowledge sharing system for co-working spaces. Bangkok: Chulalongkorn University; 2020.
12. Arslanca T, Fidan C, Daggez M, Dursun P. Knowledge, preventive behaviors and risk perception of the COVID-19 pandemic: A cross-sectional study in Turkish health care workers. *PLOS ONE*. 2021;16(4):e0250017.
13. Thane Glomjai, Junya Kaewjiboon, Taksika Chachvarat. Knowledge and Behavior of People regarding Self-care Prevention from Novel Coronavirus 2019 (COVID-19). *Journal of Nursing, Public Health, and Education*. 2020;21(2):29-39.
14. Thawatchai Yeunyow WP, Kunlayarat Kadsanit. Knowledge, Attitude and Prevention behavior of Coronavirus disease 2019 (COVID-19) infection among Nursing Students in Boromarajonani College of Nursing, The North Eastern Region Network Udonthani Hospital Medical Journal. 2021;29(2):204-13.
15. Jitra Moonti. Factors Influencing Preventive Behavior of Coronavirus Disease 2019 Among Village Health Volunteers in Kong Krailat District, Sukhothai Province. The Office of Disease Prevention and Control 9th Nakhon Ratchasima. 2021;27(2):5-14.
16. Apiwadee Inthacharoen, Kantamaht Kanchanapoom KT, Suwanna Pattapat. Factors Influencing Preventive Behavior towards Coronavirus Disease 2019 among People in Khohong Town Municipality Songkhla Provincet. *Journal of Council of Community Public Health*. 2021;14:25.
17. Daranchanok Phansuma PB. Knowledge, Attitudes, and Preventive Behaviors of COVID-19 among Residents in Pru Yai Sub-district, Muang District, Nakhon Ratchasima Province. *Srinagarind Medical Journal*. 2021;36(5):597-604.
18. Bongkoch Morasakul, Pornsiri Punthasee. Knowledge and Prevention Behaviors Regarding COVID-19 among the First-Year Nursing Students of Saint Theresa International College and Saint Louis College. *Regional Health Promotion Center 9 Journal*. 2021;15(37):179-95.
19. Passakorn Ongarj, Ratchadaporn Ungcharoen. Self-protection behavior of COVID-19: A Case Study of Students at Kasetsart University, Chalermphrakiat Campus, Sakon Nakhon Province. *Public Health Policy & Law Journal*. 2021;7(1):85-100.
20. Wirunya Sribunrueng, Thanarat Ninwattana, Sirisopa Sumransuk, Kanokporn anirapai, Sanasun Rugthangam, Pawina Spiller. FACTORS AFFECTING PREVENTION BEHAVIOR OF COVID-19 INFECTION IN BANGKOK. UDON THANI RAJABHAT UNIVERSITY JOURNAL OF HUMANITIES AND SOCIAL SCIENCE. 2021;10(1):195-206.
21. Papagiannis D, Malli F, Raptis DG, Papathanasiou IV, Fradelos EC, Daniil Z, et al. Assessment of knowledge, attitudes, and practices towards new coronavirus (SARS-CoV-2) of health care professionals in Greece before the Outbreak Period. *International Journal of Environmental Research and Public Health*. 2020;17(14):4925.
22. Yang K, Liu H, Ma L, Wang S, Tian Y, Zhang F, et al. Knowledge, attitude and practice of residents in the prevention and control of COVID-19: An online questionnaire survey. *Journal of Advanced Nursing*. 2020;77(4):1839-55.
23. Reuben RC, Danladi MMA, Saleh DA, Ejembi PE. Knowledge, attitudes and practices towards covid-19: An epidemiological survey in north-central nigeria. *Journal of Community Health*. 2021;46(3):457-70.
24. Alrazeeni D. Knowledge, attitude, and practice toward COVID-19 among paramedics in Saudi Arabia: Implications for educational program. *International Journal of Advanced and Applied Sciences*. 2021;8:71-7.
25. Chant Paktanyasit. The knowledge attitude and health behavior of the runners for health. Bangkok: Chulalongkorn University; 2020.
26. Becker MH. The health belief model and sick role behavior. *Health Education Monographs*. 1974;2(4):409-19.
27. Kongkrissadakorn Chondaeng. The factors influencing HIV preventive behaviors among male youth in a correctional institution. Pathumthani: Thammasat University; 2016.
28. Jurairat Dathong. Factors associated with preventive behaviors regarding coronavirus disease 2019 (COVID-19) among the elderly. Bangkok: Chulalongkorn University; 2019.
29. Fathian-Dastgerdi Z, Khoshgoftar M, Tavakoli B, Jaleh M. Factors associated with preventive behaviors of COVID-19 among adolescents: Applying the health belief model. *Research in Social and Administrative Pharmacy*. 2021;17(10):1786-90.
30. Nittaya Kor-issaranuphob, Wanwisa Samrannet, Panatda Arsa. Factors Related to Self-protective for Coronavirus Disease 2019 Infection Among Type 2 Diabetic Patients. *Journal of Sakon Nakhon Hospital*. 2022;25(1):43-55.
31. Kanathip Srivarom. The Concept of Knowledge Management. *Journal of the Professional Development Education Association of Thailand*. 2021;1(4):41-50.
32. Amornsri yodkham. Knowledge management. Bangkok: Department of Health Service Support; 2006.
33. Pairote Boonsirikhanchai. Lessons learned on volunteer management in the event of a disaster. Bangkok: CHANGE MAKER; 2009. 135 p.
34. Pornitiwa Kongkun, Rawi Kaewsuksai, Rangsarit Waedueramae, Boonying Tongkoop, Muhammadsaid Salaeh. Prevention of Coronavirus Disease (COVID-19) among Food Vendors in Narathiwat Province: Relationships Between Perception, Social Support and "New Normal Behaviors". *The Southern College Network Journal of Nursing and Public Health*. 2022;8(3):133-46.
35. Sasina Simpong, Sirikarn Auppasit, Siriporn Nakornlam, Sirinart Tonsawan, Sujitra Sukson, Suttida Phosai, et al. Factors related to prevention behavior for coronavirus (covid-19) of nursing students in Ratchathani University. *Journal for Public Health Research, Ubon Ratchathani Rajabhat University*. 2022;10(2):148-58.

36. Waraporn Srinarat. GEN1127 Thai for Communication in the 21st Century Thai for Comunication in the 21 Century. Chiang Rai: Chiang Rai Rajabhat University; 2560.
37. Saralee Sonchan, Wirat Sonchan. MEDIA EXPOSURE, ATTITUDE, AND RISK PREVENTION BEHAVIORS OF ELDERLY PEOPLE TOWARDS THE SITUATION OF THE SPREAD OF THE CORONAVIRUS DISEASE (COVID-19). NRRU Community Research Journal. 2022;16(1):64-77.
38. Vipha Buasanit. Risk perception, communication and protective behaviors during the COVID-19 Bangkok: Thammasat University; 2021.
39. Benjawan Thanormchayathawat, Ratthayanaphis Ratchatawan, Boonprajuk Junwin. FACTORS INFLUENCING SELF - CARE PREVENTION BEHAVIORS AND SOCIETY OF CORONAVIRUS DISEASE 2019 AMONG VILLAGE HEALTH VOLUNTEER PERFORMANCE (VHV) IN NAKHON SI THAMMARAT PROVINCE. Journal of Social Science and Buddhistic Anthropology. 2021;6(12):361-75.
40. Kurnia AD, Masruroh NL, Melizza N, Al Busthomy Rofi'i AY. Factors associated with preventive behaviors of COVID-19 among Indonesian nursing students: Application of Health Belief Model. Russian Open Medical Journal. 2021;10(2):1-6.



Article

Application of Multi Hazard Risk Assessment for the Preparation of Risk Sensitive Land Use Plan (RSLUP) adopting DRRM: A Case Study of Lamkichuha Municipality, Sudur Paschim Province, Nepal

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Abstract: The multi-hazard risk assessment (MHRA) of Lamkichuha Municipality in Kailali District of Far Western Province, is a major component of the Risk Sensitive Land Use Planning (RSLUP), commissioned under DRRM Act 2017. The study is mainly focused to support on developing RSLUP incorporating both qualitative and quantitative techniques. The study was covered with the collection of primary and secondary datasets including field hazard mapping, household surveys, institutional surveys, field and laboratory soil tests and historical hazard events. For the scientific modeling, OpenLISEM (for flood hazard), existing literature data (for earthquake hazard), statistical and heuristic method (for landslide susceptibility maps), global satellite datasets (for wind hazard), Spatial Multi-Criteria Evaluation (for animal attack and fire susceptibility maps) in GIS, globally accepted climate indices (for climate extremes) were used. Besides, elements-at-risk data were collected for building footprints, population, agricultural areas, and roads. Exposure assessment was completed for all relevant combinations of hazard types, elements-at-risk types and administrative units.

Keywords: MHRA, RSLUP, GIS, Lamkichuha Municipality

1. Introduction

The unique geo-physical setting and the tropical location makes Nepal vulnerable to a wide range of natural and climate related hazards (earthquakes, floods, landslides, storms, droughts, avalanches and Glacial Lake Outburst Floods (GLOFs)). It is among the 20th most disaster-prone countries in the world and it ranks 4th, 11th and 30th in terms of climate change (CC), earthquake and flood risk respectively [1, 2]. It is the 7th most vulnerable nation in the world for deaths related to floods, landslides and avalanches combined; 8th for flood-related deaths alone; and 23rd in terms of total natural hazard related deaths [3]. More than 80% of the total population of Nepal is at risk of natural hazards such as floods, landslides, windstorms, hailstorms, fires, earthquakes and GLOFs (ibid). Terai area is prone to flooding and fire whereas hill and mountain regions are hazardous to landslides and glacial lake outburst floods. Valleys are highly susceptible to liquefaction and the middle hills and higher mountains are vulnerable to earthquake-induced landslides.

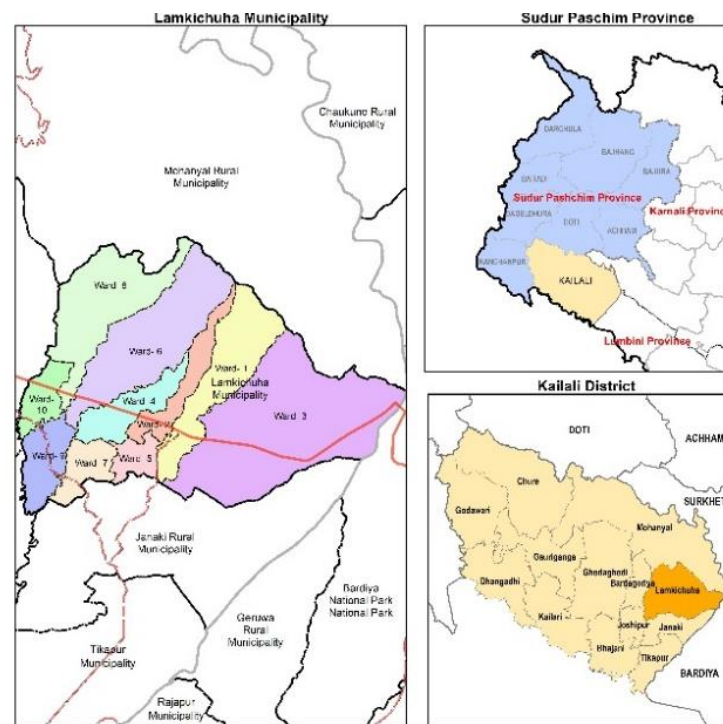


Fig. 1. Location of Lamkichuha Municipality of Sudur Paschim Province.

A pilot study has been carried out in Nepal for the development of risk sensitive land use plan (RSLUP) incorporating detailed multi hazard risk assessment and multi vulnerability assessment for the planned future urban planning and urban development in Lamkichuha Municipality in Kailali District of Sudur Paschim Province (Fig. 1). The geographical location extends from 28°35'8" to 28°43'50" in Northern latitude and 81°3'14" to 81°17'15" of eastern longitude with an area of 225 sq. km. The municipality lies 72 kilometers east of Dhangadhi and 590 km west of the capital, Kathmandu. Thus, the multi-hazard risk assessment has become a major component of the RSLUP, commissioned by the USAID/Nepal's TAYAR Nepal- Improved Disaster Risk Management Project. In this context, the main objective of this paper is intended to carry out an actionable multi hazard risk assessment at the municipal level and identify types of multi hazards of the project area and overlay development nodes incorporating disaster risk reduction measures for major hazards to reduce and manage risks using land use and urban planning techniques developing RSLUP.

1.2. Disaster Scenarios

In the past 48 years between 1971 and 2018, a total of 28,597 disaster events took place in Nepal [4], 595.77 events per year (1.63 events per day), causing on average more than 2 deaths, 5 injuries and 341 people affected and 76 houses damaged per day. The first three devastating disasters were epidemic (16,598 death), earthquake (9,771 death) and landslide (5,141 death) while considering only human death; flooding (3,726,261 family), earthquake (890,995 family) and landslides (559,347 family) from the perspective of affected family number; and earthquake (982,855 houses), flood (230,900 houses) and fire (90,044 houses) in terms of number of damaged houses. Drought is the singular most devastating disaster causing loss of farm land, followed by flood and hailstorm as second and third type of disaster.

Current climate variability and extreme events have led to major impacts and economic costs in Nepal, emanating not only from floods and landslides but also from rainfall variability on agriculture and GLOFs [5]. Nepal experiences an average annual loss of \$173 million (equivalent to 0.88% of GDP in 2014) as a consequence of natural hazards (i.e., \$143.5 million for floods and \$29.5 million for earthquakes) and the 100-year probable maximum loss is estimated at \$1.4 billion for earthquakes [6]. Based on 2010 economic analysis of two earthquake and three flood scenarios, when factoring in disaster risk and considering a 10-year planning horizon, budgetary resources may be about 30% lower compared to a case without consideration of disaster risk [7]. As if action is not taken, climate impacts are likely to be greatly exacerbated in the future.

Out of 26,665 disaster events reported in the past 46 years (1971-2016) in Nepal, Sudur Paschim Province shares 9% (2,312 events) [8]. Out of total death of 43,868 in the same period, this province alone had accounted 11% (4,789 death). Far Western Region of Nepal had three major disasters in terms of death: 72% of the total death related to epidemic, 9% linked to landslide and 5% associated with flood [9]. Earthquake, flood and landslide, major causes of destruction and damaging houses, represent 56%, 27% and 6% respectively (ibid). Though, 38% of total affected population belongs to famine, flood and landslide related affected persons account 34% and 8% respectively (ibid).

Considering the risks, the vulnerability and the hazards, there is an urgent need to develop the RSLUP that focuses on reducing the probable disaster risks and build resilient communities Under this initiative, the Rajdevi Engineering Consultants and international experts from Geoinformatics Center of the Asian Institute of Technology (GIC-AIT) and Faculty of Geo-Information Science and Earth Observation of the University of Twente (ITC-UT), the Netherlands, are implementing the municipal level multi-hazard risk assessment.

2. Methods for MHRA

Multi-hazard is referred to as more than one potential physical damaging event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Multi-hazards are caused by different triggering factors, and there are often complex relations between the individual hazards. Multi hazard Risk Assessment, MHRA, is relatively a new approach and increasing practice as a tool for DRM. It is an integrated approach to urban risk assessment, and an emergent area. MHRA has different explanation and, generally accepted definition of multi-hazard still does not exist, in practice [10]. The term is often used to indicate all relevant hazards assessment that are present in a specific area.

A systematic approach is fundamental to carry out MHRA combining quantitative and qualitative methods with expert-based knowledge, decision and local experience and knowledge at community level. The aim is to generate risk information for the sub divisions within the municipality, for a combination of hazard types (indicated as earthquakes (EQ), floods (FL), windstorms (WS), landslides (LS)) and four types of elements-at-risk (buildings, people, agriculture and roads). Other hazards include animal attacks, fire and climate extremes (Fig. 2).

Table 1 gives a summary of the hazard maps with frequency classes (which are different for the various hazard types) and intensity classes (also different for the various types of hazards). The frequency classes were differed because the return periods were much larger for some hazard types (e.g., earthquakes) than others (e.g., flooding). The intensities

were modelled based on hazard modelling and describe the potentially damaging effects of the hazard (e.g., water depth for flooding, acceleration for earthquakes, and wind speed for windstorms). Given the small scale of the study and the size of the study area, the intensities are classified into general classes, where some hazard intensities needed to be rescaled locally (e.g., windstorm effects). The intensities classes were linked later with the vulnerability adopting various literatures [11-13].

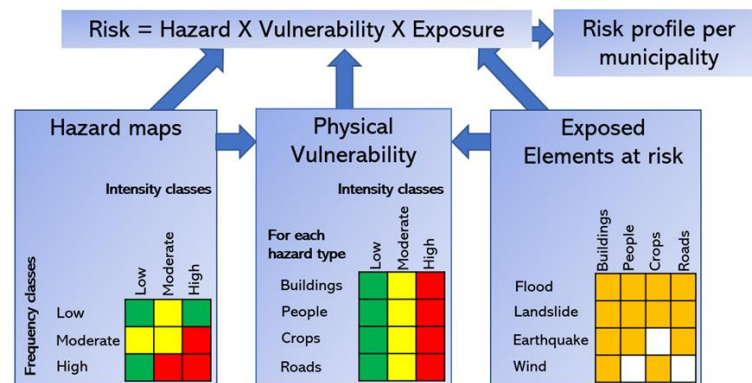


Fig. 2. Methodology for analyzing the multi-hazard risk analyses.

Table 1. Summary of the hazards (with its frequency and intensity classes) and susceptibility map.

Hazard Type	Frequency Classes	Intensity Classes	Intensity Type	Type of Map	Type of Modelling
Earthquake	475, 2475 years	4	Acceleration	Hazard	Probabilistic
Flood	20, 50, 100 years	3	Water height	Hazard	Probabilistic
Windstorm	10, 25, 50 years	4	Wind speed	Hazard	Probabilistic
Landslide	3 susceptible classes	Relative class	Susceptibility	Susceptibility	Statistical-Heuristic-Expert
Animal attack	4 susceptibility classes	Relative class	Susceptibility	Susceptibility	Heuristic-Expert
Fire	4 susceptibility classes	Relative class	Susceptibility	Susceptibility	Heuristic-Expert
Heatwave/ Coldwave	only statistical analysis; no spatial representation				Statistical

The multi hazard risk assessment (MHRA) was entirely based on two activities- analysis of the primary and secondary hazard data and the scientific modeling. The assessment was first carried out for individual hazards viz. flood, landslide, earthquake, wind-storm, heatwave and coldwave, animal attack and fire hazard. The study was covered with the collection of primary and secondary datasets including field hazard mapping, household surveys, institutional surveys, field and laboratory soil tests and historical hazard events. The individual hazards were further combined, modeled to produce the combined hazard map. Assessments were carried out for elements at risk and multi-sectoral vulnerability followed by risk and loss analyses.

The hazard intensities such as water depth (flooding), acceleration (earthquake), speed (wind) were modelled using separate modelling approaches. The frequencies of these hazards were estimated from historical records of precipitation, wind speed and earthquakes. The return periods for which intensity information was available differed

for the various hazard maps. For instance, earthquake hazard maps were generated for return periods (475 and 2475 years) that are much larger than for other hazards such as flooding. For some hazard types (e.g., landslides), susceptibility maps were made using a hybrid model (statistical modelling and heuristic) that show zones with a relative likelihood of occurrence of hazardous phenomena, without a clear indication of the frequency and intensity. For these hazard types, the spatial probability that a particular area would be impacted was estimated based on the ratio of the expected area of future events and the area of the susceptibility classes. All hazard maps were classified into three or four classes of frequency and intensity (or susceptibility and spatial probability). This classification was done considering the damaging effects of the hazard, where the high-class boundaries were chosen such that, they represent different danger levels with respect to buildings and people.

For the scientific modeling, OpenLISEM (for flood hazard), existing literature data (for earthquake hazard), statistical and heuristic method (for landslide susceptibility maps), global satellite datasets (for wind hazard), Spatial Multi-Criteria Evaluation (for animal attack and fire susceptibility maps) in GIS, globally accepted climate indices (for climate extremes) were used.

Hazard assessment was conducted in Lamkichuha Municipality for seven hazards (flood, landslide, earthquake, windstorm, animal attacks, heatwave/coldwave and fire) using hazard-specific models. All hazard maps were classified into a number of classes of frequency and intensity (or susceptibility and spatial probability). This classification was done considering the damaging effects of a hazard, where the high-class boundaries were chosen such that, they represent a clear danger level with respect to buildings and populations. For the heatwave and coldwave, statistical trend analysis of the temperature extremes was presented based on globally accepted climate indices. In this research, a combined hazard map was developed to assess the hazards of the municipality and overlain future plan of urban development.

3. Results of MHRA

A combined hazard map was generated in which the various hazard types are combined in order to show the areas which have the highest levels of hazard. For this Spatial Multi-Criteria approach was used in which a criteria tree was developed with all hazard maps. The weights were assigned to the hazard classes (**high hazard = 1, moderate hazard = 0.5, low hazard and no hazard = 0**). The maps of the different return periods, the individual hazards were also weighted with respect to their severity, with earthquakes and flood having the highest weights. Animal attacks and fire were given lowest weights because of their limited impacts in the municipality. The composite index map with High, Moderate and Low classes is shown in the **Fig. 3**. It is clear from this figure that the northern part of the municipality where there are Siwalik hills and along the river channels are highly hazardous zones. The hazard severities are especially reflected by landslides and wind along the hills and flood hazards along the river courses and settlements are affected through wind hazards. According to the MHRA the whole area of the municipality was divided in three zones **RED, YELLOW** and **GREEN** with its magnitude and direction of the risk. High risk zone area is defined as a Red Zone with an area of 12.92%, where the past events happened frequently and risk prone zone with occurrences of the multiple chances in the near future as well. Moderate type risk is denoted by yellow zone, it covers the 40.55% area of the municipality. Likewise, Low risk area are the rest of the area within the boundary and denoted by green color in the map. Which cover 12.92% of area. **Table 2** represents the areal distribution of hazards in the municipality.

4. Applications in RSLUP

The application of results of MHRA needs to be overlaid in the present land use incorporating existing population growth and future urban growth. The expected future

urban development trend has been traced for two different years: up to 2030 and between 2031 to 2050 respectively and proposed the nodal concept of urban development for the safe land utilization adopting free and control zones of hazards. For this context, a ‘nodal development’ concept is proposed as per the scale, dimension, settlement pattern, connectivity, and available social infrastructure within a defined boundary through land use zonation following the safer zone. The Primary, Secondary and Tertiary Development Nodes are recommended on the basis of existing urban sprawl and future possible growth trend. The whole municipal area is zoned into thirteen urban uses grouped into these proposed development nodes such as central business district zone, institutional and commercial zone, recreation and sport zone, culture and tourism promotion zone, residential development zone and so on. A primary node is proposed at Lamki as a CentralBusiness District (CBD). Two secondary nodes and ten tertiary nodes are proposed for a balanced and inclusive city design avoiding the future growth area along the high-risk zones shown by results of MHRA. For conservation of natural resources and agriculture land, two more zones namely natural conservation and protection zone and agriculture zone are also proposed. Fig. 4 shows the location of development nodes with multi-hazard risk zones overlaid on multi-hazard map.

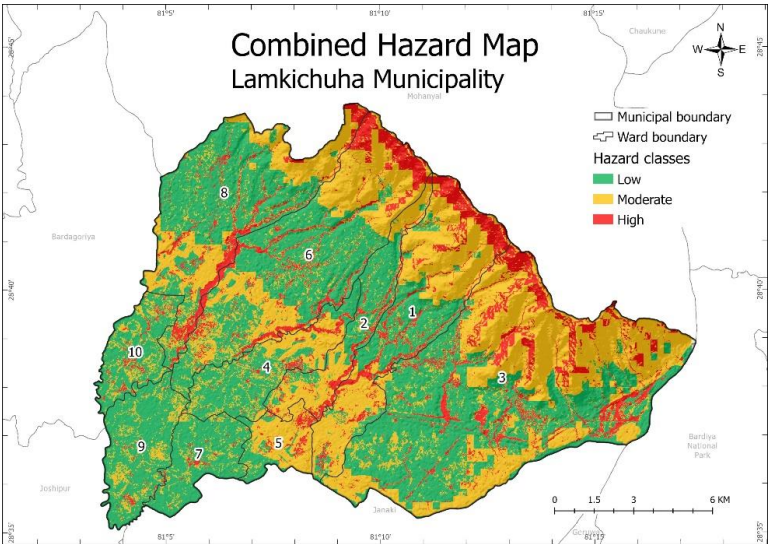
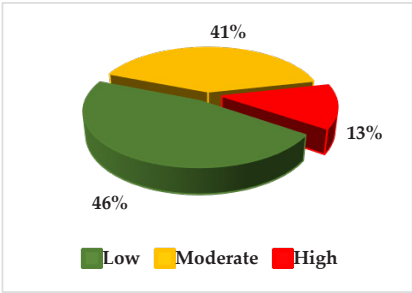


Fig. 3. Combined hazard map of Lamkichuha Municipality, Sudur Paschim Province.

Table 2. Areal distribution of hazards in the Lamkichuha Municipality.

Multihazard risk	Areas (ha)	%
Low	10441.77	46.52
Moderate	9102.20	40.55
High	2900.35	12.92
Grand Total	22444.32	



*All area is in hectares (ha)

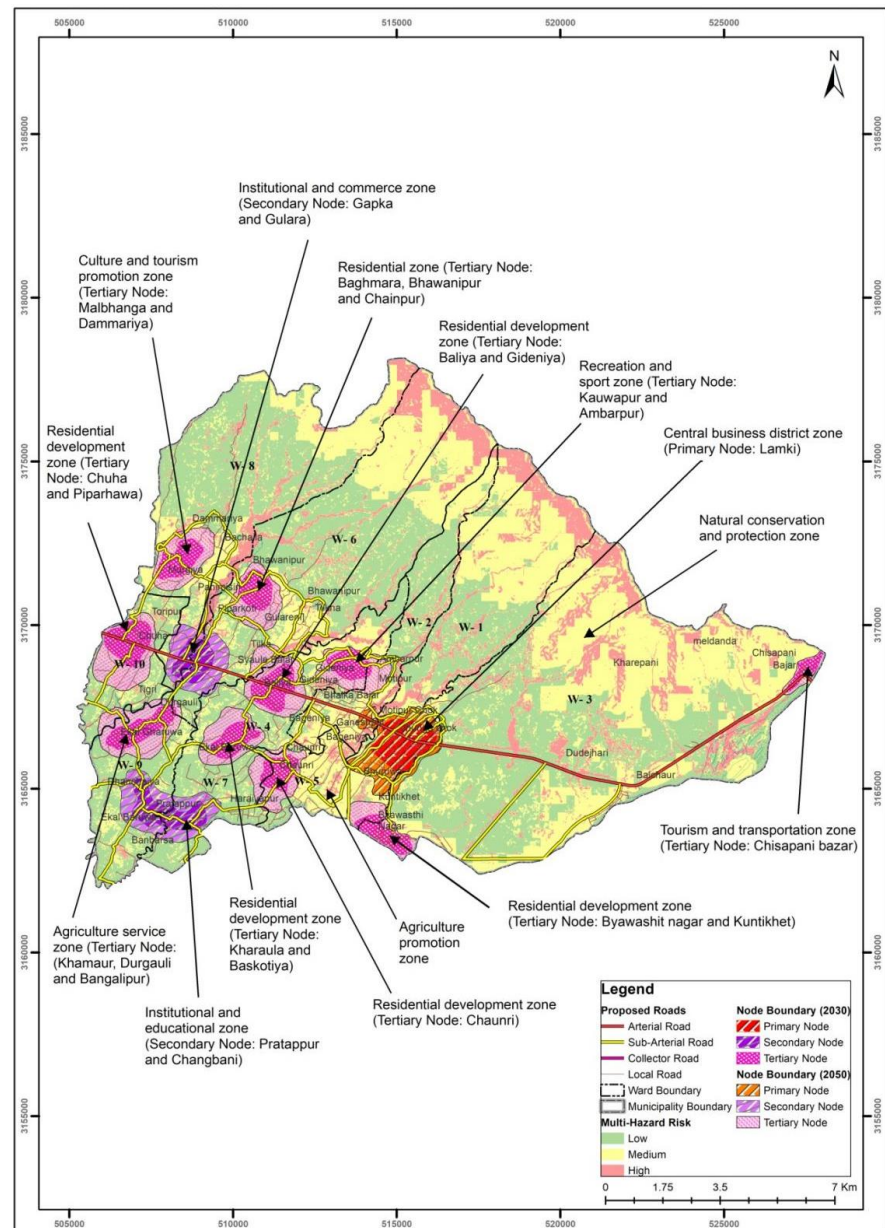


Fig. 4. Master Plan of Development Nodes for 2030 and 2050 AD overlaid on Multi Hazard Risk Assessment map.

5. Conclusions

The multi-hazard risk assessment (MHRA) has become an important tool for developing the Risk Sensitive Land Use Planning (RSLUP), commissioned under DRRM Act 2017. The MHRA outcomes are obtained from both qualitative and quantitative techniques on the basis of utilization of primary and secondary datasets including field hazard mapping, household surveys, institutional surveys, field and laboratory soil tests and historical hazard events. The scientific modeling, usage of literature, global satellite data sets, statistical tools, SMCE, etc. are responsible to delineate individual hazards and computing vulnerability using GIS. A combined hazard map was hence produced to identify high-

risk and safer zones for the planned urban development. The outcomes are thus implemented with the proposed 'development nodes' concept for the two years: up to 2030 and between 2031 and 2050 AD. The concept of Primary, Secondary and Tertiary Nodes are recommended for thirteen urban uses in the Lamkichuha Municipality. For the safer and resilient development incorporating DRM, one CBD at Lamki area under primary node, two secondary and ten tertiary nodes are proposed to support the municipality for the next thirty-year development plan. Thus, the adaptation of MHRA helps to identify the safer and more resilient zone and can be applied in developing risk sensitive land use plan (RSLUP) for a well-structured and well-planned city.

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References

1. Maplecroft. World's Fastest Growing Populations Increasingly Vulnerable to the Impacts of Climate Change- 4th Global Atlas Reports **2011**, Retrieved from: http://maplecroft.com/about/news/ccvi_2012.html.
2. UNDP/BCPR. A Global Report Reducing Disaster Risk-A Challenge for Development. United Nations Development Program **2004**, Bureau for crisis Prevention and Recovery, Geneva.
3. MOHA (Ministry of Home Affairs). Nepal Disaster Report **2009**: The Hazards and Vulnerability, Ministry of Home Affairs, Government of Nepal, Kathmandu, Nepal.
4. MOHA (Ministry of Home Affairs). Disaster Risk Reduction and Management in Nepal. National Position Paper for Asian Ministerial Conference on Disaster Risk Reduction (AMCDRR), **3- 6 July 2018**, Ulaanbaatar, Mongolia.
5. MOSTE (Ministry of Science, Technology and Environment). Economic Impact Assessment of Climate Change in Key Sectors in Nepal. Kathmandu: Ministry of Science, Technology and Environment, Government of Nepal, Nepal. **2014**.
6. UN (United Nations). Global Assessment Report 2015 Data. http://www.preventionweb.net/english/hyogo/gar/2015/en/profiles/GAR_Profile_NPL.pdf. **2015**.
7. ADPC (Asian Disaster Preparedness Centre), NGI (Norwegian Geotechnical Institute, and CISC (Centre for International Studies and Cooperation). Nepal Hazard Risk Assessment. Bangkok, 108p. **2010**.
8. NDRRP (Nepal Disaster Risk Reduction Portal). Nepal Disaster Risk Reduction Portal. Ministry of Home Affairs, Government of Nepal. At <http://www.drrportal.gov.np/>. **(no date)**.
9. UNDRR DesInventar Sendai. *Sendai Framework for Disaster Risk Reduction*. Region Nepal [np]. <https://www.desinventar.net/Des-Inventar/profiletab.jsp?countrycode=npl&continue=y>. **(no date)**.
10. Schmidt, J.; Matcham, I.; Reese, S.; King, A.; Bell, R.; Henderson, R.; Smart, G.; Cousins, J.; Smith, W.; Heron, D. Quantitative multi-risk analysis for natural hazards: a framework for multirisk modelling, *Natural Hazards* **2011**, *58*, 1169–1192.
11. Papathoma-Köhle, M. Vulnerability curves vs. vulnerability indicators: application of an indicator-based methodology for debris-flow hazards. *Natural Hazards and Earth System Sciences* **2016**, *16*(8), 1771-1790.
12. Ciurean, R. L.; Hussin, H.; Van Westen, C. J.; Jaboyedoff, M.; Nicolet, P.; Chen, L.; Glade, T. Multi-scale debris flow vulnerability assessment and direct loss estimation of buildings in the Eastern Italian Alps. *Natural hazards* **2017**, *85*(2), 929–957.
13. Fuchs, S.; Keiler, M.; Ortlepp, R.; Schinke, R.; Papathoma-Köhle, M. Recent advances in vulnerability assessment for the built environment exposed to torrential hazards: Challenges and the way forward. *Journal of Hydrology* **2019**, *575*, 587–595.



Crisis Management and Communication in the Age of the Fourth Industrial Revolution In China

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Abstract: The science of communication is difficult and much more complex than most people realize. Effective communication takes rehearsal and practice, just as any other skill does. Communication involves sending and receiving. Many people learn to be effective senders and give no effort to becoming active listeners. Unless a person is able to do both, he or she will not be an effective communicator. A negotiator can use numerous techniques to increase compliance by the hostage taker. These techniques are subtle, and when used judiciously by the negotiator, can bring the hostage situation to a timely and safe resolution. Being able to effectively communicate does not guarantee success as a negotiator. A good communicator may have other issues that prevent them from being a good negotiator. Not being able to communicate effectively does, however, guarantee failure as a negotiator. Effective communication involves a great deal more than merely picking up a telephone and initiating a conversation. Effective communication involves three principles. First, effective communication involves the ability to understand. Many police officers often get into difficult situations because there is a misunderstanding between them and a citizen. Effective communication also has to achieve the desired effect. Communication has a goal that must be achieved. In hostage negotiations, the goals include reducing the emotional level of the hostage taker, keeping hostages alive and unharmed, and talking the hostage taker into surrendering. To be effective, the negotiator must begin with clearly defined goals and always be ready to change these goals and establish new ones. This means the effective negotiator must anticipate the direction the conversation will take and be ready to respond.

Keywords: crisis management; Fourth Industrial Revolution; Communication

1. Introduction

The Fourth Industrial Revolution refers to the next-generation industrial revolution led by artificial intelligence, the Internet of Things, robot technology, drones, autonomous vehicles, and virtual reality. The term became an issue when it was first used by Klaus Schwab, the chairman of the forum, at the Davos Forum in Switzerland in June 2016. At the time, Chairman Schwab said, "Just as the previous first, second, and third industrial revolutions revolutionized the global environment, the fourth industrial revolution will be the driving force to renew the global order." Crisis management communication can be said to be a process of communication related to prevention, preparation, response, and recovery in order for an organization to efficiently manage a crisis in the event of a crisis. This includes the designation of spokespersons and specialized education for crisis prevention and damage reduction in the pre-crisis stage. In the event of an actual crisis, there should be restoration efforts such as response efforts to help the relevant stakeholders understand and prevention of recurrence to return to the pre-crisis state. (Jae Eun Lee, 2018)

The Fourth Industrial Revolution will be more turbulent than the last few industrial revolutions. Technological innovations such as mechanical intelligence undoubtedly help improve human life, and can also shock future societies. The role of the technological revolution always coexists. The new technology significantly changes the work character of

all industries and occupations, and refers to smart devices being produced using smart devices in factories, helping workers produce and even replacing workers. When productivity is high, labor employment also decreases. Smart devices can also speed up the creation of smart devices. New industries also promote labor employment. [Zuo Yi Liu]

2. peculiarity

Artificial intelligence, Internet of Things emerging industry. The production of artificial intelligence industry is realized by digitalization and information technology of the tertiary industry revolution. The industry includes advanced robots, 3D printers, driverless vehicles and new materials, and driverless trucks. Aircraft, aircraft, and ships will enter the enterprise production area, gradually popular, will be used mainly for commercial and agricultural purposes, such as agriculture can use drones to detect crop production, soil conditions, etc. On the manufacturing side, physical printing through 3D printing is currently used mainly for automotive, aerospace and medical implant materials. At present, advanced robots are limited to certain industries, such as automobiles, and are engaged in some very controlled tasks. As technology advances, robots' adaptability and flexibility will be further enhanced and applied to more fields of life such as housework, such as 3D printing in sneakers, which Adidas announced in 2017 that it would launch 3D-printed sneakers a year. The Fourth Industrial Revolution will be more drastic than the previous ones, and technological innovations such as machine intelligence will undoubtedly help improve human life and bring about its impact on future societies. The role of the technological revolution is often both positive and negative. New technologies will dramatically change the nature of work in all industries and occupations, and intelligent machines will enable factories to use them for production. Assisting workers in production and even replacing them will also reduce labour employment when productivity increases. Smart devices also create new industries that can be saved for labor.

Organizations create many communication messages to minimize the damage and impact on members and stakeholders when a crisis occurs. What, when, and how to tell the public is the beginning of crisis response, and is the basis for the public to understand and recognize crisis situations. In recent years, crisis management communication has become an increasingly important function. Delivering accurate information to the general public, public officials, and media at an appropriate time is important for effective response and recovery activities of crisis management. Sharing information about crisis prevention and preparedness promotes activities that reduce the risk of future crises. Communicating with staff members, partners and participants on the policies, goals and priorities of crisis management supports and promotes more efficient crisis management. Building partnerships with media outlets is the key to successful implementation of crisis management strategies when communicating with the public. [3] Crisis management communication prevents and prepares organizations for efficient crisis management in the event of a crisis. It can be said that it is a process of communication related to response and recovery. This includes the establishment of plans or manuals for crisis prevention and damage reduction, designation of spokespersons and specialized training to respond to communication in the event of an actual crisis, etc. In the event of an actual crisis, there should be restoration efforts such as response efforts to help the relevant stakeholders understand and prevention of recurrence to return to the pre-crisis state.

3. Communication on Chinese Public Crisis Management in the Age of the Fourth Industrial Revolution

The structure of government departments in China is linear functional, which plays an important role in the work of government departments, but it also has some shortcomings. Effective communication between government departments is particularly important not only to eliminate asymmetrical information between departments, but also to respond quickly to outbreaks and increase efficiency. Advanced technologies related to the Fourth

Industrial Revolution provide convenience to humans, but also provide various risks. Everything in the world has two sides. As is the case with well-known high-tech, it also poses risks as well as convenience. Representative risks are that personal information is easily leaked and technologies related to the 4th Industrial Revolution can replace our human jobs. Life will become increasingly difficult for people who lose their jobs because robots replace them. In addition, illegal activities such as fraud may be prevalent through electronic transactions, damaging consumers' rights and interests. China has a large population and actively uses online shopping malls. With the progress of the 4th Industrial Revolution, many consumers are more actively using online shopping malls, increasing the number of cases of damage caused by fraud. The Chinese government is trying to prevent such fraudulent damage through various means. However, fraud using unexpected loopholes continues. Against this backdrop, consumers' consumption behavior using online shopping malls is also changing. First, it is determined whether to purchase the product by looking at the evaluation of consumers who purchased the product on the Internet. With the progress of the 4th Industrial Revolution, governments in China and other countries have various tasks to solve, such as protecting personal information, maintaining jobs, and preventing damage to e-commerce. (Cheng Zhen, 2019)

4. The Impact of the Fourth Industrial Industry

The development of information and communication technology, which is rapidly developing with the progress of the 4th Industrial Revolution, is a great challenge and opportunity for service companies. The challenge they face is how to integrate the management model and advanced technology of traditional service companies in this information age to explore and utilize the market suitable for the information age. Therefore, existing service companies are pursuing changes suitable for the era of the Fourth Industrial Revolution for survival. In accordance with the pursuit of these changes, the method of selling products using information and communication networks is expanding. It is the process of this study to analyze the trends and problems of these changes. However, since the scope of the service industry is wide and each has different characteristics, this study aims to analyze several major industries that are deeply related to our daily lives, such as transportation, finance, and restaurant. The analysis targets are changes in the corporate type and consumption concepts and behaviors derived from changes in the economic structure caused by the 4th Industrial Revolution, which is judged to have a significant impact on the service industry. Since the 4th Industrial Revolution, robots have been widely used in all industries. In the case of the service industry, delivery companies are especially using robots to classify and pack delivery products.

As a result, it is also a reality that many existing workers are losing their jobs. This situation is occurring not only in delivery companies but also in many other service companies. For example, students majoring in foreign languages in college may later work as interpreters or translators. However, it is now an era in which robots can do interpretation and translation instead. As a result, jobs for students majoring in foreign languages such as English, Japanese, and Chinese will also disappear. In addition, occupations such as bakers may disappear later. In other words, most of the jobs commonly seen in our daily lives may be replaced by robots in the future. For example, one of the most important jobs related to human life is a doctor. When we go to the hospital, doctors cannot determine the exact name of the patient based on the symptoms they describe. However, robots can also determine disease names more easily and accurately than doctors. In other words, even a doctor, one of the most basic jobs, can be replaced by a robot. If so, the following questions can be raised. "Where and how are we going to keep our lives going?"

Taobao, China's largest e-commerce platform, presents us with many problems despite its very high market share. Among them, the problem of counterfeit goods is particularly serious. Many people are deceiving consumers by running online shopping malls and selling counterfeit goods. Goods coming in from abroad can be expensive because tariffs are imposed and various costs such as transportation are added. However, selling counterfeit goods can make a lot of profit because taxes and costs, especially production costs, are saved. And consumers also prefer counterfeit goods, which are not much different in quality and are much cheaper, so they sell more counterfeit goods than genuine products. In particular, in the case of bags, consumers do not know how to be deceived because they cannot distinguish counterfeit goods. Even with bags, in the case of cosmetics that come into direct contact with people's skin, the use of counterfeit products can cause serious side effects. In China, there are many people who use cosmetics produced in Korea. They prefer Korean cosmetics, but they buy Korean cosmetics online because of lack of time or communication problems. However, online shopping malls sell a lot of counterfeit goods, so there are cases where you get allergies and your face gets damaged. Banks are the industries that have the most serious impact on the progress of the Fourth Industrial Revolution. Recently, the development of information and communication technology due to the 4th Industrial Revolution has replaced various tasks of banks. As many tasks are processed through the Internet, traditional offline traditional offline stores are gradually disappearing. Nevertheless, many people still trust and prefer traditional banks. Therefore, the newly launched Internet bank has a problem in that it does not give consumers the same trust as traditional banks. In addition, many illegal actors are also using electronic payment apps such as Alipay to buy.

In addition, individuals and groups that run online shopping malls are also committing illegal activities such as tax evasion. In addition, when purchasing a product at an online shopping mall, the problem of personal information protection is raised because one must inform the seller of one's personal information. The same goes for online payments. Therefore, it is necessary to solve the big challenge of how to efficiently protect personal information. It is undeniable that the Fourth Industrial Revolution provides us with a lot of convenience. First, it makes human daily life convenient. Consumers can network and share their reviews with other consumers after purchasing products, allowing new consumers to purchase with more information than before purchasing. And since all payments can be made online, you don't have to bring a lot of cash when you travel, reducing the dignity of cash loss. In addition, it is true that new robots have been put into industrial production, reducing jobs, but at the same time, they are giving us various start-up opportunities. Students who graduate from college and cannot find a job they like can start a business in Taobao with low-interest loans provided by online financial institutions. For example, if you consult with a factory that makes clothes in advance and send an order, the factory directly sends a parcel to the customer. Usually, you can rest at home, but sometimes you just need to register a new product on an online shopping mall and answer customers' inquiries. Nevertheless, there is a high possibility that the number of students who cannot find jobs will increase due to the progress of the 4th Industrial Revolution.

5. Counterplan

On January 26, 2014, China announced <網絡交易管理办法>. With the rapid development of new information and communication technologies, e-commerce is affecting our daily lives a lot. In the process of online transactions, the characteristics of digitalization and virtualization were found to be obstacles to improving the reliability of transactions. Therefore, the Chinese government enacted the e-commerce management law to overcome these problems. The management law includes five basic policies. First, products purchased through e-commerce can be refunded unconditionally within seven days

of receipt. One of the disadvantages of purchasing products on the Internet is that it is difficult to get a refund. Delivery may take more than seven days if it takes a long time to transport by courier or if the weather worsens. Therefore, the bill specifically stipulates that the time of refund is 7 days after the consumer receives the product. Second, consumers' personal information should never be leaked to third parties. The problem of personal information being leaked as e-commerce takes place is very serious. Accordingly, the bill stipulates the protection of personal information. Third, infringement of mutual interests between competitors in the same industry is strictly prohibited. In many cases, an individual runs an online shopping mall, pretending to be a consumer, criticizing competitors and causing confusion to consumers. This is because consumers cannot know which product is good with distorted information. Fourth, online sellers must issue receipts to buyers. If you buy a product at an offline store, you will be issued a receipt, so if you have a complaint, you can report it with a receipt.

However, if a product is purchased through e-commerce, there is sometimes no evidence such as a receipt, so it is difficult to report even if a defect is found in the purchased product. Accordingly, all those who run online shopping malls were legislated to issue receipts to consumers. Finally, e-commerce platforms must notify consumers three months before the end of business. Through this, it is coping with fraudulent sales such as closing the business of selling defective products. China has a large market because of its large population and strong purchasing power. Therefore, one of the major tasks of the Chinese government is to quickly come up with measures to protect consumers in the rapidly developing online market with the progress of the Fourth Industrial Revolution.

The frequency of crisis situations and the expansion of damage are one of the characteristics representing the modern organizational environment, increasing the importance of crisis management. Crisis management communication is an area where the role and weight are rapidly expanding. This is because it has been empirically proven that failure to succeed in crisis management communication leads to failure of reputation and relationships that can be more fatal than damage caused by the crisis itself. The change in the environment combines the attractiveness of Wish News as a product with the development of the media industry, resulting in an increasing amount of organizational capabilities in managing crisis communication targeting the media (Jung Tul jo, 2004: 292-293).

Mass media is an important variable that explains the occurrence of an organization's crisis and the expansion of damage to the public. In fact, events that are not considered to be a crisis within the organization are amplified into serious crisis situations through the media, and the damage is often greatly expanded (Shun Dong Lee, 2006: 165). Communication in a crisis situation has a significant impact on the perception of stakeholders, and the characteristics of the crisis itself have a great influence on the selection of communication strategies (Bonoit, 1995a). The strategy here refers to the practical actions that an organization uses to respond to a crisis (Hyun Woo Lee, 2001). The most common thing to see is communication to defend the organization's reputation from public attacks with an 'apology for self-defense' (Ware & Linkugel, 1973). Since crises usually have characteristics that threaten the reputation of individuals or organizations, they use an apology strategy to defend themselves. Another is "Deciding Reasons," which refers to a message that people use to explain their hand movements when they are attacked by others, and serves to protect the reputation of the organization (Hyun Woo Lee, 2001).

4. Result

In 2013, the term "fourth industrial revolution" was first used by Cloud Schwab at the Davos Forum in Switzerland. It can be seen that the 4th Industrial Revolution is a symbol of advanced information and communication technology. Technologies such as big data

and artificial intelligence, which are rapidly developing with the progress of the 4th Industrial Revolution, are having a great influence on human daily life. It is not possible to say exactly to what extent high-tech technologies related to the Fourth Industrial Revolution will develop, but what is certain is that the future is the home court of these high-tech technologies. Although research on related technologies has not yet been completed, related technologies are already deeply penetrated and applied in our lives. Advanced technologies related to the Fourth Industrial Revolution provide convenience to humans, but also provide various risks. Everything in the world has two sides. As is the case with well-known high-tech, it also poses risks as well as convenience. Representative risks are that personal information is easily leaked and technologies related to the Fourth Industrial Revolution can replace our human jobs. Life will become increasingly difficult for people who lose their jobs because robots replace them. In addition, illegal activities such as fraud may be prevalent through e-commerce, damaging consumers' rights and interests. China has a large population and actively uses online shopping malls.

With the progress of the 4th Industrial Revolution, as many consumers use online shopping malls more actively, cases of damage caused by fraud are increasing. The Chinese government is trying to prevent such fraudulent damage through various means. However, fraud using unexpected loopholes continues. Under these circumstances, consumers' consumption behavior using online shopping malls is also changing. First, it is determined whether to purchase the product by looking at the evaluation of consumers who purchased the product on the Internet. With the progress of the 4th Industrial Revolution, governments in China and other countries have various tasks to solve, such as protecting personal information, maintaining jobs, and preventing damage to e-commerce.

References

1. Benoit, W. L. (1995b). Sears' Repair of its Auto Service Image: Image Restoration Discourse in the corporate Sector. *Communication Studies*, 46: 89-105.
2. Cheng, Y. How social media is changing crisis communication strategies: Evidence from the updated literature. *Journal of contingencies and crisis management*. 2018, 26(1), 58-68.
3. Civelek, M. E.; Çemberci, M.; Eralp, N. E. The role of social media in crisis communication and crisis management. *International Journal of Research in Business & Social Science*. 2016, 5(3).
4. Carr, C. T.; Hayes, R. A. Social media: Defining, developing, and divining. *Atlantic journal of communication*. 2015, 23(1), 46-65.
5. Creative Economy Research Association, "Artificial Intelligence and the Fourth Industrial Revolution", Creative Economy Research Society. 2016.
6. Girtelschmid, S.; Salfinger, A.; Pröll, B.; Retschitzegger, W.; Schwinger, W. Near real-time detection of crisis situations. In 2016 39th International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO). . 2016, 247-252. IEEE.
7. Gu, Qin. Sina Weibo: A Mutual Communication Apparatus between the Chinese Government and Chinese Citizens. *China Media Research*. 2014, 10(2).
8. Gyuhwan, Bae. "Future Sociology: Future Research and 21st Century Design," Nanam. 2000.
9. Han, Chunling. Opportunities and Challenges for Public Crisis Management in Network Environment. *China Market*. 2016 (48), 115-117.
10. Huang, Linfu; Chen, Mei. The Dilemma and Responsibilities of the Government in Public Crisis Management. *Management Watch*. 2014, (09), 163-164.
11. Hyun Woo, Lee. *Crisis Management Communication*. 2001.
12. HuXiao, Yong, Sun Shuo, YangWen, Jie. *Artificial Intelligence Empowering Educational Quality Development: Demand, Vision and Path*. 2020.
13. HouRuo, Si. "The new industrial revolution" of the problem. 1984.
14. Jae Eun, Lee. "Crisisonomy". 2012
15. Jung Yul, Jo. Media Crush and crisis communication: The media structure of the crisis news. 2004, 8(2): 269-301.

16. Jin, Y.; Liu, B. F.; Austin, L. L. Examining the role of social media in effective crisis management: The effects of crisis origin, information form, and source on publics' crisis responses. *Communication research*. 2014, 41(1), 74-94.
17. KongJing, Yuan. The fourth of the Industrial Revolution in China's path.2015.
18. Liu Zuo, Yi. Characteristics of the Fourth Industrial Revolution and Its Impact on Employment. 2018.
19. Zheng, Cen. A Study on the Impact of the Fourth Industrial Revolution on the Service Industry. 2019.
20. Shun Dong, Lee. A Study on Crisis Communication and Third Party Effectiveness.2006, 10(1): 162-190.
21. KOTSIPOULOS, Ioannis. Social media in crisis management: Role, potential, and risk. In: 2014 IEEE/ACM 7th International Conference on Utility and Cloud Computing. IEEE. 2014, p. 681-686.
22. Liang, Yijing. Problems and countermeasures of emergency management of urban public safety in China [J]. *China Management Information*. 2019, 22(17): 209-210.
23. Li, Huining. Analysis on the development of self-media communication norms[J]. *Journal of Journalism Research*. 2022, 13(15): 92-94.
24. Liu, Yuhang; Wang, Jianwen; Bao, Yong. Study on Public Crisis Management Problems of Chinese Government—A Case of Explosion Event in Tanggu of Tianjin. *Anhui Agricultural Science*. 2016, (35), 224-227
25. Mirbabaie, M.; Ehnis, C.; Stieglitz, S.; Bunker, D. "Communication Roles in Public Events: A Case Study on Twitter Communications." In: *Proceedings of the Working Conference on Information Systems and Organizations*. Auckland: New Zealand. 2014, p. 207-218.
26. Pohl, D.; Bouchachia, A.; Hellwagner, H. Social media for crisis management: clustering approaches for sub-event detection. *Multimedia tools and applications*. 2015, 74(11), 3901-3932.
27. Procopio C. H.; Procopio S. T. Do you know what it means to miss New Orleans? Internet communication, geographic community, and social capital in crisis. *Journal of Applied Communication Research*. 2007, 35(1), 67-87.
28. Qian Xue, Sen. Industrial Revolution and China's Facing Industrial Revolution.
29. Vu, H. T.; Guo, L.; McCombs, M. E. Exploring "the world outside and the pictures in our heads" A network agenda-setting study. *Journalism & Mass Communication Quarterly*. 2014, 91(4), 669-686.
30. Shen, F. 'Effects of News Frames and Schemas on Individual's Issue Interpretations and Attitudes', *Journalism & Mass Communication Quarterly*, Volume 81. 2004, Number 2. 400-416.
31. Shi, Huaijing. Research on Online Public Opinion Management Mechanism of Public Security Emergencies in Micro-communication Environment. Master's Thesis. Sichuan International Studies University. 2019.
32. Sweetser K. D.; Metzgar E. Communicating during crisis: Use of blogs as a relationship management tool. *Public Relations Review*. 2007, 33(3), 340-342.
33. SunXue, Lian. Energetically promoting artificial intelligence. 2019(19).
34. TangKe, Li. How to Prepare for the Fourth Industrial Revolution.34-49: 2018.
35. Wu, Yixuan. Crisis Communication: Theory and Empirical Views on Public Relations and Language Arts, Soochow University Press. 2005, 35-60.
36. Wu Wen, Xian. Seizing the Opportunity of the Fourth Industrial Revolution and Innovating Way. 73-77: 2021.
37. TangKe, Li. How to Prepare for the Fourth Industrial Revolution.34-49: 2018.
38. Zhao Xiao, ChenJin,Bao. For the fourth time the global industry transfer.2012.
39. Zou, Zhiwei. Research on the Problems and Solutions of Government Public Crisis Management in the Era of We Media. *Science & Technology Information*. 2021, (13): 236-238.



Article

The level of Awareness of Social Disaster Safety and the Necessity of Safety Education- The level of Response to Disaster and Major Accident Risk Situations

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Abstract: The purpose of this study is to present practical, theoretical, and policy implications for the level of citizens' awareness of social disaster safety, the need for safety education to learn regularly, and the level of response to disasters and large-scale accident risk situations. We looked for the cause of the repeated issuance of disasters and accidents that caused major social problems, focusing on the Itaewon crush disaster on October 29, 2022. He said that the level of awareness of safety in our society as a whole is moderate, and that he thinks our society is not safe. Voices that the group that should strive the most to create a safe society should be addressed as government agencies, which can accelerate efforts for the safety of citizens themselves, companies, newspaper broadcasting, and other media and civil society organizations. Social capital for safety is the biggest factor that affects the perception of social disaster safety. It is necessary to make various efforts to interact with safety culture factors, such as activation of research on safety culture and policy approaches, beyond the limitations of safety culture by exploring the necessity and effectiveness of safety education regularly and finding ways to establish safety culture.

Key words: social disaster safety, safety education, disaster, insensitivity to safety, safety culture

1. Introduction

Through the constantly repeating social disasters in Korea, I would like to shed light on the recent Itaewon disaster. First of all, the seven major disaster accidents in the 1990s are as follows. On March 28, 1993, the train overturning accident at Gupo Station (78 deaths and 198 injuries), and on July 26, 1993, Asiana Airlines Flight 733 (68 deaths and 48 survivors), on October 10, 1993, the sinking of the ferry (292 deaths and 70 survivors), on October 21, 1994 the collapse of Seongsu Bridge (32 deaths), on April 28, 1995, a gas explosion at a subway construction site in Sangin-dong, Daegu (101 deaths and 202 injuries), on June 29, 1995, the collapse of Samping Department Store (502 deaths and 6 missing, 937 injuries), and on August 6, 1997, Korean Air Flight 801 (228 deaths and 26 survivors) occurred.

Since 2000, there have been repeated disasters and accidents that have caused disastrous social problems such as the 2013 Asiana Airlines San Francisco Airport landing, April 16, 2014 Ferry Sewol (299 deaths and 5 survivors), Pangyo concert hall vent collapse, and Ohryong sinking.

Despite various factors that threaten the safety society, our society still lacks awareness of safety and countermeasures, as well as the importance of safety education to prevent safety accidents. The Itaewon crush disaster that occurred on October 29, 2022 occurred again. Whenever such a disaster occurs, there is a widespread discussion that the cause of the accident is talent, genius, or even irrationality, and related agencies announce

measures to prevent further disasters, but concerns about large-scale disasters continue. Such a series of major disasters raised serious questions about the ability of national crisis management, and brought about many changes in national sentiment as all citizens were shocked and thrilled. The safety problem is that whenever a disaster or accident occurs, it is not simply subject to temporary discussion in a specific area and is not resolved as a temporary discussion and measure. In other words, improvement of the safety management system and continuous and specific development and implementation of counter-measures are needed above all else [1].

Our society is deepening "safety insensitivity" lacking investment and safety awareness due to the development of industries, high-rise and undergrounding of urban structures, large-scale and centralization of production means, safety-oriented trend and efficiency- and speed-oriented rapid economic development [2].

This insensitivity to safety hinders citizens' lack of compliance with safety-related rules and the development of related systems. However, the recent Ferry Sewol incident served as an opportunity to change the paradigm of disaster and safety in our society. In other words, it means that safety has no longer been unnecessary or wasteful, but has become a necessary condition that must be prioritized in our society. In order to create a safe society, it is necessary above all to establish a more rational, scientific, and systematic social safety management system in terms of policy, institution, and culture. The establishment of a social safety management system may also vary depending on the level of citizens' awareness of social safety [3].

2. Materials and Methods

First of all, looking at the concept of safety, safety means a non-hazardous state, and risk is understood as the possibility or probability of having any harmful consequences [4]. Therefore, safety can be said to mean a state in which no harmful consequences are likely to occur. Safety is a concept that confronts risk and is understood segmentally and sometimes continuously [5].

Safety is considered to be an "unacceptable risk free from harm to individuals" [6][7], considering that acceptability varies depending on the individual. Social safety is a concept in which individual-level safety has been expanded to a collective level, and can be said to be a state without social risk. Social risk is understood as the possibility that a specific source of risk can expand to the social level and have harmful consequences on the premise of understanding general 'risk'.

Subjective perception of social safety is measured to the degree of individual subjective perception of an objective risk source based on risk judgment [8]. Subjective perception of social safety (risk) begins with reflection that the existing way of perceiving risks too scientifically and objectively is inappropriate. This is based on research results that actual risks are objective reality, but risks are socially created. This means that the perception of social safety (risk) is essentially a matter of science, and at the same time, it is a matter of subjective judgment that combines psychological, social, cultural, and political factors [9]. In other words, the concept of social safety (risk) has cognitive complexity, not just a scientific problem. Therefore, citizens' subjective perception of social safety (risk) is very important in that it directly affects safety management and policies of the entire society through the judgment of individuals who share culture and values in a society [10].

First, looking at major domestic studies, it can be divided into studies on perception of risk factors by field and studies exploring influencing factors. First of all, representative studies on the perception of social safety (risk) by field include Lee Jae-yeol (2005)

[11], Ahn Hyuk-geun (2008) [12], Kwak Eun-sook (2009) [13], Choi Young-hee (2009) [14], Jung Hae-mo (2010) [15], Lee Chae-sik (2010) [16],

There are studies by Bae Jung-eui et al. (2011) [17], Lee Hwan-sung et al. (2014) [18], and Hyundai Economic Research Institute (2014) [19]. Kwak Eun-sook et al. (2009) [20] questioned high school teachers and students to suggest ways to improve safety accidents in school life, and Choi Young-hee (2009) [21] questioned students, teachers, and the general public who experienced fire safety experience

It shows that it is effective in the diet. Jung Hae-mo (2010) [22] surveys the general public and presents the problems of the current education system and the direction of an efficient fire safety education model. In addition, Bae Jung-eui et al. (2011) [23] had 8,522 Busan citizens, Lee Hwan-sung et al. (2014) [24] had 1,121 people in general, and the Hyundai Economic Research Institute (2014) [25] was general.

A survey of 1,004 citizens was conducted on their perception of safety, and the common findings of these studies showed that the Korean people had a low sense of safety and that they needed education and training, but had a low sense of participation. There is also a study that compares the perception of safety internationally [26] [27].

Yoo Hyun-jung and Lee Jae-eun (2010) [26] compared and analyzed the perception and evaluation of safety management services held by the people of Korea, China, the United States, and Japan to explore the direction of safety management services for the establishment of a safety society, and Lee Jung-eun (2012) [27].

A comparison of Korean and Chinese university students' perceptions of disaster safety showed that Korean university students highly perceived nuclear disasters, while Chinese university students highly perceived transportation and transportation disasters, and Korean university students usually perceive the importance of NGOs [28].

<Table 1> Types of Focus Cases

Type	Deployment	End Speed	Occurring Factors (Examples of Events)
I	fast	fast	Natural disasters and social order disturbance (Typhoon, hostage crisis, kidnapping, etc.)
			Case Study: Typhoon Ewinia (2006)
II	slow	fast	Delayed (slow) radical (fast) crime, court ruling (Child Sex Offences, Murder Arrests)
III	fast	slow	Events such as emergency situations, etc (Oil spills, 9/11 attacks, nuclear accidents)
			Case Study: Ferry Sewol Sinking (2014)
IV	slow	slow	Policymakers' decision or reservation of decision (Proliferation of Infectious Diseases)

*Data: Hart & Boin[29], Drennan & McConnell[30], Vergari[31] reconstruction[32]

Summarizing the previous studies at home and abroad discussed above, many studies on the perception of social safety (risk) factors by field are being conducted, and on the other hand, it shows what factors affect the perception of social safety. This study is an

empirical study on the extent to which the general public perceives our social safety (risk) as dangerous and what factors are affected, and it is judged that it will contribute to the study of social safety (risk) awareness and policy [28].

Most large-scale events occur only once, and the reason why such events appear to be focal events is that the problems revealed are brought to great attention by the government and the media [33]. The focal event is a sudden and relatively rare event that triggers intensive media and public attention because of its great damage.

Focus events lead groups, government leaders, policy entrepreneurs, news media, or the general public to pay more attention to new problems or to existing or dormant problems, and to find solutions in the aftermath of potentially perceived policy failures [34].

The purpose of this study was to examine why the policy failure of the focal event due to the type of disaster occurred and what policy stage there was a problem by classifying it by type of policy failure responsibility relationship of Ingram & Mann [35]. To this end, the case of this study selected Typhoon Ewinia as a natural disaster and Ferry Sewol as a social disaster in the following two aspects. First, it was limited to disaster cases in which the Central Disaster and Safety Countermeasures Headquarters and special disaster areas were declared in accordance with Article 14 of the Framework Act on Disaster and Safety Management as a standard that can be regarded as a large-scale disaster in Korea. Second, this study selected typhoons Ewinia and the sinking of Ferry Sewol as representative examples of natural social disasters that can be sufficiently prevented in the disaster response stage before large-scale damage occurred [34]. Among natural disasters, typhoons are repeated every year, and of course, they are natural disasters, but the damage can be reduced sufficiently by the administrative authorities' systematic forecast system and the people's safety prevention measures [36]. In addition, as a human disaster, the sinking of the Ferry Sewol was a complex talent created by corruption of related organizations such as shipping companies along with insufficient disaster response [37].

3. Countermeasures

In Korean society, the problem of danger and disaster can no longer be dismissed as unusual or limited to a special few. Changes in the natural environment, such as climate change, deepened the frequency and degree of disasters, and the complexity of society created a new aspect of risk. Disaster no longer occurs only to specific groups in certain regions, but also comes as a daily risk that anyone can experience in modern society. The recent massive epidemic of diseases caused by new viruses such as COVID-19 has not posed a threat to a small number of infected people, but has resulted in threatening and changing the daily lives of the entire society and people around the world. no longer a disaster.

The problem has become a complex problem that cannot be declared overcoming a disaster situation simply by removing the cause of the disaster or physically overcoming the disaster situation. Before mentioning that the nature of disasters is rapidly changing complexly, it is necessary to simply look at how everyday disaster situations are occurring in our society. In many news and information, many people are often unaware of the repeated occurrence of disasters, but in fact, our society has been experiencing a wide variety of large and small disasters. Until recently, there were diseases such as COVID-19 and MERS in 2015, which the world has responded to together, and safety accidents such as the fire at Sejong Hospital in Miryang in 2018 and the fire at Jecheon

Sports Center in 2017 occur repeatedly every year. In addition, natural disasters such as typhoons and floods that are repeated every year, and recently, heat waves and heavy snow are also considered to be a type of disaster that can be found daily in our society [38].

<Table 1> Setting variables and survey items [39]

Variable name	Concepts and Factors	Survey items
Independent variable	Accident experience (memory)	I think our society's perception of disaster and safety has changed significantly since the Ferry Sewol accident.
	A safety perspective	I think the insensitivity to safety in our society is still serious.
	Social capital levels of safety	Citizens are actively giving way to roads when emergency vehicles come from roads. Citizens are actively participating in disaster safety training.
	Necessity of safety education	Disaster safety education for the people should be strengthened. Disaster safety field training should be strengthened.
	The degree to which the safety system is needed	Systems and regulations related to disaster safety should be strengthened compared to the present. Punishment should be strengthened for neglecting disaster safety regulations.
	demographic characteristics	What is your gender, age, educational background, occupation, and area of residence?
Dependent variable	Safety level in our society	Do you think our society is generally safe?

Effective prevention, effective response and support for disasters that affect government trust as well as many casualties and property damage once they occur is one of the main duties of the state. Large-scale disasters introduced by the National Disaster Information Center are as follows. They include a massive forest fire in Goseong, Gangwon Province in 1996, an arson attack at Jungangno Station in Daegu in 2003, marine pollution caused by the oil spill of the tanker Hebei Spirit off the west coast in 2007, and the spread of the foot-and-mouth disease epidemic that swept the country from 2010 to March 2011. Large-scale disasters in Korea have caused great damage to local residents and related stakeholders. Not only does it take away the foundation and property of life from the people at once, but it also harms people. As such, disasters that cause people's physical injury, death, loss of property, and loss of core infrastructure such as roads, power, and telecommunications should be approached as social problems, not just physical scientific ones [40]. Furthermore, large-scale disaster damage leads to a decrease in trust in the government, that is, distrust [41]. Despite the rapid and effective government response to reduce the amount of damage, existing government policies or systems do not work properly, resulting in large-scale

It is recognized as having brought about a disaster. In the end, large-scale disasters are recognized as a result of the government's failure to respond, and this result leads to satisfaction and distrust of the government.

According to an analysis by James Reason, a professor at the University of Manchester, England, the main cause of large disasters in modern times is that disasters caused by technology factors or human factors tend to decrease, while disasters caused by organizational factors tend to increase. In this way, an accident caused by an organizational error, that is, an accident caused by a Latent Failure factor inherent in an organization, is called an organizational accident. Examples of such organizational accidents include large marine accidents, aviation accidents, railway accidents, nuclear accidents, plant accidents, dam accidents, and medical accidents. The Ferry Sewol disaster on April 16, 2014 is also a typical organizational accident caused by the loss of normal supervision and management functions due to collusion and corruption of related organizations such as the Ministry of Oceans and Fisheries, the Coast Guard, the Shipping Association, and the shipping company. Therefore, how to prevent and manage these organizational factors is the most important factor to prevent the recurrence of major disasters.

After the Ferry Sewol accident on April 16, 2014, the government established a Ministry of Public Safety to oversee all disaster problems in Korea. The Ministry of Public Safety and Security absorbs and organizes the Korea Coast Guard and the National Emergency Management Agency (FEMA) under its jurisdiction, similar to the Department of Homeland Security organization [42].

However, there are a total of seven administrative or agency organizations under the U.S. Department of Homeland Security, one of which is the Transportation Security Administration in charge of traffic issues, while Korea's Ministry of Public Safety has no bureau or department in charge of traffic safety issues. However, the Safety Improvement Division under the Living Safety Policy Officer deals with traffic safety issues as part of its duties.

Therefore, in order to prevent the recurrence of large-scale traffic disasters in the future and to establish a thorough management and supervision system, it is necessary to consider setting up an organization similar to the U.S. Transportation Security Agency in the Ministry of Public Safety.

In discussing community restoration after a disaster, this study sets all members of the community who have experienced a disaster as the target in addition to the primary victims of the disaster. It is worth noting that all members of the community include members of various communities in addition to victims and bereaved families, including elements encompassing all generations and classes. In addition, unlike most post-disaster response systems focused on the short-term or medium-term period until the primary damage from disasters is recovered, this study aims to expand the scope of disasters to discuss support policies from a long-term perspective that restore community networks and heal invisible wounds. Such research is expected to provide a new perspective on the role and function of the public sector in responding to disasters in areas where disasters occur. If the existing public sector responsibility is designed to prevent disasters and restore physical damage from the time of disaster to the time of recovery, this study proposes a new role system that the public sector should aim and support the full restoration of the entire community beyond primary response to disasters and direct damage recovery.

4. Conclusions

The social capital for safety was the largest, followed by safety education and systems, safety awareness after accidents, safety insensitivity, identity, gender, and age. This means that the lower the level of social capital for safety, the more people who do not need safety education and institutional strengthening, the less safety awareness is, the more citizens than civil servants, the more women rather than men, the less secure our society as a whole.

The most important thing in social safety is the accumulation of social capital for safety. First of all, a mature civic awareness of safety is needed. The safety consciousness of Korean citizens is relatively low compared to advanced countries. Emergency vehicle concessions by citizens of developed countries are essential, and they are active in securing fire roads and complying with safety rules. Korea also needs a mature citizenship that can comply with safety order and rules well through various civic education and promotion. It is also necessary for citizens to actively participate in disaster safety training. Korea also has a number of disaster prevention training, including civil defense education. However, such disaster prevention training is formally operated due to the lack of citizens' participation

It is necessary to come up with measures to ensure that disaster safety training can be operated more substantially. Finally, it is necessary to strengthen the functions of close education, investigation, and research in large-scale disaster accidents. Policy failures also include negative ripple effects after policy execution [43] [44]. In Korea, when a large-scale disaster occurs, the person in charge is severely punished, and as shown in the example of the United States, the disaster experience is actively educated to prevent the recurrence of the same disaster need to be used for In addition, through in-depth research, it is necessary to identify whether it is a system problem, a management problem, and a human problem based on a detailed diagnosis of the cause of the accident, and to include it in the long-term disaster management plan.

It can be suggested in the direction of development that in order to prevent policy failures in disasters and social disasters, the focus should be on the stage of policy execution. In Korea, whenever a large-scale disaster occurs, problems such as insufficient policy alternatives, a battle for damage liability, and damage compensation are repeated. As a clear solution to this, as pointed out in a study by Kim Chun-seok et al. [45], it is necessary to prepare fundamental measures to prevent disasters from a long-term perspective. To this end, first, it is necessary to share the worst-case scenario and practical training through regional professional networking centered on local governments that occur disasters by various types of disasters before disasters occur. In particular, in various disaster response, it is necessary to train close to the actual practice in which the people and various institutions participate in formal training centered on existing public officials. Second, after the sinking of the Ferry Sewol in April 2014, local governments have been developing a crisis response safety management manual in response to the increased interest and demand of the people for disaster safety [46].

However, since it does not reflect the characteristics and reality of local governments, it is necessary to prepare a disaster prevention and response manual considering the specificity of the local community's geographical infrastructure [47].

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References

1. Shim Jae-hyun and Ichi-hyeon (2014). The present and future of disaster safety measures. 「 Local Government Focus No. 79
2. Choi Byung-hak (2005). Problems and Challenges of Korea's Disaster and Disaster Management System 「 Public Administration Research, 7(1): 101-124.
3. Lim Dong-jin. (2016.3) Analysis of the level of awareness and influencing factors of social safety: Journal of the 「 Korean Society of Policy Science, Vol. 20, No. 1: 89-114.
4. Quarantelli, 1988; WHO/EHA, 2002
5. Seol Dong-hoon (1988). Korean perception of danger 「Korea Social Science」, 20(1): 22-61
6. Fire and Disaster Prevention Agency (2007). 「A Study on the Strategies for Advancement of Public Safety Consciousness」 Seoul: Fire and Disaster Prevention Agency
7. Lee Hwan-sung et al. (2014). 「Analyzing the actual condition of public safety awareness and creating a foundation for safety culture」. Seoul: Economic, Human and Social Studies Association
8. Seol Dong-hoon (1988). Korean perception of danger 「Korea Social Science」, 20(1): 22-61.
9. Slovic, P. (1999). Trust, Emotion, Sex, Politics, and Science: Surveying the Risk-Assessment Battlefield. Risk Analysis, 19(4): 689-701.
10. Lim Dong-jin. (2016.3) Analysis of the level of awareness and influencing factors of social safety: Journal of the 「 Korean Society of Policy Science, Vol. 20, No. 1: 89-114.
11. Lee Jae-yeol et al. (2005). Public Safety Awareness Survey for the Development of 「 social safety indicators Seoul: Fire and Disaster Prevention Agency
12. Ahn Hyuk-geun et al. (2008). Analysis of 「 social risk factors and systematic management plan」 (Part 1). Seoul: Korea Institute of Public Administration
13. Kwak Eun-sook and Lee Jae-eun (2009). A Study on the Improvement of School Life Safety Accidents in the National Life Crisis: An Empirical Analysis of the Perception of Teachers and Students in Chungbuk High School 「 National Crisis Management Study IV, 3(2): 102-132.
14. Choi Young-hee (2009). Analysis of the impact of 「 firefighting safety experience education on safety consciousness. a doctoral dissertation at Kyunggi University
15. Jung Hae Mo. (2010). 「How to develop a fire-fighting stability education model through a citizen safety awareness survey」 a master's thesis at Kyungpook National University
16. Lee Chae-sik. (2010). Risk Perception Analysis of Community Adolescents 「Korea Crisis Management Discussion」, 6(3): 113-131.
17. Bea Jung-eui and Jung sang-tea (2011). A Study on the Safety Consciousness and Behavior of Busan Citizens 「Korea Crisis Management Discussion」, 7(6): 197-214.
18. Lee Hwan-sung et al. (2014). 「Analyzing the actual condition of public safety awareness and creating a foundation for safety culture」. Seoul: Economic, Human and Social Studies Association
19. Hyundai Economic Research Institute (2014). 「Current issues and tasks: Safety awareness and policy tasks. Seoul: The Institute for Modern Policy
20. Kwak Eun-sook and Lee Jae-eun (2009). A Study on the Improvement of School Life Safety Accidents in the National Life Crisis: An Empirical Analysis of the Perception of Teachers and Students in Chungbuk High School 「 National Crisis Management Study IV, 3(2): 102-132.
21. Choi Young-hee (2009). Analysis of the impact of 「 firefighting safety experience education on safety consciousness. a doctoral dissertation at Kyunggi University
22. Jung Hae Mo. (2010). 「How to develop a fire-fighting stability education model through a citizen safety awareness survey」 a master's thesis at Kyungpook National University
23. Bea Jung-eui and Jung sang-tea (2011). A Study on the Safety Consciousness and Behavior of Busan Citizens 「Korea Crisis Management Discussion」, 7(6): 197-214.
24. Lee Hwan-sung et al. (2014). 「Analyzing the actual condition of public safety awareness and creating a foundation for safety culture」. Seoul: Economic, Human and Social Studies Association
25. Hyundai Economic Research Institute (2014). 「Current issues and tasks: Safety awareness and policy tasks. Seoul: The Institute for Modern Policy

26. Yoo Hyun-jung and Lee Jae-eun (2010). Evaluation of safety awareness and safety management services of consumers in Korea, China, the United States, and Japan. *Journal of the National Crisis Management Association*, 2(2): 33-51.
27. Lee Jung and Lee Jae-eun (2012). A Comparative Analysis of Disaster and Safety Perception in Korea and China 「Korea Crisis Management Discussion」, 8(4): 125-142.
28. Lim Dong-jin. (2016.3) Analysis of the level of awareness and influencing factors of social safety: *Journal of the 「 Korean Society of Policy Science*, Vol. 20, No. 1: 89-114.
29. Hart, P. & Boin, R. A. (2001). Between Crisis and Normalcy: The Long Shadow of Post-Crisis Politics, In U. Rosenthal, R. A. Boin and L. K. Comfort(eds) *Managing Crises: Threats, Dilemmas, Opportunities*, Springfield, IL: Charles. C. Thomas: 28-46
30. Drennan, L. T & McConnell (2007). *Risk and Crisis Management in the Public Sector*. London & New York, Routledge
31. Vergari, S. M. (1996). *Policy Crisis and Policy Change: Toward a Theory of Crisis Policymaking*. Unpublished Ph. D. Dissertation, University Michigan.
32. Lee Dong Kyu and Min Yeong-kyung(2016) 「An Exploratory Study on the Significance of Policy Failure in Large-Scale Disaster: Focusing on media reports of natural and social disasters」 *The Korean Journal of Local Government Studies*, Vol.19 No.4 (2016 Winter:124)
33. Birkland, T. A. (1997). *After Disaster: Agenda Setting, Public Policy, and Focusing Event*. Georgetown University Press, 144.
34. Lee Dong Kyu and Min Yeong-kyung(2016) 「An Exploratory Study on the Significance of Policy Failure in Large-Scale Disaster: Focusing on media reports of natural and social disasters」 *The Korean Journal of Local Government Studies*, Vol.19 No.4 (2016 Winter:126-127)
35. Ingram, H. & Mann, D. (1980). *Policy Failure: An Issue Deserving Attention*, in *Why Policies Succeed or Fail*. ed. Beverly Hills: Sage.
36. The Jemin Daily (July 12, 2006). www.jemin.com
37. The Kyunghyang Shinmun (August 18, 2014) www.khan.co.kr
38. Birkland, T. A. (2006). *Lessons of Disaster: Policy Change After Catastrophic Events*. Georgetown University Press. (2006). *Handbook of Public Policy Analysis*. CRC Press
39. Lim Dong-jin. (2016.3) Analysis of the level of awareness and influencing factors of social safety: *Journal of the 「 Korean Society of Policy Science*, Vol. 20, No. 1: 89-114.
40. Lee Dong Kyu and Min Yeong-kyung(2016) 「An Exploratory Study on the Significance of Policy Failure in Large-Scale Disaster: Focusing on media reports of natural and social disasters」 *The Korean Journal of Local Government Studies*, Vol.19 No.4 (2016 Winter)
41. Lee Dong-kyu and Min Yeon-kyung (2015). After the Ferry Sewol disaster, does disaster safety awareness affect government trust? : Focusing on the results of the Korea Research's disaster safety national awareness omnibus survey. *Korea Crisis Management Discussion*, 11(3): 19-38.
42. Seol Jae-hoon (2016) *Korea Transportation Research Institute Monthly Transportation* 2016.03:2-4 (3)
43. Kim Do-hoon. (2003). Causes and lessons of the failure of the Sihwa Lake policy, focusing on learning organization and system thinking. *Journal of the Korean Society for Policy Studies*, 12(1): 299-323.
44. Kim Jong-beom. (2004). Policy Promotion and Media Public Policy Research, focusing on national R&D projects, 15:11-30
45. Kim Chun-seok, Ha Min-ji, and Lee Dong-gyu (2013). An exploratory study on policy learning after fire events: Focusing on the case of large-scale fire accidents in Korea. *Korea Crisis Management Discussion*, 9(4):31-58
46. Lee Jung and Lee Jae-eun (2012). A Comparative Analysis of Disaster and Safety Perception in Korea and China 「Korea Crisis Management Discussion」, 8(4): 125-142.
47. Lee Byung-ki, Kim Gun-wi, and Hyun Seung-hyun (2010). Analysis of the disaster management form of marine pollution accidents from the perspective of risk governance. *Korea Policy Journal*, 19(4): 353-378



Article

Stakeholder Analysis of Hydrological Hazard and Water Utilization toward the Network of Klongyan River Basin for Restoration and Conservation.

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Abstract: To illustrate the good practice of community disaster resilience regarding hydrological hazards. The Network of Klongyan River Basin Restoration and Conservation can be a role model of the collaboration among sectors in disaster preparedness and irrigation. At the starting point, People who live rely on the ecology of the Klongyan river basin gathered to against dam construction that tends to destroy their ecosystem. Over 10 years past, the activities grow up from nature protection to restoration and conservation. Since the landscape is upstream of the mountainous range with average rainfall is 1,636 mm per year. People completely agree that slowing water flow can contribute to reducing the severity of flooding in the rainy season. The natural check dam was chosen to implement in the area since 2007. People found that it helps sand trapping, sediment, and water store in the dry season by adding moisture to the forest as well as the loss from drought is less. Then this idea was widely disseminated to all community's neighbours. Currently, the formation of this group became the Water User Association (WUA) following the definition of the International Water Management Institute (IWMI)[1]. Therefore, this study focuses on the collaboration among sectors by using stakeholder analysis to assess the potential changes to influence the major actors and interested parties on water resource utilization and disaster preparedness

Keywords: Water User Association; hydrological hazard preparedness, community disaster resilience, stakeholder analysis

1. Introduction

This paper aims to analyze the stakeholders of the Khlong Yan River Basin Conservation and Restoration Network. Regarding climate variability and inequality development policies that cause the problem with production security and livelihood affected the communities. The researcher found that Stakeholder analysis is a tool to help networks see the priorities of jurisdictional actors and strategic proposals that should be used to manage relationships with the interacting organizations in the water resource management of the community to increase the efficiency of agricultural production by the network that plays a role in advising on water use to members. and plays a role in natural resource management, allocating water to water users and allocating funds for dam construction to ensure consistent water retention in the ecosystem. and maintenance of things related to the use of water in the way of life which has a form of operation that meets the criteria of being a Water User Association – WUA) For Data collection, researchers have

done a literature review and a focus group in the Klong Yan Basin on April 2022 to compile the context of integration and resource management for sustainability of water use in the area.[2]

2. Materials and Methods

Stakeholder analysis is a tool to help networks display the priorities of jurisdictional actors and strategic proposals that should be used to manage relationships with the interacting organizations in the water resource management of the community. The stakeholder analysis process begins with 1) identifying key actors involved in the issues to be considered, 2) assessing the level of authority and interest that stakeholders have in their operations. 3) Create proposals or plan engagement strategies that involve different stakeholders. 4) Apply the proposal or strategy that has been applied to the plan. In order to support or reduce the resistance that hinders the operation Typically, authority and interest assessments are assigned to the informant member to rate those involved on a scale of 1-5, with 1 being low, 5 being high. The results obtained from this step are shown. The hierarchy of stakeholders and the four areas of power are(3).

- high power, high-interest groups that must be persuaded to work closely on the transition (transformation) since the determination of operational goals Improve key metrics Resource support to drive solutions including the audit of operating results

- high power but Low-interest group may be a local philosopher, a government agency, or an agency in the area. which must receive reports of information, news, and clarification of continuous operating results to be satisfied by allowing giving advice or use relationships for proper resource management

- low power but high interest are usually professional personnel and experts who are affected by the project. which must be heard to exchange information When the project started

- Lower power, low interest is the person who is following the work. Attention must be paid to this group in managing risks so that they do not interfere with operations. or has a vision that does not match the goal that occurred

3. Results

The results of the network analysis are a set of data that can help illustrate the priorities and the degree of closeness that should be done to the agencies interacting to optimize cross-sector collaboration. For this analysis, the researchers created a list of internal and external stakeholders from the literature review to contribute to the network coordinator and network members addressing the importance of cooperation during the group discussion. Network members are then asked to determine the level of power and interest of each organization. This was coupled with an in-depth self-assessment during the interview.

There are 5 sub-component dimensions of power towards water resource management that must be considered: 1) being a source of knowledge-information 2) having political power 3) having the power to control budgets/expenses of equipment (Economic power) 4) Power to enforce rules (Legal power) and 5) Social power from work in the area (Social power)

For the sub-components of interest (interest) towards water resource management, there are 4 aspects: 1) obtaining adequate water for production costs 2) economic outcomes 3) social response. Participation 4) Sustainability/Disaster risk reduction

The results of the data collection indicated that There are 15 organizations that are important to the conservation and restoration of the Klong Yan Basin. The researchers

arranged the data in metrics to show the jurisdiction of water resource stewardship as shown in Figure 1.

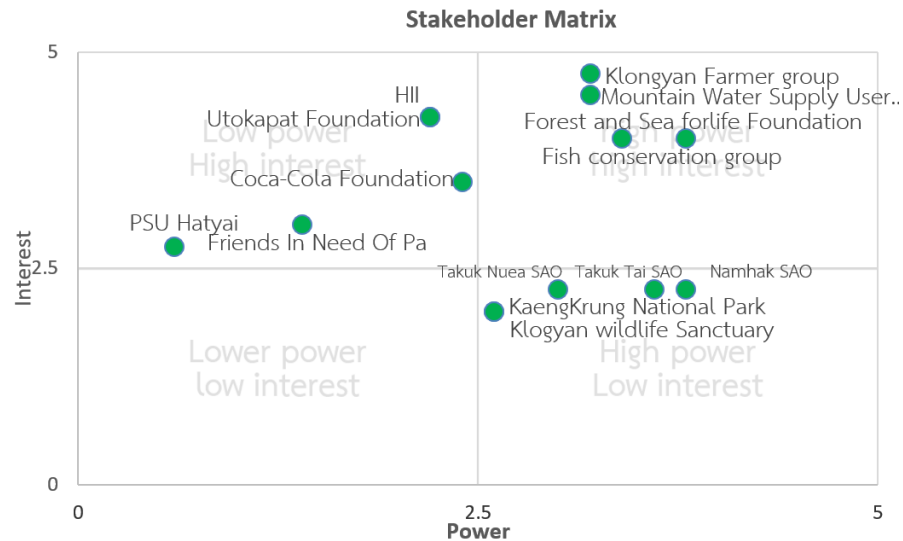


Figure 1 Power Area Graph for Stakeholders in the Khlong Yan River Basin Conservation and Rehabilitation Network

From the area of power that appeared only three groups. without a group of low-powered, but high-interest the operational strategies that should be treated with the stakeholders of the network can be divided into three groups as shown in Table 1

Table 1 Areas of Authority and Strategies that influence Network Stakeholders

Power Area	Actor	Roles	Strategies
high- power, high-interest groups	Forest and Sea for Life Foundation	Knowledge transfer, coordination among the sector, resource allocation	Engage closely at the start of the project (key players). This group must act as project initiators or consultants who join in to set goals when starting new projects. Explore existing problems in the area. Monitor performance, work hard, and support resources to drive operations closely to create transition.
	Farmers, as water users in the community of Khlong Yan River Basin	Construction of check dams and maintenance of check dams distributed in the watershed area	
	Mountain water users group	Operate and Maintain Community Mountain Water	
	Fish culture conservation zoning Group	Fish culture conservation	
High-power but Low-interest group	Hydro-Informatics Institute (HII),	HII came to install telemeters and trained on flood and water, know how to use the application Thai-water.net to follow up the situation	Keep satisfied. All you need to do is ask for feedback when planning activities. Or, after a while, this group of indicators should be used to assess the quality of the operation. Because this group is professional personnel, ex-
	Utokapat Foundation	Support soil mapping - identify evacuation points, evacuation routes, and plans to	

Power Area	Actor	Roles	Strategies
		transport victims until the floods are over.	perts can exchange information. Helpful advice
	Friends in Need of Pa Foundation	Coordinate rescue and response during disaster strike	
	Coca Cola Foundation Thailand	Do CSR support the construction of check dams to return water to the community	
	Surat Thani Rajabhat University	Support student volunteer workers in making do and civil works	
	Prince of Songkla University, Hat Yai Campus	Support community reverse osmosis drinking water production	
Low-power group but high-interest group	Kaeng Krung National Park	Maintain and control natural resources access as a gatekeeper	Spend the effort to get involved (keep informed) must increase intimacy through communication. Continuously update the information to build relationships. Must find opportunities to share the expectations of the network to get attention. Give opportunity to come and give advice as a policymaker and manage resources appropriately
	Khlong Yan Wildlife Sanctuary		
	Nam Hak Subdistrict Administrative Organization,	As a gatekeeper for land use and submit a project and budget from ONWR. Activity such as bringing machinery into parks or wildlife sanctuaries have to approve by this group according to the regulations of Forrest law	
	Takuk Nuea Subdistrict Administrative Organization, and		
	Takuk Tai Subdistrict Administrative Organization.		

4. Limitations

This network has no process for creating a water use plan but there are a wide variety of technology and economic tools applied to water management in the area. Be transparent in sharing information necessary for water management. There is a horizontal network of associates within the district and across the province. Sustainable Water Management along with having a good relationship with government agencies in the area. It's contributed to well flexibility to deal with crises through links with other resources by advocating for policies at the local level to enhance the quality of life to lead to action and has been motivated into action at the local level In the long term, this group is likely to continue to work. because they have the ability to manage funds Using economic tools through networking

5. Conclusions

The Khlong Yan River Basin Conservation and Rehabilitation Network have community-level sub-groups established with diverse members who addressing on knowledge sharing of water conservation. The information on water resources was used in disaster risk assessment. There are flexible rules and regulations within the group. Focus on collective decision-making within the group (4).

As for the analysis of stakeholders in the Khlong Yan River Basin Conservation and Rehabilitation Network, which has a working model that meets the criteria for being a

Water User Association (WUA), it was found that the high-power, high-interest group that must be closely involved since the beginning of the project, including the Forest-Sea for Life Foundation; Farmers who use water in the network of community organizations for resource management in the Khlong Yan River Basin Community Mountain Water User Group, Fish culture conservation zoning Group Influence on the consultation on water use and water allocation to members. Taking care of natural resources to ensure consistent water production for efficient agricultural production.

In conclusion, The finding shows that a High-powered, high-interest group that must be kept closely involved since the beginning of the project are the villager group as well as Forest and Sea for Life Foundation. Low-power but high-interest groups that need to provide information regularly are the Hydro-Informatics Institute (HII), and Utokapat Foundation which influence the hydrological hazard preparedness toward the communities. while the Coca-Cola Foundation Thailand influenced funding to build check dams to ensure consistent water retention in the water source ecosystem. The high-power but low interest which is supposed to keep involved, it is the national park, wildlife sanctuary and subdistrict Administrative Organization. This group occupied full authority to organize water allocation and maintain irrigation infrastructure for community livelihood.

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References

1. IWMI. How to establish a Water Users Association? Practical steps for social mobilizers. 2003; Available from: http://www.iwmi.cgiar.org/regional-content/central_asia/pdf/wua_eng.pdf
2. Samart Sukbanjong et al. “Tourism-oriented research project. Ecosystems in the Klongyan Basin.” Surat Thani: Office of the Research Fund. Forest-Sea for Life Project Resource Management Project by Community Organizations in the Southern Basin. 2546.
3. Sukhothai Thammathirat Open University. Teaching Documents Course Series 58708 Strategic Management in Hospital Management. 2021. p. 1–54.
4. Chaweewan Suklim and Chupan Chmpuchan. Stakeholder Analysis in the Pracharath Watershed Development Project: A Case Study of the Lower Kottanao Yai Canal Sub-basin Sa Kaeo Province. In: 12th Thaacid National symposium. 2562. p. 259–71.

Article

Research on the Improvement Direction of Forest Fire UAV in the Background of Climate Crisis

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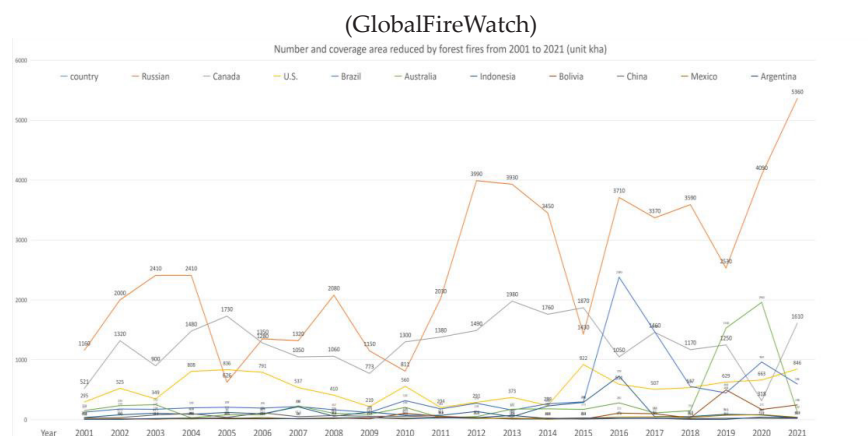
Abstract: In the past two decades, the environmental impact of rising temperatures caused by the climate crisis has become increasingly obvious. But in terms of forest fires, they have been becoming more frequent since 2001. It has affected the economic, social and natural environment of some countries. Especially in the past two years, the frequent large forest fires caused heavy casualties. With the development of the fourth industrial revolution, cutting-edge technologies such as big data, AI and drones have gradually been integrated into all walks of life. The integration of drones into forest fire fighting is a feasible way with dozens of precedents to reduce casualties, gradually forming a popularity of putting prevention first and developing corresponding means. This paper will put forward several improvement directions of forest fire fighting UAV based on the needs of real examples.

Keywords: forest fire, the fourth industrial revolution, UAV

1. Introduction

1.1 Hazards caused by forest fires

From 2001 to 21, the decline of fire-caused forest coverage area showed an overall upward trend, especially from 2019 to 2021.



In 2021, British Columbia, the Yukon, Manitoba, and Ontario burned over more than 34,000 square kilometers. British Columbia had the worst fire situation. By the end of July, there were 1,251 wildfires in British Columbia in 2021, covering an area of 4,500 square kilometers.(Canadian Wildfire Information System) As of early September, more than

43,440 wildfires had occurred in the United States since 2021, with a total area of more than 20,000 square kilometers.(Data to the National Interagency Fire Center) From January to August 2021, nearly 900,000 fires broke out in Brazil's six ecosystems. In August alone, 28,000 fires occurred in the Amazon rainforest, above the historical average for three consecutive years. In addition, the South American countries of Chile, Argentina, Peru, Bolivia are also frequent wildfires. In the first eight months of 2021, Spanish wildfires burned 74,260 hectares of forest, and more than 150,000 hectares of land in Italy were hit by wildfires. From July 29 to August 11, Greece burned more than 93,600 hectares. The Greek Civil Defense Agency has issued an extreme fire warning to half the country. A wildfire occurred on August 9 in the Kabilia region of northern Algeria. In addition, large-scale wildfires also broke out in Cyprus, Turkey, Lebanon, France, Tunisia and Montenegro along the Mediterranean coast.(Data) In the first eight months of 2021, Russian bushfires burned more than 161,400 square kilometers of land, with 95.6 percent of the fires concentrated in Yakut, Chukchi, Magadan, Chumung, Kamchatka and Khabarovsk Krai. Mountain fires covered more than 2,000 hectares in the Cherry Orchard area in the southern suburbs of Adelaide in late January, and 11,000 hectares in suburban Perth in early February. Greek bushfires, Cyprus bushfires, Italy, France, Spain, Portugal and other countries. In the summer of 2021, some European countries were hit by floods, while others were suffering from wildfires. Across the Atlantic in the United States, almost the annual California bushfires in recent years have also dyed the west coast sky. The Dixie wildfire, the largest ever, is approaching California for more than 3,700 square kilometers.(CNN, Sept. 8) 33 people were killed in the "Black Summer" disaster in September 2019 and more than 3,000 homes were damaged for four months until January 2020.

wildfires are a topic of natural disaster in recent years. Due to various natural factors and human activities derived from the influence of the rise of global temperature, wildfires occur one after another around the world. The west coast states have been in the heat this summer. Currently 80 major wildfires in 11 states are burning, exceeding 4 than 43,400 this year, covering more than 20,000 square kilometers. In California, the Caldoro wildfire, which had burned for nearly a month, had covered 863 square kilometers, while California, the largest wildfire, Dixie, had burned for more than a month and a half, covering more than 3,700 square kilometers. Five of the seven of California's largest wildfires in its history have occurred since 2020, according to the California Forestry and Fire Department. California has had more than 6,000 wildfires in 2021, covering a total area of more than 2,300 square kilometers. In Europe, about 600 wildfires have occurred in Greece in August alone. In less than two weeks, nearly 100,000 hectares of forest and farmland in Greece were destroyed at faster speeds than previous levels, and at least two people were killed, adding to dozens of injuries.

This is only a small part of the global wildfire disaster. In recent years, extremely massive bushfires have taken place around the world. From America, Europe to Asia and Australia, the wildfires seem to have never stopped, and the damage caused to mankind is immeasurable. The 2019 Amazon rainforest fires led to a marked surge in global carbon monoxide and carbon dioxide emissions, while the Australian wildfires in late 2019 burned nearly 24 million hectares and hundreds of people died from smoke covering much of the country. Russian Siberian coniferous area in June and July fire directly caused about 50 square kilometers of vegetation disappear, fire smoke for about 1500 kilometers, even within the Arctic circle of Alaska also occurred the fire, among them, in mid-June this year the Alaska fire also led to the Arctic circle north of 125 miles, Alaska northwest corner of noatak national reserve more than 18000 acres of tundra fire. Casualties, property losses and even rescue efforts are only the direct consequences of wildfires, while some invisible consequences have even more profound effects on humans.

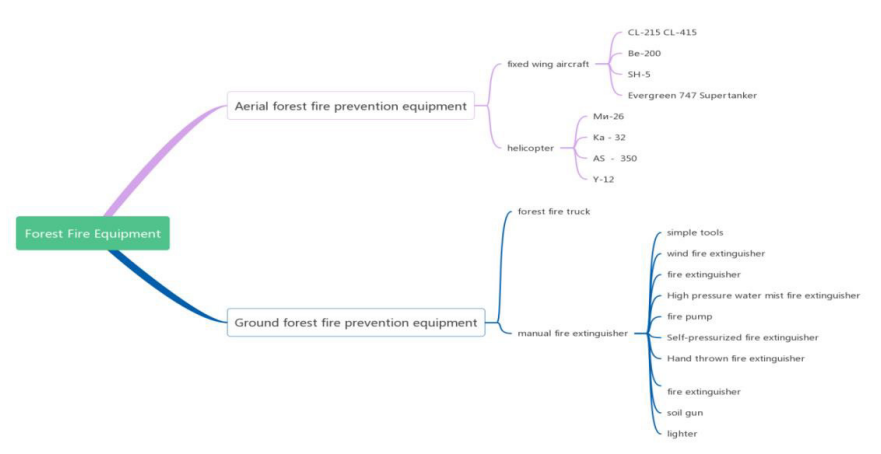
characteristic	document	example

The fire time is extended	Climate change leads to increased temperature, intensified drought, and decreased air humidity. The global forest fire season is extended by 20% on average, showing the characteristics of seasonal fire prevention to annual fire prevention transition, [1]	The fire season in parts of eastern Australia is four months longer from the 1950s, the heat and dry season in California is at least two and a half months from the 1970s, and the fire season in the Saha Republic of Russia is two weeks from 10 years ago.
The scope of the fire expanded	Due to climate change, the spatial scope of forest fires is also expanding, large-scale wildfires are also frequently erupted in some humid and cold areas, and the frequency and intensity of wildfires in tropical rain forests and high latitudes are increasing by [2-3].	In March 2021, the Nordic countries Sweden more than 50 forest fires, including more than ten are located within the Arctic circle, may the world's coldest region in Russia iya was found near 12 wildfires, Nordic countries Iceland issued the country's first wildfire danger alert, August satellite images show that Siberian wildfire smoke floating over more than 3 000 km to the arctic for the first time.
The fire loss was serious	Under the influence of extreme weather, the frequency and intensity of high energy fire behavior increased significantly, resulting in more serious loss of life and property [4].	The Oregon wildfires, moving at 6.4 to 8 k m a day, have more than tripled overnight, destroying 1,259 buildings and threatening nearly 13,000 buildings. The French province of Valal reached 7,000 h m 2 in dozens of hours, producing 25 clouds of wildfire. The raging wildfires have led to the emergency evacuation of a large number of residents, the destruction of their buildings, and even once approaching the important targets of nuclear power plants, residential areas, gas stations and World Heritage sites, causing a serious negative impact on the economic, social and ecological aspects.

Release of harmful gases	The process of burning wild-fires will emit toxic gases and a variety of harmful particles, which will seriously affect the regional air quality and affect the health of local residents in [5].	Fushfires in the western United States spread eastward more than 4,000 k m east, affecting more than 40 million people. The thick smoke produced from the Siberian wildfires covers an area about 3,200 k m wide from east to west and about 4,000 k m long from north to south. PM2.5 is a major pollutant in wildfire smoke. Increasing the 10 μ g/m ³ of PM2.5 concentration in the air increases respiratory disease mortality by 2.3%. Each year, 33,000 people die from short-term inhalation of wildfires worldwide, with up to 1.6 percent in Central America and Southeast Asia. The smoke from the wildfires also increases the risk of the novel coronavirus infection. For every 10 μ g/m ³ increase in the PM2.5 concentration, the positive rate increases by about 6.3 percent after two to 6 days.
Affect social order	Continuous burning forest fires lead to states of emergency in many places, affecting the normal social order.[6]	A wildfire south of Lake Tahoe, California, forced an extreme bike ride across the Sierra Nevada. The Oregon bushfires have caused damage to a number of interstate transmission lines, seriously threatening the grid operation. The Perth, Australia, fire severely damaged local power infrastructure in February, damaging about 800 telephone poles and 100 transformers and cutting power to more than 2,000 homes and businesses. At one point, wildfires in Turkey approached the power plant, affecting about 3,714 farmers, 3,100 h m ² of land, 66.8 hm ² greenhouses and 4,358 animals. The burning fire also delayed hundreds of flights to Denver International Airport in the United States, temporarily closing Yaktsk airport.
Threat estate security	Catastrophic forest fires are one of the important disasters threatening the world's natural and cultural heritage.[6]	A forest fire on Table Hill, South Africa, on 18 April, caused the destruction of a large number of isolated ancient books at the University of Cape Town Library, which was built in the 1930s. Statues of the Most Mill, built in 1796, the Table Mountain landmark Rhodes Memorial Restaurant, and the 19th-century British imperialist supporter Rhodes were also destroyed by fire. The catastrophic forest fires in Greece were just 32 km away from Mount Panisa, and the Hera Temple became one of the worst-hit areas, posing a serious threat to the Olympic site.

1.2. Fire fighting tools for forest fire fighting

Forest fire is a natural disaster that all forest countries must face. Due to the different national conditions, the forest fire extinguishing mode with regional and national characteristics has been gradually formed in the long-term forest fire extinguishing practice. The traffic conditions of the wild vehicles in Australia are good, and the forest fire trucks are easy to approach the fire site. Therefore, the large, medium and small wheeled forest fire trucks are used as the important fire fighting and support platforms, and the water pumps and aircraft are used as the auxiliary equipment. The United States and Canada mainly develop aviation fire extinguishing means, supplemented by ground fire extinguishing means, mainly using water fire extinguishing method [9]. China's forest fire fighting is still mainly to the ground fire extinguishing machine wind fire extinguishing, light fire fighting equipment and hand-held tools with fire fighting, supplemented by water pump, crawler forest fire truck, aircraft indirect fire fighting mode.



Studies of forest fires in the world for many years shows that even the most advanced fire fighting methods and technology can do nothing about forest fires in extreme weather conditions. Therefore, while improving the mechanization and modernization level of forest fire prevention machines and tools, we should continue to adhere to the forest fire prevention policy of "prevention first and active elimination".

1.3 Definition and characteristics of forest fire-fighting UAV

Uav is short for unmanned aircraft, it is not manned by radio remote control equipment or self-provided program control device control, is a kind of power-driven, unmanned, reusable aircraft. A typical UAV consists of aircraft, control station, take-off (launch), recovery device, and detection system. It is an aerial robot capable of flying by command. Uav can usually fly independently beyond the range of sight, can carry a certain payload, perform reconnaissance, aerial photography, monitoring and other tasks. It can also calculate the possibility of completing a task according to various complex conditions, such as the weather, the ground environment changes, and even the location of the obstacles in the air, and automatically perform or abandon the task. The micro aerial forest fire monitoring system composed of drones and monitoring equipment can realize part of the functions of aviation forest protection, with good fireworks detection ability, can timely detect the abnormal forest area and make alarm tips, Is a brand-new kind of aviation forest protection technology and equipment. It is mainly used for daily forest patrol operations and real-time data transmission, to provide decision-making reference for the command and dispatch of fire fighting. Under normal circumstances, the flight planning can be carried out according to the area size, terrain situation and vegetation

characteristics of the target forest area, including flight frequency, flight purpose, flight route and other [11], etc.

characteristic	explain
Flexible response and easy to operate	It can effectively meet emergency needs; equipped with camera, high-resolution camera, front-view infrared device and image transmission equipment, realize the air patrol, and return video images for ground processing. Front-view infrared device can also meet the requirements of night patrol, including hand throwing and umbrella recovery, with low site requirements and adapt to various complex use environments.
Low cost and high-risk operations	When a forest fire occurs, the visibility over the fire is low, even if the manned aircraft can reach the fire, the observers cannot observe the ground fire situation in detail. In this case, there are safety risks in flying, and the drones can overcome the deficiency of manned aircraft. Equipped with camera equipment and image transmission equipment, fire alarm reconnaissance and fire detection tasks can be carried out at any time, and ground personnel can grasp the dynamic information of the fire site at any time by receiving microwave signals from drones.
Monitor the fire site all day long	Drones can monitor the forest area all weather in the air, detect the fire in time, report the location of the fire site, and take action to eliminate the fire in the early stage. The UAV conducts aerial patrol of the forest area according to the predetermined navigation track, and transmits the image data obtained from the air patrol back to the ground monitoring station in real time, which transmits the real-time images to the fire prevention duty department through the network. For the suspects or areas, the flight path and flight altitude of the UAV can be changed by the remote control instructions for detailed investigation, and the detailed investigation images can be transmitted back to the ground in real time through the wireless link.
Scientific fighting command	To has appeared fire area for air fire situation observation, make the blazes command quickly and effectively organize, deployment of fire fighting team, improve the efficiency of fire fighting, timely notify firefighters evacuation of dangerous areas, and according to the fire image data provide path for fire personnel evacuation, prevent firefighters casualties, do scientific rescue command.

2. Application of forest fire-fighting UAV

2.1 Application method of forest fire fighting UAV

Uav fire fighting is a new type of fire fighting means, with the characteristics of light and flexible, good applicability, but it is expensive, and it is difficult to directly attack the long-distance, high-intensity fire line. After comprehensive analysis, UAV is more applied and targeted in fire fighting operations. The biggest advantage after being put into use is that it can increase the time period, location and means of fire fighting operations. For the political, economic and ecological value of forest resources, the benefits of UAV fire fighting are far greater than its cost.

Its advantages are: first, medium and low intensity fire lines difficult to reach by the terrain, low risk can be used in complex terrain and dangerous environment to reduce the risk of direct fire fighting, third, fast fire fighting and new fire points at any time to prevent spread; fourth, multiple functions, such as fire reconnaissance, material delivery, humidification operation and other purposes to provide strong support for fire fighting, which can be reinforced by aviation and highway according to task needs.

purpose	method
Fight the fire point and fly the fire	Fire point is the surface fire that has just burned and has not expanded, forming a certain area of combustible or unable to expand due to other conditions; flying fire refers to the fire point in the process of the burning fire occurs in the forest. When the forest fire just happened, the use of UAV spraying to implement the elimination, when the fire points are small, more machines can be implemented in turn, when the fire points can be carried out separately, in the process of fire extinguishing, we should distinguish the priority, adhere to the principle of the first focus and then general.
Save the cliff fire	Cliff fire refers to the forest fire occurring in the cliff, because of the impact of the terrain and combustible materials did not expand the scope, formed one or more fire points, fire fighting personnel can not reach the fire is difficult to implement the fire. Use UAV spraying to extinguish or airborne water gun to fire water extinguishing.
Rescue of a single tree crown fire	A single canopy fire is a fire that occurs in the trunk and spreads upward along the trunk to burn into the canopy, and only a single canopy burns due to the small depression. Use UAV cluster spraying to implement chemical extinguishing, air fire bomb explosion or airborne water gun water extinguishing.
Fight the low and low intensity surface fire	Medium and low intensity surface fire refers to the occurrence of the ground surface, the height of the flame is about 1.5 meters. This is only refers to the short fire line. The UAV is divided into several groups (depending on the number of UAV), and the UAV cluster spraying is used to implement chemical extinguishing, air fire extinguishing bomb explosion or airborne water cannon to fire water alternately. The specific approach is that no. 1 UAV jump on the fire, No.2 UAV put out the fire 4-5 meters in front of it (depending on the airborne fire fighting equipment), and No.3 UAV put out the fire 4-5 meters in front of No.2 UAV. Each group of drones extinguished the fire line after the reference to this method.

Clusters break through the fire line	Breakthrough fire line refers to the use of all available fire extinguishing equipment to quickly extinguish the open fire in the low fire intensity, relatively flat terrain, rare combustible areas, and then implement the fire extinguishing method. Breaking through the fire line is the key link of fire fighting, which is prone to danger. After breaking through the fire line, people who quickly enter the fire site can effectively avoid casualties. Therefore, the use of drones to break through the fire line can greatly reduce the danger. All uav points (with water carrying, chemical extinguishing agents, fire extinguishing bombs, etc.) are concentrated to put out the fire at one point, so that it quickly appears in an extinguishing area, and then one point and two sides.(Can be jointly implemented together with the ground fire fighting team).
Clean up the fire line, the smoke point	Cleaning up the fire line refers to the use of drones to clean up the fire line that can not be reached by the steep mountain slopes, special terrain and large combustible fire extinguishing personnel, and focus on cleaning up the smoke points to ensure that the fire line does not reignite. Practice has proved that the casualties and economic losses caused by the reburning of the fire line are often difficult to measure, and the Xiaozhu Mountain forest fire in Qingdao on April 23,2020 is the reburning fire.
Point burning isolation belt and fire attack and fire extinguishing	Point burning isolation zone refers to the use of uav in the front of the fire head to use the support (path, stream, no combustible area, etc.) to the mountain steep slope, special terrain, large combustible load of fire extinguishing personnel can not reach the fire line point burning, if there is no support for uav to spray chemical agents to establish support. Use the UAV to separate loading ignition facilities or drop combustion bombs for point firing.
Protect the safety of key targets	The focus of protection refers to the use of drones to protect key facilities built in complex terrain, steep mountains and inaccessible to fire extinguishing personnel. Use uav (water, chemical extinguishing, fire bombs, etc.) to fire disposal around key targets or the target itself.
Reconnaissance in inflammable, explosive and chemical fire accidents	Wireless remote control drones can be in at any time blasting or produce toxic gas environment, to provide favorable information for rescuers, wireless remote control drones can carry micro combustible gas, toxic gas detection instrument of toxic and harmful gas concentration and diffusion detection, to determine the rescue, prevention and control route, easy to monitor the scene of fire changes, reduce the blindness and effectiveness of rescue.
Rescue site auxiliary supervision and monitoring and tracking	Wireless remote control drones by aerial equipment monitoring high or high-rise buildings, predict all kinds of hidden fire hazards, can also monitor fire rescue fire, and fire inspection results, the scene fire image for air surveillance video, and fire monitoring system connection, in order to achieve large capacity long image storage, call function, and wireless remote control drones can also be through intelligent terminal remote view, remote control. In addition, the wireless remote-controlled UAV can not only carry out disaster reconnaissance on the fire fighting and rescue site, but also monitor and track the constantly changing

	fire and fire, providing accurate disaster information for the rescue workers. The commanding personnel at all levels can timely understand the changes of the fire situation, facilitate the timely adjustment of emergency and rescue plans, and control the scope of fire damage.
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[12][13][14]

2.2 Limitations of forest fire-fighting UAV

At present, UAV technology design is not targeted enough to fight forest fires. The main performance is in: one is the heavy load and endurance time. At present, most industrial drones have a combat load of less than 100 kg and an endurance time of less than 1 h, which is difficult to meet the needs of direct fire fighting. Such as increasing the endurance time and load weight, the volume of the UAV will be greatly increased. Second, signal transmission and command and control. The data chain of UAV is limited by power and frequency band, and the communication distance of UAV is proportional to the flight height. The mountainous terrain is complex, and the occlusion and interference are more, resulting in the uav cannot accurately fire extinguishing at high altitude, and prone to data chain break after reducing the height. Third, the means and methods of fire fighting. The direct fire fighting accuracy of the UAV is not high enough, and it is difficult to directly act on the fire line or the fire point. In addition, the fire fighting agent that can be used is relatively single.

UAV is vulnerable to fire environment restrictions: high temperature, wind speed and wind direction change, smoke (temperature, carbon particles, tar, water vapor, etc.), various ions and other interference, plateau typical microclimate characteristics (obvious turbulence, turbulence, fast weather change) all affect flight safety. China's plateau and mountainous areas account for about 70% of the total land area. Most forest resources are concentrated in the mountainous areas, with complex terrain, diverse climate, poor traffic conditions, and difficult for people and cars to arrive. Especially in southwest China, the forestry land area is wide, a wide variety of plants, forest

Forest coverage rate is large, belongs to the forest fire frequent area. From 2000 to 2009, more than 2,460 fires occurred in Yunnan, Sichuan, Guizhou, Tibet and Chongqing in southwest China, with 29 casualties annually. The fire prevention situation was extremely severe by [17]. In the plateau area, the weather conditions affecting the take-off and landing of drones are even more prominent, such as heavy fog, cloudy days, too fast cloud flow, unstable aircraft posture, insufficient clarity of aerial pictures, discontinuous and non-overlapping images affect the later image synthesis, and the strong wind may lead to the failure of the take-off and landing of the aircraft to [18]. The flight altitude is not enough (the high altitude of the southwest forest area, hypoxia, obvious microclimate, different forest type fire characteristics), take-off and landing difficulties, and even the possibility of damage.

3. The development direction of forest fire-fighting UAV

Fire UAV is suitable for a wide range of fields. It can not only be used for on-site fire fighting and rescue of fire or explosion accidents in super high-rise buildings, petrochemical devices and their storage tank areas and hazardous chemical parks, but also for emergency rescue of earthquakes, mountains and waters. Although there are still many technical problems in the research of fire UAV, the actual needs of fire fighting and rescue combat point out that the development of fire UAV with efficient fire fighting and emergency rescue functions is one of the main directions of future fire research. Therefore, it is necessary to closely follow the actual combat needs of fire fighting and rescue, adhere to the combination of original innovation and integrated innovation, and strive to improve the professional, integrated and intelligent level of fire-fighting UAV.

3.1 Specialization

According to the characteristics of different types of fire and disaster accidents, the development of suitable fire UAV is one of the development trends. For forest fires, the development of forest fire fighting UAV should meet the needs of forest fire fighting, not only to meet the needs of long cruise time, but also to achieve technological breakthroughs in forest fire detection and spread detection algorithm. For petrochemical fire, fire uav should pay attention to the monitoring of toxic and harmful gases and the prediction of dangerous range. For emergency rescue in earthquakes, mountains and waters, fire-fighting drones should focus on the delivery of life-saving materials.

3.2 Integration

The integrated fire UAV should not only realize the real-time multi-dimensional display of disaster and accident site information, but also be able to participate in the special places

Auxiliary fire fighting, but also to have the ability to provide auxiliary emergency rescue for the trapped personnel. Only a trinity of fire drones can meet the emergency needs of all-round operations.

3.3 Intelligent

The intelligence of fire UAV is reflected in the combination of fire UAV and emergency rescue software, relying on the combination of the corresponding emergency rescue software

The hardware basis of fire fighting UAV realizes the intelligent rescue, which is also one of the important contents of intelligent fire fighting. The intelligent auxiliary rescue decision-making platform combining soft and hard mainly includes the determination of the main attack scope, the choice of fire fighting methods, the deployment of rescue forces, the choice of evacuation guidance and rescue methods, and the control of rescue time, etc.

3.4 Modularity

Through the UAV equipped with multi-functional module, the field gas, temperature, direction and field image information are collected in the first time to display the disaster situation in an all-round way, and quickly provide auxiliary fire fighting and emergency rescue, so as to maximize the auxiliary actual combat effectiveness of the fire UAV. Integrated functional modules mainly include:

module	act on
Gas analysis module	Gas analysis module can carry a variety of different types of gas sensor at the same time, real-time monitoring of toxic and harmful gases in the fire, and various gas sensors can be replaced at any time according to the field demand, provide forecast warning for personal protection of firefighters, and will collect the key data input into the database, for future scientific research and provide information support for field command.
Image acquisition module	The image acquisition module can realize the collection of HD video information and night vision video information in the disaster and accident site. Visible light and night vision video information using integrated visible light and night vision integrated HD movement, can more clearly distinguish the fire information. Night is the time of high fire,

	night vision can be used to realize the accurate collection of fire information. This module should realize the real-time amplification and reduction of the field video information, photography, video recording, day and night switching, etc.
Tilt photography module	Through the fire UAV mounted 3D modeling system (tilt camera), the integrated HD camera is used to quickly and effectively cover the surface and feature points from different directions. Meanwhile, based on the post-processing 3D modeling technology based on the graphics computing unit GPU, the 3 D accurate modeling of key fire safety units is realized.
Infrared temperature field module	Infrared thermal images can make drones used in different scenarios. The high-performance analog image transmission system can transmit infrared thermal images in real time, and can map the temperature information of the scene in real time, providing strong decision support for fire commanders.
Emergency broadcasting module	Emergency broadcasting shall have the function of long-distance directional broadcasting, realize the induced evacuation and emergency broadcasting in disaster scenarios, reduce the risk of personnel panic and congestion, and prevent the occurrence of stampede accidents. The emergency broadcast module can realize the sound propagation within 600 m, and realize the broadcasting direction of 0~180 by increasing the stable cloud platform.
Strong light lighting module	The high-intensity searchlight is the lighting device carried on the fire UAV, which is set in the same direction as the air surveillance camera. First, it can enhance the aerial shooting effect through strong aerial lighting under limited light; second, it can provide on-site lighting for firefighters in night operations to ensure the smooth implementation of fire fighting and rescue operations.
Auxiliary rescue module	Airborne emergency rescue devices are used to carry and release breathing masks, life ropes, life jackets, life buoy, food, medicine and other rescue materials to improve the viability of the trapped people and ensure the life safety of the trapped people in the rescue process.
Fire extinguishing device module	Drawing lessons from acoustic fire fighting, fire fire prevention and other technologies, and actively adopt new efficient fire extinguishing technology, research and develop equipped with fire extinguishing device module, using fire uav to quickly project efficient fire extinguishing medium, and strive to achieve early fire fighting and effective fire control.

Research and development of fire drones central task is to meet the actual combat conditions of auxiliary fire fighting and emergency rescue requirements, the focus of the research should be a breakthrough general civilian unmanned flight vehicles, ground re-

remote control device, task load equipment technical performance, to adapt to high temperature, wind and rain, smoke, electromagnetic interference, explosion risk and other environmental requirements, and formulate the corresponding standards accordingly. The main technical performance should include: maximum flight altitude, maximum flight time, maximum take-off quality, maximum control distance, wind resistance performance, rain resistance performance, explosion-proof performance, climate and environment adaptability energy, mechanical environment adaptability energy, electromagnetic compatibility performance, etc.

At present, the application of uav has been fully developed in various fields, and each one has its own advantages. Especially in emergency rescue, such as strengthening the introduction of satellite remote sensing information, using unmanned reconnaissance aircraft to make up for the impossible images obtained by satellite remote sensing, and solving the problems of too long traditional satellite remote sensing revisit cycle. In forest fire fighting, the situation of the fire site can be grasped in various directions, which provides situational awareness for emergency personnel in real time. The use of drones has become an indispensable and necessary means. In the future, drones will play an irreplaceable role in forest fire fighting, emergency rescue, disaster early warning and other areas.

References

1. Su Zhangwen. Research on forest fire occurrence driver and prediction model in the Greater Hinggan Mountains based on Geographic Information System [D]. Harbin: Northeast Forestry University, 2020.
2. Liu Zhaoyan. Enlightenment of Amazon rainforest and Australian forest fires on forest fire prevention work in China [J]. Fire Protection Industry (electronic version), 2019,5 (23): 67-68.
3. White Night, Wang Bo, Wu Yingda, et al. Inspiration of bushfires in the Arctic Region to forest fire management in the alpine regions of China [J]. Fire Protection Science and Technology, 2021,40 (4): 554-557.
4. Wei Shujing, Luo Bizhen, Li Xiaochuan, et al. Analysis of the causes of casualties caused by forest fires and the response measures [J]. Forest fire prevention, 2019, (3): 15-17 + 34.
5. Liu Xiaodong, Wang Bo. Progress in the major emissions of forest combustion [J]. Journal of Beijing Forestry University, 2017,39 (12): 118-124.
6. White Night, Wang Bo, Wu Yingda, Liu Xiaodong. A Global Forest Fire Review in 2021 [J]. Fire Protection Science and Technology, 2022,41 (05): 705-709.
7. Sheng Yanling, Zhang Yin, Qiao Jigang. Fire change characteristics and relationship with precipitation in the Amazon ecoregion based on GEE [J]. Journal of Ecology, 2021,40 (8): 2553-2562.
8. Zheng Zexun, Li Qiang, Li Jinmei, et al. Forest (grassland) -town border area fire safety discussion [J]. Fire Protection Science and Technology, 2020,39 (10): 1442-1446.
9. Park Jinbo. Research on the World Forest Fire Fighting Mode [J]. Forest fire prevention, 2012, (1): 36-37.
10. Sun Jiabao, Yao Qingxue, CAI Jianwen. Overview of forest fire fighting tools at home and abroad [J]. Journal of Heilongjiang Ecological Engineering Vocational College, 2014,27 (04): 15-17 + 30.
11. Ma Ruisheng, Ma Shuqing, Wang Liping, et al. Unmanned Fire Monitoring System and its Preliminary Test [J], Meteorological Technology, 2008,36 (1): 100-104.
12. Mu Shaoyu, Sun Hui. Application of Forest Fire Rescue [J]. Forestry Machinery and Woodworking Equipment, 2022,50(09):34-36+43.DOI:10.13279/j.cnki.fmwe.2022.0141.
13. Liu Pengde, CAI Jizhong. Application of UAV in Fire Fighting and Rescue Work [J]. Digital Communication World, 2019 (11): 180 + 239.
14. Liu Qiaohong. The Application of UAV in Fire Fighting and Rescue Work [J]. Fire Protection (electronic version), 2020,06 (08): 36 + 38.
15. Zhang Tingbin, Tang Juxing, Liu Dengzhong. Application analysis of the spatial resolution of satellite remote sensing images [J]. Journal of Earth Sciences and the Environment, 2006,28 (1): 79-82.
16. Tang Yan. Research on the Vegetation Recognition Method Based on UAV Image Acquisition [D]. Chengdu: Chengdu University of Technology, 2014:2-10.
17. Park Dong-hyuk, Wu Jianguo. Countermeasures for forest fire source management in Southwest China [J]. Forest fire prevention, 2010 (2): 12-14.
18. Lu Bodi, Meng Diwen, Lu Ming, et al. Application and discussion of UAV in major natural disasters [J]. Disaster science, 2011,26 (4): 122-126.
19. Nanjiang Forest. Research and application prospect analysis of fire-fighting UAV [J]. Fire Protection Science and Technology, 2017,36 (08): 1105-1107 + 1112.

20. Tang Wandi, Tan Yongcang, Tang Huang. Discussion on the application of UAV in fighting forest fires in Tibet [J]. Fire Protection Today, 2022,7 (09): 1-3 + 21.
21. Zhou Changgang, Zhou ju. The application of UAV in forest fire inspection and early warning [J]. Jiangxi Surveying and mapping, 2022 (03): 21-24.
22. Wang Qiuhua, Shu Lifu, He Cheng, Shan Baojun, Jiangxi Army, Li Shiyu. The Application of UAV in Forest Fire Protection [J]. Forestry Machinery and Woodworking Equipment, 2017,45(03):4-8.DOI:10.13279/j.cnki.fmwe.2017.0028.
23. Feng Bin. Research on the application of UAV in forest fire fighting command [J]. Production safety in China, 2021,16 (06): 52-53.
24. Si Dayong. Application advantages and optimization countermeasures of UAV system in forest fire prevention [J]. Country Technology, 2020,11(33):114-115.DOI:10.19345/j.cnki.1674-7909.2020.33.058.
25. Luo Xuanjiang, Fu Yujie, Ji Renxin, Zhang Zhi. Practical Application of UAV System in National Forest Fire Team [J]. Fire Protection Today, 2020,5 (09): 34-36 + 39.
26. Zhang Fan. Research on UAV Application in Forest Fire Fighting [J]. Fire Protection (electronic version), 2020,6(08):58-59.DOI:10.16859/j.cnki.cn12-9204/tu.2020.08.037.
27. Ao Kanghua, Zhou Junliang, Shu Lifu, He Cheng. The exploration of socialized paid service for forest fire prevention in China [J]. Forest fire prevention, 2017 (02): 1-7.
28. Zhang Jing. Scientific and technological demand of forest fire fighting and UAV application in China [J]. Breeding Technical Consultant, 2014 (07): 94.



Article

Intelligent Fire Fighting of Chinese City in the Context of the Fourth Industrial Revolution

Xiangnan Lin

Abstract: With the rapid development of urbanization, making urban fire safety is facing greater risk, more gathered, the fire situation is more complex. Due to the concentration of population in modern cities, buildings have become high-rise and large-scale, and large-scale densely populated areas have emerged underground such as subway stations and underground shopping streets. If a large-scale disaster such as a fire, earthquake, or collapse accident occurs in such super high-rise buildings or underground densely populated facilities, it is difficult for even professionally trained firefighters to launch effective rescue activities. In the context of the fourth industrial revolution, with the integration of robotics with artificial intelligence, drones, and IoT technologies, scout robots that can enter the narrow crevices of collapse sites to explore survivors, unmanned flying robots that quickly provide information on fire conditions with high-performance cameras in the air, waterproof vehicles that travel unmanned to extinguish fires, and operational robots that are responsible for eliminating hazards in areas where fires occur are being used for segmented purposes. Intelligent robots are being actively developed in the United States, Japan, Europe, and other developed countries. At present, the intelligent construction of China's fire rescue is still in the initial stage, although some results have been achieved, but there are still many problems and bottlenecks that need to be cracked, but also need to continue to explore boldly, transformation and upgrading, so that the safety of people's lives and property to get more effective and timely protection. With the help of big data technology to establish a sound fire safety-related new message database, through the extensive collection of multi-dimensional, multi-domain, multi-level data, while using big data analysis, rational research, and judgment, objective assessment of the entire rescue work process, results, to provide a more authoritative and efficient decision-making basis for the construction of China's fire rescue management system.

Keywords: intelligent fire fighting; crisis management; 4IR ;

1. Introduction

By the end of 2021, the total number of cities in China has reached 691, with an urbanization rate of 64.72% of the resident population. China currently has 130 cities with a million people, while under the same conditions Europe has only 36, the United States has 45 and South America 46, and China has already surpassed all of them combined. The number of mega and large cities in China is also increasing, and the emerging metropolitan areas and urban agglomerations have become an important platform to drive China's rapid economic growth. However, along with this, the problem of urban fire safety is also becoming more and more prominent. The continuous growth of city scale and population makes the city a complex and huge operational system, and urban fire safety becomes an important element that cannot be ignored. The "4.15" accident in Jinan, the "8.12" accident in Tianjin Port, the "2.25" accident in Nanchang, etc., once again show the importance of fire safety issues, and whether effective Whether to do a good job of urban fire safety risk prevention and control has become an important task of urban development, but also one of the key elements of urban governance.

At present, the Internet of things, big data, cloud computing, converged communications, artificial intelligence and other new generation of information technology is

booming, setting off a profound change in the field of smart city, smart industry, smart home. Not only China, but in fact there are many other countries that likewise recognize the need to incorporate the concept of smart cities when planning for late stage cities at present. According to the founder of the World Economic Forum, Laux. Schwab, in the development of the existing fourth industrial revolution, smart cities are an important development direction and support. In the process of smart city construction, there are diversified Internet information terminals to realize effective sensing, monitoring and analysis of city operation data, providing necessary data support and automated response for city management, citizen services and livelihood development.

The "Intelligent Firefighting" system is an information firefighting management system based on big data, Internet of Things and other technologies, which is based on the traditional firefighting facilities and systems within the city, and introduces new information technology to realize the construction of online management platform. And in the process of operation, the system is constantly updated and optimized to achieve perfection in the practice of dealing with fire fighting problems.

2. Materials and Methods

This paper is studied in the context of the fourth industrial revolution: the first part is a study of the relevant concepts and theoretical foundations involved. The concepts of fire safety management, crisis management, grid-based management and intelligent firefighting are analyzed. The second part is the analysis of the current situation and problems of urban fire safety management. The current situation and the changing situation faced by China's urban intelligent firefighting are discussed, and the current problems are analyzed and countermeasures are proposed based on the crisis management perspective by collecting and organizing literature.

3. Literature Review

In 2012, the National Institute of Standards and Technology (NIST) in the United States proposed the development and research of "Smart Fire Fighting". Its core purpose is to realize the effective sensing of firefighting scene, the improvement of firefighting effectiveness and the goal of firefighters' own safety through the integrated application of information physical system (CPS) and measurement science theory. The "smart firefighting" system it discusses contains three main aspects, namely, smart building and robotics, "smart firefighting" equipment and robots, and intelligent firefighting equipment. The United States also attaches great importance to collecting some real data of the society when carrying out specific research, and in this process, using cloud computing to analyze and integrate the data and some actual situations, each city has a corresponding fire department and a professional firefighting team, so in the whole management process, if you can use science and technology to manage very scientifically, you can solve the actual problems very effectively. It reduces the waste of resources in all aspects. Therefore, when analyzing and processing the data, it is necessary to add some compilation processors and so on to analyze and code the information accordingly, and of course, some new factors in the society should also be incorporated into the analysis platform in time.

Yang, Jiann C, Manzello, Samuel L suggested that the city needs to use many advanced science and technology if it wants to construct a real intelligent firefighting. If modern robotics can be incorporated, it will be able to deal with problems more precisely and with a high degree of consistency in the completion of tasks at a later stage. (Yang, Jiann C, Manzello, Samuel L, 2016).

Marshall argues that although there is a concept of intelligent firefighting, and there is also a strong emphasis on some of the technology management systems, but in this

process without strong theory as a guide, there is a high probability of poor decision making, coupled with the existence of rigid firefighting infrastructure in many areas is not well established, then whether the later can really be designed to However, it is undeniable that the current cloud analysis technology is able to deal with many data and problems very accurately (Marshall, 1995).

Many cities have a relatively large population density distribution, in this case, once the fire really happened, if you can not accurately grasp the actual situation of the whole fire, it is likely to lead to significant casualties, for the firefighters also can not understand some of the real situation inside, but if you can grasp the relevant data in advance, it is also conducive to the firefighters very accurate to deal with the problem The firefighters are able to protect the people's time and safety. And if you can have a full understanding of the local environment, it is very helpful to carry out the actual work later, in the design of the intelligent fire, and your join the computational analysis technology and positioning technology, then, the relevant scientific personnel proposed to join the robot to because and analysis of the scene situation may also have a strong superiority. SERS system is also used in the whole system, which can really help users match to the best solution. It can simulate some actual situation, which is beneficial for the firefighters in charge to take a more reasonable treatment.

4. What is "Intelligent Fire Fighting" ?

"Intelligent Fire Fighting" is an important part of the current smart city construction, and is also an important goal of urban public safety management project construction. At present, although the planning of "smart fire" has been gradually piloted in many cities, the whole is still in the initial exploration and construction stage. The realization of "intelligent fire" system construction, can more effectively improve the level of urban fire management and urban emergency rescue disposal capacity, improve the supervision and management of urban fire, realize the prevention of fire in advance in different areas of the city, so as to solve at the source of different geographical fire and disaster relief capacity gaps and untimely deployment of assistance. The problem. Therefore, in the process of "intelligent firefighting" system construction, it should be fully based on the characteristics of the city's own firefighting work and the fire-prone characteristics, and establish a remote urban firefighting intelligent management platform with close relevance to local firefighting affairs. Based on the above analysis, the author determines the concept of "intelligent firefighting" as follows: based on information technology, the comprehensive use of big data, cloud computing and Internet of things, to realize the digitalization and professional dynamic data collection and tracking of the city's firefighting management work, to broaden the scope of the previous firefighting management work data collection layer, and to enhance the effective analysis and management of the city's firefighting data. The effective analysis and management of firefighting data, the realization of the city's fire warning, rescue and rescue, fire prevention supervision and other work powerful support, to complete the innovation and development of urban firefighting management.

5. Limitations

6. Conclusions

Although China's research on intelligent firefighting started late, it has developed rapidly, and the proportion of the overall research on firefighting has increased extremely rapidly, and various computer technologies have been continuously applied to the research on firefighting, which has brought great convenience to the daily firefighting work. Research gaps and lack of systematic research.

Through the research and analysis of a large number of studies on intelligent firefighting, it is found that in the background of the era of vigorous development of intelligent firefighting, the relevant standards and norms in China are not perfect enough, which aggravates the scattered development situation of intelligent firefighting in the complex Chinese market. Therefore, it is important to continuously update and establish the standards and norms adapted to the development of smart fire protection in China, supplement the relevant theoretical knowledge, and systematize the research related to smart fire protection for the development of smart fire protection in China.

References

1. Fu Yongcai. Exploring intelligent firefighting under big data thinking[J]. Fire Science and Technology, 2016, 35(12):5.
2. Ding Xiangguo. Thinking about the construction and development of "intelligent firefighting"[J]. Computer Security, 2012(10):4.
3. Ding Hongjun. Intelligent fire protection construction based on Internet of things technology[J]. Fire protection technology and product information, 2017(5):3.
4. Liu Xiaolu, Wang Wenqing. Overview of the development status of intelligent firefighting in the United States[J]. Science and Technology Bulletin, 2017, 33(5):4.
5. Deng C. Intelligent firefighting service cloud platform based on the Internet of Things [J]. Jiangxi Chemical Industry, 2017(3):3.
6. Zhang Lei. Intelligent firefighting construction based on Internet of Things technology [J]. Firefighting industry:Electronic version, 2018.
7. Dong Shuangshang, Yuan Qiusheng, Cui Jiubing, et al. A floor alarm device with easy disassembly for the construction of a wisdom firefighting cloud platform;: CN112258775A [P]. 2021.
8. Ge Jianhui. Preliminary investigation on the application of Internet of things technology in the construction of "intelligent firefighting" [C]// Firefighting science and technology and economic development--2014 Zhejiang Province Firefighting Academic Paper Excellence Award Proceedings. 2015.
9. Li Yanyuan. Design and implementation of intelligent fire fighting system monitoring extension software [D]. Chongqing University of Posts and Telecommunications.
10. Zhao Chengjing. Research on the application of big data technology in the field of intelligent firefighting [J]. Firefighting, 2021, 007(017):P.68-68,70.
11. Mao Chuanxin, Yao Chunli. The opportunities and thoughts brought by intelligent fire fighting to property safety management[J]. 2021.
12. Li Huan. Problems and Suggestions Facing the Construction of Intelligent Fire Protection[J]. Construction Technology Research, 2021, 4(1):11-12.
13. Cheng Chao, Huang Xiaojia, Xie Shuibo, et al. The development and future of smart city and smart firefighting[J]. Fire Science and Technology, 2018, 37(6):4.
14. Liu Jida, Kang N, Mai Qiang. Development and changes of domestic intelligent firefighting research based on VOSviewer[J]. China Safety Production Science and Technology, 2020, 16(5):6.
15. Zhang ZG. Research on the application of narrowband Internet of Things in the construction of "intelligent firefighting" model[J]. Fire Science and Technology, 2020, 39(12):4.
16. Afghah, F., Razi, A., Chakareski, J., Ashdown, J.: Wildfire monitoring in remote areas using autonomous unmanned aerial vehicles. In: IEEE INFOCOM 2019-IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS), pp. 835–840. IEEE (2019)



Article

Chronic Crisis: Only Art Can Save Us Now

Rory O'Dea

Hito Steyerl's video work *Free Fall* from 2010 begins with the alarming image of a Boeing airliner plummeting to the Earth. In this chaotic opening scene, a stunned pilot helplessly stares at the message "system failure" flashing on the screen as the metal carapace of the plane ruptures. Objects inside the cabin chaotically whirl around, and the world appears to fall apart before the viewer's eyes. Steyerl made this jarring work as a symbol the financial crisis of 2008, though it strikes me as an all-too relevant symbol for the state of accelerating crisis we currently find ourselves in. As Paolo Magagnoli proposes, "In *Free Fall*, contemporary capitalism emerges as a precarious world, rife with destruction."¹ Human transcendence crashes back to earth, and with them the utopian dreams of modernity.

Acceleration is a critical concept in Steyerl's work, and to my mind, it is also a central component for understanding the Fourth Industrial Revolution. Rather than a fundamentally new phase of human development, Industrial Revolution 4.0 represents an amplification and acceleration of the digital technologies first set in motion by the Third Industrial Revolution. In the words of the economist Klaus Schwab, "In its scale, scope, and complexity, the transformation will be unlike anything humankind has experienced before."² In its extreme realization, Industrial Revolution 4.0 promises the total integration of life on earth, and it is characterized by the convergence and fusion of human innovations in biotechnology, artificial intelligence, the Internet of things, nanotechnology, 3D printing, and robotics that will profoundly blur the boundaries between the physical, digital, and biological spheres. As its

proponents emphasize, the convergent and accelerating nature of these technologies is the essence the Fourth Industrial Revolution, each creating a positive feedback circuit that amplifies the power of all. Ultimately, Schwab believes that emerging technologies "interact with one another and co-evolve as our relationship with data is transformed, the physical world is reformed, human beings are enhanced and new systems with huge power envelop us."³

In a sense, the vision of total integration, interactivity, and networked connectivity proffered by the new industrial revolution is fundamentally ecological in its thinking—Schwab's use of the word *envelop* is critical in this regard. In the vision of the Fourth Industrial Revolution, human technologies rather than natural Earth systems are responsible for catalyzing an abundant and sustainable environment. Viewed in this way, Industrial Revolution 4.0 corresponds with the contemporary movement described as Eco-Modernism, the proponents of which argue that economic growth need not come at the

¹ Paolo Magagnoli, "Capitalism as Creative Destruction The Representation of the Economic Crisis in Hito Steyerl's In *Free Fall*," *Third Text* Vol. 27, No. 6 (2013): 723

² Klaus Schwab, "The Fourth Industrial Revolution: What it Means and how to respond," *World Economic Forum* (January 14, 2016), Accessed on November 22, 2022,

"<https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond>

³ Klaus Schwab, *The Fourth Industrial Revolution* (New York, NY: Portfolio Penguin, 2016) 3.

expense of climate and earth system stabilization. To my mind, the potential problems and blindspots of the Fourth Industrial Revolution and Eco-Modernism become clearer when interpreted through the lens of the *Anthropocene*, the new human geological era we inhabit in the twenty-first century. While the designation *Anthropocene* positions humans as a geological agent and recognizes the ways we have profoundly altered the planet—thus assigning accountability—it also suggests that we remain in a position of mastery and control. Indeed, the author Mark Lynas has deemed humans “the God species,” and the eco-modernist Stewart Brand declares that, “we are as gods and we have to get good at it.”⁴ Mocking the hubris of these statement and the failure to recognize the paradox of developing bigger and more technology at ever increasing rates to solve the crises created by technology, the environmental scholars Lesley Green comments how, “in the Anthropocene, it is the gods and goddesses of reason in the techno sphere who will yield the Geo cycles to come, and they alone will determine who and what is relinked or delinked among the earths spheres”⁵

Combining the worldviews of Eco-Modernism and Industrial Revolution 4.0, we are promised a way out of the current crisis via the simultaneous geo-engineering of the material earth and the radical dematerialization of the human. According to the techno-optimists, though we may ultimately not escape the anthropogenic catastrophe of climate change, we will have created the technological and transhumanist means to transcend the planet we have rendered uninhabitable.

In the early days of 2020, the Corona virus was transmitted around the world like a pulse speeding through the grid of our globalized society. At the same time, unprecedented swarms of locusts—breathtaking in their expanse and density—swept through east Africa and west Asia, blanketing the sky in darkness and devouring all vegetation in their path. On June 20th, 2020, a temperature of 100 degrees Fahrenheit/38 degrees Celsius was recorded in Siberia, the highest temperature ever measured above the arctic circle. The staggeringly high temperature was connected to what is ominously described as Zombie fires—a portentous term that describes the return of a fire from the past that was never fully extinguished. History, it seems, haunts us in the present ecological crisis. The zombie fire is a perfect yet terrifying metaphor for the vengeful return of humanity’s historical actions in the contemporary Anthropocene—a visceral example of what the German theorist Max Horkheimer described as “nature’s revolt.” In the context of the climate crisis, the revolt of nature signifies the moment when the human exploitation of the ecological systems of the earth causes a rupture in those systems, and thus what had been perceived as the unlimited resources and harmony of the natural world turns into a source of menace and threat. Zombie-like, the dead matter of the natural world existing for human mastery becomes undead and is suddenly beyond our control. In the age of the Anthropocene, the philosopher Eugene Thacker proposes that, “The world is increasingly unthinkable – a world of planetary disasters, emerging pandemics, tectonic shifts, strange weather, oil-drenched seascapes, and the furtive, always-looming threat of extinction. In spite of our daily concerns, wants, and desires, it is increasingly difficult to comprehend the world in which we live and of which we are a part. To confront this idea is to confront an absolute limit to our ability to adequately understand the world at all.”⁶ Indeed, life in the times

⁴ Mark Lynas, *The God Species: Saving the Planet in the Age of Humans* (Washington, DC: National Geographic, 2011).

⁵ Lesley Green, “The Changing of the Guards of Reason: Cecil John Rhodes, Carruth Fracking, and the Decolonizing of the Anthropocene,” *e-flux journal* 65 (June 9, 2015), accessed on November 27, 2022
<https://www.e-flux.com/journal/65/336591/the-changing-of-the-gods-of-reason-cecil-john-rhodes-karoo-fracking-and-the-decolonizing-of-the-anthropocene/>

⁶ Eugene Thacker, *In the Dust of this Planet: Horror of Philosophy, vol 1* (Washington and Winchester: Zero Books, 2011), 9.

of the pandemic and climate crisis becomes increasingly uncanny, increasingly unpredictable, and under the pressures of the anthropogenic changes to the planet, the very materiality and reality of the world as we once knew it can no longer be taken for granted.

Crisis represents a rupture in the normal flow of life, and in so doing triggers a potentially fertile moment of destabilization that creates opportunities to either re-entrench and amplify the values of the lost normalcy—here, we can think of former US president Donald's Trump's mantra to "Make American Great Again"—or to deconstruct the normalcy that created the crisis and imagine radical new ways of being in the world made possible by the ruptures. While times of crisis cause real loss and deep destruction, they also vividly demonstrate that things *could be otherwise*. In *The Great Derangement*, the author Amitav Gosh proposes that "the climate crisis is also a crisis of culture, and thus of the imagination."⁷ I tend to agree, and the potential power of art, lies in its ability to critically and speculatively envision what this *otherwise* might be.

Accelerating the Crisis

The unique challenge of our current moment is that the crises we face feel constant and chronic, never relenting nor achieving a point of resolution. The turning point demanded by crisis is never reached, and as the philosopher Steven Shaviro proposes, "Crises never come to a culmination; instead, they are endlessly and indefinitely deferred."⁸ In the case of the climate crisis, which presents an unprecedented existential threat to all forms of life, this deferral of resolution or transformation is tantamount to the conscious commitment to planetary destruction. The political theory and aesthetics of accelerationism is fascinating in this regard. Rather than proposing practical or utopian solutions in the present, accelerationism makes the argument that the only way out of the crisis of capitalism is through it. In other words, current conditions of existence that have generated the crises must be intensified to the point at which they explode or collapse under their own weight, and only then will we be able to move beyond them. In their "Manifesto for an Accelerationist Politics," Alex Williams and Nick Srnicek do not embrace the violent excesses and contradictions of the technology and economics of the Fourth Industrial Revolution, but rather, aim to repurpose its most advanced technologies to common ends: "The existing infrastructure is not a capitalist stage to be smashed, but a springboard to launch towards post-capitalism."⁹ To my mind, what the Industrial Revolution 4.0 and Accelerationism have in common is an attitude of transhumanist "prometheanism" that seeks to amplify our capabilities in order to rationally overcome intellectual and material limits. Williams and Srnicek's accelerationist theory is emphatically speculative, and that authors insist that, "given the enslavement of technoscience to capitalist objectives . . . we surely do not yet know what a modern technosocial body can do. Who amongst us fully recognizes what untapped potentials await in the technology which has already been developed?"¹⁰

The expansive possibilities imagined by Williams and Srnicek echo the sense of unprecedented social, political and economic transformations promised by the technological convergence of the Fourth Industrial Revolution, but the alarming concerns that arises, to

⁷ Amitav Gosh, *The Great Derangement: Climate Change and the Unthinkable* (Chicago: The University of Chicago Press, 2016), 9.

⁸ Steven Shaviro, *No Speed Limit: Three Essays on Accelerationism* (Minneapolis, MN: University of Minnesota Press, 2015).

⁹ Alex Williams and Nick Srnicek, "#ACCELERATE MANIFESTO for an Accelerationist Politics," *Critical Legal Thinking* (May 14, 2013), Accessed on November 27, 2022 <https://criticallegalthinking.com/2013/05/14/accelerate-manifesto-for-an-accelerationist-politics/>

¹⁰ Ibid.

my mind at least, is that we are being driven by the technology rather than driving the technology ourselves. A truly autonomous Artificial Intelligence that cognitively surpasses humanity and no longer has a use for us is perhaps the most dystopian instance of this, but undoubtedly other unintended and perhaps irreversible consequences will present themselves. From the perspective of climate change, we must ask whether it is wise or ethical for humans to pursue massive geo-engineering projects such as spraying sea water into the troposphere to whiten clouds or applying stratospheric sulfate aerosols to reflect sunlight when we know that such large-scale interventions into the planetary systems will have unforeseen consequences.

Given the potentially catastrophic risks that the speculative future promised by Industrial Revolution 4.0 hold, I propose that the art best suited to our state of chronic crisis is that one that decelerates our freefall in order to create the time and space necessary to avert disaster. Or, more simply, to make us aware that we are falling.

Only Art can Save Us Now

In 2017, the philosopher Santiago Zabala released a book provocatively titled *Why Only Art Can Save Us*. The claim of the title bears repeating. *Only art can save us*. Can he actually believe this to be true, and if so, how exactly does he imagine it doing so. For Zabala, the eruption of emergencies into everyday life—whether it be the refugee crisis, the war in Ukraine, terrorist attacks, catastrophic forest fires, or a global pandemic—are not themselves the underlying crisis, but are, rather, the moments when the unending catastrophes and derangements that have been normalized and naturalized suddenly erupt and make reality strange or untenable. The real crisis or danger, for Zabala, is the desire for things to return to normal soon after the rupture in the fabric of reality, normal here being defined by as safety of the globalized system that produced the emergency to begin with. As the political theorist Mark Fisher proclaims, “it’s easier to imagine the end of the world than the end of capitalism.”¹¹ In other words, the emergency or crisis is not the apocalyptic floods and fires caused by climate change, but rather, lies in the acceptance, normalization, perpetuation, and acceleration of the capitalist system that produces them. But the unique power of art is to reveal the ideological prison we are trapped within, and in so doing, bring us back to our senses so that we can see the crisis we have become totally anesthetized to. The goal of art, consequently, is not to put out the fire, but rather, to spark a fire that cannot be ignored.

The Uncanny Anthropocene

One of the most unsettling aspects of the Covid-19 crisis has been the manner in which it has subverted the banalities and rituals of everyday life into sources of anxiety, fear and doubt. Handshakes become taboo. To cough in public borders on being a crime. In her work *Tender: Balance* (2021), the American artist Jill Magid explores the ways that the pandemic has transformed the body into a fraught site of transaction and transmission. For this piece, the artist laser-inscribed the edges of 120,000 American pennies with the phrase “THE BODY WAS ALREADY SO FRAGILE.” The number of pennies equals \$1,200, which is the amount of money that many Americans received as part of the first round of the government’s financial stimulus program during the early days of the pandemic. In the Fall of 2020, Magid began conducting all of her financial transactions in public using only these pennies, which she described as a “dispersed monument” that distributed coin-sized art to the people.

While the initial performance represents a symbolic gesture of mutual care via artistic exchange, the deeper meaning of the work is illuminated in the subsequent installation

¹¹ Mark Fisher, *Capitalist Realism: Is There No Alternative?* (Winchester: Zero Books, 2009).

and its meditation on the interconnected flows of finance and human bodies. A 28-minute video tracked the coins' creation and dispersal, fraught with all the episodes of touch and fear that overtook ordinary transactions with the onset of the COVID-19. Here, each coin becomes a potential vehicle for the virus' spread. While many observers have commented on the ways that the virus was transmitted along the networks of neoliberal capital—this is why wealthy nations were impacted first—the artist here literalizes the threat of money that never stops moving. The sense of money encroaching upon the body itself is disturbingly materialized in an x-ray image of the artist's young son with a coin lodged in his chest. More broadly, the work speaks to one of the great paradoxes of the pandemic, namely, that human health and economic health are seemingly incompatible.

The artistic collaborators Helen Evans and Hieko Hansen—who present their work under the name HEHE—create spectral images that reveal the ecological devastation lurking outside the limits of human perception—analogue to the virus invisibly waiting upon the surface of a penny. In their series titled Champs d'Ozone, the artists overlay projected live images of the Paris skyline with colors representing the unseen pollutants contained within the atmosphere. The work was connected via internet to sensors positioned around the city by an independent organization that monitors the air quality in Paris, which provided a real-time data feed that modulated the colors in the projections. For HEHE, the idea of air quality is central to this work. As consumers, we are driven by a desire to acquire high-quality goods that will provide us with a high-quality lifestyle, yet we are utterly powerless to control quality of the air and atmosphere we are enveloped within and require to live. In pandemic times, when the very air we breathe has been transmogrified into an invisible enemy, the unnatural phosphorescent glow of HEHE's images strike to the heart of our existential fear of nature turned against us.

In his Hiding in the City series, Liu Bolin enacts a form of performative camouflage, allowing himself to disappear into the urban spaces he dwells within. While the dissolution of boundaries separating figure from ground—subject from object—suggest a Taoist metaphysics of oneness with the world, the excess materiality present in these images counters any such transcendental interpretations. In this image, Liu is absorbed into the abyssal darkness of a mound of coal. Coal, of course, has been a singular driving force behind China's rapid economic development manifested in industrialization, urbanization, and excessive consumption. Devoid of regulation, China's coal mines experience regular explosions, cave-ins, and other fatal disasters, while also being a major contributor to air pollution, a leading cause of premature death in. For Liu, "Coal Pile is a conceptual commentary on the consequences of not only the dependence on coal, a limited resource, but the dangers that come for families who work with and use coal, ironically, to survive."

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While the notorious smog that blankets Beijing and other Northern cities wreaks havoc on the lives and health of its residents, others have exploited this environmental crisis for profit. For example, a prominent property developer was reported to have recommended that all real estate developers install air filtration systems in their building. Rather than address the root of the problem to the benefit of all, entrepreneurs to capitalize on the disaster. In her book *The Shock Doctrine*, the journalist Naomi Klein redefines Friedman's economics which views tragedy as opportunity as disaster capitalism. "With resource scarcity and climate change providing a steadily increasing flow of new disasters" Klein ironically observes, "responding to emergencies is simply too hot an emerging market to be left to the nonprofits."¹³ In this scenario, the very right to breath becomes commodified.

¹² Liu Bolin cited in, "Liu Bolin Reminds us of the Destruction brought by Coal and Deforestation," *Sustainable Practice.org* (December 2015), accessed on November 10, 2021, <https://sustainablepractice.org/2015/12/25/liu-bolin-reminds-us-of-the-destruction-brought-by-coal-and-deforestation/>

¹³ Naomi Klein, *The Shock Doctrine: The Rise of Disaster Capitalism* (New York: Metropolitan Books, 2007), 13.

By surrendering his individuality as he is absorbed into the lumpen black mass of coal that fuels China's economic expansion, Liu's image reveals the paradox that arises when the socialist and Confucian ideologies that call for collectivism are combined with the individual freedom of consumer choice demanded by global capitalism. Indeed, such contradiction is a defining characteristic of the climate crisis. We are told to consume more and more, as our economic growth depends on it, yet we must also take personal responsibility for climate change and selflessly modify our patterns of consumption if disaster is to be averted.

More broadly, coal signifies the history of industrialization and its inevitable collapse in the face of entropy. Ironically, the Frankenstein-like second law of thermodynamics was discovered in the process of scientific experiments in pursuit of a perfectly efficient steam engine, and the concept of entropy is thus inseparable from the nineteenth century's inexorable drive for technological progress and the material transcendence it promised. The more humans were able to harness the energy of the earth, the more they accelerated the planet toward entropic dissolution. This is known as the Jevons paradox. In the nineteenth century, the economist William Stanley Jevons observed that despite steam engines becoming progressively more efficient in their use of coal, this technological "advance" did not reduce the burning of coal overall, since the increases in efficiency inevitably led to the expansion of the number of steam engines and the growth they engendered. Consequently, the outcome of all production is some kind of waste. In Liu's image, these time scales of natural history and human history collide. The lumpen masses of coal represent the material compression of millions of years that imaginatively cast us back into a pre-human geological past, and the accelerating consumption of coal in the present projects us into the darkness of a posthuman future.

The Israeli artist Nadav Kander creates photographic images that vividly capture the accelerated material transformation of life in the twenty-first century, and the radically defamiliarizing and destabilizing effects these transformations have upon us. The dizzying pace of industrial modernization that is unfolding in China strikes Kander as a stunning expression of the monumental anthropogenic transformations of the environment, and he describes his sense that, "China is a nation that appears to be severing its roots by destroying its past in the wake of the sheer force of its moving 'forward' at such an astounding and unnatural pace."¹⁴ His images, whose eerily still environments are devoid of the human figure, intimate a posthuman future. While these architectural monuments of modernity threaten to consume the natural landscape and the humans that inhabit them, Kander's representations of them suggest they that simultaneously rise and fall into a ruinous state of rubble. While his carefully composed compositions display a precise and subtle formal beauty, the sense of transience they conjure takes on a haunting dimension in the uncertain future of the Anthropocene. Given the scale of changes that have already been set in motion, Kander speculates that, "These are photographs that can never be taken again."¹⁵

While Kander's photographs evoke science fictional landscapes of the Anthropocene's future in which ruins seem to rise reverse, they also reveal the fiction or illusion of the Fourth Industrial Revolution's promise of an immaterial future. Between the years 2011 and 2013, China used more concrete in its massive and accelerated process of urbanization than the United States used in the entire twentieth century, and the world is literally running out of the sand necessary to produce concrete. While our salvation from the climate crisis will undeniably hinge, in part, on technological solutions, the fourth industrial revolution perhaps embraces a degree of magical thinking in its belief that technology can dematerializing economic production and create a "weightless society" thereby, con-

¹⁴ Andrew Brown, *Art & Ecology Now* (New York and London: Thames and Hudson, 2014), 25.

¹⁵ Ibid.

tinuing its relentless expansion but with a rapidly diminishing effect on the environment.¹⁶ But the scientist preeminent scientist Vaclav Smil makes clear that this is illusion: "The fundamental thing really is that civilization rests on stuff like steel, cement, plastic, copper, and ammonia for fertilizers. ... You can digitize the control processes but not the material force. ... The idea that digitization is leading to a dematerialization of the economy is ridiculous."¹⁷

There is, perhaps, no better metaphor than that of the digital cloud for this dream of technological transcendence from the constraints of material reality, and the Covid-19 pandemic has exponentially accelerated the transition to a totalizing digital economy that makes actual human contact and location in place redundant. But even the cloud world of digital technologies and the virtual world of images are profoundly material in origin. The conceptual artist Simon Starling offers an elegant yet stunning illustration of this point in his 2005 series of five photographs titled *One Ton, II* (Five handmade platinum/palladium prints of the Anglo American Platinum Corporation Mine at Potgieters, South Africa, produced using as many platinum group metal salts as can be produced from one ton of ore). The lengthy title is, in essence, a textual equivalent of the five identical images that index the physical site of extraction from which these photographs materially originate. Necessitating one ton of ore to extract the minerals necessary for their production, the virtual world of the images and the artworld they circulate within can hardly be described as immaterial, and Starling makes it clear that both are deeply implicated and entangled in the economics and politics of resource extraction.

The American artist Trevor Paglen offers another illuminating example. In his series of photos documenting underwater fiber optic cables and the so-called "choke-points" where the American government's National Security Agency performs digital surveillance, Paglen at once renders visible and material the supposedly invisible and immaterial world of digital communication, while also exposing the ways that the democratic free-flow of information is subverted and controlled. As Paglen observes, "Intuitively 'the Internet' seems like a liminal space, a kind of abstract nowhere that is everywhere, seemingly, a space of pure culture. But the telecommunications technologies and networks are made out of physical stuff in the same way that everything else is. ... a lot of the metaphors we use like "the Cloud" or even notions like "Internet Freedom" are highly ideological and deeply misleading.¹⁸ Yet, the more our lives are immersed and contained within the advanced digital technologies of Industrial Revolution 4.0, the easier it becomes to accept if not embrace the illusion of separation from material reality. While the reality created within the total environment of media immersion makes the crisis feel inescapable, it also serves as a dangerous source of pacifying illusion and remove. In his book *24/7: Late Capitalism and the Ends of Sleep*, Jonathan Crary argues that permanent connectivity produces "the final capitalist mirage of post-history," and our ever-increasing enclosure in a virtual cocoon allows us to be blind to the destruction of nature around us. Crary continues, "The more one identifies with the insubstantial electronic surrogates for the physical self, the more one seems to conjure an exemption from the biocide underway everywhere on the planet."¹⁹

Moon Kyungwon and Jeon Joonho's 2012 work *El Fin del Mundo* (The End of the World) is a thirteen-minute film installation that presents a speculative dystopian future in which genetic engineering and biotechnology have gone awry. Set in the late twenty-

¹⁶ Charles Leadbeater, *The Weightless Society* (New York: Texere, 2000); See the discussion of "the myth of dematerialization" in John Bellamy Foster, *Ecology Against Capitalism* (New York: Monthly Review Press, 2002), 22–24.

¹⁷ Vaclav Smil, "Waste Not, Want Not," *Noema Journal* 2 (Summer 2021): 28.

¹⁸ Paglen, quoted in Laura Cornell and Ed Halter, eds., *Mass Effect: Art and the Internet in the Twenty-First Century* (Cambridge, MA: The MIT Press, 2015), 256.

¹⁹ Jonathan Crary, *24/7: Late Capitalism and the Ends of Sleep* (London: Verso, 2013), 9 and 100.

first century, the film begins in the aftermath of a global catastrophe that has submerged most of the world below water and wiped out the majority of the human population. Survivors now eke out a life in the chaotic post-apocalyptic environment in which all semblance of order, values, democratic government, and social systems have collapsed. But a small number of corporations survived the catastrophe. Using the survivors' labor, which is acquired by the promise of the restoration of the material comforts of their former lives, the corporations now compete with one another to acquire total dominance of the new world order.

The End of the World is clearly influenced by science fiction cinema, and explores common tropes of dystopian fiction such as the lone survivor in the midst of an apocalyptic disaster and the emergence of totalitarian governmental and corporate power that the last remnants of humanity must rebel against. For Moon and Jeon, "Sci-fi is always the fable of the present. By employing a way to look at the future instead of the present, we wanted to address current issues, especially in relation to what art is and what art could be."²⁰ While *The End of the World* can be read as a necessary cautionary tale about the fate of humanity and the planet if the technological imagination, driven by power, profit, and its own hubris, is allowed to continually run amok, the visual seduction of its sci-fi poetics risks aestheticizing the myriad crises we face. Rather than proposing real solutions, works like *The End of the World* fatalistically dwell in our collective fascination with futuristic nightmares. Here, the boundaries between critical art and popular culture dangerously dissolve. As the journalist Naomi Klein argues, this aesthetic of pop apocalypticism "is so much a part of our culture that we think all we are capable of doing is becoming like societies portrayed in *Snowpiercer*, *Elysium* or *The Hunger Games*. It's actually not controversial to say this is where we are headed. The question is, can we imagine another way of responding to crisis other than one of deepening inequality, brutal disaster capitalism and mangled techno-fixes, because that seems to be where in this regard, people agree we're headed."²¹

The ecological threat posed by the climate crisis foreshadows an increasingly uninhabitable planet, and, consequently, the possibility of human extinction. This is the post-human reality to which I have alluded to thus far. But the COVID-19 crisis we find ourselves within signals a different meaning of the post-human. Rather than the end of humans, the viral nature of life in the twenty-first century suggests the radical transformation of what it means to be human. Or, rather, it reveals that we have never quite been fully human in the way conceived by humanism. The modern concept of the human subject is rooted in its rigid separation from nature. Instrumentalizing the power of reason—which is what we believe distinguishes us from supposedly unthinking and unconscious animals—humans develop tools and technology that exponentially increase the distance between themselves and the natural world. While this historical telos of modernity results in humanity's alienation from nature, it also reduces nature to an inert object of domination. The paradox of climate change is that the more the natural world is exploited by humans, the more strangely alive and menacing it becomes, consequently forcing us to further distance ourselves from it. A vicious cycle indeed.

Posthumanism, however, represents the end of a system of belief rooted in the inviolable boundary between the human and nonhuman world, and the scholar Tobias Rees has described COVID-19 as the great "un-differentiation event." Without minimizing the very real and ongoing devastation wrought by the virus, the pandemic urgently calls into

²⁰ Moon and Jeon, cited in several interviews with Sook-Kyung Lee between August 2011 and June 2012. Accessed on November 8, 2021, <https://www.tate.org.uk/art/artworks/jeon-moon-the-end-of-the-world-t15357>

²¹ John Tarleton, "Interview: Naomi Klein Breaks a Taboo," (September 2014), accessed on November 8, 2021, <https://independent.org/2014/09/interview-naomi-klein-breaks-a-taboo/>

question the belief in human exceptionalism and our presumed right to be masters of the natural world. COVID-19 proliferates through zoonotic spillover, meaning the virus spreads across species. Bats, pangolins and humans form the pathway of its transmission, and humans are but one among many fertile sites for viral replication. If nothing else, the corona virus has made us keenly aware of the interconnectedness of nature, and the porosity of our bodies within it.

While the virus passes freely into our bodies, and we pass the virus onto others, in a sense viral matter has always been a part of us. Recent research shows that eight percent of our DNA consists of remnants of ancient viruses, and another 40 percent is made up of repetitive strings of genetic letters that is also thought to have a viral origin. If we consider our viral origins in combination with the fact that the bacterial ocean of our gut produces the neurotransmitters that produce thought, the claim that thought itself distinguishes humans from the nonhuman world becomes increasingly tenuous. Tiffany Jaeyeon Shin's immersive and interactive installation *Microbial Speculation of Our Gut Feeling* (2020) has the utopian aim of generating a collective space for speculating on the possibilities for interconnection and care that the microbial world might provide. Taking up residence in a Brooklyn gallery, Shin created a do-it-yourself microbiology lab; among the myriad makeshift scientific apparatus to be found in the gallery are a dehydrator repurposed to make Korean rice wine; a pressure cooker to make essential oils; and a grow tent to incubate assorted baby greens sprayed with lactic acid bacteria. Like Yi, Shin is drawn to that which eludes vision, and the microscopic workings of her impromptu lab suggest a practice more mystical than scientific in nature. For Shin, the regeneration of microscopic organisms explores the possibilities for common survival, interspecies symbiosis, and mutual care. Fermentation is central to her practice. Fermentation is the process of chemical breakdown of materials by bacteria, yeasts, or other microorganisms, and for Shin, it represents a form of transformative alchemy, a force of creative destruction that dissolves and recreates the subjects and objects of the earth in an unending cycle of regeneration. In so doing, it offers a microcosmic vision of human beings harmonized with the world around them.

This essay began with the artist Hito Steyerl's meditation on free fall as a metaphor for crisis, and I would like to return to the metaphor of the airplane to conclude it. In the essay "Beauty and Trauma," the Korean artist Lee Bul notes how,

the secular teleology of technological progress is getting a boost these days from the proliferation of everything with an 'e-' prefix. We are now living, the popular media would have us believe, in a new, brilliant electronic age. But has the word really advanced that much. Living in Korea can point up the contradiction between the growing faith in the new technology and chastening reality of things breaking down.²²

One of the breakdowns Bul calls specific attention to is the crashes of Korean Air's jumbo jets. Despite the fallibility of both humans and machines that can lead to these plane crashes, Bul describes how we join in "the collective, immemorial dream of absolute mastery over gravity."²³ In her sculpture *Willing To Be Vulnerable – Metalized Balloon* (2015–16), we glimpse this dream of mastery and transcendence in the shimmering and weightless mirrored surface of the object which hovers above the gallery floor. In this work, Bul explicitly alludes to the infamous Hindenburg zeppelin, an iconic symbol of technological progress and modernity in the early 20th century that came spectacular crashing down. Perhaps the terror and shock of airplane crashes arises from their revela-

²² Lee Bul, "Beauty and Trauma," *Art Journal* Vol. 59, no. 3 (2000): 106.

²³ Lee Bul, "Beauty and Trauma," *Art Journal* Vol. 59, no. 3 (2000): 107.

tion of human finitude and mortality. No matter how weightless or immaterial our technologies, we are always and ultimately falling. Bul invites us to lean into the fall, to dive into and sift through the wreckage that we have wrought. This is the urgent work of art in an emergency.



Disaster Vulnerability of both Persons with Disability and Evacuation Assistance Volunteers Living in Depopulated Areas

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Abstract:

The number of depopulated areas in Japan, where the population is declining and aging in 63,237 small communities. Of these, 23,372 are depopulated areas, accounting for 32.2% of all depopulated areas. Of the depopulated areas, 2,744 are likely to have zero population in the future. A major challenge in disaster response is that the members of local disaster management organization, who are registered with those who assist in the evacuation of the frail elderly and disabled in the depopulated areas, are also aging. The number of evacuation assistants in those areas will decrease drastically as those who support evacuation will be needed to evacuate. The solution lies in reviewing social capital and removing the normalcy bias toward people with disabilities and bias of against disasters. Our survey of disaster management personnel at facilities for persons with disabilities in depopulated areas revealed that disabilities are able to evacuate independently depending on their level of disability. It also cleared that they can play various roles in evacuation centers. However, we also found that they do not interact with local people on a daily basis, thus do not provide social capital in the event of a disaster. Keywords: COVID-19; pandemic; crisis management; efficacy; anxiety

Keywords: Depopulated area, aged population, Normalcy bias, social capital theory,

1. Introduction

The Asian region is a high disaster-prone region, with twice as many weather-related disasters as Africa, six times as many as Latin America, and 30 times as many as the United States and Europe (UNSCAP, 2022). Moreover, the Great East Japan Earthquake revealed that the mortality rate of people with disabilities was twice that of able-bodied people, and that people who have difficulty evacuating on their own are more likely to be left behind during a disaster (Fujimi, 2011).

The population has been aged and declining the population since 2008 in Japan. It is estimated to become even more severe with the overall population size should be shrinking further more. 817 (47.6%) are villages with declining population. The mountainous areas are at high risk of heavy rainfall and landslide disasters even earth quakes. The aging rate is 28.9 % and 90% of high-risk peoples live in the rural community. Our challenge is finding a problem-solving process of evacuation for preventing from victimize persons with disabilities in the rural communities of mountainous areas.

Background of Our Research :

We focused on facilities for people with disabilities, those were established until the 1980s and are located whether in mountainous areas (urbanization control zones) not in urban areas. In depopulated areas, both those who providing

assist and need of receiving assist in the event of a disaster are aging, and the aging ratio is expected to rapidly increase in the future. This is the greatest issue in minimizing damage from disasters in mountainous areas. Furthermore, people have a normalcy bias that all disabled people are those in need of assistance. Persons with disabilities have different functions and different levels of disabilities. we have to recognize such differences. Many of persons disabilities can evacuate own by own if they can learn evacuation skills by evacuation training with sharing with community residents. Furthermore, persons with disabilities might be helpful one of social capital for community disaster assistance team. Our challenge is finding a problem-solving process of preventing persons with disabilities from natural disaster in mountainous areas. We focused on facilities for people with disabilities, those were established until the 1980s and are located whether in mountainous areas (urbanization control zones) not in urban areas. In depopulated areas, both those who providing assistance and need of receiving assistance in the event of a disaster are aging, and the aging ratio is expected to rapidly increase in those areas in the future. This is the greatest issue in minimizing damage from disasters in mountainous areas. Furthermore, local peoples have a normalcy bias for whom all persons with disabilities are those in need of assistance. Nearly 90% of persons with disabilities are residents in local communities.

2. Methods and Materials

(1) Our study utilized an online interview survey for chief staff of fire and disaster prevention management at 13 Disabilities Facilities in mountainous areas. The survey was conducted a such severe Covid-19 infectious serious season in February to March, 2022.

(2) The another observation research was utilized to observed persons with disabilities who mental disabilities , interec-tual disabilities and physical disabilities on the day time work productive facilities (workplace of vocational facility) in peacetime. Frequency distributions, reliability analyses, and regression analyses were conducted.

(3) Materials were utilized laws and Acts relevant to Disaster prevention, response and recovery in Japan. Interview Survy: Job Training Center for Disabilities in rural and depopulated areas in Kyoto, Japan.

Number of facilities: 13 facilities for self-reliance for disabilities.

Survey period: February-March 2022.

Survey method: Online interview survey for 13 chief staff of fire and disaster prevention managers.



Fig.1 Job Training Center for Disabilities 2022 (photo by author, Kitagawa)

(4) Interview Survey contents: Six categorized interview questions were asked of the facility's disaster & fire risk managers at facility for self-reliance support for disabilities.

(i) Social capital elements : Actively interact in the community. (ii) Evacuation Management: Safety evacuation guidance to disabilities living in the community. (iii) Emergency evacuation planning guide: Inform routes and evacuation methods to disabilities who evacuate independently. (iv) Prepared evacuation supporters (volunteers in community): Community peoples' ability of support disabilities. (v) Facility Location: evacuation difficulties in a rural depopulated areas. (vi) Expecting Community peoples' evacuation support: unconscious bias to disabilities, and ability of evacuation support as the social capital.

3. Research Limitations

This study has several limitations of interview survey and observation survey, both. Our survey was postponed 3 times because of the cluster of Covid -19 at disabilities facilities. Both of survey of the facility staff and observation survey of the disabilities working at the facility were postponed, 3 times. Thus, we conducted online survey for facility staff as fire and disaster prevention manager in each facilities were successfully. However the most of them had not learn such online interview, their each answer for question were short. This is clearly limitation of our interview survey.

4-1 Interview Results (Findings)

Interview Survey to disaster & fire risk managers at disabled facility:

(1) Social capital elements, (2) Emergency of Evacuation: All those who at the 13 facilities are little involved community activities. They do not contact community members. They are busy for their duties, teaching technical skills, support daily living as their daily routine work.

Disabilities work from 10:00 to 4:00 pm, Mon. to Fri. The staff works from 9:00 to 5:00 pm and add overtime work usually. They must be tired when they return to home. On weekends, they need time to rest at home with families. The younger staffs also devote themselves to their hobbies, shopping, and dating. Even though Staffs are the key person to contact community people for disabilities. All staffs answered, they know the community life of facility users who stay at home after work and weekends.

From this interview survey we found Disabilities are living alone, isolated from the community. They are isolated from disaster information from their community and evacuation support by community people. (3) Emergency evacuation planning guidance :

We asked if they inform disabilities of appropriate evacuation routes and evacuation methods, because majority number of disabilities are minor disability than Moderate disability or Severely disabled. Need to know their ability of independent evacuation. The response of 13 facility staff answered positively. Disabilities, physically, intellectually, and mentally disabled those who can work at facility and live in the community by themselves. The answer was that It is inconceivable that they cannot evacuate independently. Only wheelchair users are limited to evacuate on their own. Sometime mental disabilities may have difficulty evacuation in an extraordinary event. Disabilities are needed to train the evacuation. We found that All 13 facilities prepared BCP in place, but staff of firefighting and disaster prevention 1 out of 13 was aware of their facilities' BCP, despite overseeing is a major problem. We have to know the fact of disabilities who can evacuate independently. This fact is an effect to erase peoples' normalcy bias of disability.

(4) Prepare the evacuation supporters in a community:

The presence or absence of community supporters and their number is essential for facilities where many people with disabilities congregate and work in one place to ensure the safety of disabilities at a disaster.

Every prefecture in Japan has a local voluntary firefighting & disaster response organization called “Sho-bo-dan”. Their functions are quite different to volunteer’s relief. Disaster volunteers can support to victims after a disaster, But Sho-bo-dans can relief victims at a disaster. the existence of Sho-bo-dan is incredibly significant for the disabled facilities. The member of Sho-bo-dan in local cities/towns are gradually aging, disabled, too. The expectation of the Sho-bo-dan will be changed, no longer be able to rely on their support. And members will need assistance just as much as the disabled. 2/3 staff of 13 facilities concern this issue. Soon or Later, every depopulated area will face the same issue as well. The staff took this seriously and recognized the need to promote independent evacuation of disabilities.

(5) Facility Location and Evacuate tool:

If visualization of disaster risk and warning area and for real-time information should be done, how to communicate the nearest evacuation site from the current location to disabilities, those are immediate resolving issues. The wave of DX is also coming to disabilities and facilities. Many disabilities have mobile devices. They are not aging yet, the information can be conveyed to disabilities in an easy to understand form, independent evacuation will be realized sooner.

(6) Expecting Community peoples’ evacuation support

Expectations for the community people evacuation assistance is to serve as social capital in the community to assist in the evacuation of disabilities in the event of a disaster. In response to this, as mentioned above, all respondents captured the concern that the people who are already considered capable of supporting the community are aging, and that the population will be further aged peoples.

1/13 responder indicated that the greatest need is to dispel the normalcy bias of disabilities. She also said that it is necessary to collaborate with the community volunteers to prepare meals together in shelters, with using the experience in food processing and production skills as their daily job at the facility.

This is particularly important awareness for the people. It is possible to realize the "mutual aid," in which disabilities can utilize their abilities and contribute to the benefit of community.

4-2 Related Laws and Regulations

(1) Japan's Basic Law on Disaster Countermeasures defines the vulnerable to disasters as the elderly, the disabled, infants, expecting mothers. (Basic Act on Disaster Countermeasures 2013)

(2) The Flood Prevention law obliges the local government to prepare a list of requiring special support peoples in evacuation action.(Guidelines for Support Evacuation Actions,2015)

(3) Current Data: Number of facilities for special evacuation support : 111,950

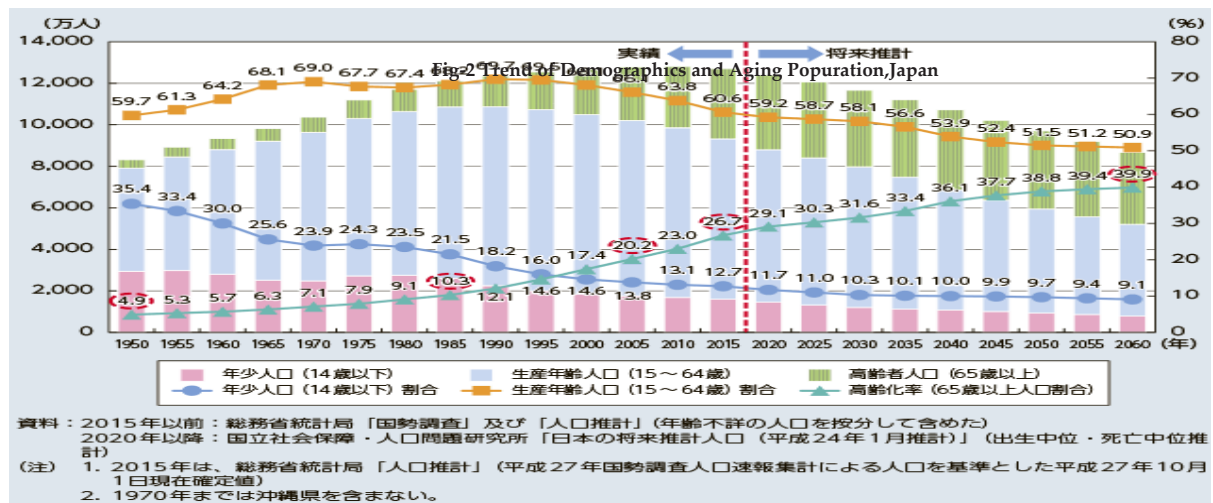
Number of facilities procedure evacuation plans: 92,712

The expected inundation zone: the local government must prepare a plan to ensure evacuation, including evacuation methods, evacuation sites, and evacuation routes, by means of hazard maps (2015).

(4) Flood Prevention Law requires: Measures against the largest floods, inland water and storm surge. Sewerage water Law requires: Measures against flooding through public-private sector partnership.

4-3 Attributes of People with Disabilities in a Super-Aging Society

The population of Japan at about 123.6 million, the seventh largest population in the world following China, India, the former USSR, the USA, Indonesia and Brazil. Japan's population density, 327 persons/km², is one of the heaviest in the world. The total number of disabilities are 9366,000, or about 7.4% of the population. Of these, 4.4 million are physically disabled, 1.1 million are mentally disabled, and 3.9million are mentally disordered. The number of disabilities are increasing. And nearly 90% of disabilities are living at home in the communities. The percentage of the population aged 65 and over in Japanese aging rate is 28.9%(Population and Social Security Research Institute, 2022).The percentage of residential disabled population (90%) who aged 65 and over is 72.6% (about 2.7 times) compare of 1970.It was about 30%. The disabled population is also steadily aging.



Source : White paper on the Aged, Ministry of Health, Labor and Welfare

By disability, the percentage of institutionalized persons with intellectual disabilities was 11.1%, compared to 1.7% for physical disabilities and 7.2% for mental disabilities. There are 4.36 million people with physical disabilities, 1.082 million with intellectual disabilities, and 4.193 million with mental disabilities. In terms of the number of persons per 1,000 population, there are 34 persons with physical disabilities, 9 persons with intellectual disabilities, and 33 persons with mental disabilities. Although this is not a simple total because some people have more than one disability, approximately 7.6% of the Japanese population currently has some form of disability. Urbanization control areas are considered "areas where urbanization should be controlled" and, in principle, no buildings can be built. However, since permission is granted for facilities for the care needed older adults and the disabilities even in an urbanization control area when the local government deems it necessary based on the demand and needs of the surrounding residents, many care facilities for the older adults and disabilities were built in such areas as the population aged. These facilities are often located in rural areas, where traffic is inconvenient and roads are narrow.

Fig-3 Physical Disabilities

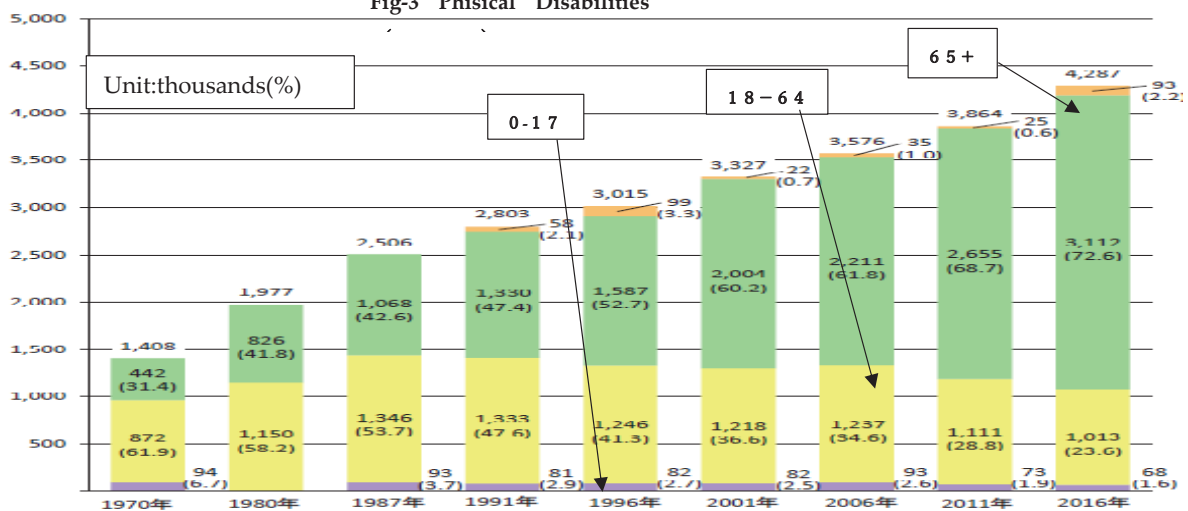
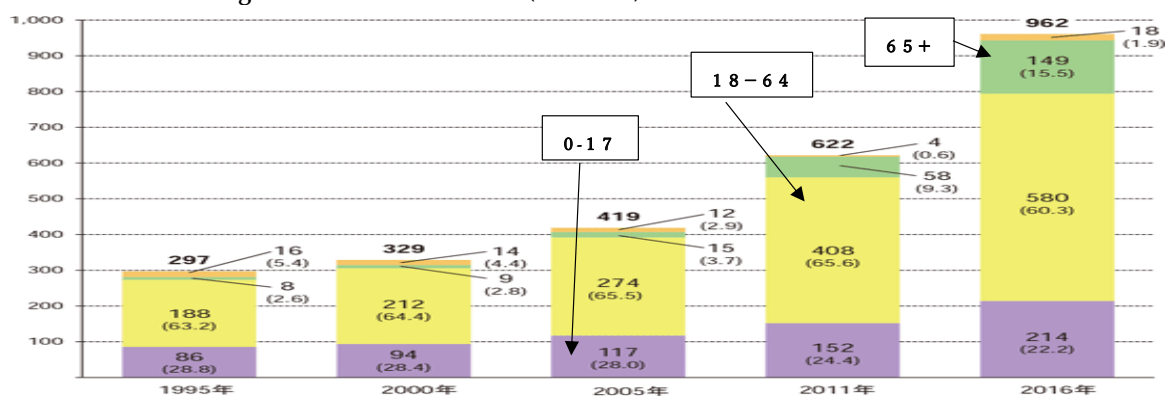
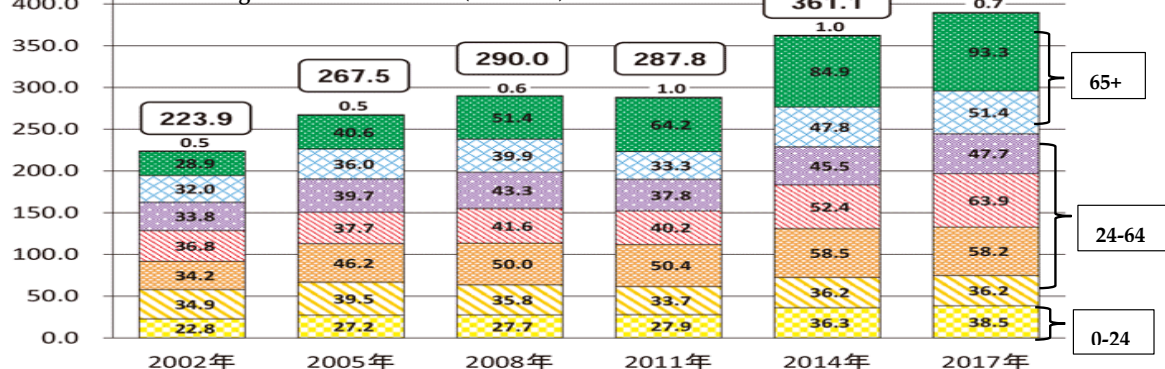


Fig-4 Interlectual Disabilities(residents)



(単位:万人)

Fig-5 Mental Disabilities(residents)



5. Conclusions

In this study, there are several considerations in our interview survey. We reviewed community resilience. We are trying to develop a community disaster resiliency and social capital. We found a difference of normalcy bias by persons with disabilities facility staff who charges fire and disaster prevention and local community peoples. Our research suggests the importance of identifying pre-disaster and post disaster vulnerabilities as their awareness of abilities are sufficient to evacuate by themselves.

If we are to truly create resilient communities, we can understand older adults and disabilities ability at an event of disasters. Awareness of these vulnerabilities is neighborhood

Our survey area was an aging and depopulated area, peoples who signed up the staff as evacuation assistance voluntary teams, Sooner or later, they will be rescued by some one more younger people.

Vocational self-support disability facilities' users are currently younger than 50 and be able to evacuate independently. They can work there until 65 years old. They are getting older and gradually more severe disability. Evacuation in depopulated area concerns increasing the number of people needing their support. Soon or later Sho-Bo-Dan members (community disaster prevention volunteer's group) are not expected the evacuation social capital. For the social capital of prevention from disaster and evacuation assistance when a disaster occurrence, those members have to know the need to understand long-term recovery efforts and how they serve to vulnerabilities.

References

1. Edwards Frances L., All hazards, Whole Community: Creating Resiliency, Disaster Resiliency, Routledge. Taylor & Francis, 2013, 21-47,
2. Rivera Fernando I., Settembrino, Marc R. Sociological Insights on the Role of Social Capital in Disaster Resiliency, Disaster Resiliency, Routledge. Taylor & Francis, 2013, 48-60

3. Arora, R., Arora., Disaster Management-Medical Preparedness, Response and Homeland Security. CABI International,2013, 521-590
4. Parsloe, P. Old people at Risk, Training Professionals in Risk Assessment and Risk management. Risk Assessment in Social Care and Social Work, Athenaeum Press,1999,201-216
5. Diacu, Florin, Model and Prediction- How Far Can We Go, Press Princeton.edu,2010,168-178
6. Hilhorst,Dorothea, Disaster. Conflict and Society in Crises-Everyday Politics of Response, Disaster Conflict and Society in Crises, Taylor& Francis, 2013 1-16,258-274
7. Valcik Nicolas A., Tracy Paul E., Guidelines and General Information for public Officials and Administrators, Case Studies in Disaster Response and Emergency Management Press, Taylor & Francis,2013, 6-84
8. Avgar Amos, Kaufman Roni, Community Development and organizational Interventions- Challenges for Community Development in Disaster Situations, Crisis as An Opportunity, University Press of America,2011 33-46
9. Lawless Cristopher, New Ideas for Emergency Risk Regulation, Governing Disasters, Edward Elgar Publishing, 2011,233-262
10. Tsutsumi Kenji, Social Capital and Environment of Rural Villages, 人口減少・高齢化と生活環境 (Population declining ・ Aging and Living Environments) 2015 199-218
11. Suzuki Toshifumi, Tachibana Akihiko

University Enterprise Collaboration for Disaster Resilience in Thailand

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Abstract: Nowadays, the university enterprise collaboration (UEC) has been introduced as the key successful tool for applying to achieve the missions of education, research and academic services all over the world. However, the UEC policies and practices, both national and institutional levels, have been focused on economic development rather than social development. From literature reviews, it has been a little number of UEC studies which focus on the serious global social issue of climate change, particular to disaster resilience (DR). Therefore, this paper aims to discover the UEC for DR amongst three case studies of Thai universities which are Chiang Mai University (CMU), Naresuan University (NU), and Mahasarakham University (MSU). The surveys were developed and sent to research participants in three universities. The results show the difference of UEC types and activities that is necessary to approach for Thai universities. In addition, three main enabler factors, which support for implementing UEC for DR in Thai universities, are (1) supporting of disaster management (DM) policy, (2) empowering the collaboration and coordinate working system amongst all stakeholders, and (3) strengthening the academic staff capacities.

Keywords: University Enterprise Collaboration; Disaster Resilience; Thailand; Thai Universities

1. Introduction

The university enterprise collaboration (UEC) concept has been initiated and disseminated widely both developing countries and developed countries [1][2][3][4]. It can be done through a number of channels such as industrial training programme, skills development, conducting knowledge transfer projects, co-researching, consulting, internships through public-private partnerships, and student exchanges [5]. The advantages of collaboration can be created to both university side and enterprise side [6]. On the university side, it could engage in up-to-date problem-based projects; and could employ the body of knowledge and skills in real life situation. Considerable funding could be achieved. On the enterprise side, it could: (a) gain the right person working for their projects; (b) attain the state of 'the lower costs and the better profits'; and (c) become a knowledge-based enterprise, throughout collaborative partnership. Additionally, there still be the benefits for the third side; that is societal, which could gain profits from those innovation and invention developed through the partnerships. Social problems could be also solved [7].

The concept of collaboration between Thai university and other sectors has been recognized. However, in general, the UEC is still dearth of continuity, implementation, funding, and long-term strategic plan [8]. The effective collaboration could be obtained through four main pathways: (a) creating efficient policy; (b) enhancing skill acquisition and job op-

portunities; (c) allocating research grants strategically; and enhance (d) supporting collaboration both national and international level [9]. The intensity of collaboration between university and enterprise can be grouped into low, medium, and high levels [6].

The UEC practices has been considered as the supporter for strengthening Thai university collaboration with outside enterprises in the aspects of teaching and learning, research, and academic services. For examples, numerous of UEC practices have been introduced such as University Business Incubator (UBI), Technology Licensing Office (TLO), Collaborative Research Fund, Innovation & Technology Assistance Program (iTAP), Research & Researchers for Industries (RRI), University Science Parks, Talent Mobility Program [10]. However, Thai government's UEC policies and practices have been mostly focused on national economic development, for example, Thailand 4.0, a new economic model, which drive partnership among university and private sector.

Therefore, this paper aims to study of the types of university enterprise collaboration (UEC) for disaster resilience (DR), UEC activities, and barrier & enabler factors amongst three universities in Thailand, which includes research participants from Chiang Mai University (CMU), Mahasarakham University (MSU), Naresuan University (NU). Moreover, the related documents were collected and analyzed.

2. Materials and Methods

There are two main methods in this study. First, the official government policies which are related to UEC for DR were analysed in order to understand national policy. Second, the structure interviews based on questionnaire were collected through three Thai universities. It includes Chiang Mai University (CMU), Mahasarakham University (MSU), and Naresuan University (NU). The structured interview that was followed the questionnaire separated into three main parts. They are UEC types, UEC activities, and barrier & enabler factors on doing UEC for DR.

3. Results

There are four main findings. The first part presents current policies and practices that related to UEC for DR through the document study. The second part illustrates UEC types. The third part shows UEC activities in the aspect of teaching, academic service, and research in three universities of this study. The last part displays barrier & enabler factors for doing UEC for DR. The result details are in the follow.

3.1 The UEC for DR: Policy to Practice

The natural disaster has been the serious global issue. The roles and duties of all governments and stakeholders have been need for (1) enhancing resilience at local level, (2) increasing public investment for disaster and climate risk management to protect and sustain development gain, (3) promoting private sector role – public and private partnership for disaster risk reduction (DRR), (4) promoting the use and development of science, technology and innovation for DRR, (5) enhancing governance, transparency and accountability of all stakeholders in disaster risk management (DRM), and (6) encouraging an inclusion of DRR as part of sustainable development [11]. Nevertheless, the UEC policies and projects have not been identified how are they related to disaster resilience (DR); and there is very limited study that has investigated primarily on this issue. This situation seems to be a critical gap to enhance UEC concerning DR in Thailand.

Research and Innovation (R&I) policies and practices were recognised as the critical part of the UEC which can be generated the innovation supplying for driving economic and social development. These policies and practices related to several ministries related

to DRR such as Ministry of Education, Ministry of Higher Education, Science, Research and Innovation, National Research Council of Thailand (NRCT).

In the national plan of disaster management, the activation of the plan was designed for achieving the goals. There was the set of actions which can be illustrated in Figure 1.

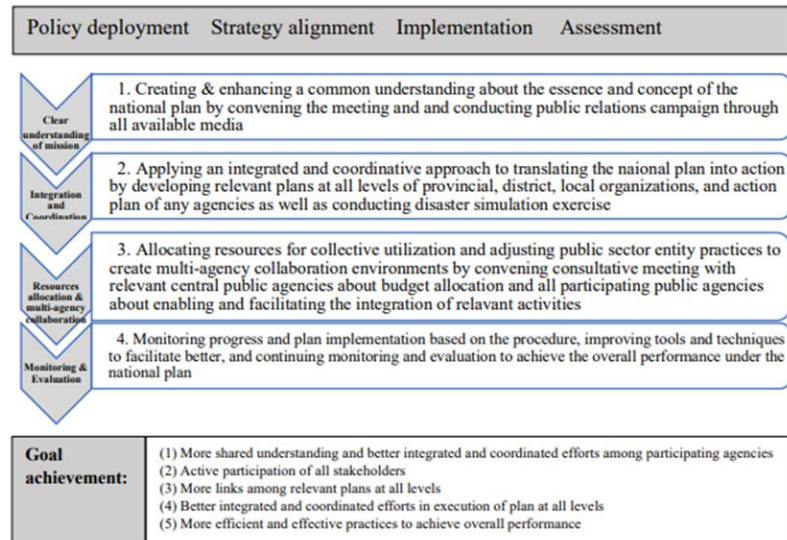


Figure 1 Process for translating the national DM plan into action

In Figure 1, it can be found that the UEC is needed to be closely linked amongst all participants of implementing national plan for disaster management and university can support the advancement of science, technology and innovation of disaster aspects in order to conduct to giving information, instituting awareness, teaching, training, consulting, academic servicing, and doing research and innovation for serving any participants.

Therefore, the policies and practices of the UEC for DR in Thailand, it was quite clearly statement. However, the literature reviews showed that something went wrong when bring the disaster approach through the policies and practices. There were many problems for using UEC.

In summary, it seemed to be difficult to apply UEC for DR successfully in both policies and practices in Thailand. The gap of UEC for DR can be categorized into two layers of policies and practices which may be affected on implementing UEC for DR in Thailand.

3.2 The UEC Types

The collaboration in three universities was both formal and informal agreement. Mostly, it was depended on potential academic staff for finding his/her industrial networks. These can be classified into four main channels of Personal contact, Mutual agreement, Specific function units, and Individual project. It can be explained as follows.

- Personal contact: UEC is depended on personal contact. Strong relationship between staff and industry can lead them to work together for achieving the UEC project goals.
- Mutual agreement: UEC is depended on the university's MOU agreement between university and industry. The university needs to assign staffs to work with industry to achieve the UEC project goals.

- (c) Specific function units: university has the UEC function units which work together with staffs and industry for achieving UEC goals e.g., science park, university business incubator centre, technology licensing unit, technology clinic etc.
- (d) Individual project: relationship is in short term and temporarily occurred when they want some help from the others. For examples, staff wants industry to join his/her short-term research project or industry wants staff to train their employees to upskill for improving productivity.

3.3 The UEC Activities

The university enterprise collaboration (UEC) is the key success for achieving the 21 academic goals in three universities in this study. However, most UEC practices in the universities were focused on economic development rather than social development, particular in disaster management. According to the survey, the UEC in three universities activities have been achieved through three main aspects: teaching, academic services and research. The details are illustrated in Table 1.

Table 1 The UEC Activities in Three Universities

Teaching & Education	Academic Services	Research
* Information & Suggestion	* Information & Suggestion	* Information & Suggestion
* Curriculum development	* Knowledge transfer	* Research project
* Course learning development	* Training & Workshop	* Joint research
* Expert instructor	* Seminar & Conference	* Corporate research project
* Industrial site visit	* Academic service project	* Matching research funding
* Field trip	* Consulting	* Sharing facilities & resources
* Training & Internship	* Materials testing	* Licensing
* Cooperative education	* Laboratory testing	* Staff exchange
* Sharing facilities & resources	* Sharing facilities & resources	
* Student project	* Staff exchange	
* Problem/Project based learning	* Talent mobility	
* Staff exchange		

3.4 The Barrier & Enabler Factors on Doing UEC for DR

The findings show significant barrier factor that affected on the successful implementation of the UEC for DR is structural level. It has been stated that the ineffective universities' mechanism of UEC is pivotal barrier factor for hindering UEC for DR. This claim focuses predominantly on lack of unit, resources, budget and process that could encourage university academic staff in doing UEC for DR, as a number of research participants describes:

- Interviewee A: "I aware about UEC, but it's quite not effective for university collaboration. I try the best to do my duties under UEC by myself. No university's mechanism for helping me to do effective UEC activities."
- Interviewee B: "University policies and practices should be focused on the university and industry partnership activities and support these by resources and budget."
- Interviewee C: "The needs or expectations of industry and university are very important for finding of good matching of collaboration (UEC)."

- Interviewee D: "University has promoted UEC, but it's not effective because of (1) lack of central unit that response to do the collaboration with industry and manage the relationship, (2) lack of university policy to encourage staffs for doing things in industries under the collaboration, (3) without university fund for continuing the collaborative project, and (4) high expected results from industries, but no support from them."
- Interviewee E: "Thailand locates in the safe zone of natural disaster. We don't need to focus more on the research in this issue."

In the views of gaps for doing UEC above, the enablers that support UEC can be classified into three group of views. They are (1) supporting of DR policy, (2) empowering the collaboration and coordinate working, and (3) strengthening the staff capacities. The detail of these enablers can be seen in the Table 2 below.

Table 2 The enablers that support UEC for DR

Group of views		Enablers
1	Supporting of DM policy	<u>National DM Policy</u> - Updated policies to support DM from national to local and from government to all stakeholders - The integrated policies and practices of DM, coordinate working amongst all stakeholders - Government agencies who take action on DM e.g., Dept. of Disaster Prevention and Mitigation, Meteorological Department, Dept. of Disease Control, etc. - The legislation of DM - The government decentralization of DM from central to community implementation - Communication/mass media focus on DM - Effective policy deployment process at all levels
		<u>University DM Policy</u> - University & faculty policy and practices to support staff to do R&I - Focus of university administrators from university to department levels e.g., policy, vision & mission, strategy, practice, staff support, and facilities & resources, etc. - International DM cooperation: information, knowledge & innovation, experts, etc. - DM education & research e.g., awareness, education, training, conference, etc. - University characteristics: comprehensive or research-based university
2	Empowering the collaboration and coordinate working	- Building trust, transforming informal to formal collaboration - Building good environment and providing space, internet, facilities and resources - Building and strengthening partners network - UEC system and mechanism for doing DM - Partner selection process event e.g., meeting, workshop, seminar, site visit, etc. - Intellectual properties consideration - Database of partners both enterprise requirements and university staff expert - Funding for UEC purposes e.g., teaching, academic service, research, etc. - Reward and recognition system for doing UEC
3	Strengthening the staff capacities	- Appropriate staff workload - Building capabilities of supporting staff and administration unit - Clear understanding enterprise needs and suitable matching staff for developing product & process innovations, knowledge & technology transferring and solving industrial problems - Reskill/upskill of academic staff for improving their research potential & transferable skills for research development framework - Graduate programs for producing master/ Ph.D. students who generate research works as well as developing research skills for university staff - Providing the sources of knowledge e.g., library, publication databases, etc. - Research environment for building research culture, motivation & incentive, appropriate regulation, promotion to higher academic position, and others - Depended by individual capabilities of staff for doing UEC and research skills - Expertise network, partnership network and research mentorship system

4. Conclusions

The UEC is a very important tool for developing innovation to improve economy and society. Therefore, most of UEC project focus on economic development rather than social development such as disaster management issues. Following this study, it is not an easy task to apply UEC for DR in both policies and practices in Thailand. It has been shown that two main layers: policies and practices, are the gap of UEC for DR which could effect on implementing UEC for DR in Thailand. Although the three universities in this study have been doing a number of projects and activities that related to UEC for DR, it still faces significant barrier factor. It is their structural level that has affected on the successful implementation of the UEC for DR. However, three main group of views have been identified as the enablers that could support UEC for DR. They are (1) supporting of DR policy, (2) empowering the collaboration and coordinate working, and (3) strengthening the staff capacities. In summary, in order to promote as well as strengthen UEC for DR in the university, it is a need to designate particular unit for UEC for DR because it could sustainably support universities' staff in doing projects, plan and strategies that related to UEC for DR.

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References

1. Salleh, M.S. and Omar, M.Z. (2013). University-Industry Collaboration Models in Malaysia. *Procedia – Social and Behavioral Science*, 102, 654-664.
2. Larsen, K. et al. (2016). Promoting University-Industry Collaboration in Sri Lanka. Washington, DC: International Bank for Reconstruction and Development, The World Bank.
3. Zhou, P., Tijssen, R., & Leydesdorff, L. (2016). University-Industry Collaboration in China and the USA: A Bibliometric Comparison. *PLoS ONE*, 11(11), 1-18.
4. Tantanee, S., Buranajarakorn, P. and Apichayakul, P. (2018). University-industry linkages in the disaster resilience sector: A case study of Thailand. *Procedia Engineering* 212(2018), 519-526.
5. Liyanage, C. et al. (2020). University-industry partnership (UIPs) for research and innovation in disaster resilience. in Theme Seminar 2020 Sri Lanka Association for the Advancement of Science
6. Guimón, J. 2013. Promoting University-Industry Collaboration in Developing Countries. *Policy Brief, Innovation Policy Platform*, OECD and World Bank.
7. Kong, E. (2013). Strategic Trisector Collaboration in Disaster Response. *World Review of Business Research*. 3(2), March 2013 Issue. 127 - 140.
8. Shiller, D. and Diez, J.R. (2007). University-industry linkages, potential and realization in developing countries: Thai experiences. *Tech Monitor*.
9. Tantanee, S., Apichayakul, P., Buranajarakorn, P., Pardthaisong, L., Suwanprasit, C., Charoenpanyanet, A., & Sin-Ampol, P. (2019). Policies to promote research and innovation in developing countries' universities: The case of Thailand. *Indian Journal of Public Administration*. 65(3), 718-732.
10. Pathumnakul, S. (n.d.). University-Industry Collaboration Programs in Thailand. Khon Kaen University, KCU-INNOPRISE.
11. Department of Disaster Prevention and Mitigation. Ministry of Interior. Thailand. (2015). National Disaster Risk Management Plan. (<https://data.opendevopmentmekong.net/dataset/2558>).



Article

Community Disaster Resilience Model for Sustainable Society in the Era of Climate Crisis

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Abstract: The purpose of this study is to suggest a community disaster resilience model to become a sustainable society in the era of climate crisis. The climate crisis not only has a direct impact on human life, but also has a wide and severe impact on various environments surrounding humans. In fact, all spheres that make up or surround a community are affected. For example, all areas such as politics, economy, society, culture, nature, science and technology, medical health, military, and safety of a country or region are being forced to change by the climate crisis. If we refuse to change due to the climate crisis or do not accept a new paradigm, the very survival of human society will be threatened. If we want sustainable living, if we want sustainable development, we must do our best to embrace all the changes the climate crisis demands. Humanity must create and adapt to a new normal life paradigm, just as it creates a new great civilization. In this context, in order to secure community disaster resilience, it is necessary to improve resilience at individual, community, and environmental levels. Efforts should be made to improve psychological resilience, physical resilience, and economic resilience at the individual level, family resilience, conflict resilience, and cultural resilience at the community level, and facility resilience, administrative resilience, and nature resilience at the environmental level.

Keywords: community; disaster; resilience; sustainability; climate crisis

1. Introduction

Modern society is in the era of climate crisis. In the history of human society, there has never been a time when human life and climate are more closely linked than now. Although climate may have affected agriculture or changed life in any one region or country, it has never had such an enormous global impact as it does today. In recent years, the scope and intensity of climate impacts are so great that global leaders are using the term climate crisis instead of climate change.

The climate crisis not only directly affects the lives of individual humans, but also has a wide-ranging and severe impact on various environments surrounding human communities. The climate crisis is affecting all spheres of community. For example, the climate crisis is forcing changes in most areas of the community, including politics, economy, society, culture, nature, science and technology, medical health, military, and safety in a country or region. If we reject the changes caused by the climate crisis or do not accept the new paradigm, the climate crisis will threaten the very survival of our communities. If we want sustainable living, if we want sustainable development, we must do our best to embrace all the changes the climate crisis demands. It means that humanity must create and adapt to a new normal life paradigm, just as it creates a new great civilization.

Of course, the climate crisis is not the only major new wave of change. The 4th Industrial Revolution is also forcing tremendous changes in human life. The common feature of the climate crisis and the 4th Industrial Revolution is that they are products created

by humans over a long period of time. For example, with the help of big data, disaster managers can identify potential hazards, take action to prevent them, and provide disaster resilience to cities (Mano, et. al., 2019). But it is true that these two waves of change are not identical. Humanity has created a desirable wave of change called the 4th Industrial Revolution with endless imagination, scientific and technological challenges, and unbreakable will and passion. In contrast, the climate crisis is a wave of change in which humans are alienated from nature as a result of endless desire and consumption along with science and technology developed by humans. The relationship between the climate crisis and the 4th Industrial Revolution, which ran in opposite directions, existed in a completely different paradigm in the past. But for now, these two giant waves are meant to heal the many members of society damaged by the climate crisis.

There are two important tasks that the present generation, who is living a happy life today, must pursue. First, the global society needs to improve its perception of the seriousness of the climate crisis. Responding to the climate crisis is now a survival crisis that can no longer be passed on to the next generation. Because the climate crisis is a survival crisis. Second, the global society needs to increase its resilience to various disasters. Due to the climate crisis, natural disasters on a scale incomparably larger than those of the past are occurring every day. The severe damage it causes is crippling resilience. Resilience arises from the social order as an inherent property of social organization, as a consequence of intentional actions aimed at lessening the impacts of disaster, or as a spontaneous outpouring of collective innovation when disastrous events occur (Tierney, 2014: 5). Disasters affected by the climate crisis include not only natural disasters such as typhoons, floods, torrential rains, heat waves, heavy snowfalls, and droughts. Rather, various disasters, such as super-large forest fires, the emergence of pandemics, power grid losses, and information and communication system collapses, are caused by or affected by the climate crisis.

In this context, this paper aims to propose a community disaster resilience model necessary to create a sustainable society in the era of climate crisis. To achieve the purpose of the study, this study set the following goals. First, it examines what it means to create a sustainable society from disasters in the era of climate crisis. Second, in order to secure community disaster resilience, which resilience needs to be improved? To be a sustainable society, it is important that communities have the ability to recover from disaster damage to a normal state. Third, this study aims to present a sustainable community disaster resilience model. This model consists of important indicators in three domains: individual level, community level and environment level.

2. Climate Crisis, Resilience, and Sustainable Society

Just 20 years ago, disasters were large-scale events that occurred very rarely and caused great damage. Today, however, a disaster can be defined as a routinely occurring event that causes great damage. The reason why man-made disasters always occur is that unlike in the past, people and people, people and things, and things and things have become hyper-connected through information and communication technology according to the development of science and technology. Moral hazard is also a reason why the tendency to neglect the safety of employees, systems, and facility operation does not disappear. In contrast, the climate crisis can be described as a major cause of natural catastrophes that occur on a daily basis, with great damage to millions of people. Sometimes the climate crisis is the reason for the frequent occurrence of large-scale man-made disasters.

A society with resilience that can overcome various disasters caused by the climate crisis and return to its normal state can be defined as a sustainable society. In order to become a sustainable society, the causes that accelerate the climate crisis must be identified. First of all, it is desirable to work to eliminate the causes accelerating the climate crisis. Second, if it is difficult to eliminate the causes of the climate crisis, it is possible to transform into a sustainable society only when efforts are made to slow down the progress of the climate crisis.

There is considerable overlap between the two concepts of resilience and sustainability, and it is necessary to understand resilience and sustainability together (Rodriguez-Nikl, 2015: 157-169). To become a sustainable society, it is necessary for affected communities to have the ability to overcome the disaster and recover to a normal state or return to a situation better than the pre-disaster normal state. A society composed of communities with disaster resilience can be said to be a sustainable society. Resilience encompasses a society's capacity to bounce back after a disaster, its level of preparedness to confront or deal with a disaster and its ability to recover quickly and successfully (Alexander, 2013: 2707-2716; Platt, et. al., 2016: 447-449). Resilience involves sustained practices, policies, and plans that improve the ability of communities to recover disasters. Since most disasters are local and have unique and different impacts on communities, resilience is focused at the community level (Truesdale and Spearo, 2014: 735).

In order to increase community disaster resilience, it is necessary to consider resilience from three perspectives. First, disaster resilience should be considered at the level of individuals constituting a community. It is only when disaster-affected individuals recover from disasters that the resilience of the community can be secured. Resilience at the individual level requires the capacity to return to a normal state prior to a disaster from psychological, physical and economic harm. Disasters bring shocks that individuals cannot handle with their capacities, so it is urgently required that the community overcome them and support individuals so that they can live normally. When disasters strike, lots of people suffer physical, mental and material damage. Vulnerable groups such as the elderly, children, the disabled, and foreigners are not prepared for disasters, and do not have the conditions to effectively prepare for disasters (Zhang and Lee, 2022: 39).

Second, disaster resilience at the community level should be considered. A community consists of two or more people who are closely related to each other and interact with each other. It is necessary to have the capacity to recover to a normal state from the disintegration of the family that makes up the community, the conflict between members, and the destruction and collapse of culture due to the impact of a disaster. Disasters bring shocks that the community cannot handle with its existing capacity, so it is necessary to overcome the disaster and restore the community so that it can live normally.

Third, disaster resilience at the environmental level inside and outside the community should be considered. It is necessary to have the capacity to recover to a normal state from the collapse of facilities necessary for community operation, paralysis of the administrative system, and damage to nature. Disasters destroy the internal management environment and the external natural environment necessary for community operation, so the community needs to overcome these damages and recover to return to a normal state.

Holling (1973) defined the term resilience as a concept that measures the ability of an ecosystem to absorb changes and still persist. He also compared the concept of resilience to that of stability, which he defined as the ability of a system to return to equilibrium after a temporary disturbance. That is, the faster the system returns to equilibrium, the more stable it is. He concluded that resilience and stability are two important properties of an ecosystem. So in this context the system is very resilient, but still subject to large fluctuations; low stability. Twenty years later, Holling, et. al. (1995) revisited his definition and redefined the concept of resilience as the buffer capacity or the ability of a system to absorb perturbations, or the magnitude of disturbances that one system can absorb before changing its structure by changing a variable (Mayunga, 2007: 2). Resilience can be defined as an ability that can reduce the vulnerability of human communities to disasters and reduce the possibility of disasters. Even if a disaster strikes, the system can recover to its basic structures and functions before the disaster (Zhang and Lee, 2022: 41).

3. Community Disaster Resilience Model

Disaster damage in different communities depends on the size of the community's disaster resilience. Therefore, it is important to identify the factors that affect community disaster resilience. Identifying the factors that cause differences in disaster resilience

among communities is very important for us to prepare for various disasters in modern society (Jo and Lee, 2021: 2). Disasters disrupt habitual and institutionalized patterns of behavior and produce a social shock that leads to social and personal change (Lee, et. al., 2022: 1-2).

Assessing community resilience is a complex process because of the dynamic interactions of people, communities, society and the environment. There are currently many conceptual frameworks proposed to measure this concept (e.g., Brown & Kulig, 1996/1997; Tobin, 1999; Adger, 2000; Buckle, 2006; Foster, 2006; Mayunga, 2007: 5). In general, most of these frameworks conceptualize disaster resilience in the same way, all focusing on similar factors that can reduce vulnerability and increase community resilience. These factors include economic resources, assets and skills, information and knowledge, support and supportive networks, access to services, and shared community values (Mayunga, 2007: 5).

A good definition of resilience, as the term is currently used in disaster risk reduction, is as follows: "The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions." (UNISDR, 2009: 24; Alexander, 2013: 2710).

Since 2000, scholars in areas such as disasterology, psychology, and sociology have also started to study resilience. The natural disaster resilience is an important part of the disaster environment research, and through qualitative and quantitative studies on various responses of the environment, economy, and human society after the disaster, the process of change of other victims after the disaster is analyzed (Dong and Lee, 2020: 26).

Michel Bruneau, et. al. (2003: 737-738) represents the genre and provides a framework for assessing community resilience. Bruneau, et. al. (2003) identify four properties of resilience, each useful for assessing regional capacity to respond to a disturbance:

- robustness: the strength of a system and its elements to withstand disruption without suffering degradation or loss of function
- redundancy: the extent to which a system or its elements have substitutes to ensure functioning in the event of a disruption
- resourcefulness: the capacity within a system to identify problems, establish priorities and mobilize and apply resources in face of disruption
- rapidity: the capacity to meet priorities and achieve goals in a timely manner to contain losses and thwart future disruption

3.1. Individual Level

Psychological Resilience

Psychological resilience is the ability of community members to mentally or emotionally overcome the psychological shock of a disaster or to quickly return to a pre-disaster state. Disasters have the first impact on a person's psychological state. People are psychologically shocked by the mere fact that a disaster is approaching, even if it has not yet harmed it. Resilience can reduce the adverse effects of stress factors on mental health and promote positive mental health in difficult times such as pandemic (Zhai and Lee, 2022: 35). In the case of actual damage to life, body, property, community value, etc., many people who make up the community are psychologically shocked. Psychological shock can occur before, during, or after a disaster. Resilience is distinct from temperaments such as strength, outlook such as optimism, and mood states such as happiness. These are just some of the components of resilience. Psychological resilience is a developmental and psychosocial process in which individuals exposed to persistent adversity or potentially traumatic events experience positive psychological adjustments over time (Graber, et. al., 2015: 7-8).

Physical Resilience

Physical resilience is the ability to recover from physical damage from a disaster or to overcome a lack of elements necessary for maintaining physical health in a disaster situation to return to a normal state before the disaster. Disasters damage people's bodies. An unhealthy body that has been injured causes psychological trauma and stress, which makes it difficult for individuals to lead daily life, preventing them from recovering to a normal state. Physical health is maintained through exercise, sleep, and nutrition, but these factors cannot function properly in a disaster-affected situation. A healthy body can help maintain a healthy mental state.

Economic Resilience

Economic resilience is the ability to overcome economic crises caused by loss of life and property from a disaster or to return to a normal state prior to the disaster. Disasters damage personal property. Disasters cause damage to personal property, such as houses, cars, and household goods, and it takes a lot of money to restore them. In most cases, individuals have a lot of difficulty recovering from these damages on their own, and there are many cases that even lead to bankruptcy. According to Enarson's report on labor and disasters (2000), working-class women at home who are mostly household workers or agriculture-based are very vulnerable to social security, employment and access to public services in the event of a disaster (Kwon & Lee, 2021: 10). An individual's economic bankruptcy or irrecoverable financial condition increases the financial burden of the community, reducing the community's disaster resilience

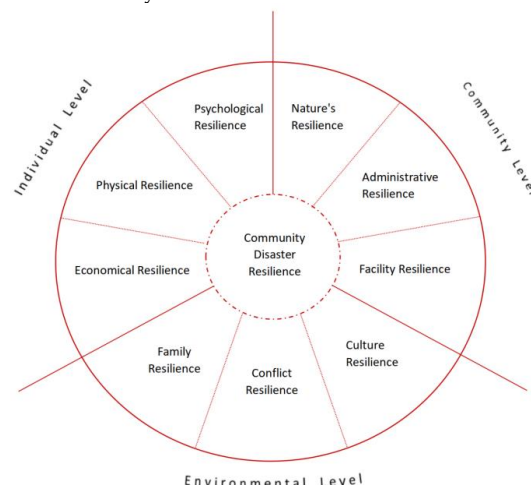


Figure 1. Community Disaster Resilience Model

3.2. Community Level

Family Resilience

Family resilience is the ability to overcome adversity caused by a breakdown in trust and communication between family members affected by a disaster and return to a normal state before the disaster. According to McCubbin and McCubbin (1988: 247), family resilience is defined as family characteristics, dimensions, and properties that help families to be resilient to disruption in the face of change and to adapt in the face of crisis situations. Healthy or strong families can be described as sharing a process of resilience in response to stress or change (Black and Lobo, 2008: 34-35). Disasters cause damage to individuals as well as families, and in severe cases, cause unhappiness or even break up

families. When a disaster shocks family members psychologically, physically, and economically, dissatisfaction, fights, conflicts, and hardships of life occur among family members, and eventually the family is broken up by divorce or separation. Disasters make it difficult for families to overcome disasters and lead normal, happy family lives.

Conflict Resilience

Conflict resilience is the ability of a community to overcome conflicts between community members caused by a disaster and return the community to its normal state before the disaster. Disasters damage communication, cooperation, decision-making, and agreement processes among community members and cause conflicts. Conflicts caused by disasters interfere with the efforts and energy of the community to achieve common goals or desirable outcomes. Conflict also causes misunderstanding and unconscious prejudice by causing tension within the community.

Culture Resilience

Culture resilience is the ability of a community to overcome cultural shock and adversity and to return to its pre-disaster normal state. Culture is a central feature of all communities that strongly influences individual behavior. Culture can be distinguished between material and nonmaterial elements. Material culture includes clothing, homes, tools, stories, and physical objects. Nonmaterial cultures are shared values, moral beliefs about what is right or wrong, norms and rules, traditions, and sense of unity. Of course, the two elements of culture are very closely related (Lee, 2020: 139). Disasters damage the values, customs, norms, etc. that have been the culture of the community, and throw individuals and communities away from the culture they have kept and plunge them into chaos that they have never experienced before. In order for communities to achieve disaster resilience, it is necessary to escape from cultural shock and confusion, the disintegration of customs and norms, and the absence of values and philosophies.

3.3. Environmental Level

Facility Resilience

Facility resilience is the ability of a community to return to its pre-disaster normal state by restoring and improving various facilities of a community that have been destroyed and paralyzed by a disaster. Disasters destroy facilities operated by the community or necessary for community operation. Super typhoons or super disasters caused by the climate crisis reduce the disaster resilience of communities by destroying bridges, houses, roads, and rivers to an extent incomparable to the past. Communities should make efforts to restore and rebuild facilities destroyed by disasters.

Administrative Resilience

Administrative resilience is the ability of a community's administrative systems and operational mechanisms paralyzed and disrupted by a disaster to return to their pre-disaster normal state. Disasters destroy and even paralyze the systems and mechanisms that communities operate and manage. The primary function of the government is to protect life and property of people. The government's measures include not only a reactive response to disaster but also a method. In order to ensure the effectiveness of the disaster management policy, the government should make efforts to prevent the disaster from occurring before it happens (Lee, 2019: 120). It is the most prominent federal requirement in the state to maximize the efficiency of the system. There should be a single agency respon-

sible for emergency preparedness and relief within each state. This state agency is responsible for coordinating all activities at the state level. It also serves as the primary liaison between local and federal relief efforts. Therefore, it occupies an important and central place in the disaster response process (Schneider, 1995: 30). Even in a disaster situation, to reduce disaster vulnerability and maintain the lives of vulnerable members, the administrative system and operational mechanisms of the community must function normally.

Nature's Resilience

Nature resilience is the ability of communities to support nature that has been destroyed by disasters so that it can be restored to its normal state before the disaster. Disasters not only change human society, but also radically change and even destroy the natural environment. The natural environment surrounding a community changes slowly, but disasters reduce nature's resilience by destroying it at a speed so fast that humans cannot protect it and prevent its destruction. Community resilience cannot be improved or achieved unless nature is restored.

Table 1. Components of Community Disaster Resilience

Classification	Components	Contents
Individual Level	Psychological Resilience	ability of community members to mentally or emotionally overcome the psychological shock of a disaster or to quickly return to a pre-disaster state
	Physical Resilience	ability to recover from physical damage from a disaster or to overcome a lack of elements necessary for maintaining physical health in a disaster situation to return to a normal state before the disaster
	Economic Resilience	ability to overcome economic crises caused by loss of life and property from a disaster or to return to a normal state prior to the disaster
Community Level	Family Resilience	ability to overcome adversity caused by a breakdown in trust and communication between family members affected by a disaster and return to a normal state before the disaster.
	Conflict Resilience	ability of a community to overcome conflicts between community members caused by a disaster and return the community to its normal state before the disaster.
	Culture Resilience	ability of a community to overcome cultural shock and adversity and to return to its pre-disaster normal state.
Environmental Level	Facility Resilience	ability of a community to return to its pre-disaster normal state by restoring and improving various facilities of a community that have been destroyed and paralyzed by a disaster.
	Administrative Resilience	ability of a community's administrative systems and operational mechanisms paralyzed and disrupted by a disaster to return to their pre-disaster normal state
	Nature Resilience	ability of communities to support nature that has been destroyed by disasters so that it can be restored to its normal state before the disaster

4. Conclusions

In conclusion,

A community is a place where two or more people live together. A community is a group in which people share a bond while interacting in a specific social space. There are many factors that threaten the safety of a community, such as serious internal conflicts,

rapid environmental changes, economic crises, crimes, wars, and disasters. Among them, in order to establish a sustainable society, it is necessary to secure the resilience of communities from disasters.

To make a safe community, it is necessary to strengthen the ability of the community system to quickly recover the negative effects of disasters. Most communities are repeatedly subjected to loss of life and property when a disaster occurs again, and it is a common practice to repeatedly make a hard recovery effort. By improving disaster resilience abilities, it is necessary for communities to prevent, prepare for, respond to, and recover from disasters and prevent them from repeatedly suffering the same disaster (Lee, et. al., 2019: 95). It is important for communities to play a role in preventing, preparing for, responding to, and recovering from disasters. In addition, communities need to have the ability to overcome the damage caused by disasters and return to their normal state before the disaster occurred. Of course, it is even more desirable for communities to have the ability to return to better conditions than before the disaster struck. The climate crisis is making disasters more frequent, and the scale and scope of the damage much greater. The climate crisis has put the safety of communities at even greater risk. The roots of both risk and resilience exist within the social order itself, societies, communities, and organizations have the power to reduce risk and become more resilient (Tierney, 2014: 5). Efforts to prevent/mitigate, prepare for, respond to, and recover from disasters have faced a more difficult reality than in the past. Community disaster resilience has become more important in the era of climate crisis.

This paper aims to propose a community disaster resilience model necessary to create a sustainable society in the era of climate crisis. The model for improving community disaster resilience discussed variables at three levels: individual, community, and environment. First, at the individual level, improving psychological resilience, physical resilience, and economic resilience is necessary for community disaster resilience. Second, at the community level, improving family resilience, conflict resilience, and culture resilience contributes to community disaster resilience. Third, at the environmental level, improving facility resilience, administrative resilience, and nature's resilience is helpful for community disaster resilience.

References

1. Adger, W. C. 2000. Social and Ecological Resilience Are They Related? *Progress in Human Geography*. 24(3): 347-364.
2. Alexander, D. E. 2013. Resilience and Disaster Risk Reduction: An Etymological Journey. *Natural Hazards and Earth System Sciences*. 13: 2707-2716.
3. Birkland, Thomas A. 2006. *Lessons of Disaster: Policy Change after Catastrophic Events*. Washington, D.C.: Georgetown University Press.
4. Black, Keri and Marie Lobo. 2008. A Conceptual Review of Family Resilience Factors. *Journal of Family Nursing*. 14(1): 33-55.
5. Bragdon, Clifford R. 2014. *Global Resilience to Enhance Crisis and Emergency Management*. Ali Farazmand. ed. *Crisis and Emergency Management: Theory and Practice*. 2nd ed. Boca Raton, FL: CRC Press. 711-731.
6. Brown, D. & Kulig, J. 1996/1997. The Concept of Resilience: Theoretical Lesson from Community Research. *Health and Canadian Society*. 4(1): 29-50.
7. Bruneau, Michel, Stephanie E. Chang, Ronald T. Eguchi, George C. Lee, Thomas D. O'Rourke, Andrei M. Reinhorn, Masanobu Shinozuka, Kathleen Tierney, William A. Wallace and Detlof von Winterfeldt. 2003. A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities. *Earthquake Spectra*. 19(4): 737-738.
8. Buckle, P. 2006. Assessing Social Resilience. D. Paton & D. Johnston. *Disaster Resilience: An Integrated Approach*. Springfield, IL: Charles C. Thomas. 88-103.
9. Choi, Choongik and Chun-II Kim. 2017. The 4th Industrial Revolution, Smart Cities, and Sustainable Urban Regeneration: A Perspective Study. *Journal of Environmental Policy and Administration*. 25(Special Issue): 61-91.
10. Coppola, Damon P. 2015. *Introduction to International Disaster Management*. 3rd ed. Waltham, MA: Elsevier Inc.
11. Cutter, Susan L., Christopher T. Emrich, Beverley J. Adams, Charles K. Huyck, and Ronald T. Eguchi. 2007. *New Information Technologies in Emergency Management*. William L. Waugh Jr. and Kathleen Tierney. eds. *Emergency Management: Principles and Practice for Local Government*. 2nd ed. Washington, D.C.: ICMA Press. 279-297.

12. Cutter, Susan L., Kevin D. Ash, Christopher T. Emrich. 2014. The Geographies of Community Disaster Resilience. *Global Environmental Change*. 29(2014): 65-77.
13. Dong, Lin, Jae Eun Lee, Seol A Kwon, and Quan Jin. 2020. Enhancing Natural Disaster Resilience through NGO Participation in China. *Crisisonomy*. 16(10): 21-36.
14. Dror, Yehezkel. 1988. Decisionmaking under Disaster Conditions. Louise K. Comfort. ed. *Managing Disaster: Strategies and Policy Perspectives*. Durham and London: Duke University Press. 255-273.
15. Foster, Kathryn A. 2006. A Case Study Approach to Understanding Regional Resilience. A Working Paper Prepared for the Building Resilient Regions Network and Presented at the Annual Conference of the Association for Collegiate Schools of Planning, Fort Worth, Texas, November 9-12, 2006. Institute of Urban Regional Development. University of California.
16. Graber, Rebecca, Florence Pichon, and Elizabeth Carabine. 2015. Psychological Resilience: State of Knowledge and Future Research Agendas. Working Paper 425. Overseas Development Institute.
17. Holling, C. S. 1973. Resilience and Stability of Ecological Systems. *Annual Review of Ecology and Systematics*. 4: 1-23.
18. Holling, C. S., D. W. Schindler, B. W. Walker, and J. Roughgarden. 1995. Biodiversity in the Functioning of Ecosystems: An Ecological Synthesis. In C. Perrings, K. G. Maler, C. Folke, C. S. Holling & B. O. Jansson. eds. *Biodiversity Loss: Economic and Ecological Issues*. 44-83. Cambridge: Cambridge University Press.
19. Jo, Yeong Seok and Jae Eun Lee. 2021. A Core System Approach to Improving Local Community Disaster Resilience: Focusing on the COVID-19 Pandemic. *Crisisonomy*. 17(10): 1-27.
20. Kwon, Seol A and Jae Eun Lee. 2021. Gender Disaster Resilience and Prevention Management: Vulnerable Theory. *The Korea Policy Journal*. 21(2): 1-21.
21. Lazzaroni, Sara, Peter A.G. van Bergeijk. 2014. Natural Disasters'Impact, Factors of Resilience and Development: A Meta-analysis of the Macroeconomic Literature. *Ecological Economics*. 107: 333-346.
22. Lee, Jae Eun, Dohyeong Kim, An Chen, Keiko Kitagawa, Jeong Hun Won, Sungeun You, Gajendra Sharma, Azam Muhammad, Minsun Song, and Longtian An. 2020. Disaster Preparedness, Vulnerability and Resilience: Review of Theories and Implementations. *Crisisonomy*. 16(5): 133-154.
23. Lee, Jae Eun, Seol A Kwon, Dong Kyun Yim, Jae Soo Yoo, Young Woon Ban, Hyun Jung Yoo, Seung Jin Maeng, Sungeun You, Hae-Jin Lee, Joong-Kook Choi, Muhammad Azam, and Gajendra Sharma. 2019. A Transdisciplinary Approach of Crisisonomy for Implementing SDGs in Global Society: Using the Core System Model and Disaster Resilience Concept. *Crisisonomy*. 15(6): 89-104.
24. Lee, Jae Eun, Seol A Kwon, Eugene Song, and Sang Il Ryu. 2022. Disaster Resilience Differs between Survivors and Victims' Families: A Semantic Network Analysis. *Social Sciences*. 11(117): 1-16.
25. Lee, Jae Eun, Seoyong Kim, Gajendra Sharma, and Muhammad Azam. 2019. Effective Disaster Prevention or Mitigation by Examining the Significance of Disaster Resilience. *Crisisonomy*. 15(3): 119-139.
26. Mano, R. M., A. Kirshcenbaum, and C. Rapaport. 2019. Earthquake Preparedness: A Social Media Fit Perspective to Accessing and Disseminating Earthquake Information. *International Journal of Disaster Risk Management*. 1: 19-31.
27. Mayunga, Joseph S. 2007. Understanding and Applying the Concept of Community Disaster Resilience: A Capital-based Approach. Summer Academy for Social Vulnerability and Resilience Building. 1-16.
28. McCubbin, H. I. and M. A. McCubbin. 1988. Typologies of Resilient Families: Emerging Roles of Social Class and Ethnicity. *Family Relations*. 37(3): 247-254.
29. Pfefferbaum, Rose L. 2014. Advancing Community Resilience to Disasters: Considerations for Theory, Policy, and Practice. Ali Farazmand. ed. *Crisis and Emergency Management: Theory and Practice*. 2nd ed. Boca Raton, FL: CRC Press. 691-709.
30. Phillips, Brenda D., David M. Neal, and Gary R. Webb. 2017. Introduction to Emergency Management. 2nd ed. Boca Raton, FL: CRC Press.
31. Platt, Stephen, Daniel Brown, Martin Hughes. 2016. Measuring Resilience and Recovery. *International Journal of Disaster Risk Reduction*. 19: 447-460.
32. Rodriguez-Nikl, Tonatiuh. 2015. Linking Disaster Resilience and Sustainability. *Civil Engineering and Environmental Systems*. 32(1-2): 157-169.
33. Schneider, Sandra K. 2011. Dealing with Disaster: Public Management in Crisis Situations. 2nd ed. Armonk, N.Y.: M. E. Sharpe.
34. Stanley, Ellis M., Sr. and William Lee Waugh, Jr. 2014. Emergency Managers for the New Millennium. Ali Farazmand. ed. *Crisis and Emergency Management: Theory and Practice*. 2nd ed. Boca Raton, FL: CRC Press. 761-770.
35. Tierney, Kathleen. 2014. *The Social Roots of Risk: Producing Disasters, Promoting Resilience*. Stanford, CA: Stanford University Press.
36. Tobin, G. A. 1999. Sustainability and Community Resilience: The Holy Grail of Hazards Planning. *Environmental Hazards*. 1: 13-25.
37. Truesdale, Sheridan "Butch" and Jesse Paul Spearo. 2014. Contemporary Community Resilience: Successes, Challenges, and the Future of Disaster Recovery. Ali Farazmand. ed. *Crisis and Emergency Management: Theory and Practice*. 2nd ed. Boca Raton, FL: CRC Press. 733-759.
38. UNISDR. 2009. Terminology on Disaster Risk Reduction. United Nations International Strategy for Disaster Risk Reduction, Geneva.
39. Zhai, Linpei and Jae Eun Lee. 2022. Improving Disaster Management Capability and Disaster Resilience by Using Big Data: A Comparative Analysis between Korea and China. *Crisisonomy*. 18(7): 33-48.

40. Zhang, Ke and Jae Eun Lee. 2022. Disaster Vulnerability and Resilience of Foreigners in South Korea. Journal of Safety and Crisis Management. 12(5): 39-49.



Article

Review on Digital Payment Ecosystem and Associated Risks in Financial Sectors of Nepal

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Abstract: Adoption of digital payment in Nepal is exponentially increasing in recent years due to the effective and efficient services provided by Real Time Payment System. This rise is largely been driven by Nepal Rastra Bank (NRB), Payment System Operators (PSOs), Payment System Processors (PSPs) and Banking & Financial Institutions (BFIs) leveraging innovative technologies. Various digital payment instruments are seamlessly enhancing to focus the customer's superior. As much as the digital payment is provisioned by Government of Nepal, there are a lots of associated risks lags behind the front face of the payment ecosystem. Building a faceless, paperless and cashless economic culture is the target of Digital Nepal which might come true when the payment system is fully secured, trustworthy and uninterrupted. To help to create safe payment landscape, it was intended to review the existing digital payment ecosystem of Nepal and analyze the associated risks around it. The result show that existing technologies being used for digital payment are suggested to enhance with innovative technologies such as Artificial Intelligence, Big Data Analytics, Distributed Ledger Technology, Internet of Things (IoT) etc. considering the possible risk and disaster factors in Financial Sectors.

Keywords: digital payment; risk management; disaster management; innovative technologies; national infrastructure;

1. Introduction

The term "digital payment" refers to a payment technique in which payment data and instructions are transmitted through digital devices, such as a Point of Sale (POS), Personal Computer (PC), cellular phone etc. It is a financial transaction in which the end-user does not need to have any cash in order to complete the purchase, and, instead, uses digital payment methods which can be broadly categorized into card payments, electronic payments, mobile payments [1] and crypto currencies [2, 3]. In Nepal, prevailing means of digital payment are payment cards (Credit, Debit, and Prepaid), Automated Teller Machine (ATM), POS, internet banking, mobile banking, payment gateway, digital wallet, Quick Response (QR) code and many more. As per Nepal Rastra Bank (NRB), the journey of digital payment in Nepal was started when credit card introduced by Nabil Bank at early 1990's, ATM machine introduced by Himalayan Bank at 1995, Internet Banking introduced by Kumari Bank at 2002, SMS Banking introduced by Laxmi Bank at 2004 [4]. All Banks and Financial Institutions (BFIs), Payment Service Operators (PSOs) and Payment Service Processors (PSPs) then gradually uplifting the digital payment in Nepal to the considerable height. The ongoing covid-19 pandemic has also impelled the rapid growth of digital payment and has helped to create less cash society in Nepal.

Digital wallets and 'Buy Now Pay Later' (BNPL) are taking the world by storm while cash payment is taking a backseat [5]. Enhancing and supporting the growth of digital

payment as well as properly managing the technology and cyber related risks are the issues for BFIs. The issue of the consumer privacy is also sprouting as a major issue with the growth in the digital payment.

The root causes of risks of using FinTech and uncovered the legal aspects of risk management of FinTech innovations in financial institutions [6]. The impact of innovation and FinTech are on systemic risks in the USA and Europe, in particular, data protection regulation, the use of regulatory technologies (RegTech), digital identification, reliable operation of payment systems and digital transformation of the financial services market and the financial regulatory system [7]. Like any other field, digital payment faces several risks. These risks cause many financial losses for companies and customers. These risks are tremendous drawback and need to limit their surges to protect digital payment system.

2. Objectives of the Study

The general objective of the study is to know about the digital payment ecosystem in Nepal. The following are the specific objectives,

1. To review the various modes of digital payment instruments and attendant transactions that is offered by various financial institutions,
2. To explore the innovative digital payment landscape in context of Nepalese society,
3. To identify various threats and risks associated with digital payment, and

3. Digital Payments Situation in Nepal

Nepal has enjoyed incredible success in digital adoption compared to its neighbors, with mobile penetration exceeding 100% and Internet penetration reaching 63%. According to the Nepal Telecom Authority (NTA), there was an addition of 2.25 million new Internet users in 2017 alone, translating into approximately 250 new Internet users every hour [8]. The early success with Internet and mobile provide the impulse for Nepal to leverage the potential of digital technologies to drive accelerated growth. The Digital Nepal program is designed to enable Nepal to harness its growth potential by leveraging disruptive technologies and driving socioeconomic growth [8].

There is a dominance of the banking sector in Nepal's financial system. As of mid-July 2022, there are a total of 126 BFIs in operation as licensed by NRB: 26 Commercial Banks, one Infrastructure Development Bank, 17 Development Banks, 17 Finance Companies and 65 Microfinance Financial Institutions [4]. Further, with technological advancement, more and more people are adopting electronic cards (contact and contactless), digital wallets, internet banking, quick response (QR) code and mobile banking services to perform financial transactions which indicate that Nepal is moving rapidly towards a less cash economy. Considering the access on digital payment, Table 1 illustrates the data of payment instruments and payment terminals/merchants in Nepal.

Table 1. Access on Digital Payment in Nepal

S.N.	Particulars	Numbers
1	Digital Wallet Users	14,839,820
2	Mobile Banking Users	19,102,652
3	Internet Banking Users	1,719,733
4	ConnectIPS Users	946,293
5	Debit Cards	11,557,174
6	Credit Cards	262,945
7	Prepaid Cards	118,942
8	POS Terminals	21000+
9	ATM Terminals	4,664
10	QR Code Based Merchants	1500000+

(Source: Nepal Rastra Bank; <https://www.nrb.org.np>)

3.1. Digital Payment Instruments

Digital Payment System is a set of instruments, banking procedures, and, typically, interbank funds transfer systems that ensure the circulation of money. Digital payment instruments means the devices involved during payment process and which can be of two types namely Issuing Instruments and Acquiring Instruments. Issuing instruments contracting to provide a payer with a payment instrument to initiate and process the payer's payment transactions. Acquiring instruments contracting with a payee to accept and process payment transactions, which results in a transfer of funds to the payee. Most common payment instruments are being used in Nepal are:

Payment Cards:

It includes debit cards, credit cards, prepaid cards, charge cards, gift cards and travel cards or international cards issued by SmartChoice Technologies (SCT), Nepal Electronic Payment System (NEPS), National Payment Network (NPN) and few commercial banks. In Nepal, various card schemes are being issued by issuers such as VISA, Master Card, China UnionPay, Amex. In this context, Nepal is consuming the heterogeneous card technology which is chip based contact and contactless cards.

Mobile Wallet:

It is a way to carry cash in digital format. The card (credit or debit or prepaid) information can be linked in mobile device to mobile wallet application and payment can be performed using mobile wallet. FOCUSONE Payment Solutions launched a Mobile Payment System (MOCO), which could be used mobile phones to make digital payments. Similarly, independent mobile wallets are being used to initiate digital payments. Some popular mobile wallets are IMEPay, PrabhuPay, eSewa, Khalti, NamastePay, QPay, Cell-Pay etc. where fund could be loaded by using the wallet interoperability provided by Nepal Clearing House Limited (NCHL).

Mobile Banking:

Mobile banking is a service provided by a bank or other financial institution that allows its customers to conduct different types of financial transactions remotely using a mobile device such as a mobile phone or tablet.

Internet Banking:

Internet banking, also known as online banking, e-banking or virtual banking, is an electronic payment system that enables customers of a bank or other financial institutions to conduct a range of financial transactions through the financial institution's website.

Point of Sale (POS):

Also called as point of purchase, is the place where sales are made and customer completes a transaction, such as a checkout counter. It can be Physical POS and mobile POS. POS devices are being acquired by SmartChoice Technologies (SCT), Nepal Electronic Payment System (NEPS), National Payment Network (NPN) and few commercial banks.

Electronic Cheque:

This means electronically transferring cheque images between the banks and clearing house where Banks collect cheque from customers and then pushes the cheque images to beneficiary bank using the cheque processing system provided by Nepal Clearing House (NCHL).

Interbank Payment System (IPS):

It is a safe and efficient means of funds transfer from one account to any other account by supporting direct credit (payments) and direct debit (collection) related transactions. Nepal Clearing House Limited (NCHL) is providing this payment system.

Real-time Payment System (RPS):

It is an instant real-time inter-bank online funds transfer (P2P), Government revenue payment (C2G), Creditor payments (C2B) and payment processing (e-commerce payments) system processed directly from/to the bank account. This service is available 24/7 throughout the year including holidays. Nepal Clearing House Limited (NCHL) and FonePay are providing this payment system.

Quick Response (QR) Code Payment System:

QR code payment is a contactless payment method where payment is performed by scanning a QR code from a mobile app. There are three QR payment networks namely FonePay, NepalPay and Smart QR are offering QR code payments in Nepal.

3.2. Innovative Payment Technologies

FinTech innovators, academics, and policymakers need to understand the impact of new technologies on payment systems in Nepal to create sustainable economic growth. There are two main movements at play: the explosion of innovation in the financial services sector, often referred to as FinTech or financial technology, and the growing appetite for new, innovative financial services in developing countries [9]. Few innovative payment technologies in Nepal that are mostly awaited to implement are:

Artificial Intelligence:

Artificial intelligence can be described as a set of technologies that can simulate human actions in technological devices that have been previously taught without any new intervention [10]. A related technological concept is Machine learning (ML), which is a set of algorithms that can predict new scenarios. For digital payment automation, AI and ML is the best option to incorporate in existing payment platforms.

Big Data Analytics:

Big Data analytics refers to the application of analytical methods to large amounts of data sets. These data sets are outlined regarding the "Four V's Dimension" (Volume, Variety, Velocity, Veracity). For the holistic analysis of digital payment, big data is the best way forward technology. Data Science is the supreme powerful asset in digital age, big data could be leveraged to design business specific applications/ methods/ workflow.

Open Banking:

Open Banking is a new way of handling banking data protocols introduces a secure way to give financial service companies consensual access to a bank's customer financial information. This new way of handling banking data protocols introduces a secure way to give financial service companies consensual access to a bank's customer financial information.

Blockchain:

Blockchain is a digital system that enables recording transactions in a decentralized distributed ledger. It is decentralized since any authority or institution do not regulate it. It is considered a "trust machine" [11]. Since it relies on the work of all the constituted networks of the platform and all the transactions are recorded and available in the blockchain. Consequently, a hacker would have to change all the blocks, making cyberattacks almost impossible.

3.3. Risk and Disaster on Digital Payment System

Technological transformation of financial infrastructure is the major component of rising economy and social life in the digitally developing countries like Nepal. Development of digital technologies leads to the transformation of behavior of financial services consumers. They move from off-line environment with cash payments to online service with non-cash payments through distant interaction. This tendency started by means of payment cards and then moving forward with internet banking, mobile wallet, mobile banking and yet to go for digital currency using DLT. Upon moving forward with the pace, there are various fraudulences, security concerns, possibility of risks and probable disaster always knocking to consumers and BFIs and FinTech entities.

Generally, digital frauds are categorized into two types, namely direct and indirect frauds. It has been categorized based on their activities in the internet domain and type of robbery [12]. The debit/credit card fraud, and money laundering activities comes under direct type. Sometimes direct fraud was happened due to the employees of the BFIs. Website phishing, hacking, spreading virus, and malware comes under indirect types [13]. Due to having some door open in the financial technology infrastructure; fraud, security flaws, and risk zone get arises and ultimately consumers and organizations could face disasters.

Nepal is not away from such frauds and risks. Every year, several cases of fraud related activities in BFIs and payment technologies are happening.

4. Materials and Methods

The study is based on various articles, research papers and NRB's website. The materials were collected from books, journals, newspapers and relevant websites which have been consulted in order to make the study an effective one. This paper is therefore grounded in an exhaustive thematic analysis of the secondary sources.

The research process was organized into four main phases. The first phase covered the research design, and the main parameters of the study were elucidated, mainly the research purpose and questions. Phase two involved reviewing and exploring Digital Payment circumstances of Nepal through a detailed search process. The third phase of this process focused on analysis and a specific evaluation of relevant research themes. Finally, the report was structured and anchored to ensure the quality of results by cohesively presenting themes.

5. Results and Discussions

Government of Nepal has been prioritizing the digital payment infrastructure in the recent years. The proper digital infrastructure plays a role for enabling the adoption of innovative digital payments and enhancing the existing payment technologies with binding multilateral security measures towards the steady growth in the priority sectors. All the Banks, PSOs and PSPs are utilizing the time relevant technologies to provide fully digital payment environment for urban and rural area civilians. In spite of this digital pace, digital payment education and internet facility to consume all available payment technologies are yet to go forward.

Risk Management was identified as relevant to FinTech products and applications. To maintain proper operational stability and uninterrupted execution of critical operations, the operational process of risk management of innovation in financial institutions was specified by types of technological, administrative, methodological, and organizational measures.

Table 2. Security and risk operations

Security Stage	Operations	Tasks
Preventions	Data Protection	Encryption, PKI, TLS

		Data Loss Prevention (DLP) User Behavior Analytics Email Security Cloud Access Security Broke
	Network Security	Firewall, IDS/IPS, Proxy Filtering VPN, Security Gateway DDoS Protection
	Application Security	Threat Modeling Design Review Secure Coding Static Analysis WAF, RASP
	Endpoint Security	Anti-virus, Anti-malware HIDS/HIPS, FIM App Whitelisting
	Secure Configurations	
Detection		Log Management/ SIEM Continuous Monitoring Network Security Monitoring Advanced Analytics Threat Hunting Penetration Testing Vulnerability Scanning Web App Scanning Bug Bounties Human Sensor Data Loss Prevention (DLP) User Behavior Analytics (UBA) Security Operations Center (SOC) Threat Intelligence Industry Partnerships
Response		Incident Response Plan Breach Preparation Tabletop Exercises Forensic Analysis Crisis Management Breach Communications

Central Bank of Nepal has implemented the policy of balancing the need for risk management without stifling innovation and growth in this area. Digital Payment transaction security functions ensure that transactions are authentic and processed securely without any outside divulging of sensitive information. A variety of encryption, decryption, verification, and authentication cryptographic functions are highly recommended.

Financial regulation and financial inclusion build resilience to disasters, from catalyzing finance to ensuring the stability of the financial system. While financial regulators are not directly involved in national DRR planning and coordination, they can complement national initiatives with enabling policies.

Digital Payment offering BFIs shall combine battle-tested expertise with innovation to deliver large-scale modernization projects that inherently deliver choice, availability and scalability. Security and compliance are fundamental to digital payment. It is recommended to have a deep bench of experienced compliance experts committed to meeting security, risk and central bank mandates. It is also recommended to have the broadest real-time experience of any technology provider across banks, processors, acquirers, issuers and national infrastructures for digital transaction banking including high value transactions, consumer payments acquiring & processing including low value, cards & alternative payment methods.

6. Limitations

In this paper, we tried to present an integrated picture of digital payment and associated risks on it. We have talked about their types, challenges and risks they face, as well as the future of digital payment. This was in an attempt to give a clear and general picture to those interested in the field of digital payment. Through this research, many points emerged that need to be explored in the future. One of the most important points is how the country's national payment infrastructure planning could be focused on risk and disaster management towards Nepal's Digital Payment ecosystem.

7. Conclusions

In conclusion, the Government of Nepal shall implement backbone infrastructure of digital payment. Nepal Rastra Bank, the central bank of Nepal shall focus towards the convergence payment modality including modern digital payment technologies such as digital currency, micro-credit, open banking, distributed ledger-based payment architecture etc. As governments, regulator, FinTech operators and service provider's work together to improve electronic payment systems and related infrastructure, it is advisable to study how end users perceive the available payment options as secure and trustworthy. In the existing payment ecosystem in Nepal, Central Bank is regulating the interoperability among different Payment System Operators which shall be implemented without any delay due to which Nepalese consumers are not able to perceive the full digital payment inclusion. In every hierarchical payment modality, all the banks and financial institutions including PSOs, PSPs shall implement active-active primary and secondary nodes in data centers. On top of this, they shall implement layer-1 and layer-2 disaster recovery sites so that any risks and disasters could be easily get safe landed. The guidelines recommended by Government and Central Bank shall thoroughly be followed. From the perspectives of users, manual security guidelines shall be followed.

Author Contributions: Conceptualization, H.P.A. and G.S.; methodology, G.S.; software, H.P.A.; validation, G.S.; formal analysis, H.P.A.; investigation, G.S.; resources, H.P.A.; data curation, H.P.A.; writing—original draft, H.P.A.; writing—review and editing, H.P.A. and G.S.; visualization, H.P.A.; supervision, G.S. Both authors have read and agreed to the published version of the manuscript.

References

1. Rahman, M., Ismail, I., & Bahri, S. (2020). Analysing consumer adoption of cashless payment in Malaysia. *Digital Business*, 1(1), 100004.
2. DeVries, P. D. (2016). An analysis of cryptocurrency, bitcoin, and the future. *International Journal of Business Management and Commerce*, 1(2), 1-9.
3. Shahzad, F., Xiu, G., Wang, J., & Shahbaz, M. (2018). An empirical investigation on the adoption of cryptocurrencies among the people of mainland China. *Technology in Society*, 55, 33-40.

4. Nepal Rastra Bank, Bank Supervision Report (2020/2021). <https://www.nrb.org.np/contents/uploads/2022/07/Bank-Supervision-report-2020-21-Final.pdf>
5. Worldpay. (2021). The Global Payments Report 2021. <https://worldpay.globalpaymentsreport.com/en/>
6. Kang, Y., & Duoqi, X. U. (2020). Legal Governance on Fintech Risks: Effects and Lessons from China. *Asian Journal of Law and Society*, 7(2), 275-304. <https://doi.org/10.1017/als.2020.14>
7. Franco, L., García, A. L., Husetović, V., & Lassiter, J. (2020). Does Fintech Contribute to Systemic Risk? Evidence from the United States and Europe (ADBI Working Paper Series). Retrieved from <https://www.adb.org/sites/default/files/publication/606506/adbi-wp1132.pdf>
8. EY Global. (2017). EY Fintech Adoption Index 2017 - Key Findings (No. EYG no. 03893-174) (p. 2). [ONLINE] Available at: [https://www.ey.com/Publication/vwLUAssets/ey-fintech-key-findings-2017/\\$FILE/ey-fintech-key-findings-2017.pdf](https://www.ey.com/Publication/vwLUAssets/ey-fintech-key-findings-2017/$FILE/ey-fintech-key-findings-2017.pdf). [Accessed 29 January 2019].
9. Digital Nepal Framework (2019). <https://mokit.gov.np/application/resources/admin/uploads/source/EConsultation/EN-Digital-Nepal-Framework-V8.4> 15 July 2019.pdf
10. B. Buchanan (2019). Artificial Intelligence in Finance The Alan Turing Institute, London (2019) Google Scholar
11. K. Wang, C. Bellavitis, C. DaSilva (2018). An introduction to blockchain, cryptocurrency and initial coin offerings. *New Frontiers in Entrepreneurial Finance Research*, 7, pp. 181-206
12. D. Rahmawati, R. Sarno, C. Fatichah, & D. Sunaryono (2017). Fraud detection on event log of bank financial credit business process using hidden Markov model algorithm, in *Proc. 3rd Int. Conf. Sci. Inf. Technol. (ICSITech)*, pp. 35–40.
13. H. A. Hartanto, R. Sarno, & N. F. Ariyani (2016). Linked warning criterion on ontology-based key performance indicators, in *Proc. Int. Seminar Appl. Technol. Inf. Commun. (ISemantic)*, pp. 211–216.



Article

Estimation of Risk Mitigation Rate by Item of Hierarchy of Controls Using Bayesian Networks

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Abstract: The employer must conduct a risk assessment to judges whether the risk of accident is within an acceptable range. If risks are unacceptable, then establish risk reduction measures are needed. When the employer selects the reduction measures, the economic cost and order of the hierarchy of controls must be considered. If the risk mitigation rate for each item of the hierarchy of controls is given, employer can select reduction measures efficiently. Therefore, in this study, the risk mitigation rate for each item of the hierarchy of controls was estimated. As a research method, the cause of the accident in the accident investigation report was classified into the items of the hierarchy of controls. Classified cause of the accident turned into likelihood and was used as the probability of the basic node of Bayesian Networks. In addition, expert opinions were reflected as the probability of connection of each node through AHP. Through this, the risk mitigation rate for each item of the hierarchy of controls was estimated. The result value can be used to risk score obtained after the risk assessment to identify the minimum items that the employer should adopt as a reduction measure.

Keywords: risk assessment; hierarchy of controls; Bayesian networks; risk reduction

1. Introduction

After risk assessment, unacceptable risks must be mitigated. In the case of Korea's Occupational Safety and Health Act, reduction measures should be implemented in consideration of the order of the Hierarchy of Controls. The UK provides some but not the order. In the case of the laws of the United States and Australia, it is not provided. However, even if not provided, OSH agencies, such as NIOSH recommend considering the Hierarchy of Controls when establishing reduction measures [1]. However, since there is no reduction rate for each item, the cost effectiveness must be separately obtained and applied at the workplace. The purpose is to provide research on the reduction rate by doing so.

2. Theoretical Backgrounds

2.1. Hierarchy of Controls

Hierarchy of controls represents the category of measures required to control risks and is commonly divided into 5 steps. The highest level of Hierarchy of controls talks about fundamental measures, and describes that hazards are fundamentally excluded from work. This refers to the elimination of hazardous materials and operations from the design stage or changes to less hazardous materials. Below that, there are methods to protect objects to be protected from hazards using facilities, administrative measures, or PPE. Elimination is the best in reducing the risk, and PPE is the lowest.

2.2. Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP) technique is a method devised by Saaty (1977) to facilitate selection among several alternatives considering various purposes. The AHP technique is a method widely used in the decision-making process in various fields as a method of giving weight to each item and quantifying it based on this when making decisions in areas where quantitative access is difficult.

By structuring the problem in a hierarchy, analysis can be performed by pairwise comparison of elements below it. What needs to be paid attention to during stratification is that if the number of evaluation criteria and alternatives increases, the number of questions requiring pairwise comparison can increase exponentially, so the criteria should be set to a minimum. In addition, the more consistent the respondent's response, the lower the value of the consistency ratio, and a response is judged to be consistent when it is at least 0.1 or less [2].

2.3. Bayesian Networks

Based on the Bayes Theorem above, the Bayesian network sees each node as a variable and expresses the causal dependence between variables with conditional probability that the variables are connected. The feature of the Bayesian network is that it is a directed acyclic graph, and the connection is not cyclic, so if you calculate along the node, there is an end.

The Bayesian probability theorem, which is the basis of the Bayesian network, is as follows.

$$p(A|B) = \frac{p(B|A)p(A)}{p(A)}, \quad (1)$$

In Equation (1), $p(A)$ is Prior Probability, which is known in advance, and B is the probability of new data (Evidence). Here, $p(B | A)$ means Likelihood and represents the probability that event B will occur under the condition that A is true. $p(A | B)$ means Posterior Probability, which is the probability updated with the data $p(B)$ [3].

When the structure of the graph is causal, the Bayesian network can grasp the interaction between variables and predict the influence between variables. Thanks to these characteristics, Bayesian networks are actively used in the fields of deep learning and machine learning [4].

3. Research Method

In this study, the cause of the accident pointed out in the accident investigation report was reclassified as a Hierarchy of controls item, and the mitigation rate was estimated by putting the value in the BN. Even if only one of the items identified as the cause of the accident in the accident investigation report had been resolved, the accident would not have occurred. Therefore, the importance of each countermeasure converted to the item of Hierarchy of Controls was obtained. The parts that did not appear in the accident investigation report could be calculated by giving weights by conducting a survey to experts through AHP.

3.1. Accident Report

Based on 20 CSB accident investigation reports, the causes pointed out in the report were classified according to Table 1. In the case of the recent accident investigation report, a separate chapter was prepared for the cause found. However, in past reports, cause was included along with other items such as key finding or accident analysis.

Table 1. Accident cause classification standard table

Condition	Behavior
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Elimination	Eliminate Hazardous Materials by Design	Eliminate hazardous work methods
Substitution	Substitution of Hazardous Substance and Design	Changing hazardous work methods
Engineering	Hazard prevention using equipment	Manually Operated Safety Equipment
Administrative	Appropriate regulations exist, alarm systems, operator training	Access restriction, facility inspection, compliance with regulations
PPE	Provision and management of personal protective equipment	Wearing personal protective equipment

3.2. AHP

A hierarchical diagram was created from the classified causes up to the accident. Thinking is seen as a combination of actions and states, and each action and state is placed as arising from five stages. Alternative, engineering, and administrative groups that come up in combination with other elements have been grouped. Based on this hierarchy, the AHP questionnaire was prepared and conducted to two experts whos currently working as safety managers. The results of AHP are shown in Table 2, and the consistency criterion was satisfied because the inconsistency rate was less than 0.1.

Table 2. AHP survey results

Unsafe Condition VS Unsafe Behavior	
Unsafe Condition	0.5505
Unsafe Behavior	0.4495
Unsafe Condition	
Elimination	0.3572
Substitution	0.1207
Engineering	0.0528
Administrative	0.0351
PPE	0.0494
Substitution&Administrative	0.1135
Engineering&Administrative	0.0663
Substitution&Engineering&Administrative	0.205
Inconsistency rate	0.04832
Unsafe Behavior	
Elimination	0.5619
Substitution	0.2234
Engineering	0.1115
Administrative	0.0562
PPE	0.0471
Inconsistency rate	0.07344
Substitution&Administrative	
Substitution	0.8571
Administrative	0.1429
Engineering&Administrative	

Engineering	0.6667
Administrative	0.3333
Substitution&Engineering&Administrative	
Substitution	0.6858
Engineering	0.1911
Administrative	0.123
Inconsistency rate	0.01138

3.3. Bayesian Networks

The Bayesian Networks model was created using Agena Risk software based on the above hierarchical diagram for AHP. For the basic node, the frequency of causes from the accident investigation report was used. For the values not shown in the accident investigation report, the values provided by Risk Assessment(Popov et al., 2016) were used. The value of the conditional probability table (CPT) linking each node was created using the results of AHP [5].

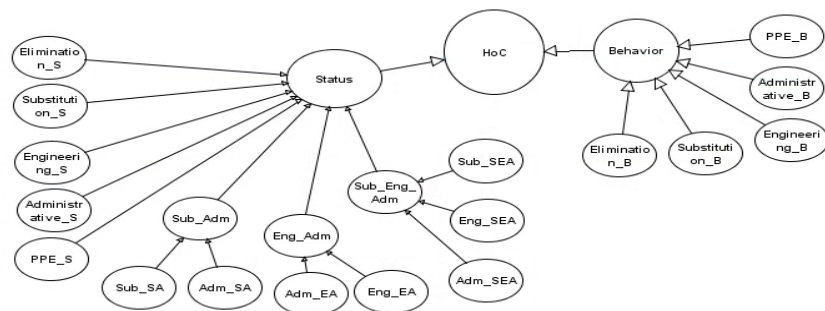


Figure 1. Bayesian Networks Model for Hierarchy Item

The results of the sensitivity analysis are shown in Figure 2. What can be obtained through this is that if an accident occurs, if the cause of the accident is found among the five items, it will be as shown in Table 3.

Table 3. Cause of Accident

Hierarchy of Controls Item	비율
Elimination	0.323
Substitution	0.201
Engineering	0.159
Administrative	0.154
PPE	0.163

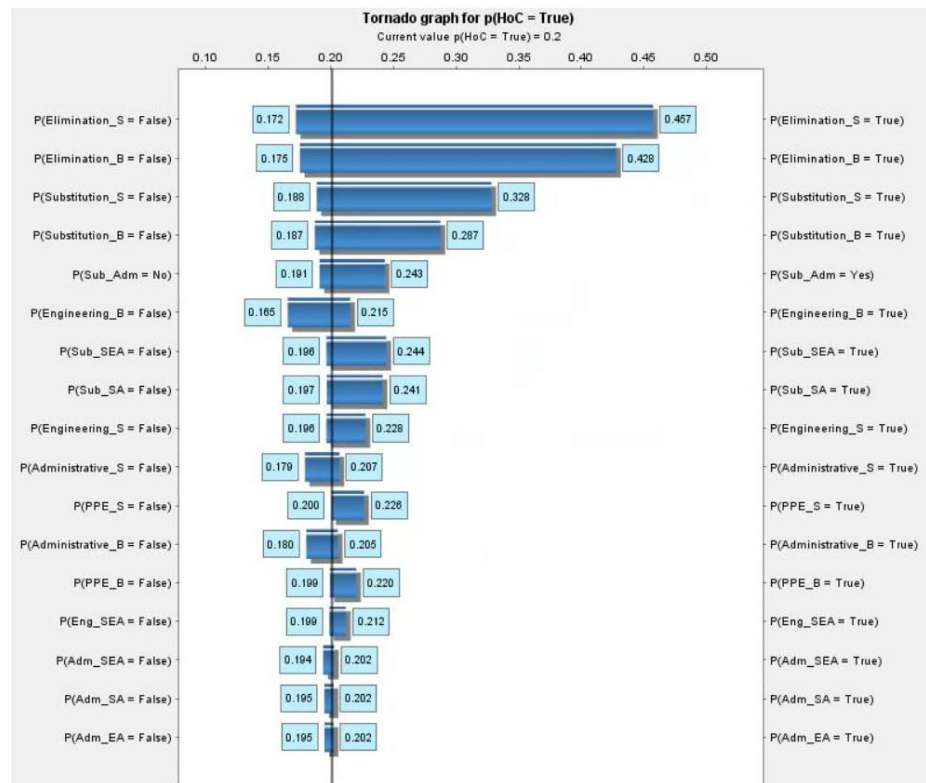


Figure 2. Sensitivity Analysis of BN

Based on the value in Table 3, it can be considered that the risk will be reduced by that value each time the corresponding countermeasure is implemented. For example, if an elimination measure is implemented once, the risk can be expected to be reduced by about 32%.

Through this, it can be judged that even if the effectiveness is low compared to the price, the risk can be sufficiently mitigated if several independent reduction measures are implemented.

4. Limitations

This study has several limitations. First, the number of accident investigation reports used is small. In particular, recent data were used, which tried to see the current thinking form in which technology was developed compared to the past. In future studies, it is urgent to increase the number of accident investigation reports.

Second, the accident investigation report used is only the CSB accident investigation report, so it is focused only on chemical accidents. Since the characteristics of chemical accidents are reflected, additional analysis of accident investigation reports must be reflected in order to use this value in other industries.

Third, there is a shortage of AHP survey subjects. It is difficult to say that the two opinions reflected the opinions of all safety-related experts. Therefore, it is necessary to increase the number and range of survey subjects in future studies.

5. Conclusions

In conclusion, if the values derived from this are used when estimating reduction measures in chemical manufacturers, it is thought that necessary steps of reduction

measures can be found effectively. However, better results could have been obtained if the value was reinforced through additional data acquisition and verification through actual application research was obtained.

References

1. The national institute for occupational safety and health. (2022, August 11). Hierarchy of Controls. Centers for Disease Control and Prevention. <https://www.cdc.gov/niosh/topics/hierarchy/default.html>
2. Soo Won Mo, Chang-Beom Kim. (2012). A Relative Importance Evaluation of the Industrial Sector According to the FTA Using AHP and Fuzzy AHP. *Journal of Industrial Economics and Business*, 25(2), 1827-1842.
3. Seunghee Choi, Goo Yeon Lee. (2016). Bayesian Network-based Probabilistic Management of Software Metrics for Refactoring. *Journal of KIISE*, 43(12), 1334-1341.
4. Aeri Kim, Dooyoul Lee. (2022). Bayesian Network Based Situational Awareness and Course of Action Decision-Making Support Model. *Journal of the Military Operations Research Society of Korea (MORS-K)*, 48(1), 131-141.
5. Popov, G., Lyon, B. K., & Hollcroft, B. D. (2016). *Risk Assessment: A Practical Guide to Assessing Operational Risks* (1st ed.). Wiley.



Article

Harnessing ICT to Enhance Community Disaster Resilience: A Case Study of Employing Social Media to Zhengzhou 7.20 Rainstorm, China

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Abstract: This study aimed to explore how community disaster resilience can be enhanced through the use of ICT to ensure that citizens play an active role in disaster management and to enhance community resilience to natural disasters, three social media applications were selected. Using the "7.20" rainstorm in Zhengzhou as an example, based on the collected and analyzed questionnaires, the findings showed that both the use of WeChat, TikTok, and Weibo had positive effects on community disaster resilience, specifically, the public's use of social media (WeChat, TikTok, and Weibo) during rainstorm disasters had a positive relationship with convenience and trust, creation and dissemination, emotion and communication, cooperation and collective action, and relief and release. The positive influence relationship was also compared and analyzed for the differences of the three social media, which provides a reference for effectively guiding citizens' use of social media in disaster risk reduction and enhancing disaster resilience in the future.

Keywords: ICT; heavy rainstorm; social media; disaster resilience

1. Introduction

Disasters are events that affect humans and societies, and their occurrence poses a significant threat to development outcomes globally. Intensive and widespread risks are increasing at an unprecedented rate, and in addition, climate change is accelerating the occurrence of natural hazards and exacerbating the risk of extreme weather hazards, and human behavior is creating greater and more dangerous risks, and as climate change and natural hazards intensify, these extreme hazards may occur in areas where they have never been encountered before[1]. According to a report by the United Nations Office for Disaster Risk Reduction, the number of global disasters is climbing rapidly due to factors such as climate change and some human behaviors, and the frequency of global medium and large disasters is expected to reach 560 per year by 2030, with an average of 1.5 per day. During the past 20 years, there have been 350 to 500 medium and large disasters per year globally. This number is continuing to climb compared to previous years[2]. Although natural disasters can occur in many parts of the world, their consequences depend on the relationship between the severity of natural phenomena and the vulnerability of human communities to such events[3]. Natural disasters tend to be more devastating in developing countries because economic, political, social, and cultural factors increase vulnerability [4]. Global disaster losses have averaged \$170 billion per year over the past decade, with the worst hit being in developing countries, where the average annual loss due to disasters is about one percent of GDP, compared to one to three thousandths of a percent in developed countries. The Asia-Pacific region suffers the most severe economic

losses from disasters[2]. Despite the promise of building resilience, the current social, political and economic choices to address climate change and create sustainable development pathways are doing the opposite. People do not seem to be able to fully control the occurrence of these phenomena, but they can prepare for them and can mitigate their impacts. It is therefore very important that people invest in mitigating the effects of natural disasters to reduce human and economic losses from these disasters.

The world needs to do more to address disaster risk by acting together to reduce the incidence of disasters and increase resilience to disasters while working to achieve sustainable development goals for all people around the world. The impact of disasters on communities and overall is increasing. Communities are on the front lines of disaster resilience, and community resilience and disaster recovery will also influence and reduce disaster recovery time, and community-level responses are critical to disaster loss reduction and disaster governance. Communities have hazards that have been struggling with the effects of disasters related to natural or man-made hazards. To address this struggle, great efforts have been made in disaster research mitigation and resilience. While resilience as a new idea in disaster governance, disaster resilience is related to the ability of a group to reduce the impact of a disaster and recover its full functionality soon[5]. As an emerging approach to disaster emergency preparedness and response, community resilience, or the sustained ability of communities to withstand and recover from adversity, includes individual preparedness as well as the creation of a supportive social environment in communities to withstand and recover from disasters, emphasizing effective and efficient disaster risk reduction, response, and recovery [6]. Therefore, improving community disaster resilience is critical to reducing the economic costs of disaster response as well as increasing resilience [7]. Therefore, academics have been seeking alternative ways and means to enhance community resilience in the event of disasters.

In recent years, we have witnessed revolutionary developments in information technology, communication technology (ICT) and its impact on people's lives, especially its use in disaster management processes. The use of ICT in coordinating emergency relief efforts [8], providing ICT-enabled administrative services for citizens [9], being able to access health-related information and emergency services [10], how Internet connectivity and mobile services enable social inclusion of marginalized groups [11], reaching out to diverse family and friends for emotional support in crises and disasters [12,13] and information sharing [14]. At the same time, there is growing evidence that ICTs are being used to bridge communication gaps during and after crises [15,16]. In particular, the use of social media and its analysis has yielded benefits in disaster management [17–19]. Due to the global prevalence of disasters, ICT has become a valuable tool for governments and organizations in providing information and organizing resources for disaster management to mitigate the overwhelming effects of disasters [20]. The role of information and communication technologies (ICT) in enabling the coordination of aid delivery and assistance during disasters has become an active research topic.

The use of ICTs helps to generate information and make better decisions for effective disaster management systems, and ICTs are considered necessary to enhance adaptive capacity and support feedback, ensure access to information, promote active participation, and reduce vulnerability [21]. Given the tremendous impact of ICT on many aspects of human socio-political, economic and life in the world today, the study of ICT in developing countries in particular has attracted the attention and interest of a growing number of scholars and policy makers worldwide. While most of the current many studies have focused on the use of ICT in developed countries during the recovery phase of a disaster, little attention has been paid to what role ICT can play for developing countries in the event of a disaster, and this paper attempts to fill this gap. Therefore, there is a need for more rigorous, focused research on the impact of ICT on people's lives in developing countries, particularly on how social media use affects and enhances resilience when disasters occur. Therefore, this study will fill these research gaps by exploring cases of ICT use, with an analysis of how social media can be used to enhance or complement existing

community resilience and reduce disaster risk as a case study of how citizens used social media to enhance disaster resilience during the Zhengzhou rainstorm to ensure that citizens play an active role in disaster management while achieving increased community resilience to natural disasters.

2.Theoretical Background

2.1. ICT and disaster resilience

Disasters are sometimes equated with crises, but crises can be thought of as organization-based, whereas disasters are community-based [22]. Given the emergent and complex nature of disasters, mitigation of their impact is critical [23]. In order to obtain accurate, reliable and timely information during disasters, people have turned to embracing potential technologies, and ICT has become a response action in promoting effective disasters [24]. According to Tamilselvan et al [25], ICT: Often used as an expanded synonym for Information Technology (IT), but is often a more general term emphasizing the role of unified communications as well as telecommunications (telephone lines and wireless signals), computers, The integration of middleware and the necessary software, storage and audiovisual systems that enable users to create, access, store, transmit and manipulate information. According to Anderson [26], ICTs “encompass a number of technologies that enable us to receive information and communicate or exchange information with others”, as shown in Figure 1. Information and communication technologies provide real-time communications for life-saving applications such as search and rescue Actions, mainly ICT, help to confirm the safety and security of family, friends, people and assets, and then, it helps to provide disaster recovery services [27].

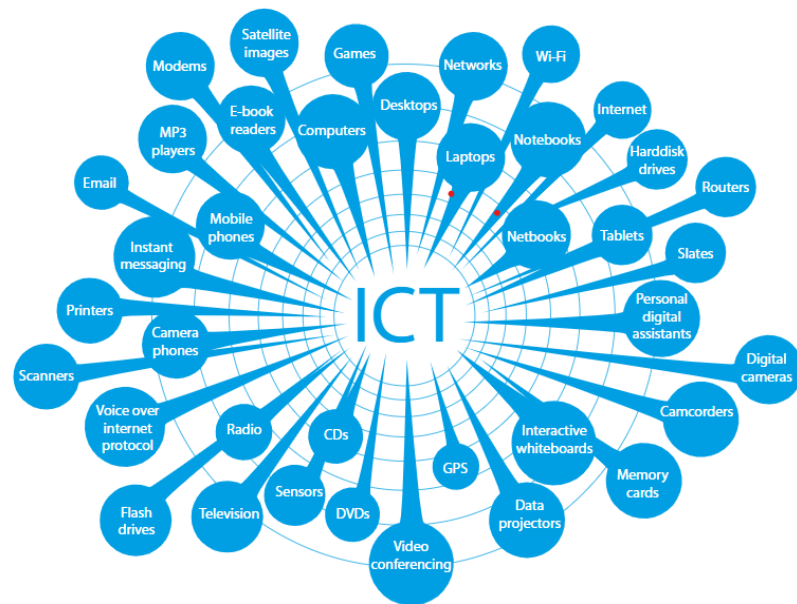


Figure 1. Components of ICTs.

Source: Anderson (2010:4)

Today, ICTs are used in many fields to facilitate and accelerate human life. Existing ICTs are already being used by the public, private and civil society sectors, offering the potential to reach a wide range of people, especially mobile devices that allow unrestricted access to the Internet anywhere. Today, there are more than 75 social media, and the most popular are Facebook, YouTube, WhatsApp, Messenger, WeChat, Instagram, Tik Tok, Tencent QQ, QZone and Sina Weibo according to the number of users [28](Figure 2). Information and Communication Technology (ICT) has made remarkable progress, using

different types of smart and connected technologies, enabling the generation of real-time information at an unprecedented rate. In addition to this, there are significant improvements in computing power to manage and analyze large datasets [29]. Specifically, the rapid development of artificial intelligence, ubiquitous sensing technologies, smart cities/infrastructure, availability of big data sources such as social media, mobile devices, infrastructure management systems, etc., allow us to collect and analyze Detailed information and coverage data, new generation (3G and 4G) communication technologies provide very fast transmission of voice, images and data that was previously unimaginable [30–32].

The utility of technology lies in the way it is used rather than in the idea of the technology itself – which could explain why ICT, which had no real role in an organization before the crisis, may become the backbone of its technology structure post-crisis. Technology in practice "focuses on emerging technological structures formulated in practice rather than specific structures fixed in technology"[33]. Thus, as people respond to environmental changes caused by disasters, they build and reconfigure their communication and technology structures by adapting ICT to acquire the resources and contacts needed for recovery [14,34]. Researchers are increasingly focusing on studying the role of ICTs in disasters and disaster response [35–37]. There is also evidence that using not just one technology, but multiple technologies can help people recover after a disaster. Katz & Rice [38] found that during a crisis, people use various media to develop temporary solutions in order to stay connected to their networks. This "interdependence" of technology use in disaster situations means that using multiple ICTs is more beneficial than using a single device [12].

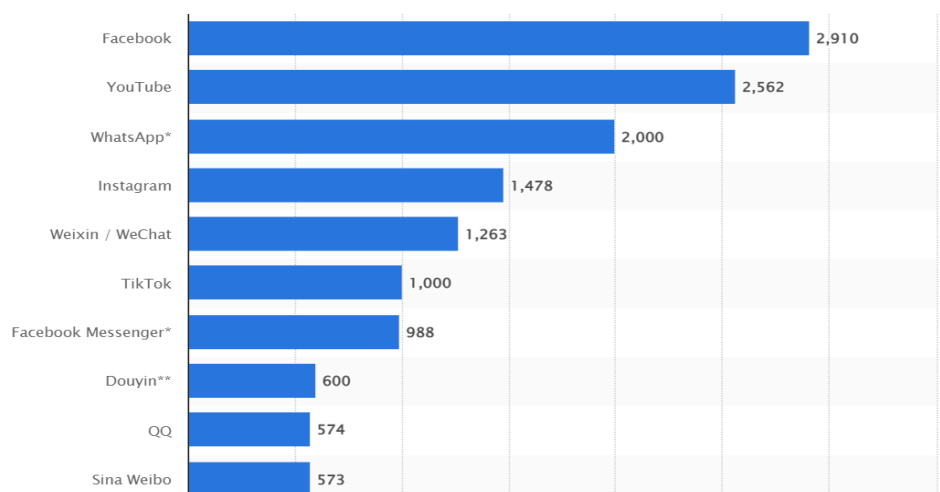


Figure 2. Most popular social networks worldwide as of January 2022, ranked by number of monthly active users(in millions).

Source: Statista (2020)

Existing information on the use of ICT tools, particularly the use of social media during disaster response, to enhance disaster resilience, and how these may contribute to disaster response efforts to better prepare for future crises. This is important for governments and the public who need to understand social media.

2.2.Social media and community disaster resilience

Although the use of ICT is prominent in various contexts, social media (eg, Facebook, Twitter, TikTok) has become an important disaster response technology in recent years

due to its instant connection and open platform, Provides real-time information [39,40]. During the crisis, social media has been used as a new form of communication [41]. Social media is seen as a new communication channel in the context of natural and climate change-induced disasters, allowing for the dissemination of a wider variety of sources of information, allowing communities to help each other through information sharing and emotional support, and stay connected when traditional communication channels cease to function [13]. Social media allows users to create and participate in virtual communities that provide sharing capabilities to communicate, publish, manage, collaborate, and interact with members or the public at the click of a button [42]. In general, social media has been described as facilitating an online community of up-to-date crisis information in which members seek and share information and guide them in unfamiliar situations during times of crisis [43]. Cheng et al [44] analyzed the effectiveness and different aspects of social media-enabled crisis management tools. Although there are two types of active and passive use of social media, ICT positively influences the recovery process by building networks, enhancing social capital and increasing engagement. For example, Twitter was used to provide information on tsunami warnings, missing and dead persons, service availability and road conditions in the hours following the 2010 Chile earthquake [19]. Thus, during Tropical Cyclone Winston in Fiji (2016), Facebook and Twitter, as the most common forms of social media, played an important role in connecting people to the recovery process [41]. Kankanamge et al [45] propose that Australian emergency response organizations make posts with images on Facebook and Twitter countries to raise awareness to be more prepared and to strengthen their participation in manufacturing decisions and actions. Bird et al [18] analyzed the importance of social media during floods in Victoria and concluded that Facebook and Twitter were effective tools for disseminating information and curating informal information.

Following the 2008 Sichuan earthquake in China, Qu et al [46] found that local residents used popular online forums to organize information and express their emotions about the disaster. During disasters, social media is used for C2C communication, taking Typhon Meranti in Xiamen, China as an example, showing that people in catastrophic disasters rely on authentic information from the government, although they may obtain this information from official government sources on social media [47]. Social media platforms are important for creating situational awareness to coordinate actions among affected communities during natural disasters [48]. Kitazawa and Hale [49] analyzed the effectiveness of social media for disaster management during the 2015 Kanto-Tohoku typhoon in Japan. They argue that social media makes people more aware of the warnings and increases their awareness. Additionally, social media messages may make people feel ready and respond to action. For example, crowdsourced mapping enables volunteers to help report local conditions and allows rescue teams to focus on other operations [50]. Fang et al [51] investigated the process of using social media message extraction from social media microblogging platforms in China to investigate the process of social media activity to track disasters and further compared with observed precipitation data. In addition, the main impact of the disaster was assessed through word frequency analysis of impact-related topics. Finally, location-related information is extracted to map disaster hotspots. The results showed that the temporal variation of social media activity was consistent with the rainstorm process, and social media activity was significantly positively correlated with precipitation intensity. Research has shown that social media promotes collective intelligence, in which large, dispersed groups of people solve complex problems [52,53], and other studies have highlighted the phenomenon of digital volunteering—distance from others Help can be provided through interactive platforms [54].

3. Materials and Methods

This research adopted the method of questionnaire to collect relevant data of each index variable. The questionnaire was divided into two parts: the basic personal information and the main part of the questionnaire. In the first part of the questionnaire, the

identification questions were set to differentiate the respondents, and the question "Have you experienced the "7.20" rainstorm in Zhengzhou?" was designed to screen out the respondents who had experienced the "7.20" rainstorm in Zhengzhou as a valid sample, and the question "What kind of social media software did you mainly use to obtain and publish information about the disaster when you experienced the "7.20" rainstorm in Henan in 2021? What kind of social media software did you mainly use to obtain and release information about the "7.20" rainstorm?" The questions were categorized to prepare for the main part of the questionnaire using WeChat, TikTok and Weibo. Secondly, the main part of the questionnaire was set to measure the corresponding indicator variables of convenience and trust, creation and dissemination, emotion and communication, cooperation and collective action, relief and release, and usage behavior and willingness, which are also the most important parts of the questionnaire. The questionnaire was administered uniformly on a Likert scale (1-5), and respondents were asked to select "strongly disagree", "disagree", "undecided", "agree", and "strongly agree" after reading the relevant questions.

Table 1. Descriptive statistics of survey participants ($N = 211$).

Characteristics		Frequency	Percent (%)
Gender	Male	109	51.66
	Female	102	48.34
Age	<20	42	19.90
	20-29	43	20.40
	30-39	47	22.30
	40-49	27	12.80
	50-59	37	17.54
	<60	15	7.11
Education	Primary school	31	14.70
	High school	36	17.06
	College	52	24.64
	Four-year university	59	28.00
	Graduate school	33	15.64
Employment	Student	48	22.75
	Government and public institution staff	18	8.53
	Company employee	53	25.12
	Company owner or self-employed	41	19.43
	Other	51	24.17
Monthly income	<5000RMB	113	53.60
	5000-10000RMB	45	21.30
	10000-15000RMB	29	13.74
	15000-20000RMB	21	10.00
	>20000RMB	3	1.40

Note: * 1000 Chinese yuan (USD 1 = RMB 7.253).

This study adopted an online questionnaire survey to distribute the questionnaire. The study entered the questionnaire into the online questionnaire survey website questionnaire.com beforehand and got the link to the questionnaire. The channels for collecting the questionnaires were mainly citizens living in Zhengzhou, and the questionnaires were distributed on social media such as WeChat groups, friend circles and QQ groups through interpersonal relationships such as classmates and friends, and respondents directly opened the questionnaire links to fill in the questionnaires themselves. In order to increase the coverage and heterogeneity of respondents, online questionnaires were sent to men and women of different age groups, who filled out the questionnaires and then passed them to their acquaintances. At the same time, we selected three respondents for in-depth interviews via WeChat, all of whom were Zhengzhou residents who had experienced the "7.20" rainstorm in Zhengzhou.

The questionnaires were distributed from November 1, 2022 to November 5, 2022, and 229 questionnaires were collected, and after eliminating invalid data, the final valid data was 211. The basic demographic information of these 211 respondents is shown in Table 1 below. Among them, 109 (51.66%) were male and 102 (48.34%) were female. In terms of age, 42 (19.9%) were under 20 years of age, 43 (20.4%) were 20-29 years of age, 47 (22.3%) were 30-39 years of age, 27 (12.8%) were 40-49 years of age, 37 (17.54%) were 50-59 years of age, and 15 (7.11%) were over 60 years of age. In terms of education, 31 people (14.7%) had junior high school education, 36 people (17.06%) had high school education, 52 people (24.4%) had college education, 59 people (28%) had bachelor's degree, and 33 people (15.64%) had master's degree or above. In terms of occupation, students accounted for 22.75%, government and institution staff accounted for 8.53%, company employees accounted for 25.12%, self-employed accounted for 19.43%, and other occupations accounted for 24.17%. In terms of monthly income, 53.6% had a monthly income of less than 5,000 RMB, 21.3% had a monthly income of 5,000-10,000 RMB, 13.74% had a monthly income of 10,000-15,000 RMB, 10% had a monthly income of 15,000-20,000 RMB, and 1.4% had a monthly income of more than 20,000 RMB.

In order to determine the reliability of the questionnaire, a reliability analysis should first be performed. We chose the Cronbach's coefficient. In general, the stability of the data increases with the increase of the alpha value. According to the results of the reliability analysis, it can be seen that the reliability coefficients of convenience and trust, creation and dissemination, emotion and communication, cooperation and collective action, relief and release, and usage behavior and willingness are 0.831, 0.858, 0.845, 0.851, 0.845, and 0.835, respectively. The reliability coefficient of the overall questionnaire is 0.968. The range of the reliability coefficient is between 0 and 1, and the closer to 1, the higher the reliability. Therefore, the reliability of this survey is good and the survey is reliable.

Table 2. Reliability statistics.

Variables	N of items	Cronbach's Alpha
Convenience and Trust	3	0.831
Creation and dissemination	3	0.858
Emotion and communication	3	0.845
Cooperation and collective action	3	0.851
Relief and release	3	0.845
Use behavior and willingness	3	0.835
Total	18	0.968

4. Results

According to the analysis results, in terms of social media choices when encountering heavy rainfall, the most citizens used TikTok to obtain disaster information, 86, followed

by WeChat and finally Weibo (Figure 3). Domestic Internet applications in China have been growing explosively in recent years, with a steady growth of various social media software and news APPs. Chinese citizens seldom get relevant information through traditional TV and news broadcast, but more often use smartphones and computers to get and publish relevant information in the fastest and largest amount through social media, such as WeChat, Weibo, and TikTok.

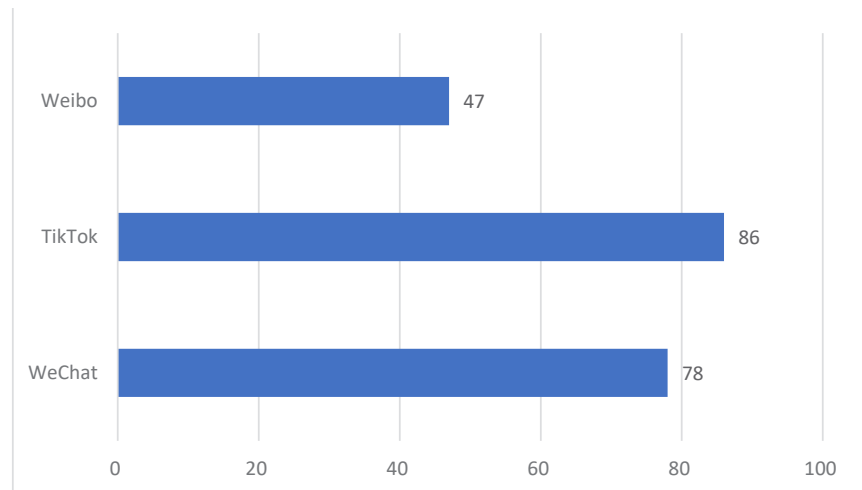


Figure 3. Choice of social media.

Figure 4 shows the scores of three different social media, WeChat, TikTok and Weibo, for each variable. We can see that the degree of satisfaction of the public with the use of WeChat, TikTok and Weibo is 3.90, 3.74 and 3.77 respectively, with WeChat being the most satisfied. Figure 5 shows the differences between WeChat, TikTok, and Weibo according to sociodemographic variables. We can see that there are more women than men among the citizens who use WeChat, more men than women among the citizens who use TikTok, and more women than men among the citizens who use Weibo. In general, male citizens use TikTok more, and female citizens use WeChat more.

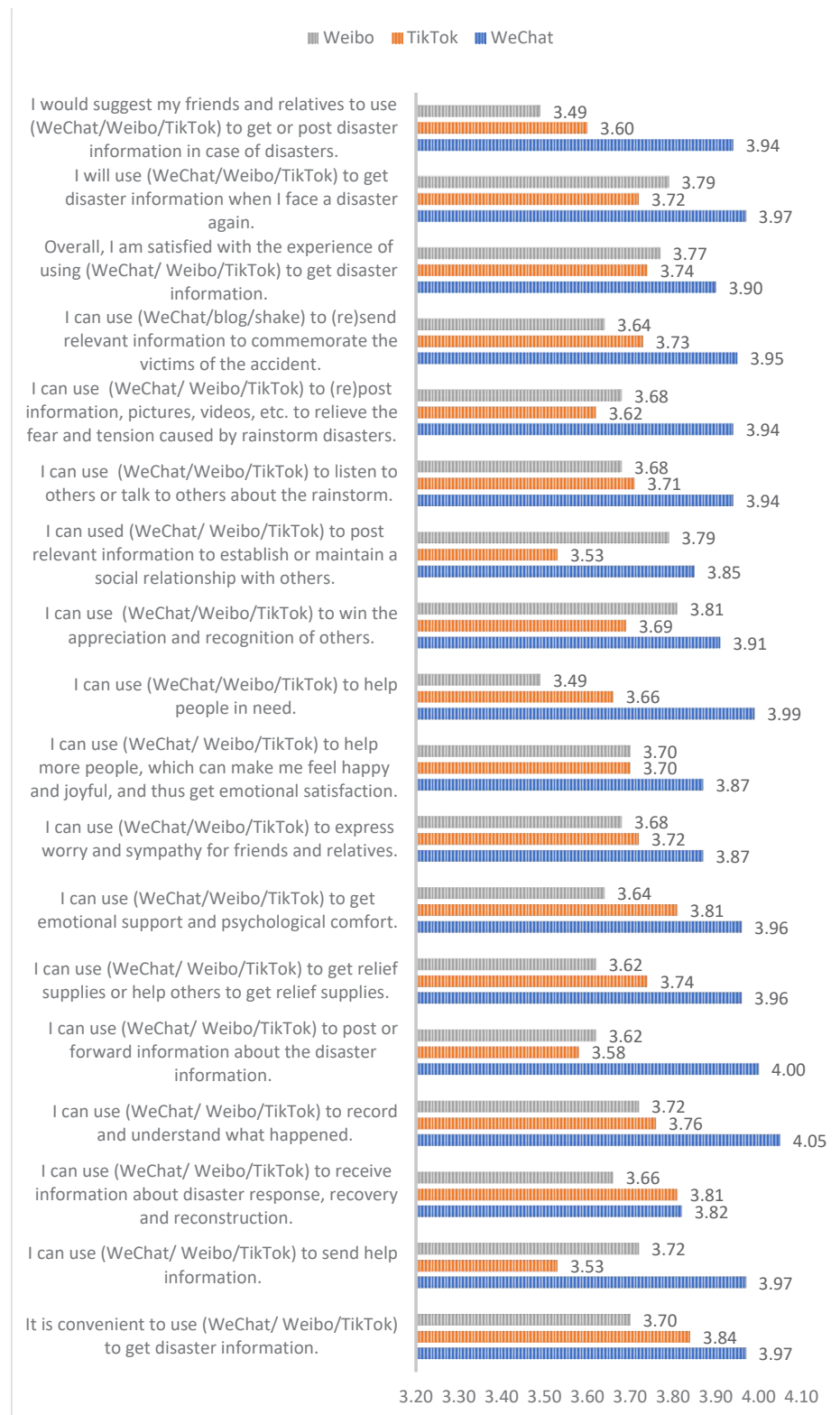


Figure 4. Social media scores on each variable.

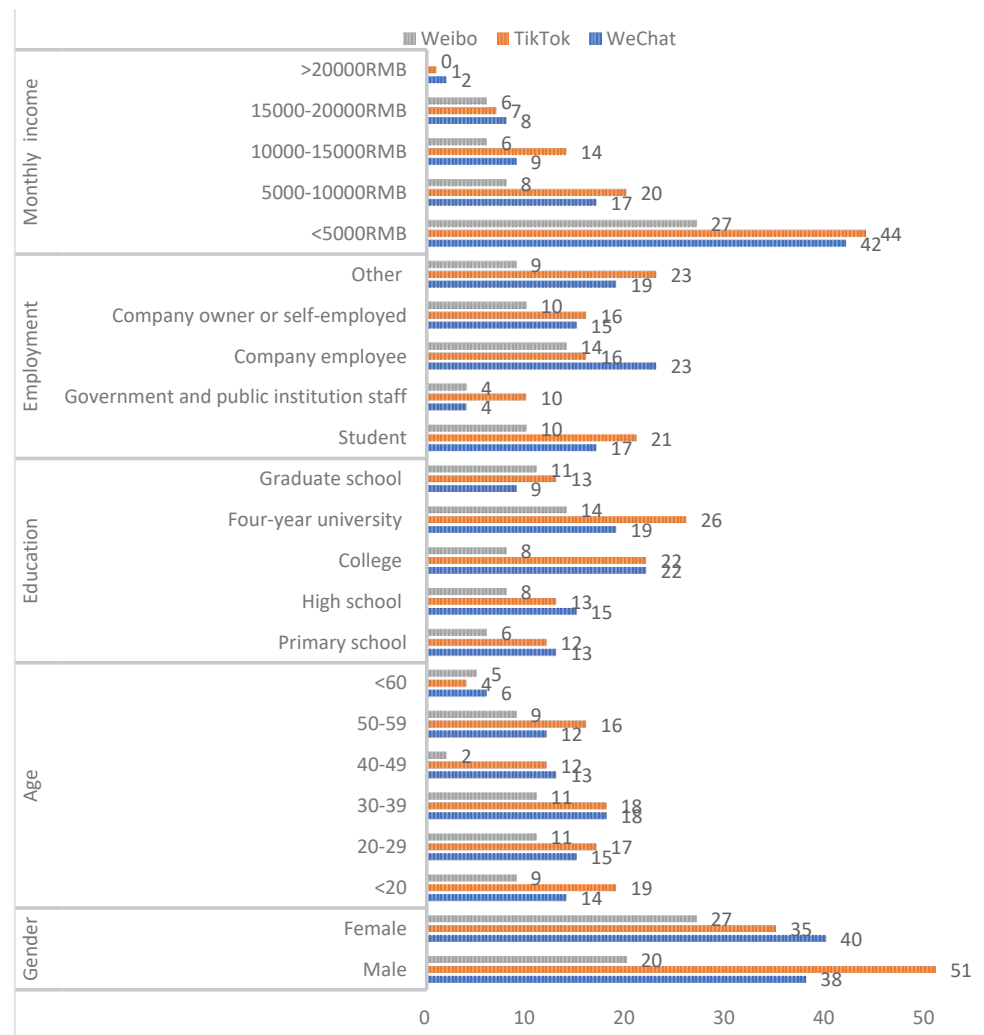


Figure 5. The differences between WeChat, TikTok, and Weibo according to socio-demographic variables.

In the age category, citizens under 20 and 20-29, 50-59 use TikTok the most, citizens 30-39 frequently use WeChat and TikTok, and citizens 40-49 and over 60 use WeChat the most. Most of them use WeChat. In the category of education level, people with university and master's degree or above in Civic Middle School mostly use TikTok, while those in middle and high schools mostly use WeChat. Among the occupational categories, citizens whose occupations are company employees use WeChat the most, while students, government workers, self-employed people and other occupations use TikTok the most. Finally, citizens with incomes below 5,000 RMB, 5,000-10,000 RMB, and 10,000-15,000 RMB use TikTok the most, while those with 15,000-20,000 RMB or more use WeChat the most.

To investigate the relationship between these variables, we performed a simple correlation analysis. The analysis results are shown in Table 3. As can be seen from the table, the analysis results all show that the use of social media (WeChat, TikTok, Weibo) is related to convenience and trust, creation and dissemination, emotion and communication, cooperation and collective action, and mitigation and release. In particular, they all show a positive correlation with each other. All variables have significant correlations at the 99% significance level, and the correlation coefficients are all greater than 0, so they are all positively correlated with each other. Specifically, the correlation coefficients between the

use of social media (WeChat, TikTok, Weibo) and convenience and trust, creation and dissemination, emotion and communication, cooperation and collective action, and mitigation and release are 0.830, 0.831, 0.860, 0.850, and 0.836, respectively. , and all showed a significance level of 0.01, indicating that there is a significant positive correlation between users' use of social media information release behavior and willingness, convenience and trust, creation and dissemination, emotion and communication, cooperation and collective action, mitigation and release. The relationship between convenience and trust, creation and dissemination, emotion and communication, cooperation and collective action, and mitigation and release also have a significant positive correlation between several variables that represent the community's resilience to disasters.

Table 3. Correlations.

	Convenience and trust	Creation and dissemination	Emotion and communication	Cooperation and collective action	Relief and release	Use behavior and willingness
Convenience and trust	1					
Creation and dissemination	.838**	1				
Emotion and communication	.849**	.840**	1			
Cooperation and collective action	.837**	.836**	.843**	1		
Relief and release	.818**	.786**	.812**	.808**	1	
Use behavior and willingness	.830**	.831**	.860**	.850**	.836**	1

** . Correlation is significant at the 0.01 level (2-tailed).

The data were then subjected to linear regression analysis, and the results are shown in the table 4. The results of the analysis show that the use of WeChat has a positive effect on community resilience during rainstorms, especially the use of WeChat on convenience and trust ($\beta=.819$, $P<.000$), creation and dissemination ($\beta=.815$, $P<.000$), emotion and communication ($\beta=.874$, $P<.000$), cooperation and collective action ($\beta=.883$, $P<.000$), and relief and release ($\beta=.790$, $p<.000$). Second, the use of TikTok also had a positive effect on community resilience during rainstorms, especially the use of TikTok on convenience and trust ($\beta = .939$, $P < .000$), creation and dissemination ($\beta = .935$, $P < .000$), emotion and communication ($\beta = .930$, $P < .000$), cooperation and collective action ($\beta = .936$, $P < .000$), and relief and release ($\beta = .949$, $P < .000$). The use of Weibo had a positive effect on community resilience during rainstorms, especially the use of microblogs on convenience and trust ($\beta = .703$, $P < .000$), creation and communication ($\beta = .718$, $P < .000$), emotion and communication ($\beta = .851$, $P < .000$), cooperation and collective action ($\beta = .856$, $P < .000$), and relief and release ($\beta = .756$, $P < .000$).

As we can see, the results of all three social media analyses show that the use of ICT has a positive impact on resilience. With the explosive growth of domestic Internet applications in China in recent years, Chinese citizens are more likely to use smartphones and computers to access or publish relevant information through social media, such as WeChat, Weibo, and TikTok, at the fastest pace and in the greatest quantity. Firstly, convenience and trust, social media may be a more reliable form of media than traditional media in a disaster situation [13]. In addition to reliability, social media in a disaster may prove to be a faster mechanism through which accurate disaster information can be received [55]. Between these three social media, the differences are mainly reflected in the fact that TikTok presents short videos with a stronger visual impact, an easy-to-understand and accessible way to communicate to people the events of the day. Compared with WeChat and Weibo, the more novel and interesting TikTok has objectively enriched the methods and means of releasing information and obtaining relevant disaster information. At the same time some of the official TikTok accounts as the government, in the video

release style of TikTok is not the serious image in the past, but shows the affinity, so that the government media is revitalized and fully integrate the voice and video, so that the public is more willing to use this way. At the same time, there is a large body of literature that emphasizes a holistic framework for social media design for disasters [13], models to help emergency responders understand how the public generates and shares crisis information through social media [39], architectures for data quality assessment and filtering user-generated content accessed from social media for disaster management [56].

Table 4. Results of regression analysis.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	VIF	R ²
Independent variable	Dependent Variable	B	Std. Error	Beta				
Behavior and willingness to use WeChat	Convenience and trust	0.819	0.075	0.781	10.906	0.000	1.000	0.61
	Creation and dissemination	0.815	0.068	0.809	12.007	0.000	1.000	0.655
	Emotion and communication	0.874	0.072	0.813	12.160	0.000	1.000	0.661
	Cooperation and collective action	0.883	0.067	0.834	13.192	0.000	1.000	0.696
	Relief and release	0.790	0.070	0.791	11.262	0.000	1.000	0.625
Behavior and willingness to use Weibo	Convenience and trust	0.703	0.073	0.821	9.635	0.000	1.000	0.674
	Creation and dissemination	0.718	0.088	0.774	8.187	0.000	1.000	0.598
	Emotion and communication	0.851	0.060	0.903	14.138	0.000	1.000	0.816
	Cooperation and collective action	0.856	0.066	0.887	12.875	0.000	1.000	0.787
	Relief and release	0.756	0.062	0.876	12.188	0.000	1.000	0.767
Behavior and willingness to use TikTok	Convenience and trust	0.939	0.057	0.875	16.539	0.000	1.000	0.765
	Creation and dissemination	0.935	0.055	0.878	16.853	0.000	1.000	0.772
	Emotion and communication	0.930	0.058	0.869	16.109	0.000	1.000	0.755
	Cooperation and collective action	0.936	0.067	0.837	14.009	0.000	1.000	0.700
	Relief and release	0.949	0.065	0.848	14.646	0.000	1.000	0.719

Secondly, creation and dissemination, and also, social media are usually more reliable in disaster situations, so requests for help after a disaster can be made through social media [57,58]. Relief information is posted through social media to get relief and help the fastest. More importantly, during and after a disaster, people will want to know that their family and friends in the affected area are safe. Compared with TikTok, WeChat is mainly social-oriented, facilitating communication and contact between people, breaking the limits of time and space, and making communication between people more convenient, fast

and free. At the same time, with the growth of users, WeChat is no longer just a communication tool, the circle of friend's function and WeChat public number derived through the WeChat platform have involved in every aspect of life. The group chat function of WeChat is more like a "meeting room", which is a trend of value homogeneity among different individuals based on one or more different connections and values.

Next comes emotion and communication, where individuals often need a place to check in, let others know about their situation, and connect with others if the level of disaster damage is significant. Social media can help with these processes [16,59,60]. For example, following the mass shooting on the Virginia Tech campus on April 16, 2007, students used text and instant messaging to let others know they were safe and to check on the safety of their friends [52,61]. In previous studies, Tiktok has been shown to play an important role in combating the spread of COVID-19, the epidemic awareness in this epidemic. New media play an important role not only in conveying information and guiding public opinion to appease people, but also in providing an easier way of life for people in special times.

Cooperation and collective action are mainly reflected in the provision and receipt of preparedness information through social media in the event of a storm disaster, and an informed and prepared population may be more resilient in the face of a disaster [62,63], so individuals and organizations strive to learn how to prepare for disasters and how the dissemination of inherent preparedness through organizations and government content can benefit people and communities [13]. Also, because of the nature and connectedness of social media, it may also lead to improved capital and social connections in social communities if it happens or stays again, which may improve the level of community resilience overall [62]. Compared to WeChat and TikTok, Weibo is a typical representative of weak ties, which differ from strong ties in that they do not require a network of social interaction relationships with people of the same value or with the same needs. The open and fissionable communication characteristics of microblogs allow us to search through our own needs when we are exposed to information, and we are able to access a broader range of information. In terms of communication content, the communication content of microblogs is more like an open cultural square. Due to the openness and inclusiveness of microblogs, a non-homogeneous set of values is presented, and different values appear to collide and communicate, by reprinting, sending, browsing through the microblog hot search bar or entering keywords in the search to see the information of the message that one wants to browse [64].

Finally, there is relief and release, and social media may promote attitudes and feelings that may be relevant and improve mental/behavioral health. Expressing emotions, concerns, and blessings; remembering victims, social media may give users the opportunity to express their emotions about the event, convey their concern for those affected by the event, and mourn and remember anyone who lost their life in the event [58,59,65–67].

5. Conclusions

Disasters and crisis events that cause significant disruptions and impacts on human societies will inevitably leave their footprints on social media [51]. Therefore, social media can be an effective tool for tracking disaster processes and has great potential to provide localized and human-centered information to facilitate decision making for disaster mitigation and resilience enhancement.

Taking the "7.20" Zhengzhou rainstorm as an example, this paper formulates a research question on the impact of social media use on community resilience in the rainstorm disaster and tries to grasp the relationship between them, starting from the impact of social media use and influence. After collecting and analyzing relevant data and discussions, the main conclusion is that the public's use of social media (WeChat, TikTok, and Weibo) in a rainstorm disaster has a correlation with convenience and trust, creation and dissemination, emotion and communication, cooperation and collective action, and

mitigation and release; therefore, the use of social media has and shows a positive influence relationship on disaster resilience. As previously discussed, another emergency use of disaster social media, in addition to accessing and distributing disaster information, disseminating relevant information, and obtaining emergency relief, is to provide and receive disaster psychology, and disaster social media may be a mechanism through which individuals experiencing disasters are connected to mental/behavioral health services or information [63]. More generally, social media can connect disaster survivors with others who have experienced the event, friends and family, and individuals outside of the disaster who are concerned about what happened, thus providing a resource for social support [68]. As the event phase of a disaster recedes into the post-event time frame, social media can allow users to continue to engage with disaster-related efforts and to communicate stories of personal involvement [16]. On some social media sites (e.g., Facebook), coverage of a disaster may last longer [69].

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References

1. Field, C.B.; Barros, V.; Stocker, T.F.; Dahe, Q. *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation: Special Report of the Intergovernmental Panel on Climate Change*; Cambridge University Press, 2012;
2. United Nations Office for Disaster Risk Reduction 2022.
3. Alcántara-Ayala, I. Geomorphology, Natural Hazards, Vulnerability and Prevention of Natural Disasters in Developing Countries. *Geomorphology* **2002**, *47*, 107–124.
4. Guinau, M.; Pallàs, R.; Vilaplana, J.M. A Feasible Methodology for Landslide Susceptibility Assessment in Developing Countries: A Case-Study of NW Nicaragua after Hurricane Mitch. *Eng. Geol.* **2005**, *80*, 316–327, doi:10.1016/j.enggeo.2005.07.001.
5. Timmerman, P. *Vulnerability, Resilience and the Collapse of Society. A Review of Models and Possible Climatic Applications*; Institute for Environmental Studies, University of Toronto: Toronto, Canada, 1981;
6. Plough, A.; Fielding, J.E.; Chandra, A.; Williams, M.; Eisenman, D.; Wells, K.B.; Law, G.Y.; Fogleman, S.; Magaña, A. Building Community Disaster Resilience: Perspectives From a Large Urban County Department of Public Health. *Am. J. Public Health* **2013**, *103*, 1190–1197, doi:10.2105/AJPH.2013.301268.
7. UNISDR, 2015. Sendai Framework for Disaster Risk Reduction 2015 - 2030.
8. Arnold, J.L. Information-Sharing in out-of-Hospital Disaster Response: The Future Role of Information Technology. *Prehospital Disaster Med.* **2004**, *19*, 201–207.
9. Madon, S.; Reinhard, N.; Roode, D.; Walsham, G. Digital Inclusion Projects in Developing Countries: Processes of Institutionalization. *Inf. Technol. Dev.* **2009**, *15*, 95–107.
10. Miscione, G. Telemedicine in the Upper Amazon: Interplay with Local Health Care Practices. *MIS Q.* **2007**, 403–425.
11. Andrade, A.D.; Doolin, B. Information and Communication Technology and the Social Inclusion of Refugees. *Mis Q.* **2016**, *40*, 405–416.
12. Dutton, W.H.; Nainoa, F. The Social Dynamics of Wireless on September 11: Reconfiguring Access. In *Crisis communication: Lessons learned from September 11*; Noll, M., Ed.; Rowtman & Littlefield: Lanham, MD, 2003; pp. 69–82.

13. Houston, J.B.; Hawthorne, J.; Perreault, M.F.; Park, E.H.; Goldstein Hode, M.; Halliwell, M.R.; Turner McGowen, S.E.; Davis, R.; Vaid, S.; McElderry, J.A.; et al. Social Media and Disasters: A Functional Framework for Social Media Use in Disaster Planning, Response, and Research. *Disasters* **2015**, *39*, 1–22, doi:10.1111/disa.12092.
14. Carey, J. Media Use during a Crisis. In *Crisis communications: Lessons from September 11*; A, I.M.N., Ed.; Rowman & Littlefield: Lanham, Maryland, 2003; pp. 1–16.
15. Macias, W.; Hilyard, K.; Freimuth, V. Blog Functions as Risk and Crisis Communication during Hurricane Katrina. *J. Comput.-Mediat. Commun.* **2009**, *15*, 1–31.
16. Procopio, C.H.; Procopio, S.T. Do You Know What It Means to Miss New Orleans? Internet Communication, Geographic Community, and Social Capital in Crisis. *J. Appl. Commun. Res.* **2007**, *35*, 67–87.
17. Stieglitz, S.; Mirbabaie, M.; Ross, B.; Neuberger, C. Social Media Analytics—Challenges in Topic Dis-Cover, Data Collection, and Data Preparation. *Int. J. Inf. Manag.* **2018**, *39*, 156–168.
18. Bird, D.; Ling, M.; Haynes, K. Flooding Facebook—the Use of Social Media during the Queensland and Victorian Floods. *Aust. J. Emerg. Manag.* **2012**, *27*, 27–33.
19. Mendoza, M.; Poblete, B.; Castillo, C. Twitter under Crisis: Can We Trust What We RT? In Proceedings of the Proceedings of the first workshop on social media analytics; 2010; pp. 71–79.
20. Tha, O.; Khet, K. Exploring the Role of ICTs in Addressing Societal Challenges in Developing Countries: An Affordance Perspective. PhD diss., UNSW Sydney, 2020.
21. Aydin, C.; Tarhan, C.; Ozgur, A.S.; Tecim, V. Improving Disaster Resilience Using Mobile Based Disaster Management System. *Procedia Technol.* **2016**, *22*, 382–390, doi:10.1016/j.protcy.2016.01.027.
22. Seeger, M.W.; Sellnow, T.L.; Ulmer, R.R. Communication, organization, and crisis. *Ann. Int. Commun. Assoc.* **1998**, *21*, 231–276.
23. Albala-Bertrand, J.M. Globalization and Localization: An Economic Approach. In *Handbook of disaster research*; Springer: New York, NY, 2007; pp. 147–167.
24. Huang, C.-M.; Chan, E.; Hyder, A.A. Web 2.0 and Internet Social Networking: A New Tool for Disaster Management?—Lessons from Taiwan. *BMC Med. Inform. Decis. Mak.* **2010**, *10*, 1–5.
25. Tamilselvan, N.; Sivakumar, N.; Sevukan, R. Information and communications technologies (ICT)". *Int. J. Libr. Inf. Sci.* **2012**, 15–28.
26. Anderson, J. ICT Transforming Education: Regional Guide 2010.
27. Mohan, P.; Mittal, H. Review of ICT Usage in Disaster Management. *Int. J. Inf. Technol.* **2020**, *12*, 955–962, doi:10.1007/s41870-020-00468-y.
28. Statista Most Popular Social Networks Worldwide as of April 2020, Ranked by Number of Active Users" 2020.
29. Tonmoy, F.N.; Hasan, S.; Tomlinson, R. Increasing Coastal Disaster Resilience Using Smart City Frameworks: Current State, Challenges, and Opportunities. *Front. Water* **2020**, *2*, 3.
30. Kitchin, R. The Real-Time City? Big Data and Smart Urbanism. *GeoJournal* **2014**, *79*, 1–14.
31. Gupta, R.; Gupta, R. ABC of Internet of Things: Advancements, Benefits, Challenges, Enablers and Facilities of IoT. In Proceedings of the 2016 Symposium on Colossal Data Analysis and Networking (CDAN; IEEE, 2016; pp. 1–5.
32. Murayama, Y.; Scholl, H.J.; Velez, D. Information Technology in Disaster Risk Reduction. *Inf. Syst. Front.* **2021**, *23*, 1077–1081.
33. Orlikowski, W.J. Using Technology and Constituting Structures: A Practice Lens for Studying Technology in Organizations. *Organ. Sci.* **2000**, *11*, 404–428.
34. Sutton *Collective Intelligence in Disaster: Examination of the Phenomenon in the Aftermath of the 2007 Virginia Tech Shooting*; University of Colorado: Boulder, CO, 2008;

35. Leidner, D.E.; Pan, G.; Pan, S.L. The Role of IT in Crisis Response: Lessons from the SARS and Asian Tsunami Disasters. *J. Strateg. Inf. Syst.* **2009**, *18*, 80–99.
36. Pan, S.L.; Pan, G.; Leidner, D.E. Crisis response information networks. *J. Assoc. Infor-Mation Syst.* **2012**, *13*, 31.
37. Yang, T.-K.; Hsieh, M.-H. Case Analysis of Capability Deployment in Crisis Prevention and Response. *International J. Inf. Manag.* **2013**, *33*, 408–412.
38. Katz, J.E.; Rice, R.E. The Telephone as a Medium of Faith, Hope, Terror, and Redemption: America, September 11. *Prometheus* **2002**, *20*, 247–253.
39. Simon, T.; Goldberg, A.; Adini, B. Socializing in Emergencies—A Review of the Use of Social Media in Emergency Situations. *Int. J. Inf. Manag.* **2015**, *35*, 609–619.
40. Birregah, B.; Top, T.; Perez, C.; Chatelet, E.; Matta, N.; Lemerrier, M.; Snoussi, H. Multi-Layer Crisis Mapping: A Social Media-Based Approach. In *2012 IEEE 21st International Workshop on Enabling Technologies: Infrastructure for Collaborative Enterprises*; IEEE, 2012; pp. 379–384.
41. Finau, G.; Tarai, J.; Varea, R.; Titifanue, J.; Kant, R.; Cox, J. Social Media and Disaster Communication: A Case Study of Cyclone Winston. *Pac. Journal. Rev.* **2018**, *24*, 123–137.
42. Nah, S.; Saxton, G.D. Modeling the Adoption and Use of Social Media by Nonprofit Organizations. *New Media Soc.* **2013**, *15*, 294–313.
43. Endsley, M.R. Situation Awareness Global Assessment Technique (SAGAT). In *Proceedings of the Proceedings of the IEEE 1988 national aerospace and electronics conference*; IEEE, 1988; pp. 789–795.
44. Cheng, J.W.; Mitomo, H.; Otsuka, T.; Jeon, S.Y. The Effects of ICT and Mass Media in Post-Disaster Recovery – A Two Model Case Study of the Great East Japan Earthquake. *Telecommun. Policy* **2015**, *39*, 515–532, doi:10.1016/j.tel-pol.2015.03.006.
45. Kankanamge, N.; Yigitcanlar, T.; Goonetilleke, A. How Engaging Are Disaster Management Related Social Media Channels? The Case of Australian State Emergency Organisations. *Int. J. Disaster Risk Reduct.* **2020**, *48*, 101571.
46. Qu, Y.; Wu, P.F.; Wang, X. Online Community Response to Major Disaster: A Study of Tianya Forum in the 2008 Sichuan Earthquake. In *Proceedings of the 2009 42nd Hawaii International Conference on System Sciences*; IEEE, 2009; pp. 1–11.
47. Boas, I.; Chen, C.; Wiegel, H.; He, G. The Role of Social Media-Led and Governmental Information in China's Urban Disaster Risk Response: The Case of Xiamen. *Int. J. Disaster Risk Reduct.* **2020**, *51*, 101905, doi:10.1016/j.ijdr.2020.101905.
48. Abedin, B.; Babar, A.; Abbasi, A. Characterization of the Use of Social Media in Natural Disasters: A Systematic Review. In *Proceedings of the 2014 IEEE Fourth International Conference on Big Data and Cloud Computing*; IEEE, 2014; pp. 449–454.
49. Kitazawa, K.; Hale, S.A. Social Media and Early Warning Systems for Natural Disasters: A Case Study of Typhoon Etau in Japan. *Int. J. Disaster Risk Reduct.* **2021**, *52*, 101926.
50. Sigala, M. Social media and crisis management in tourism: Applications and implications for research. *Inf. Technol. Tour.* **2011**, *13*, 269–283.
51. Fang, J.; Hu, J.; Shi, X.; Zhao, L. Assessing Disaster Impacts and Response Using Social Media Data in China: A Case Study of 2016 Wuhan Rainstorm. *Int. J. Disaster Risk Reduct.* **2019**, *34*, 275–282, doi:10.1016/j.ijdr.2018.11.027.
52. Palen, L.; Vieweg, S.; Liu, S.B.; Hughes, A.L. Crisis in a Networked World: Features of Computer-Mediated Communication in the April 16, 2007, Virginia Tech Event. *Soc. Sci. Comput. Rev.* **2009**, *27*, 467–480.
53. Vieweg, S.; Palen, L.; Liu, S.B.; Hughes, A.L.; Sutton, J.N. *Collective Intelligence in Disaster: Examination of the Phenomenon in the Aftermath of the 2007 Virginia Tech Shooting*; University of Colorado: Boulder, CO, 2008;

54. Starbird, K.; Palen, L.; Hughes, A.L.; Vieweg, S. Chatter on the Red: What Hazards Threat Reveals About the Social Life of Microblogged Information. In Proceedings of the Proceedings of the 2010 ACM conference on Computer supported cooperative work: ACM; 2010; pp. 241–250.
55. Bunce, S.; Partridge, H.; Davis, K. Exploring Information Experience Using Social Media during the 2011 Queensland Floods: A Pilot Study'. *Aust. Libr. J.* **2012**, *61*, 34–45.
56. Shah, S.A.; Şeker, D.Z.; Demirel, H. A Framework for Enhancing Real-Time Social Media Data to Improve the Disaster Management Process. In Proceedings of the International Cartographic Conference; Springer: Cham, 2017; pp. 75–84.
57. Acar, A.; Muraki, Y. Twitter for Crisis Communication: Lessons Learned from Japan's Tsu-Nami Disaster'. *International J. Web Based Communities* **2011**, *7*, 392–402.
58. Taylor, M.; Wells, G.; Howell, G.; Raphael, B. The Role of Social Media as Psychological First Aid as a Support to Community Resilience Building'. *Aust. J. Emerg. Management* **2012**, *27*(1), 20–26.
59. Hughes, A.L.; Palen, L.; Sutton, J.; Liu, S.B.; Vieweg, S. Site-Seeing in Disaster: An Examination of on-Line Social Convergence. In Proceedings of the Proceedings of the 5th International ISCRAM Conference; Washington, DC, May 2008; pp. 44–54.
60. Austin, L.; Liu, B.F.; Jin, Y. How Audiences Seek out Crisis Information: Exploring the Social-Mediated Crisis Communication Model'. *J. Appl. Commun. Res.* **2012**, *40*, 188–207.
61. Palen, L. Online Social Media in Crisis Events'. *Educ. Q.* **2008**, *3*, 76–78.
62. Norris, F.H.; Stevens, S.P.; Pfefferbaum, B.; Wyche, K.F.; Pfefferbaum, R.L. Community Resilience as a Metaphor, Theory, Set of Capacities, and Strategy for Disaster Readiness. *Am. J. Community Psychol.* **2008**, *41*, 127–150, doi:10.1007/s10464-007-9156-6.
63. Houston, J.B. Public disaster mental/behavioral health communication: intervention across disaster phases'. *J. Emerg. Manag.* **2012**, *10*, 283–292.
64. Zhang, L.; Zhao, J.; Liu, J.; Chen, K. Community Disaster Resilience in the COVID-19 Outbreak: Insights from Shanghai's Experience in China. *Risk Manag. Healthc. Policy* **2021**, *Volume 13*, 3259–3270, doi:10.2147/RMHP.S283447.
65. White, C.; Plotnick, L.; Kushma, J.; Hiltz, S.R.; Turoff, M. An Online Social Network for Emergency Management'. *Int. J. Emerg. Manag.* **2009**, *6*, 369–382.
66. Smith, B.G. Socially Distributing Public Relations: Twitter, Haiti, and Interactivity in Social Media'. *Public Relat. Rev.* **2010**, *36*, 329–335.
67. Hjorth, L.; Kim, K.H.Y. The Mourning after: A Case Study of Social Media in the 3.11 Earthquake Disaster in Japan. *Telev. New Media* **2011**, *12*, 552–559.
68. Vicary, A.M.; Fraley, R.C. Student Reactions to the Shootings at Virginia Tech and Northern Illinois University: Does Sharing Grief and Support over the Internet Affect Recovery?'. *Personality And. Soc. Psychol. Bull.* **2010**, *36*, 1555–1563.
69. Lobb, A.; Mock, N.; Hutchinson, P.L. Traditional and Social Media Coverage and Charitable Giving Following the 2010 Earthquake in Haiti'. *Prehospital Disaster Med.* **2012**, *27*, 319–324.



Article

What are the effects of safety management and attendees' awareness of safety at festivals on public awareness (public collective self-esteem and national role identity)? Focused on 2030 Busan EXPO Concert

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Abstract: Going with the flows of globalization, cultural activities have witnessed the increase in a broad range of international events. Successful international events add to the national brand value of their host countries. Thus, countries compete to host large-scale international events. This study analyzes the effects of a purposive festival aimed to host an international event on public awareness(national role identity). The analysis found that the public security management, safety accident management, awareness of safety levels and trust in safety at the festival had positive effects on the public awareness(public collective self-esteem and national role identity). The findings suggest the central and local governments should strive to increase the public trust through the systematization of the safety management planning and implementation so as to raise the public awareness(public collective self-esteem and national role identity) in hosting a festival.

Keywords: Festival, Safety management, Crisis management, Public collective self-esteem, National role identity

1. Introduction

The Article 27 of the Universal Declaration of Human Rights recognizes the cultural life constitutes a human right (OHCHR | Universal Declaration of Human Rights, searched on Nov. 14, 2022). Also, sustainable cultural activities are deemed to maintain the balance against the sociocultural inequality and thereby explicitly attain some sustainable development. In particular, the culture industry could be a key driver for the positive change in public awareness and behavior (UNWTO, 2020; Louw & Esterhuyzen, 2022).

Despite being a route to guarantee the right to enjoy culture, festivals generally attract crowds, where any inefficient safety management and security measures could cause significant damage to life and property. Therefore, it is highly important to set up safety management systems for festivals or special events(Sun, 2016; Baby, 2022).

Notably, the size of the crowd to be managed complicates the safety management at festivals aimed to host international events. In case of purposive occasions related to international events, the central or local government acts as host. Thus, in pursuit of a safer crisis management system, it is important for governments to identify the effects of crowd behavior, and take the initiative to develop a safer festival management system. In case of

a purposive festival intended to host an international event, any problem in safety management could be detrimental to the image and reputation of the country (Höglund, 2013).

Focused on a festival held for the purpose of hosting an international event, this study analyzes the effects of safety management and attendees' safety consciousness on the public awareness (national role identity) with intent to contribute to the settlement of a safer culture of public performance.

2. Theoretical background

2.1 Safety management at festivals

2.1.1 Public security management

Festivals provide important social, cultural and spatial elements for many youths and adults. 'Festivals' refer to a variety of events, where different scales, durations, types, age groups, classes, genders, ethnicities, hosts and objectives are involved (Fileborn, 2020).

Festivals provide opportunities to escape from daily routines to have new experiences, and embody some spaces conveying diverse identities. Particularly, festivals can serve as transcendental spaces where normative practices and power structures could be overturned and as the places where such practices and structures could be reinforced (Dilkes-Frayne, 2016).

Festivals where unrelated crowds come together are prone to crime, security and human conflict factors (Hughes & Moxham-Hall, 2017; Houlton, 2018). For example, according to Hughes & Moxham-Hall (2017), 65.3% of music festival attendees used illegal drugs. Likewise, Sampsel et al., (2016) reported on the high risks of being exposed to violence or sexual assaults at festivals.

Such findings suggest that extra attention should be paid to festivals where diverse public security risks are likely to occur and that the public security management by central and local governments as well as certain social norms should be analyzed.

2.1.2 Safety accident management

Safety management is the top priority for successful festivals. Festivals attract large crowds, where the younger the audiences are, the greater the risks get. In general, the risks include disorder, riots, crowd surges, stampedes, assaults and contagion (Sealy, 2020; Raineri, 2019; Zhao, et. al., 2020).

Injuries and deaths of concert audiences are no longer surprising news. Amid a series of nonviolent protests in the U. S. back in the 1960s, 3 people died and 6,000 supporters were injured and treated at the 1969 Woodstock Festival (De Barros, 2000). In the same year, at the notorious Altamont Festival in Northern California, 850 people were injured and 3 died (DeBarros, 2000).

Serious accidents occur not uncommonly at concerts within a short time. For example, at an all-day concert in Maryland in 1999, 61 fans were seriously injured and taken to hospitals. In the weeks following the incident, a 16-year-old boy collapsed and fell into a coma due to a crowd crush in Indiana (De Baros, 2000).

Hence, it is essential to implement the safety management to prevent incidents resulting from crowd surges.

2.2 Safety awareness

2.2.1. Awareness of safety levels

The awareness of safety levels is one of the important factors in identifying the crowd behavior at festivals. A previous study reported that the compliance with safety management measures was in line with the shared social identity (Cruwys, et.al., 2020). Particularly, when the crowd thought the safety measures mattered or when the administration

showed a high awareness of safety levels, they felt they were managed safely and complied with the management as much (Templeton, et. al., 2020; Khazaie & Khan, 2019).

The shared awareness of safety levels serves as a factor that manipulates the level of perceived importance of safe behaviors, and thereby lessens the burden of risk taking. Thus, by opting for safe behaviors as per social norms, the crowd members share a potential risk (Hopkins & Reicher, 2020).

Hence, hosts should put proper safety management into practice, ask crowds to comply with safety guidelines, and foresee the behaviors that might occur, so as to encourage and facilitate safe behaviors among the members of crowds (Templeton, 2021).

2.2.2. *Trust in safety*

Festival attendees' trust in safety has positive effects on the decrease in risks. Hosts need to foresee the behaviors that might occur, so as to encourage the crowd members to act safely. The clarity of the information provided by hosts is an important factor for predicting the extent to which attendees believe they will be kept safe and their compliance with safety measures (Templeton, et. al., 2020).

Carter, et.al (2041) analyzed that the clarified safety guidelines facilitated a shared social identity among attendees, and had positive effects on their compliance with safety behaviors by enhancing the trust among themselves.

Hence, at festivals expected to attract large crowds, it is important for hosts to explicitly establish a shared social identity, and to secure the trust in their safety management, since the shared social identity and trust add to the acceptance of the compliance with the guidelines required by the hosts (Templeton, 2021).

3.3 *Public awareness (national role identity)*

3.3.1 *Membership collective self-esteem*

When a person belongs to a group, the person feels the value of being part of the group. For that reason, the membership collective self-esteem refers to 'the attitude of determining the self-value of a person based on the fact that the person is a member of a certain group' (Lopez, 2013; Kim & Kim, 2019; Golec de Zavala & Lantos, 2020).

Particularly, positing the group is a country, people as the members of the country feel the membership collective self-esteem. Specifically, the identity, achievement, failure or shameful behavior of a country is linked to the rise or fall of its people's membership collective self-esteem (Nathanson, 1992; Dresler-Hawke & Liu, 2006; Dimitriadou, et. al., 2019).

3.3.2 *Public collective self-esteem*

Public collective self-esteem is utilized as a major indicator for the reputation of a country among the public. Importantly, the public may have negative effects on the public collective self-esteem, and a negative stereotype of a country could cause its national brand value to decline around the world (Yousaf & Li, 2015).

People demand a sense of belonging and security from their groups and country. Thus, the public collective self-esteem is formed when people feel their country fulfilling its accountability for public safety and protection, and when they feel their groups fulfilling their accountability for collective safety and protection for members (Druckman, 1994).

3.3.3 *Importance to identity collective self-esteem*

In light of Branscombe & Wann(1994), when a country's social identity is threatened, its people find their collective self-esteem dropping. Also, when people find themselves

not belonging to the mainstream but being treated as marginalized outsiders, their collective self-esteem dropped. Such insecure self-esteem has negative effects on the unity of a community (Jetten, et. al., 2002).

A robust social identity is highly instrumental for the unity and solidarity of a country as a community, which is supported by previous reports that individuals determine their collective self-esteem in the process of forming their social identity (Ozer, et. al., 2020; Jetten, et. al., 1997; Mavrić, 2014).

3.3.4 Reputation of a country

A country's reputation is defined as 'a general valuation of a country over time based on its multiple aspects including its history, culture, economy, society and communication by the peoples of other diverse countries in the international society characterized by cultural differences' (Szondi, 2008).

The reputation of a country exerts substantial effects on raising its brand value in the age of globalization transcending the economic, cultural and political boundaries. Given diverse risk factors emerging in times of globalization, the high valuation of a country's reputation is conducive to its major competitive advantage in the globalization of capitalism (neoliberalism) (Kaneva, 2011).

3.3.5 Self-appraisal

People's favorable awareness of their country is likely to lead to the community's respect for its members, who in turn are more likely to comply with policies and procedures. Furthermore, people's positive valuation of their country reinforces their willingness to support their nation (Yousaf, 2015).

Conversely, Baumeister, et. al (1996) reported that people's self-appraisal of their low self-esteem in regard of their country significantly impacted the egoism, violence and aggressiveness detrimental to their national unity.

3. Hypotheses

3.1 Awareness of safety levels

Based on the literature review (Hopkins & Reicher, 2020; Templeton, et. al., 2020; Khazaie & Khan, 2019), the safety management system underpinned by the appreciation of the characteristics of attendees, crowd behaviors and objectives of festivals may well lead the crowd to spontaneously comply with the order for safety.

Moreover, the compliance with the order is possibly embodied via the public consent by virtue of the delivery of accurate safety information. The compliance with the order is likely to affect the government authorities' public awareness in their management of festivals, which is supported by previous findings (Branscombe & Wann, 1994; Druckman, 1994) that governments' high public awareness served as a factor that induced some positive behaviors beneficial to the unity of people in their community.

Therefore, attendees' demand for awareness of safety levels at festivals is to influence the public awareness of national identity.

H1 : The awareness of safety levels will have positive effects on public awareness.

3.2 Trust in safety

Hosts should develop diversified crisis management plans to minimize a range of risk factors that might occur at festivals. Especially, in case of government-organized international events, they should pay extra attention to attendees' safety and minimize any risk. It is essential for the host of a festival expected to attract crowds to explicitly establish its shared social identity and to secure trust in the safety management (Templeton, 2021).

Therefore, the trust in safety at festivals is to influence the public awareness of identity.

H2 : The trust in safety will have positive effects on public awareness.

3.3 Public security management

Festivals encourage diverse people to come together. Particularly, free festivals organized for the purpose of hosting an international event provide the venues where different age groups, genders, ethnic groups and classes join together (Fileborn, 2020).

With different types of crowds coming together, festivals are prone to a range of crime, security and human conflict factors. Above all, in case a country hosts a festival, it is crucial to develop a proactive public security management plan to preclude various risk factors that might arise (Hughes & Moxham-Hall, 2017; Houlton, 2018).

Therefore, the public security management at festivals is to influence the public awareness of identity.

H3 : The public security management at festivals will have positive effects on public awareness.

3.4 Safety accident management

In case of a purposive festival intended to host an international event, different types of locals and foreigners attend. Also, the central or local government undertakes the roles and responsibilities as a host. Thus, the government or municipality will bear the consequences of any accident resulting from its failure to preclude any crisis factor. Hence, the administration needs to meticulously develop a proactive crisis management plan (Höglund, 2013).

Therefore, the safety accident management at festivals is to influence the public awareness of identity.

H4 : The safety accident management at festivals will have positive effects on public awareness.

4. Sample and Measure

For the purpose of this study, an online survey was conducted in Korea. The questionnaire survey was intended to measure the concert attendees' awareness of safety levels, trust in safety, public security management, safety accident management and public awareness. The data was collected from October 18 to 30, 2022 from the attendees at the 2030 Busan EXPO Concert held in Busan on October 15, 2022. 552 respondents completed the questionnaire survey as requested.

The age groups of the respondents included teens(8.1%), 20s(18.1%), 30s(33.8%), 40s(31%), 50s(7.9%) and 60s(0.7%). As for the respondents' residence, 52.9% were in Seoul/Incheon/Gyeonggi, 6% in Gwangju/Jeolla/Gangwon/Jeju, 30.3% in Busan/Daegu/Ulsan/Gyeongsang, 9.4% in Daejeon/Sejong/Chungcheong and 1.1% in overseas countries. As for their educational attainment, 15.9% of the respondents completed high schools or lower levels of schools; 22.2% attained vocational college certificates; 49.1% attained bachelor's degrees; and 12.5% attained master's or higher degrees. As for the types of employment, 32.7% of the respondents were full-time workers; 4.7% were part time workers; 1.8% were running enterprises (large corporations and small and medium companies); 7% were self-employed; 12% were students; 11.6% were housewives; 25.5% were professionals; and 3.6% were unemployed.

All variables were rated on a 5-point Likert scale. Also, for the analysis, reliability and validity were measured. The reliability measurements are shown in Table 1 below.

All the reliability coefficients (Cronbach's alpha) were greater than the threshold for acceptance(0.60), and thus were considered reliable.

Table 1. Concept, measure, and reliability

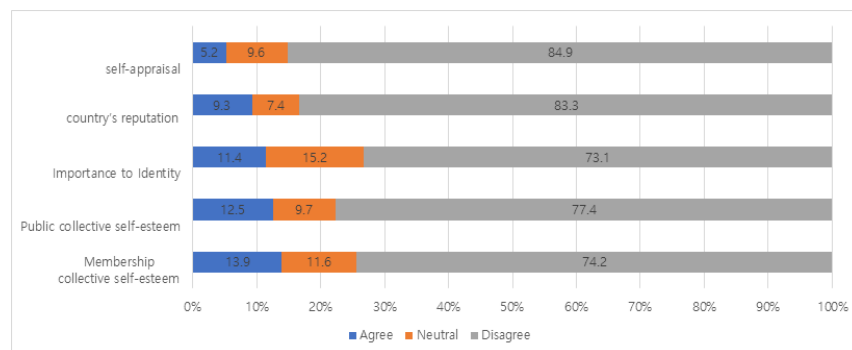
Concept		Measures	Cronbach's
Awareness of safety levels		The government plays its proper roles to secure safety.	0.827
		Our national safety management system is sound.	
		The municipality plays its proper roles relevant to safety.	
Trust in safety		I trust in the safety of commercial products.	0.716
		I trust in the government's safety policy.	
		I support the safety system in our society.	
Public security management	Crime factor	Overall, criminal threats were hardly present.	0.895
		Risks of pickpockets were hardly present.	
		Risks of thefts were hardly present.	
		The Lost and Found including reporting of lost items was well managed.	
		Risks of robberies were hardly present.	
		Risks of violence/assaults were hardly present.	
	Safety & security-related information	The information facility for the location of the police was fairly good.	0.83
		The emergency evacuation signs were fairly good.	
		Fire extinguisher signs(locations & number of units) were fairly good.	
		Danger signs (locations & number of units) were fairly good.	
	Human conflict factor	Ill-mannered staff members in and out of the venue were hardly seen.	0.71
		Verbal confrontations with staff members in and out of the venue were hardly seen.	
		Communication difficulties between audiences and staff members in and out of the venue were hardly found.	
Safety accident management	Safety guard management	Safety guards wore highly visible outfits.	0.759
		Safety guards' accident prevention measures were fairly good.	
		Staff in charge of festival management were patrolling properly.	
		Management staff were placed in proper spots.	
		Safety guards kept a close eye on customer behavior.	
		Emergency teams were properly deployed.	
	Facility safety management	Safety fences & barriers were properly installed in and out of the venue.	0.775

Public awareness(collective self-esteem & national role identity)	Safety equipment was properly installed in and out of the venue.	0.909
	Traffic safety facilities were properly placed.	
	Emergency medical equipment(medical center) was properly placed.	
	2030 Busan EXPO Concert made me feel proud of being a Korean citizen.	
	2030 Busan EXPO Concert made me feel Korea has many things to provide for international society.	
	2030 Busan EXPO Concert made me feel the value of Korea to which I belong.	
	2030 Busan EXPO Concert will add to the positive image of Korea from the perspective of other countries.	
	2030 Busan EXPO Concert made me feel other countries start to respect Korea to which I belong.	

5. Analysis & Findings

5.1. Basic Structure

Fig. 1 below outlines the public awareness (public collective self-esteem and national role identity) from the perspective of the attendees at the 2030 Busan EXPO Concert held in Busan Korea. The public awareness was rated in terms of 5 measures, i. e. membership collective self-esteem, public collective self-esteem, importance to identity collective self-esteem, country's reputation and self-appraisal as shown in <Fig. 1>.



<Fig. 1> Results of public awareness measurements

As illustrated in Fig. 1 on the attendees' public awareness (public collective self-esteem & national role identity), 84.9% of the respondents disagreed on the membership collective self-esteem, while 83.3%, 73.1%, 77.4% and 84.9% of the respondents disagreed on the public collective self-esteem, importance to identity collective self-esteem, national reputation and self-appraisal, respectively.

This finding illuminates substantial disagreements on the public collective self-esteem and national role identity among the concert attendees.

5.2 Determinant Structure

Next, the public awareness(public collective self-esteem & national role identity) was measured with the regression analysis, the results of which are shown in [Table 2] below.

Table 2. Analysis of acceptance of public awareness

		B	SE	Beta	t	Sig.
F1: Public security management	Constant	0.55	0.126		4.363	.000
	Crime factor	.108	0.044	.108	2.471*	.014
	Safety & security-related information	.326	0.078	.189	4.194***	.000
	Human conflict factor	.286	0.055	.226	5.178***	.000
F2: Safety accident management	Constant	0.862	0.125		6.925	.000
	Safety guard management	0.45	0.109	.212	4.129***	.000
	Facility safety management	0.193	0.077	.129	2.512*	.012
F3: Safety consciousness	Constant	1.037	0.134		7.744***	.000
	Awareness of safety levels	0.167	0.077	.123	2.158*	.031
	Trust in safety	0.172	0.072	.135	2.375*	.018
F1: R2/Adjusted R2	.167/.163					
F2: R2/Adjusted R2	.094/.091					
F2: R2/Adjusted R2	.056/.052					

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Constant(public awareness)

The regression analysis of the effects of public awareness(public collective self-esteem & national role identity) highlighted the following.

First, the public security management in the venue was found to have positive effects on attendees'public collective self-esteem and national role identity. Second, the safety accident management in the venue was found to have positive effects on attendees'public collective self-esteem and national role identity. Third, attendees'awareness of safety levels was found to have positive effects on attendees'public collective self-esteem and national role identity. Fourth, attendees'awareness of their trust in safety was found to have positive effects on their public collective self-esteem and national role identity.

Based on these findings, it is imperative to manage the public security and safety accidents to host an internationally significant event to achieve international goals, which implies that any failure to guarantee its attendees their safety and to earn their trust will have unfavorable effects on the public collective self-esteem and national role identity of the people of the host country.

6. Conclusion

Hosting international events and festivals exerts such positive effects as the increase in national branding effects, socioeconomic development and reinforcement of international society networks (Doe, et. al., 2021; Lee & Maguire, 2009; Yolal, et. al., 2009). Thus,

countries compete for hosting international events in diverse ways (Gold, 2016; Sheng, 2010; Kim, et. al., 2008).

To successfully host an international event, a host country should meet a few prerequisites. This study is focused on the public awareness via a concert organized to host an international event. In brief, the analysis of the attendees' responses at the 2030 Busan EXPO indicates the concert had positive effects on their public awareness of public security management, safety accident management, awareness of safety levels and trust in safety.

Focused on a concert aimed to host an international event, the findings of this study suggest that hosting an internationally significant event to achieve international goals requires public security management and safety accident management, and that any failure to guarantee its attendees their safety and earn their trust will have negative effects on the public collective self-esteem and national role identity.

Hence, to successfully host an international event, a host country should develop some detailed safety management measures starting from the planning process, and implement relevant safety information and training programs. Additionally, the host country should establish the transparency of its safety management policy before trying to raise the attendees' trust in safety and their acceptance of the policy.

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References

1. OHCHR | Universal Declaration of Human Rights. 2022. 11.14
2. Louw, L. B., & Esterhuyzen, E. (2022). Disaster risk reduction: Integrating sustainable development goals and occupational safety and health in festival and event management. *Jambá: Journal of Disaster Risk Studies*, 14(1), 10.
3. United Nations World Tourism Organization (UNWTO), 2020, Defining sustainable tourism, viewed 16 August 2021, from <https://www.gdrc.org/uem/eco-tour/sustour-define.html>.
4. Sun, L. (2016, September). Discussion on the Construction of Security System of Conference, Festival and Special Event. In 2016 4th International Education, Economics, Social Science, Arts, Sports and Management Engineering Conference (IEESASM 2016) (pp. 539-543). Atlantis Press.
5. Baby, J. (2022). Influence of Festival Attractiveness, Novelty, and Experience on Attendees' Satisfaction: Moderating Role of Risk Awareness in a Cultural Festival. *International Journal of Hospitality & Tourism Systems*, 15(2).
6. Höglund, F. (2013). The use of resilience strategies in crowd management at a music festival: And the safety organization's role in avoiding crowd conflict.
7. Fileborn, B., Wadds, P., & Tomsen, S. (2020). Sexual harassment and violence at Australian music festivals: Reporting practices and experiences of festival attendees. *Australian & New Zealand Journal of Criminology*, 53(2), 194-212.
8. Dilkes-Frayne, E. (2016). Drugs at the campsite: Socio-spatial relations and drug use at music festivals. *International Journal of Drug Policy*, 33, 27-35.
9. Hughes C., Moxham-Hall V. L. (2017). The going out in Sydney app: Evaluating the utility of a smartphone app for monitoring real-world illicit drug use and police encounters among festival and club goers. *Substance Abuse: Research & Treatment*, 11, 1-13.
10. Houlton, S. (2018). Festival security. *Intersec: The Journal of International Security*, 28(8), 30-32.
11. Sampsel K., Godbout J., Leach T., Taljaard M., Calder L. (2016). Characteristics associated with sexual assaults at mass gatherings. *Emergency Medicine Journal*, 33, 139-143.
12. Sealy, W. C. (2020). Managing the Risks: An Observation of Crowd Management and Other Risks Associated With Outdoor Music Festivals in the UK. In *Legal, Safety, and Environmental Challenges for Event Management: Emerging Research and Opportunities* (pp. 55-83). IGI Global.
13. Raineri, A. (2019). The causes and prevention of serious crowd injuries and fatalities at outdoor music festivals. Retrieved on, 20.
14. Zhao, H., Thrash, T., Kapadia, M., Wolff, K., Hölscher, C., Helbing, D., & Schinazi, V. R. (2020). Assessing crowd management strategies for the 2010 Love Parade disaster using computer simulations and virtual reality. *Journal of the Royal Society Interface*, 17(167), 20200116.
15. .Debarros, A (2000) 'Concertgoers Push Injuries Surge to High Levels Decades After Deadly Who Show, Violence Worsens', *USA Today*, Aug. 8, 2000, 2000 WL 5786192.

16. Cruwys T., Stevens M., Greenway K. H. (2020). A social identity perspective on COVID-19: Health risk is affected by shared group membership. *British Journal of Social Psychology*, 59, 584–593. <https://doi.org/10.1111/bjso.12391>
17. Templeton A., Smith K., Dang Guay J., Barker N., Whitehouse D., Smith A. (2020). Returning to UK sporting events during COVID-19: Spectator experiences at pilot events. Sports Grounds Safety Authority. <https://sgsa.org.uk/spectator-experiences-at-pilot-events/>
18. Khazaie D. H., Khan S. S. (2019). Shared social identification in mass gatherings lowers health risk perceptions via lowered disgust. *British Journal of Social Psychology*, 59, 839–856. <https://doi.org/10.1111/bjso.12362>
19. Hopkins N., Reicher S. D. (2020). Mass gatherings, health, and well-being: From risk mitigation to health promotion. *Social Issues and Policy Review*. Advance online publication. <https://doi.org/10.1111/sipr.12071>
20. Templeton, A. (2021). Future research avenues to facilitate social connectedness and safe collective behavior at organized crowd events. *Group Processes & Intergroup Relations*, 24(2), 216–222. <https://doi.org/10.1177/1368430220983601>
21. Carter H., Drury J., Rubin G. J., Williams R. J., Amlôt R. (2014). Effective responder communication improves efficiency and psychological outcomes in a mass decontamination field experiment: Implications for public behavior in the event of a chemical incident. *PLoSOne*, 9, Articlee 89846. <https://doi.org/10.1371/journal.pone.0089846>
22. Lopez, S. J. (2013). *The encyclopedia of positive psychology*. London: Blackwell Publishing.
23. Kim, B., & Kim, Y. (2019). Growing as social beings: How social media use for college sports is associated with college students' group identity and collective self-esteem. *Computers in Human Behavior*, 97, 241–249.
24. Golec de Zavala, A., & Lantos, D. (2020). Collective narcissism and its social consequences: The bad and the ugly. *Current Directions in Psychological Science*, 29(3), 273–278.
25. Nathanson, D. L. (1992). *Shame and pride: Affect, sex, and the birth of the self*. New York: Norton.
26. Dresler-Hawke, E., & Liu, J. H. (2006). Collective shame and the positioning of German national identity. *Psicología Política*, 32, 131–153.
27. Dimitriadou, M., Maciejovsky, B., Wildschut, T., & Sedikides, C. (2019). Collective nostalgia and domestic country bias. *Journal of experimental psychology: applied*, 25(3), 445.
28. Yousaf, S., & Li, H. (2015). Social identity, collective self esteem and country reputation: The case of Pakistan. *Journal of Product & Brand Management*.
29. Druckman, D. (1994), "Nationalism, patriotism, and group loyalty: a social psychological perspective", *Merston International Studies Review* , Vol. 38 No. 1, pp. 43–68
30. Branscombe, N. R., & Wann, D. L. (1994). Collective self-esteem consequences of outgroup derogation when a valued social identity is on trial. *European journal of social psychology*, 24(6), 641–657.
31. Jetten, J., Branscombe, N. R., & Spears, R. (2002). On being peripheral: Effects of identity insecurity on personal and collective self-esteem. *European Journal of Social Psychology*, 32(1), 105–123.
32. Ozer, S., Obaidi, M., & Pfattheicher, S. (2020). Group membership and radicalization: A cross-national investigation of collective self-esteem underlying extremism. *Group Processes & Intergroup Relations*, 23(8), 1230–1248.
33. Jetten, J., Spears, R., & Manstead, A. S. (1997). Distinctiveness threat and prototypicality: Combined effects on intergroup discrimination and collective self-esteem. *European Journal of Social Psychology*, 27(6), 635–657.
34. Mavrić, B. (2014). Psycho-social conception of national identity and collective self-esteem. *Epiphany*, 7(1).
35. Szondi, G. (2008). Central and Eastern European public diplomacy: A transitional perspective on national reputation management. In *Routledge handbook of public diplomacy* (pp. 312–333). Routledge.
36. Kaneva, N. (2011). Nation branding: Toward an agenda for critical research. *International journal of communication*, 5, 25.
37. Yousaf, S., & Li, H. (2015). Social identity, collective self esteem and country reputation: The case of Pakistan. *Journal of Product & Brand Management*.
38. Baumeister, R. F., Smart, L., & Boden, J. M. (1996). Relation of threatened egotism to violence and aggression: the dark side of high self-esteem. *Psychological review*, 103(1), 5.
39. Doe, F., Preko, A., Akroful, H., & Okai-Anderson, E. K. (2021). Festival tourism and socioeconomic development: case of Kwahu traditional areas of Ghana. *International Hospitality Review*.
40. Lee, J. W., & Maguire, J. (2009). Global festivals through a national prism: The global—national nexus in South Korean media coverage of the 2004 Athens Olympic games. *International Review for the Sociology of Sport*, 44(1), 5–24.
41. Yolal, M., Çetinel, F., & Uysal, M. (2009, November). An examination of festival motivation and perceived benefits relationship: Eskişehir International Festival. In *Journal of Convention & Event Tourism* (Vol. 10, No. 4, pp. 276–291). Taylor & Francis Group.
42. Gold, J. R. (2016). *Cities of culture: Staging international festivals and the urban agenda, 1851–2000*. Routledge.
43. Sheng, L. (2010). Competing or cooperating to host mega events: A simple model. *Economic Modelling*, 27(1), 375–379.
44. Kim, S. S., Sun, H., & Ap, J. (2008). Is there competition in the exhibition market in Asia? Analysis of the positioning of major Asian exhibition host cities. *Asia Pacific Journal of Tourism Research*, 13(3), 205–227.



Article

Prototype development of disaster resources operation and management system considering user convenience

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Abstract: In this study, through surveys of disaster resource operation and management systems in Korea and overseas and analysis of requirements of disaster resource managers, we grasped the system operation cases and current conditions during disasters, defined prototype functions associated with it, and the purpose is to develop a prototype considering convenience. Through the analysis of the current status of domestic and foreign disaster resource operation and management systems, the current status of systems used for disaster resource operation and management in the event of a disaster was investigated and a prototype function for disaster resource operation and management was derived. In particular, we studied how to make it easier for the manager in charge to calculate the amount of stockpile by using data such as disaster type, disaster resource grade, and disaster risk results. The main functions of the prototype being implemented in this study are roughly divided into three: 'disaster resource management', 'disaster risk level' and 'administrator management'. These functions are differentiated from existing disaster resource operation and management systems in that they provide data that can help the resource management manager calculate the proper amount of disaster resources and currentize disaster resources. The prototype developed through this study can be used as a reference material for the Ministry of Interior and Safety's Digital-Based Disaster Management Resource Integrated Management System Construction Project (2020-2022).

Keywords: disaster resource; prototype; disaster type; disaster resource grade; disaster risk results

1. Introduction

Recently, as the damage caused by disasters has increased around the world, there is a growing possibility that secondary damage will spread to national crises [1, 2]. In particular, the types of disasters are diversifying due to urbanization and population density through social development, and above all, it is necessary to have a system that can efficiently operate/manage disaster resources to minimize damage [2]. As a result, since 2014, the Ministry of the Interior and Security has been building and operating the Disaster Resource Sharing Service (DRSS) [2, 4]. But, Systematic domestic study for Systematic domestic study for disaster resource operation and management that considers regional characteristics and disaster types is still inadequate [2]. In this study, we analyzed the requirements of resource managers, grasped the current situation of the disaster resource operation and management system currently in use, derived the function of the prototype associated with it, and developed an efficient disaster resource operation and management system prototype. It was used as baseline data. In particular, by providing information such as 'system recommended amount', 'disaster resource history management' and 'regional disaster risk level' to the manager in charge within the pro-

totype, the calculation of the appropriate stockpile, which is a burden on the manager in charge, can be calculate. It distinguishes itself from the other studies in that it is easily accessible.

2. Define system requirements

In this study, based on a questionnaire survey of resource managers, we considered the convenience-centered functions of the manager in charge other than the existing system functions. The survey was divided into 'Disaster Resource Operation/Management Status' and 'Disaster Resource Stockpiling/Utilization', and the results were used as baseline data for defining the prototype requirements of the disaster resource operation/management system. As a result of the questionnaire survey, it was found that the current disaster resources were insufficient due to the overloaded work of the manager in charge. In particular, the calculation of the appropriate amount of disaster resources stockpiled in the jurisdiction area and the current availability of disaster resources due to the lack of taking over by the manager in charge was investigated as a problem. In addition, paper-based material management reports, lack of personnel in charge and lack of program education were also analyzed as problems. Based on the results of the questionnaire, the requirements for a prototype of disaster resource operation and management system that considers the convenience of the manager in charge are shown as shown in the <Figure 1>. The prototype requirements are divided into business domain, business function, requirement ID, requirement name, requirement description, user login, disaster resource search, stockpile calculation, disaster statistics, disaster information management and etc. are defined.

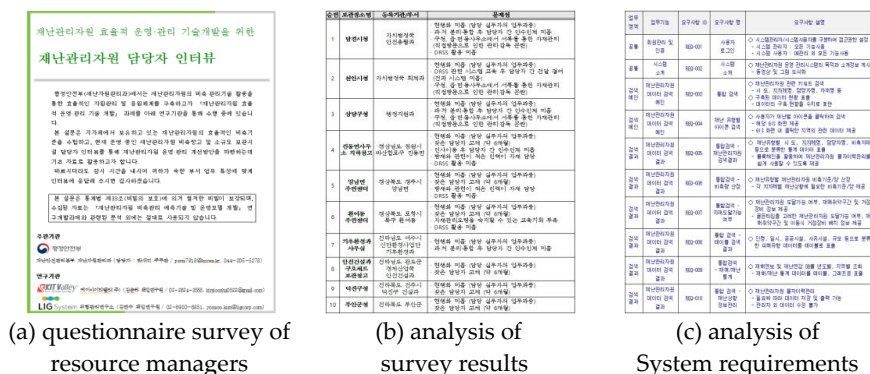


Figure 1. Define system requirements

3. Data Analysis and Database Design

We collected baseline data for constructing a disaster resource management system prototype database. Raw data such as disaster types, disaster resource grades, risk assessments and etc. were collected and then extracted for necessary information in order to build a database to be applied to the prototype.

Natural disasters and social disasters that require priority management were selected as disaster types. We collected data on natural disasters that occurred from 1996 to 2019. A total of 385 related data were collected for repeated disasters, and a total of 259 social disasters were secured. Utilizing this, we derived a priority order with high frequency for each disaster type and classified 5 natural disasters (strong wind, heavy snow, typhoon, wind storm, and heavy rain) and 9 social disasters (fire, forest fire, collapse, explosion, ship accidents, marine pollution accidents, environmental pollution accidents, livestock infectious diseases and infectious diseases).

Since it is practically difficult to accurately determine the actual amount of disaster resource usage, we consider the disaster types and disaster resources that occur in each

local government, analyze the actual usage of disaster resources by local government and a priority order for grades is derived. The top 10% of usage results were classified into grade A, the top 50% into grade B, and the rest into grade C. Out of the 124 types of equipment, 12 were classified as A grade, 50 as B grade, and 62 as C grade. Materials were classified into 4 grade A, 15 grade B, and 19 grade C out of 38 types.

The risk assessment (RA) used in this study consists of four elements (risk, exposure, vulnerability, and reduction). Each of these factors is assessed in terms of probability, risk level, vulnerability and reduction factor hazard indicators(<Figure 2>)[3].

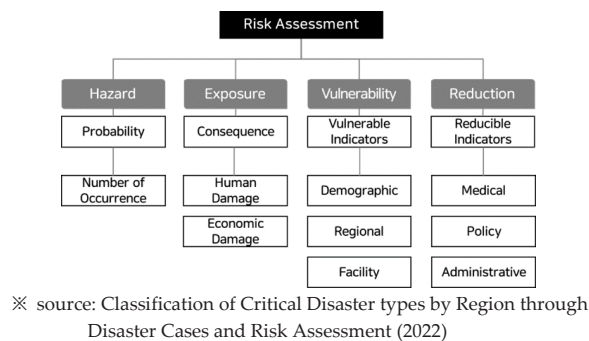


Figure 2. Methods of risk assessment

The hazard assessment formulas that reflect hazard, exposure, vulnerability and reduction are as follows:

$$Risk = \frac{Hazard \times Exposure \times Vulnerability}{Reduction}$$

Risk is the probability of occurrence according to the number of disasters in a municipality, and exposure is a method of evaluating the scale of human life and property damage caused by disasters. To establish criteria for assessing hazards and exposures, we calculated the number of incidents by type of disaster, human lives, and property damage over the past 24 years in 17 cities and 228 municipalities. A factor analysis was conducted to select vulnerability and reduction evaluation indicators, and some indicators selected by disaster type were simplified into interrelated indicators. Based on this, the factors that assess vulnerability include demographic factors, facility factors, and regional factors, and the factors that assess decline are classified into medical factors, administrative factors, and policy factors. The disaster RA results were classified into 5 levels and standardized. The 1 stage refers to areas that have had few disasters in the past or suffered little damage when disasters occur. Level 5 refers to an area with many disasters and large damage.

From the current disaster resource data, we extracted the information necessary for the stockpile calculation algorithm, such as the organization name, major category name, standard, detailed product name, quantity and date of acquisition. The data extracted in the future will be used as baseline data for calculating the appropriate amount of disaster resources/supportable amount in the prototype(<figure. 3>).

Figure 3. Raw data analysis and extraction for prototype

For table design, we defined entities, attributes, primary identifiers, etc. and created a logical ERD and table definition as shown in <Figure 4>. Each table is divided into priority resource management grade, disaster resource list_standard, disaster resource list_disaster, attached file, attached file details, fire station information, police station information, and public health center information.

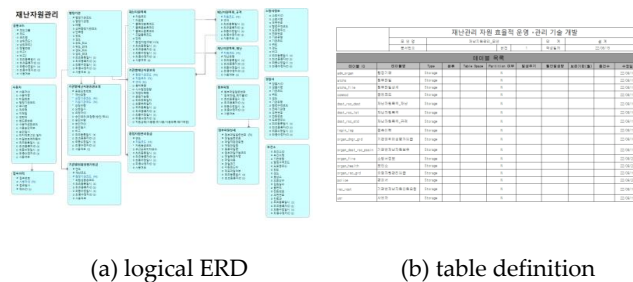


Figure 4. Raw data analysis and extraction for prototype

4. Designing and developing prototype

The prototype developed in this study considers the functions of the existing disaster resource operation and management system as well as the functions centered on the convenience of the manager in charge. In particular, the prototype of the disaster resource operation and management system considers 'disaster resource appropriate stockpile/supportable amount display', 'disaster resource mutual history query function' and 'representation of local disaster resource by searching for disaster risk'(<Figure 5>).

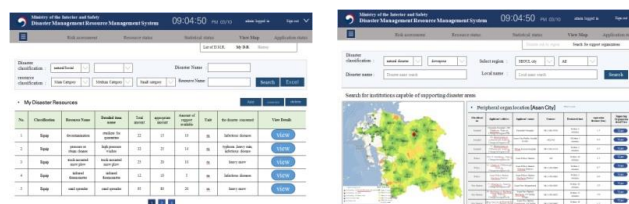


Figure 5. Screen design of prototype

In this study, the system prototype is divided into 'disaster resource management', 'disaster risk level' and 'manager management'(<Figure 6>). The 'disaster resource management' menu consists of 'my priority management resource list', 'priority management resource list', 'history management' and 'support status'. It is possible to search for the amount of support available, resource request date and time, request list, etc.. 'My priority management resource list' displays the appropriate stockpiles by disaster/resource

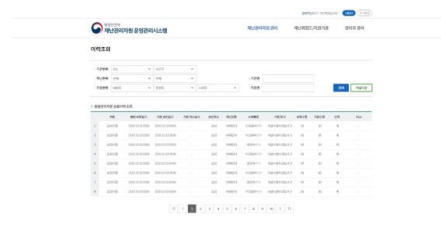
and the current supportable amount, and provides the 'system recommended amount' for calculating the appropriate stockpiles of disaster resources. In the 'priority management resource list', the total stockpile amount and supportable amount by institution/disaster/resource can be displayed, and a request for disaster resource support can be made to other institutions through the 'support request' tab. In the 'history management', the dates of support requests and support approval dates by organization/disaster/resource can be displayed, and can be used as reference materials for calculating the appropriate amount of disaster resources. 'support status' displays a list of disaster resource support requests from 'by agency/disaster/resource' and allows you to approve or reject the support request of other agencies through 'support processing'. The 'disaster risk level' menu enables the display of the disaster resource inventory quantity for each disaster type in the search area. In particular, by providing data such as the disaster resource support grade, current stock amount, and optimal stock amount according to the degree of disaster risk in a specific area, it will be able to a reference material that allows disaster management personnel to easily approach the appropriate stockpiling amount calculation. The 'administrator management' menu is created when you log in as an administrator, and consists of menus that can manage user management, common codes, disaster resources, etc.. In particular, 'resource management' can manage new disaster resource registration, disaster resource classification, standards, units, presence or absence of important resources and disaster types.



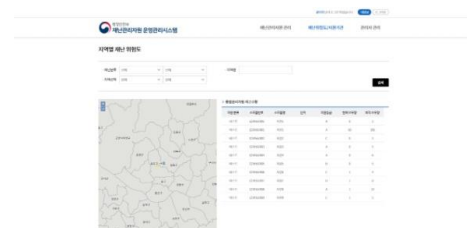
(a) main screen



(b) my priority management resource list screen



(c) history management screen



(d) 'disaster risk level screen

Figure 6. Screen configuration of prototype

5. Conclusions

The prototype of the disaster management resource operation and management system developed in this study considers the functions centered on the convenience of the manager in charge other than the existing system functions, and derived the following conclusions.

1) A questionnaire survey of disaster resource managers was conducted for prototype development, and the results were utilized as baseline data for defining prototype requirements. As a result of the investigation, it was found that the current availability of disaster resources was insufficient due to the overloaded work of the manager in charge. Therefore, in order to improve these problems, it is judged that systematic management such as training on the system currently in use and disaster resource management education by utilizing human resources specialized in disaster prevention is necessary.

2) In order to collect baseline data for constructing a prototype database, we collected raw data such as disaster type, disaster resource grade and risk assessment, and analyzed the necessary information. In particular, since it is practically difficult to accurately grasp the amount of disaster resources used, it is used for the functions of 'my prioritized management resource list', 'history management' and 'disaster risk level', which serve as reference values for calculating stockpiles. We analyzed the data for the past 24 years and extracted major natural and social disaster types, disaster resource grades, risk assessments, and disaster resource availability data.

3) In this study, the prototype is divided into 'disaster resource management', 'disaster risk degree' and 'manager management'. Functions such as 'list of my priority resources to be managed', 'history management' and 'disaster risk level' can serve as reference for disaster management personnel to easily calculate the appropriate stockpiles. In particular, the 'Disaster Risk Level' menu displays data such as the disaster resource support grade, current holding amount and optimal holding amount according to the disaster risk level.

It is judged that the prototype developed through this study can be used as a reference for establishing a disaster resource stockpiling plan by the Ministry of the Interior and Safety.

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References

1. Hong, E. K.; Kim, M. S., Yeom T. J., Park, M. J., A Study on the Enough Space per Head about Inner Evacuated Facility. *Journal of Korea Society of Disaster Information* **2017** 13(1): 15-25.
2. Kim, Y. S.; Jang, D. W.; Lee, S. K.; Kim, S. W., A Critical Review of Disaster Management Resource Problems Based on Past Disaster Events. *Journal of Korea Society of Hazard Mitigation* **2019** 19(4): 89-102
3. Kim, Y. S.; Jang, D. W.; You, J. S.; Jang, H. Y.; Lee, Y. J., Classification of Critical Disaster types by Region through Disaster Cases and Risk Assessment. *Asian Association for Crisisonomy* **2022**
4. Park, G. J.; Lee C. Y.; Kim T. H., State Analysis of the Disaster Resource Management. *Monthly Report of Korean Society of Hazard Mitigation* **2012** 12(1): 56-63.



Article

A Study on the Necessity of an Independent and Neutral National Crisis Management System - Focusing on the Itaewon tragedy

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Abstract:

On October 29, 2022, 158 citizens died in Itaewon, Seoul. Even though it was a sufficiently predictable event with current digital technology, the government did not prepare using loopholes in the Framework Act on Disaster and Safety Management. Immediately after the disaster, the people ask the government and local governments to find the truth. However, the government authorities only ask for judicial responsibility for front-line officials and refuse to investigate the overall cause. This study aims to point out the government that recognizes only the regime's crisis by showing examples of the Yoon Suk-Yeol government and the ruling party that hinder the investigation of the Itaewon disaster in order not to acknowledge the government's negligence. Furthermore, it is meaningful to record the attitude of the government and the ruling party, which are solely responsible for the disaster to individuals and lack of technology in the field through the case of digital technology improvement prepared by the government and local governments as safety measures after the disaster.

Keywords: Itaewon disaster, Yoon Suk Yeol government, crush accident, digital technology, disaster and safety management, national crisis management

1. Introduction

The day after 'The Itaewon tragedy', the government discussed using the term "Itaewon incident.". Moreover, the Ministry of Public Administration and Security unified the accident name as 'Itaewon incident and controlled the name 'The dead', not the terms of 'the victim.'¹

Incidents mean 'unfortunate things that happened unexpectedly. Of course, it is the same as a disaster in that more than a certain size of damage has occurred. However, suppose the 'Itaewon tragedy' is called an incident. In that case, we would focus on "accidentality" as the cause of the crush-accident and reduce the damage to one of the daily mishaps.

How the government names the case is a clue to how our society will solve the case. The government defines 'the Itaewon tragedy' as a simple incident like a traffic accident, stressing that the government has no administrative responsibility.

Therefore, it is a time when it has become more important to clarify the cause of 'the Itaewon tragedy' and define its character. Since the criteria for preparing countermeasures are different depending on the cause and nature of the disaster, I would like to name the term 'Itaewon tragedy' and 'the victim' first before this study.

Many media have called the incident 'Itaewon disaster'. However, since disasters include both natural and social disasters, it was necessary to distinguish between them. Therefore, considering that incident and disaster can be used in a mixture, we call this case a more accurate term.

The government defines the Itaewon disaster as an accidental event such as a traffic accident. However, in this study, it will be called the Itaewon tragedy to call for the truth and commemorate the innocent victims.

2. Materials and Methods

1. Necessity of the Study

On October 29, 2022, 158 people died in Itaewon, Seoul, for the Halloween weekend. As of 23:00 on November 13, two weeks after the disaster, a total of 158 deaths and 196 injuries were reported. In addition, there are 165 people with minor injuries and 31 seriously injured, and ten are currently hospitalized. ⁱⁱ

The injured in the Itaewon disaster have not yet recovered, and serious injuries cannot be recovered. This disaster is still ongoing. Since facing 304 victims in the 2014 Ferry Sewol disaster, South Korea has faced 158 victims again in Itaewon, Seoul. The case of crowd crush accidents in everyday space and time means we can be victims of safety accidents anytime.

On October 29, 2022, 158 people died in Itaewon, Seoul, for the Halloween weekend. As of 23:00 on November 13, two weeks after the disaster, a total of 158 deaths and 196 injuries were reported. In addition, there are 165 people with minor injuries and 31 seriously injured, and ten people are currently hospitalized.

The wounded in the Itaewon disaster are still on the verge of death. This disaster is not over yet. After the Ferry Sewolho disaster, which led to 304 victims in 2014 with state aid, the Republic of Korea has recreated 158 victims in downtown Seoul. The case of crowd crush accidents in everyday space and time means we can be victims of safety accidents anytime.

Immediately after the disaster, citizens directly asked the government and local governments to discover the truth about the disaster. Citizens paid tribute to the victims, sympathized with the pain of the bereaved families, and began to continuously emphasize the need to find out the truth of the disaster. However, the government sent an official letter to change the name to "accident" rather than "disaster," reducing the damage caused by the Itaewon disaster. The government and the ruling party made remarks avoiding responsibility for the disaster and refused to conduct a parliamentary probe and an independent counsel to find out the truth. However, the government sent an official letter to

unify the name to "accident" rather than "disaster," reducing and personalizing the disaster's damage. The government and the ruling party refused to conduct a parliamentary probe and an independent counsel to find the truth.

2. Purpose of the Study

Article 4 of 'the Framework Act on Disaster and Safety Management' stipulates the responsibility of the State and other local governments to protect people's lives, bodies, and property from disasters and other accidents and to establish and implement plans to respond and recover quickly. ⁱⁱⁱ

Even though the government and local governments can find safety management responsibility provisions in the Framework Act on Disaster and Safety Management, the government repeatedly briefed, "There are no guidelines or manuals for accidents without organizers." ^{iv}

On November 1, the third day of the disaster, the president Yoon announced that they plan to develop crowd management technologies and supplement necessary institutions by actively utilizing advanced digital capabilities such as drones to respond to safety accidents such as the Itaewon tragedy. ^vThrough this, it can be confirmed that the government analyzes the lack of digital technology as the cause of the Itaewon disaster.

The cause of the Itaewon disaster was not the absence of digital technology. Instead, digital technology to prevent the Itaewon tragedy was already prepared. Nevertheless, the government has not used digital technology, does not reflect on neglecting it, and attributes the disaster to field officials and the lack of digital technology.

3. Research method of the Study

This study is meaningful in pointing out and recording the problems of the government and the ruling party, which are avoiding responsibility in all prevention and response processes, at a time when the government and the National Assembly have yet to conduct an empirical analysis of the Itaewon tragedy.

2. Overview of the Itaewon tragedy

On October 29, 2022, a large crowd gathered in Itaewon, Seoul, for the Halloween weekend. A festive atmosphere was formed in the alley of Itaewon, and this year, a large crowd gathered because it was a Halloween weekend when the COVID-19 distancing was lifted. At around 6:30 p.m., packed crowds began to flock to the world food street in Itaewon, a 5-meter-wide alley, and a crowd crush accident occurred around 10:08 p.m. Crowd crush killed some people standing and breathing difficulties, followed by crowd collapse. At around 10:22 a.m., police tried to remove the crushed victims from the crowd collapse, but the crowd continued to flow in from the back of the alley, and it was not until 11:22, an hour later, that all the injured could be rescued from the alley for CPR.

The fire authorities have consistently counted the number of deaths and injuries, starting with their first briefing early on the 30th. According to a briefing at 23:00 on November 13, two weeks after the disaster, 158 people were killed, and 196 were injured. There are 165 casualties and 31 serious injuries, and the wounded in the Itaewon disaster are still on the verge of death. It is an unfinished disaster.

Our society suffered a Ferry Sewol disaster in 2014 that killed 304 people due to excessive capital greed by introducing 18-year-old insolvent ships without proper regulations. The government failed to rescue passengers and respond to disasters when the accident occurred. ^{vi}In addition, South Korea failed to rescue 158 victims in the middle of Itaewon, Seoul. The failure of crisis management was repeated.

Our society confirmed the Park Geun Hye government's attitude to avoid responsibility after experiencing the Ferry Sewolho disaster at every moment in the disaster response and recovery process. In addition to the irresponsible and passive attitude of public officials, the government and the ruling party's attempts to use public power to hinder the investigation of the truth have eventually prevented the construction of a safe society.

The Itaewon disaster resulted from the dereliction of duty caused by related agencies delaying responsibility to each other, even though it was possible to prepare and respond in advance.

Whenever an accident occurs, information and media often present various measures to the public. Unfortunately, the measures and discharge improvements presented for each accident cannot shake off the impression of "fixing the barn after losing the cow," even if they have little effect. 'Why couldn't we prepare more thoroughly before the accident?' The regret of doing so is repeated^{vii}.

The government's response before and after the Itaewon disaster is not "fixing the barn after losing the cow" but "crashing the barn after losing the cow." Therefore, it is time to start structural and fundamental questions about the government and public service that are carrying out "breaking the barn" to rebuild the Republic of Korea as a safe country and genuinely comfort the people and bereaved families of the Itaewon disaster.

3. Cause of Itaewon disaster

1. Analysis from the perspective of cultural events

In Korea, as the head of local governments was changed to a civilian election on June 27, 1995, each local government competitively held various cultural events suitable for regional characteristics to promote tourism and revitalize the local economy.

^{viii} Article 66-11 of the Framework Act on Disaster and Safety Management stipulates the obligation of the head of a central administrative agency or local government to take necessary measures for safety management through safety management measures when holding local festivals.

In the case of events hosted by local governments, they are obligated to take necessary measures for safety management. However, Seoul and Yongsan-gu emphasize that Seoul and Yongsan-gu did not supervise the safety management measures of the Itaewon disaster. The purpose of the Seoul Metropolitan Government and Yongsan-gu is to avoid legal responsibility, claiming that it is difficult to find a provision for the responsibility of local governments in the Framework Act on Disaster and Safety Management.

It is clear why the government and the ruling party are only trying to find the truth of the Itaewon tragedy through police investigations. The law requires organizers to take safety measures. However, the government intends to avoid the legal responsibility of the Itaewon tragedy by emphasizing that it is a Halloween event without hosting by taking

advantage of the loopholes in the provisions of the Disaster Safety Management Act, which failed to define the event without organizers.

However, since Yongsan Police Station, Yongsan-gu Office, Itaewon Tourism Council, and Itaewon Station held a meeting ahead of the festival, ^{ix}it can be assumed that the Halloween event in Itaewon was recognized as a local event. The Seoul Tourism Foundation also set up a promotional booth behind the Hamilton Hotel for two days, from October 28 to 7 p.m. on October 29 and held a promotional event. The Seoul Tourism Foundation is a foundation under the Seoul Metropolitan Government, and the event was held just before the landslide.^x

2. Analysis the Perspective of Crowd Collision

According to safety records related to domestic crowd crush accidents in the 1980s, a collision occurred while trying to enter a crowded place first. This period is characterized by the lack of public safety awareness and a system to manage safety management personnel or crowds.

However, since 1992, when professional baseball was introduced in Korea, private security guards have begun to be deployed for cultural events such as various performance halls and stadiums as the living standards of the people have improved. Therefore, since 1992, crowd crush accidents have mainly occurred in the process of managing the crowd with safety management personnel. ^{xi}

Almost all collision accidents since the 1990s have been characterized by poor safety management personnel and insufficient crowd management systems. However, Itaewon tragedy did not have a safety management system for the Halloween weekend. Therefore, Itaewon tragedy is somewhat similar to the crushing accident in 1980.

Two weeks before the Itaewon tragedy, the "Global Village" festival was held at the same place. Local governments established safety management plans in advance, and 362 police officers were deployed to the scene. ^{xii}As such, local governments need to discuss vulnerability measures through mutual coordination with event officials in advance and establish an admission plan that considers the safety of visitors as well as convenience facilities. ^{xiii}However, this Halloween weekend omitted the process.

The incident occurred at the same place two weeks ago, and no disaster occurred due to the police's prior input and response. Based on this, it can be assumed that the root cause of the Itaewon disaster is the government and local governments that have not prepared a safety management system for Halloween weekend.

4. Government's response to the Itaewon disaster

1. Fail of Digital conversion of safety management

The mayor of Seoul said at a plenary session of the National Assembly's Administrative Safety Committee on Nov. 7 that he would introduce crowd management techniques using all advanced technologies such as intelligent CCTV, the Internet of Things, and big data. However, he denied responsibility for failing to take safety measures as the head of the Seoul Metropolitan Police Agency. Instead, he assumes that it was an accident that could not be predicted or prepared for the Itaewon disaster. ^{xiv}

The same is true of the president Yoon seok-yeol. He announced, "We will actively utilize advanced digital capabilities such as drones to develop crowd management technologies and supplement them systematically." ^{xv}Government authorities and heads of local governments are seeking full responsibility for the Itaewon disaster in the absence of digital technology.

On the day of the disaster, the media expected the number of people to explode more than usual, and the number of subway passengers who got off at Itaewon Station was also able to confirm the crowd in advance. Furthermore, since everyone uses a cell phone, it was possible to check the crowd by analyzing the user concentration data of telecommunication companies in real-time. The control center could look into the Itaewon site through a closed circuit (CCTV), but it was not used properly.

^{xvi}

Yongsan Police Station even prepared a risk analysis report for safety concerns during Halloween in Itaewon. Nevertheless, the report did not reflect this. In the end, it was not until shortly after the Itaewon disaster that the information report was deleted under the order of the upper part. In addition, a related police officer committed suicide during the investigation.

The Itaewon disaster was a disaster that was sufficiently predicted by documents such as writing a report, and it was an event that could be fully prepared through existing digital technology. Nevertheless, the heads of local governments and government authorities claim that the disaster occurred due to a lack of digital technology.

Digital technology problems do not cause Itaewon tragedy. It's just that civil servants have failed to use digital technology.

Through the attitude of public officials, it is possible to confirm the Anomi phenomenon that pursues only technological development without a system that can adequately utilize digital technology. This means the limitation of bureaucracy at present.

2. Buck-passing and Personalization strategy

Since 1988, when the National Audit Act was enacted, the National Assembly has conducted a parliamentary investigation into three significant disasters. Examples include the collapse of the Sampoong Department Store, the Ferry Sewol disaster, and a survey on humidifier disinfectants.

In investigating the collapse of Sampoong Department Store (1995), the cause of the accident was found based on on-site investigation and eyewitness interrogation, and the result report was adopted by defining it as the cause of poor construction and administrative negligence. Since then, it has been evaluated as the basis of the disaster prevention bill.

During the parliamentary investigation of the Ferry Sewol disaster (2014), the transcript of the maritime police and the government was released, revealing a problem with the initial response. However, the National Assembly disagreed on the process of adopting witnesses. As a result, the parliamentary investigation was completed without even holding a hearing. Since then, the results report of the parliamentary investigation has also yet to be adopted.

The National Humidifier Sterilizer Survey (2016) revealed that companies failed to fulfil their safety responsibilities due to on-site investigations and hearings. As a result of reflecting the report's results, the Chemical Substance Registration and Evaluation Act was revised. However, it has been criticized for failing to devise measures to rescue victims and prevent a recurrence.

The Ferry Sewolho disaster, which killed 304 people, led to a parliamentary investigation, but the ruling party and the government interfered with the parliamentary investigation to protect the interests of the Park Geun-Hye administration. In the end, the hearing could not be held due to the government's non-payment of the budget, refusal to investigate, resignation and absence of the ruling party's recommendation committee, and refusal to adopt witnesses. ^{xvii}

After the Itaewon disaster, various causes have been derived to determine the cause. They include illegal renovation of buildings near the disaster site, insufficient safety accident prevention measures, the acquiescence of police reports, negligence in responding to phone calls, the disappearance of control towers, and insufficient rescue response by police and firefighters.

There are growing calls for creating a safe society by finding out the truth about the Itaewon disaster and punishing those responsible. However, since the police investigation only asks whether the direct actor violates the law, it is impossible to investigate the truth thoroughly. Furthermore, since criminal punishment targets only direct actors at the scene, fundamental responsibility cannot be held.

The opposition party is urging the National Assembly to conduct a parliamentary investigation to discover the truth of the Itaewon disaster. Article 3 (1) of the "National Audit and Investigation Act" stipulates that the National Assembly should conduct a parliamentary investigation on specific matters of state affairs (after this referred to as "investigation") at the request of more than a quarter of incumbent lawmakers.

Based on this, the opposition party can conduct its parliamentary investigation. However, the parliamentary investigation has no compulsory authority over the investigation. Therefore, government departments may refuse to cooperate in requesting data or investigating. Furthermore, cooperation between the government and the ruling party is essential for adopting or implementing the results of the parliamentary investigation. Referring to the precedent of the parliamentary investigation process of large-scale disasters in the past, cooperation between the government and the ruling party is essential for a smooth parliamentary investigation.

The government and the ruling party should actively participate in the parliamentary investigation to discover the truth of the Itaewon disaster. After the disaster, however, the government and the ruling party refused to conduct a parliamentary investigation. Accordingly, police officers and public officials are called to the scene, and the responsibility for the disaster falls only to individuals and working-level officials. Accordingly, the cause of the Itaewon disaster is found in individuals and organizations. buck-passing and personalized strategy is the second way for the government to respond to the Itaewon tragedy.

5. Conclusions and suggestions

This study derived problems and limitations of the national crisis management system by analyzing the government's pre- and post-measures process through the Itaewon tragedy case.

In particular, two methods of follow-up measures were examined. Police investigations and parliamentary investigations are the targets. The two processes were compared, and the limitations were examined by listing three major disasters dealt with through the parliamentary investigation. As a way to supplement this limitation, an independent and neutral disaster investigation body was proposed.

The Special Investigation Committee on Social Disaster recommended the establishment of an independent disaster investigation body. However, The ruling party did not implement it and neglected the legislative responsibility of the National Assembly. The government is also turning a blind eye to the state's responsibility for social disasters through retrogression, not the implementation of recommendations. Therefore, this study will be an opportunity to urge the government and the ruling party to establish a disaster investigation organization.

The government is looking for the overall cause of the Itaewon tragedy in the absence of digital technology. Furthermore, it calls for digital technology innovation as a safety measure. Therefore, this study found that the absence of digital technology was not the overall cause of the disaster. Furthermore, it clarified the government's responsibility, which did not utilize existing digital technologies.

The government and local governments should be responsible for proving the damage of a major disaster, not the people. The government and the ruling party should find out the truth through an independent parliamentary counsel and a parliamentary investigation into the disaster. Furthermore, a disaster investigation body should be established as an alternative to overcoming the limitations of the existing parliamentary investigation. This study will likely lead to the results of enacting and revising disaster prevention-related laws.

In this study, since a parliamentary investigation did not conduct yet, the Itaewon tragedy, it is regrettable that the outline of the case was investigated only through limited press releases. I will closely analyze the government's response procedures to the Itaewon tragedy as a future research project and urge the government to punish those responsible certainly. Furthermore, I plan to propose ways to develop digital culture so that existing digital technologies can be used well in the crisis management.

I wrote with a heart of mourning for the victims of the Itaewon tragedy and comforting the bereaved families. However, the government's response in the process was disappointing and embarrassing. Although it is insufficient, it is hoped that this study will contribute to the process of getting to the bottom of the Itaewon tragedy.

References

1. Mediatoday (2022.11.01)
2. Disaster and safety management headquarters of the Ministry of Public Administration and Security, briefing the Itaewon accident headquarters (2022.11.14)
- 3 Disaster and Safety Management Act
- 4 Disaster and safety management headquarters of the Ministry of Public Administration and Security, briefing the Itaewon accident headquarters (2022.11.01)
- 5 Office for Government Policy Coordination, 10th Ministerial Meeting on Current State Affairs (2022.11.03)
- 6 Lee, Ho young. (2017). How Park Geun-hye Administration Obstructs the Sewol Ferry Disaster Special Investigation Commission, 63, 205-246.
- 7 Son, Ki sang. (2003). Safety Status and Policy of Multi-use Facilities
- 8 Chosun Ilbo. (2005. 10. 7)
- 9 The Hankyoreh (2022. 11.04)
- 10 Dong-ah Ilbo. (2022. 11. 02)
- 11 Sunki Lee and Taehwang Chung . (2007). The Study on the Prevention against Accidents of Death form Pressure Events Performance Sites .Korea Sport Research, 18(5), 429-444.
- 12 The Hankyoreh (2022.11.24)
- 13 Sunki Lee and Taehwang Chung . (2007). The Study on the Prevention against Accidents of Death form Pressure Events Performance Sites .Korea Sport Research, 18(5), 429-444.
- 14 The Secretariat of the National Assembly, minutes of the Administration and Security Committee. (2022.11.07)
- 15 Office for Government Policy Coordination, 10th Meeting of Ministers on State Affairs (2022.11.03)
- 16 The Kyunghyang Shinmun (2022.11.11)
- 17 YTN.(2022.11.24.)



Article

Why do We Need more Official Development Assistance in Crisis? — Evidence from Panel Data model Investigation

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Abstract: This study aims to examine the determinants of economic growth and level of living standard in the recipient countries focusing particularly on the effect of Official Development Assistance(ODA). The research identifies two indexes: annual Korea's ODA grant by type of aid and Human Development Index (HDI) for the recipient countries during the periods of 2005 to 2019. It constructed panel model attributes by countries in data. It shows that ODA has a positive impact on the economic growth in the aggregate level, however, the same is not true for individual welfare explained by HDI. Incorporating the theoretical arguments and the empirical outputs, this study concludes with presenting possible policy implications of the Korean ODA on the construction of the development strategies for the recipient countries.

Keywords: Official Development Assistance(ODA), Human Development Index(HDI), panel model,

1. Introduction

The size of aid from the international community has increased steadily, and the total amount of official development assistance (ODA) in 2013 has been renewed since the beginning of support. If the initial international development cooperation focuses more on the economic growth of the recipient country, recent trends are focusing on welfare areas such as health and education that can enhance the quality of life of individuals. In the history of short-term aid, the aid effectiveness has also been discussed. It was the main topic to discourse on the effectiveness of aid through the leaking management and Input / Output analysis. In recent years, it has been focused on macroeconomic development effects and the study of the cause of economic growth contribution estimation and growth slowdown. However, there is no consensus among donors and aid agencies as to what factors determine the effectiveness of aid. The ripple effect of aid is due to the internal and external environmental factors surrounding the country. In addition, it is difficult to show that the improvement of the vulnerability of some determinants is inevitable causal effect directly linked to the enhancement of aid effectiveness [1].

Although developed countries have continued to provide aid to developing countries in spite of their financial burden, no clear result has been drawn as an answer to whether ODA has contributed to the economic growth of the recipient country. In the developed countries, public opinion has been formed, such as aid fatigue, which means that tax is wasted on continued aid, and also, criticism has been raised that donor's aid is being used to pursue donor's strategic and commercial interests rather than to support domestic development in developing countries. In this context, discussions on effectiveness have been raised for the purpose of improving aid policies that are not satisfactory to both donor and recipient countries, and to enhance policy performance. In order to improve the effectiveness of aid, it is becoming more important to consider the conditions of the administrative system of the recipient rather than the relationship between

aid and economic growth. The main conclusion of these discussions is that aid should be provided to countries that have a sound policy environment because they can guarantee the effectiveness of aid in these countries. Especially, the Assessing Aid report, published by the World Bank in 1998, became the starting point of a new discussion on the effectiveness of development aid, and the linkage between democracy and administrative system began to attract attention [14]. The Assessing Aid report pointed out that while some countries, such as Korea, Indonesia and Vietnam, have succeeded through aid, many countries still do not show the effect of aid and it suggested ways in which aid could be most effective. With the publication of the Assessing Aid report, the international community has begun to highlight 'Good Governance' as a key development agenda. There are also studies that discuss the effectiveness of aid by applying both the national level economic development and the personal level of human development [2,3]. Shirazi et al. (2009) suggests that the causal effects of aid and economic growth are identified that aid has a positive effect on education, life expectancy, and human development. The results of Ranis et al. (2000) are also similar. The Aid for health and education contributes to the development of human capital, and factors such as increased investment by aid and income distribution affect the level of economic growth. Akinkugbe & Yinusa (2009) also confirms the relationship between technological cooperation and policy support and the level of human development index (HDI) in sub-Saharan countries [1,2]. The results of the analysis show that infrastructure-related technical support is effective in improving the level of welfare, but it cannot be expected to have a positive effect if technical support is applied to non-production sectors such as government spending. In previous work, most studies are based on case studies of specific donor countries, or have not conducted more specific statistical analysis such as the aid types to prove the determinants of aid concentration [7, 9-11]. It is necessary to take an empirical approach considering the factors that have been emphasized in previous studies related to aid concentration. This study demonstrates the effectiveness of aid from a comprehensive point of view by setting the macroeconomic economic growth and improving the living conditions of the residents as indicators of aid.

2. Data and Variables

The data for this study were created by combining official development assistance data from 2005 to 2019 in the health care field provided by the OECD with health information from the recipient country extracted from the UNDP database during the same period. From 2005 to 2019, Korea provided official development assistance in the health and medical field to a total of 88 countries. Among them, 60 countries are matched with the World Bank's World Development Indicators data, and the sample is a total of 648 observations over 15 years [8, 12-14, 16]. However, there are values that are not reported by country, so the observed values for each variable differ. After excluding observations with unreported values, the variables for the number of observations used in the empirical analysis are presented in Table 1. The dependent variable (Y) is the quality of life index of the recipient country. For this, the life index provided by UNDP was used. The Human Development Index (HDI) that was created to emphasize that people and their capabilities should be the ultimate criteria for assessing the development of a country, not economic growth alone. The HDI can also be used to question national policy choices, asking how two countries with the same level of GNI per capita can end up with different human development outcomes [3-5, 10]

The dependent variable is the time t (2005 - 2018) and the independent variable and the control variable are the time $t-1$ (2006 - 2019). This reflects the time lag between the aid and the effects. As an independent variable (X), the total amount of donation to which Korea provided aid was selected. The natural logarithm was taken to fit the distribution with other independent variables. Independent variables (X) that can affect the recipient country's quality of life index included variables that can represent the recipient country's economic and demographic characteristics and political stability. Direct

investment with Korea in the recipient country, a variable representing Korea's economic interests, was used as an independent variable. According to previous studies, donor countries sometimes provide official development assistance to low-income countries according to their own interests, especially economic interests [6, 7]. In particular, official development assistance for economic purposes refers to providing assistance for the donor country's sales of goods to the recipient country or for the donor country's economic growth [14]. In order to control the economic scale, inflation and population of the recipient country were included as control variables, and regional dummy variables by continent were included as control variables in the model. This is to control the impact of the economic scale of each country, factors that cannot be observed in a specific year, and factors that depend on regional characteristics on official development assistance.

Table 1. Measurement of variables

	Variables	Symbol	Description of Variables
Dependent Variable	HDI	<i>H</i>	Human Development Index: average achievement in a long and healthy life, knowledge and decent standard of living (HDI of t-time)
	(log) Total ODA	<i>ODA</i>	(log) Total grant-aid of bilateral aid to recipient countries: t-1 (US dollar)
explanatory Variables	Inflation	<i>I</i>	Annual consumer price index (CPI): t-1
	Population (log)	<i>POP</i>	(log) The number of people that live in the country: t-1
	FDI (log)	<i>F</i>	(log) FDI (Foreign Direct Investment) financial flows: t-1 (US dollar)
	Political stability and Absence of violence	<i>P</i>	Perceptions of the likelihood of political instability and/or politically motivated violence, including terrorism: t-1 (Worldwide Governance Indicators: WGI)
	Government Effectiveness	<i>G</i>	Perceptions of the quality of public services and the degree of its independence from political pressures: t-1 (WGI)
	Control of Corruption	<i>C</i>	Perceptions of the extent to which public power is exercised for private gain as well as "capture" of the state by elites and private interests: t-1 (WGI)

Sources: ODA(<http://www.odakorea.go.kr/ez.main.ODAEngMain.do>)

UNDP(hdr.undp.org/en/statistics/hdi)

WGI(www.govindicators.org)

Note: The data was reconstructed by expanding the data used in Lee et al, 2018, Lee 2022a, and Lee 2022b studies by year, country,

and sector.

3. Research Model

The unit of empirical analysis is the recipient country. The amount of official development aid (X), economic characteristics, and demographic characteristics received from Korea in year j by recipient country i were modeled as a function of the quality of life index (Y) of the recipient country. In addition, a region fixed-effect and random-effect multiple regression model including a regional dummy variable was used to control unobserved regional characteristics for analysis. The panel model used in the analysis is expressed as a general linear model as follows.

$$Y_{it} = \beta_0 + \beta_{10}X_{it-1} + \beta_2I_{it-1} + \beta_3POP_{it-1} + \beta_4F_{it-1} + \beta_5P_{it-1} + \beta_6G_{it-1} + \beta_7C_{it-1} + \mu_i + e_{it} [1]$$

($i = 1, 2, \dots, N$; $t = 1, 2, \dots, T$; X = total amount of bilateral aid; I = inflation of the recipient country; P = population of the recipient country; F = Foreign Direct Investment; P = Political stability and Absence of violence, C = Control of Corruption μ_i = An error term representing the characteristics of a panel case that does not change with time; e_{it} = error term)

4. Analytical Results

4.1. Descriptive Statistics

This study observes Korea as a donor and analyzed 60 countries that Korea supported from 2005 to 2019.

Table 2. Descriptive Statistics

Variables	N	Mean	Standard Deviation	Minimum	Maximum
<i>H</i>	648	0.6131	0.10308	0.3940	0.7890
<i>ODA</i>	648	14.5223	1.78110	8.6739	18.3526
<i>F</i>	648	12.1877	6.85149	0.0000	22.4638
<i>I</i>	648	7.5143	17.66132	-6.8112	379.8480
<i>POP</i>	648	10.0209	1.47331	6.4019	14.1715
<i>P</i>	648	-0.7553	0.76026	-2.8100	0.9178
<i>G</i>	648	-0.6340	0.49723	-2.4837	0.6435
<i>C</i>	648	-0.7144	0.43048	-1.7148	0.7625

4.1. Panel Regression Analysis

Table 3 and 4 show the results of analyzing the effects of ODA on the recipient's quality of life through the amount of ODA.

Table 3. The effects of ODA on the human development index (HDI)

N=648	Fixed Effects Model		Fixed Effects Model (IV)		Random Effects Model		Random Effects Model (IV)	
	Variables	b	SE	b	SE	b	SE	b
ODA	0.0009	0.00062	0.0117***	0.00290	0.0047***	0.00075	0.0351***	0.00394
F	0.0003***	0.00012	0.0003*	0.00015	0.0003*	0.00016	0.0003	0.00030
I	0.0000	0.00004	0.0000	0.00005	0.0000	0.00005	-0.0001	0.00010
Pop	0.1921***	0.00830	0.1298***	0.01912	0.0693***	0.00646	-0.0139	0.01321
P	0.0078***	0.00201	0.0011	0.00303	0.0129***	0.00252	-0.0129	0.00580
G	0.0196***	0.00412	0.0237***	0.00520	0.0171***	0.00517	0.0360***	0.01010
C	0.0142***	0.00414	0.0152***	0.00512	0.0235***	0.00518	0.0170*	0.00991
Intercept	-1.3008***	0.08028	-0.8346***	0.15628	-0.1090	0.06335	0.2642**	0.10668
	Within R²=0.674		Within R² =0.463		Within R² =0.526		Within R² =0.183	
	Between R²=0.0002		Between R²=0.0003		Between R²=0.006		Between R²=0.116	
	Overall R² =0.0014		Overall R²=0.0053		Overall R² =0.016		Overall R²=0.121	
	Hausman test				POLS relevance test:			
	$\chi^2(7)= 524.94,$				$\chi^2(1)= 2025.27,$			
	Prob. > $\chi^2=0.0000$				Prob. > $\chi^2=0.0000$			

Notes: 1) b=regression coefficient; SE=standard error; 2) Hausman test for the null hypothesis that difference in coefficients is not systematic (i.e., the coefficients are equal); 3) POLS test indicates Breusch and Pagan Lagrangian multiplier test for random effects, judging whether or not to reject the null hypothesis that there is a common intercept (i.e., pooled OLS is appropriate); 4) IV=Instrumental variable estimation to control for the endogenous problem of 'ODA' variable. Two instrumental variables such as three administrations(Lee Myung-bak, Park Geun-hye, and Moon Jae-in administrations) of South Korea as dummy variables compared with the reference group (i.e., Rho Moohyun administration); 5) ***: $p<.01$, **: $p<.05$, *: $p<.10$

Table 4. The effects of ODA on the human development index (HDI)_ODA: t-1, t-2

Variables	Fixed Effects Model		Random Effects Model_1		Random Effects Model_2	
	b	SE	b	SE	b	SE
ODA	0.0011*	0.00062	0.0044***	0.00075	0.0042***	0.00072
F	0.0002**	0.00012	0.0002	0.00016	0.0002	0.00015
I	0.0000	0.00005	-0.0001	0.00006	0.0000	0.00006
Pop	0.1877***	0.00831	0.0685***	0.00639	0.0783***	0.00635
P	0.0077***	0.00203	0.0127***	0.00252	0.0125***	0.00243
G	0.0167***	0.00408	0.0146***	0.00509	0.0140***	0.00493
C	0.0159***	0.00411	0.0253***	0.00511	0.0251***	0.00494

Asia					-0.1725***	0.02896
Africa					-0.1867***	0.02482
Intercept	-1.2590***	0.08093	-0.1007	0.06325	-0.0773	0.05970
	Within R ² =0.6372		Within R ² =0.5169		Within R ² =0.5385	
	Between R ² =0.0003		Between R ² =0.0124		Between R ² =0.1758	
	Overall R ² =0.0015		Overall R ² =0.0161		Overall R ² =0.2049	
	Hausman test		POLS relevance test:		POLS relevance test:	
	$\chi^2(7)= 489.94,$		$\chi^2(1)= 1994.88,$		$\chi^2(1)= 1871.55,$	
	Prob. > $\chi^2 = 0.0000$		Prob. > $\chi^2 = 0.0000$		Prob. > $\chi^2 = 0.0000$	

Notes: 1) b=regression coefficient; SE=standard error; 2) Hausman test for the null hypothesis that difference in coefficients is not systematic (i.e., the coefficients are equal); 3) P test indicates Breusch and Pagan Lagrangian multiplier test for random effects, judging whether or not to reject the null hypothesis that there is a common intercept (i.e., pooled OLS is appropriate); 4) IV=Instrumental variable estimation to control for the endogenous problem of 'ODA' variable. Two instrumental variables such as three administrations (Lee Myung-bak, Park Geun-hye, and Moon Jae-in administrations) of South Korea as dummy variables compared with the reference group (i.e., Rho Moohyun administration); 5) Region controlled Asia and Africa; As a result of inputting regional variables such as Asia, Africa, Latin America, the Middle East, Western Europe, and CIS based on the Oceania region, it was found that the Asian and African regions had a significant effect; 6) ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.10$

First, in the Fixed Effects (FE) model estimation coefficient, it indicates that the recipient country's ODA amount, FDI, population and governance index variables are statistically significant. In particular, it shows that Government Effectiveness (G), and Control of Corruption (C) monitoring for the corruption of the leadership is a significant variable in improving the quality of life needed through ODA

Second, in the Random Effects (RE) model estimation coefficient through instrument variables, it was measured that the donor's continued support is a statistically significant variable. In detail, two instrumental variables such as three administrations (Lee Myung-bak, Park Geun-hye, and Moon Jae-in administrations) of South Korea as dummy variables compared with the reference group (i.e., Rho Moohyun administration) are tested. This shows that assuming that each country's unique characteristics are random, continuous aid can improve the life expectancy through ODA amount for the recipient country.

Third, in the FE and RE models, the recipient country's population, political stability, government's efficient operation capacity, and the ability to control the corruption of elites were measured as significant variables. It is inferred that the donor country's continuous aid is important, but the recipient country's political and administrative capabilities are important factors in improving the people's life expectancy.

Fourth, as a result of the analysis considering regional variables, it was found that donations had a significant impact on Asia and Africa. Region controlled Asia and Africa; As a result of inputting regional variables such as Asia, Africa, Latin America, the Middle East, Western Europe, and Commonwealth of Independent States (CIS) based on the Oceania region, it was found that the Asian and African regions had a significant ef-

fect. The results show that life expectancy is lower in Asia and Africa than in other regions. The fact that the ODA effect appeared even after controlling for regional and instrumental variables shows that it has a particularly strong influence on the health sector. Therefore, it emphasizes the need for continuous support to developing countries such as Asia and Africa, which are Korea's major donors.

5. Conclusions

As a result of the empirical analysis, it was analyzed that Korea's official development assistance contributed to the improvement of life expectancy in the health sector of the recipient country, and the amount of trade with the recipient country also had a positive effect. Continuous aids by government for 15 years also show statistical significance. By region, HDI in Asia and Africa is low, it indicates the need for continuous support.

The quality of life of the recipient country was affected by the amount of trade with the donor country. It means that the donor country's direct investment has a positive impact on the health sector of the recipient country. These analysis results suggest that Korea's official development assistance policy needs to be made in the direction of responding to the health sector that improves the quality of life of the recipient country.

Furthermore, it is thought that an independent performance management system for public health care official development assistance is needed. The formal framework for the feasibility study or evaluation of official development assistance projects in Korea was first created in 1999 and has been steadily improved. Although the project performance management system or manual has been prepared in accordance with the OECD guidelines, it is pointed out that in terms of actual operation, it is limited to formal project management rather than performance management in terms of the quality of project execution (Organization for Economic Cooperation and Development. 2010). Evaluation at the level of individual projects is still the main focus, and evaluation of project performance by aid sector or related policy execution performance has not been conducted. In the future, it is necessary to systematically analyze the performance of each sector or project to improve the performance management system for grounded policy improvement. This can be linked to the analysis of ODA effectiveness and contribute to efficient and customized aids in the future.

References

1. Ahn, H., & Park, D. Recipient Countries' Financial Development and the Effectiveness of ODA. *The Journal of Industrial Distribution & Business* **2019**, 10(1), 69-76.
2. Akinkugbe, O. & Yinusa, O. ODA and Human Development in Sub-Saharan Africa: Evidence from Panel Data. Presentation at the 14th Annual Conference on Econometric Modelling for Africa organised by African Econometrics Society, at the Sheraton Hotel, Abuja-Nigeria, 8-10 July, **2009**
3. Lee, S.-W.; Jeon, J.-K. Dynamic Relationships between Mega Projects and Official Development Assistance: Case of South Korean Infrastructure Construction Projects in ASEAN's Developing Countries. *Sustainability*, **2018**,10: 44-91.
4. Lee, E. Exploratory Test of the Effectiveness of Educational Aid in Official Development Assistance. *J. Saf. Crisis Manag.* **2022(a)**, Vol.12 No.9; 19-27.
5. Lee, E. Should We Provide More Economic Aid to Recipient Countries in Crisis? *Crisisonomy* **2022(b)**, Vol.18 No.9: 139-148
6. Lebovic JH. National interests and US foreign aid: the Carter and Reagan years. *J Peace Res* **1998**, 25:115-135.
7. Moonyoung Joe. An Analysis of the Aid Effectiveness of Aid Volume. *The Journal of Humanities and Social science* **2022**, 21, 13(3), 2663-2677.
8. ODA(<http://www.odakorea.go.kr/ez.main.ODAEngMain.do>)
9. Ranis, G., Stewart, F., & Ramirez, A. Economic Growth and Human Development. *World Development* **2000**, vol.2, no.82, pp. 197-219.
10. Shirazi, Nasim Shah, Turkhan Ali Abdul Mannap, and Muhammad Ali. "Effectiveness of foreign aid and human development." *The Pakistan Development Review* **2009**, 853-862.
11. Shon, C.; Lee, T.H.; Ndombi, G.O.; Nam, E.W. A Cost-Benefit Analysis of the Official Development Assistance Project on Maternal and Child Health in Kwango, DR Congo. *J. Environ. Res. Public Health* **2018**, 15: 14-20.
12. UNDP(hdr.undp.org/en/statistics/hdi)

13. WGI(www.govindicators.org)
14. WHO "Looking Back at a Year that Changed the World: WHO's Response to Covid-19." **2021.**
15. Wolf C. Foreign aid: theory and practice in southern Asia. Princeton: Princeton University Press; **1960.**
16. World Bank. World Development Report. Oxford: Oxford University Press, **1997.**



Article

Earthquake an Unpredictable Casualties, It's Scenario and Impact in Nepalese livelihood

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Abstract: Nepal frequently experiences earthquakes with a high risk due to unmanaged town planning and a huge number of vulnerable buildings that were constructed before 2004. The country still does not have strong retrofit policies despite mechanisms for financing retrofits from aid and few amounts from the Nepal government. In 2015, Nepal Earthquake (M 7.8), an estimated 8,790 people died and a large number of buildings collapsed. However, its scenario and impact in Nepali livelihood were still not well understood. This study elucidates the response of earthquakes and its relation to Nepali livelihood on different capitals through statistically analysing the various data using ANOVA and Pearson's correlation. The result shows that low-income groups and women were severely affected during and after the earthquake. The age group between 35 - 45 were statistically significantly less affected compared to other age groups. Taken together, the economic crisis became the major issue to sustain their livelihood after this unpredictable causality. The recommended financing retrofit policies for Nepal may be overcome during or after the severe effect caused by the earthquake.

Keywords: earthquake, capitals, age-group, ANOVA, co-relation

1. Introduction

Nepal lies on two active tectonic plates, the Indian Plate and the Tibetan Plate, which have frequently produced devastating earthquakes. Nepal's past history of frequency and intensity of earthquakes has exposed the nation's vulnerability and resilience. The damage caused by earthquakes is huge, for example in 1988 a 6.7 magnitude earthquake killed 721 people and destroyed 7,000 buildings. In addition, the most noted Gorkha earthquake in 2015 killed a total of 8,790 people and injured more than 22,300. This earthquake destroyed more than 50,000 residential buildings and 2,656 official buildings. In addition, about 2,00,000 residential buildings and 3,622 official buildings were partially damaged. Afterwards these earthquakes underscored the need for a national building code to ensure the structural safety of buildings.

Studies have shown that building collapses are a major cause of death and injury during earthquakes [1] However, many of the world's buildings were constructed before modern seismic design codes and standards because both seismic risk and design standards are evolving [2] Furthermore, buildings damaged in previous earthquakes may not be able to withstand additional damage from future seismic events [3] Thus, there is a growing appreciation for pre-earthquake risk reduction to address the existing building stock [4]. In Nepal, early structures were mostly made of adobe and

low-strength masonry, which are susceptible to earthquakes and many other natural factors (e.g. dry shrinkage, thermal movement, foundation settlement, plant growth). However, some of those structures are historically and culturally important to preserve [5,6].

Seismic retrofitting generally does not make older buildings as strong as newer ones [7]. Standards generally require that buildings have sufficient standing capacity so that occupants can evacuate safely, but such buildings may be damaged beyond repair. Current codes for most new buildings aim to save occupants' lives by reducing the likelihood of building collapse under earthquakes considered significant. Some buildings, such as hospitals, may be subject to higher standards so that they can remain operational after a moderate earthquake, i.e., a design-level event.

This study carefully studies the status of earthquakes in different districts after 2015 and its impact on Nepalese people life. In this connection, the problems caused by this unexpected reason in different types of capitals are studied. The purpose of this research is to identify policy best practices that may be useful for national and local governments. Finally, this study help to recommends what should be included in Nepal's development financing infrastructure policies. For earthquake risk reduction, Nepal also discusses the strategies, policy effectiveness, and implementation challenges that can be used to reduce earthquake risk. The aim of this study is that all earthquake-prone countries interested in pursuing or enhancing seismic risk reduction approaches can use best practices to create a sustainable frame-work for development.

2. Methodology

The site selection was done in the four earthquake high and less affected districts in the year 2015 (Table 1 and Fig. 1). The responses from the questionnaire responded (n=180 each district) collected from Gorkha, Sindhupalchowk, Kathmandu and Sankhuwasabha for data analysis (Fig. 2). In Gorkha, the average household size is 4.08 and carries the total population of 271061 (55% women) (Table 1). Similarly Sindhupalchowk and Sankhuwasabha population carries higher percentage of women. The area of Kathmandu is less as compared to other three districts. The gender data collected in the questionnaire were categorized into 5 different gender groups. Subsequently the questionnaires were prepared on the way that it represents Natural Capital, Physical Capital, Financial Capital, Social and Human capital. Each capital contains more than one questionnaire.

Table 1. The distribution of earthquake affected districts of Nepal.

Districts	House holds (HH)	Av HH Size	Population			Area in sq. km.
			Total	Male	Female	
Gorkha	66506	4.08	271061	121041	150020	3610
Sindhupalchowk	66688	4.32	287798	138351	149447	2542
Kathmandu	436344	4	1744240	913001	831239	395
Sankhuwasabha	34624	4.58	158742	75225	83517	3480

The data collected were analysed with two-way ANOVA to compare the mean square of each questionnaire using Tukey's HSD with R package "agricolae". The earthquake magnitude data and bar plot were drawn using the latest "tkiz" package. In addition, the reference data of households, population and area were taken from Nepal government website.

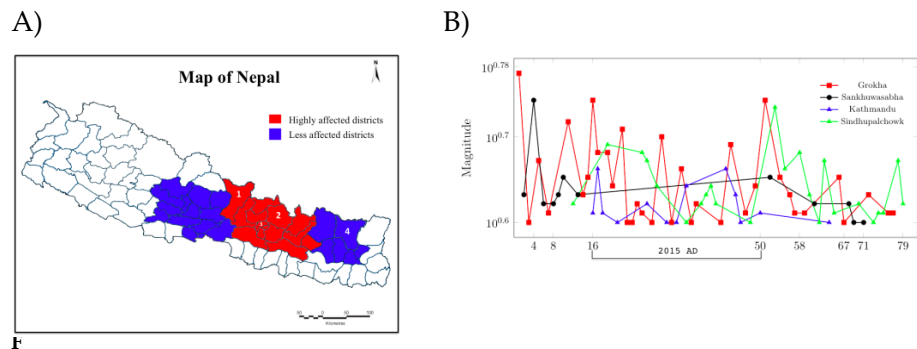


fig1. A) Earthquake effected districts of Nepal in 2015, Gorkha(1), Sindhupalchowk(2), Kathman-du(3) and Sankhuwasabha (4). B) Graph of frequently produced earthquake in Nepal.

3. Results

3.1. Natural Capital

The analysis results showed that 80% (137) respondents in Gorkha were male, amongst them 48 respondents fell in ages between 12-20 years (Fig. 2). Most of the respondents (73) opinion is that at least one of the water sources were damaged due to the earthquake. The respondents (47-48) thought that cereal and vegetable production had decreased and landslides (66 respondents) were the major problem after the earthquake.

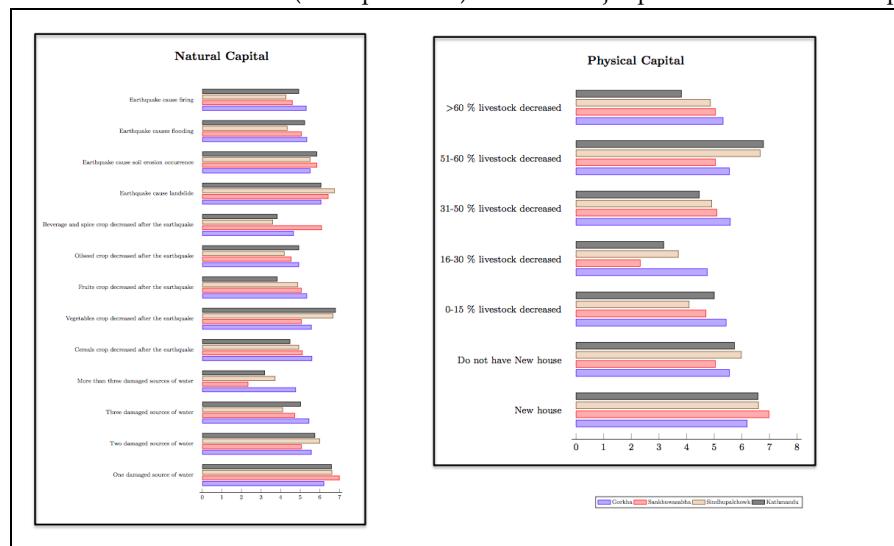




Fig. 2. log₂ data bar graph showing the components response on different capitals.

There was a mean significant (16.16 ± 8.26 , $p < 0.01$) response on agriculture crops categorized with the age group (Table 2). In Sindhupalchowk 54% (104) respondents were men, amongst them 104 respondents fell in ages between 35-45 years (Fig. 2). There was a mean significant (12.6 ± 12.59 , $p < 0.001$) response on agriculture crops categorized with the age group (Table 2). In Kathmandu 57% (109) respondents were women, amongst them 76 respondents were fall in ages between 35-45 years (Fig. 2). Most of the respondents (96) opinion is that at least one of the water sources were damaged due to the earthquake. There was a mean significant (12.2 ± 11.9 , $p < 0.001$) response on water sources categorized with the age group (Table 2). The respondents (110) thought that vegetables production had decreased and landslides (66 respondents) were the major problem after the earthquake (Fig. 2). In Sankhuwasabha 64% (122) respondents were women, amongst them 69 respondents fell in ages between 35-45 years. There was a mean significant response on water source (9.73 ± 6.3 , $p < 0.05$) and agriculture crop (17.13 ± 11.09 , $p < 0.01$) categorized with the age group (Table 2). All of the natural capital components were positively correlated except the age group 35-45 years which only shows that one source of water was damaged due to the earthquake (Fig. 3).

Table 1. The mean response on age group of different capitals from the earthquake effected districts of Nepal.

Capitals	Components	Gorkha	Sankhuwasabha	Sindhupalchowk	Kathmandu
* * Natural * * * i s Physical	Water Source	0.72	9.73*	1.95	12.2***
	Agriculture	16.16**	17.13**	12.6***	3.68
	Crop				
	Environmental	1.94	0.195	0.045	0.082
	Change				
0 Financial	House	4.56	0.018	2.95	4.64*
	livestock	0.33	0.32	0.71	0.093
0 0 Social and 1 Human	Income	5.44	3.38	0.44	4.98*
	loan	1.01	3.02	1.73	0.19
	Social Organisa- tion	3.38	1.56	0.71	0.045
	Health Care	2.22	5.32	1.42	4.1

*** is 0.01, and * is 0.05, ns, non-significant differences, between different to the Gender and Age Group.

3.2. Physical Capital

A total of 97 Gorkha people responded that they have new houses after the earthquake. They still thought 31-50% livestock were decreased in their area after the earthquake (Fig. 2). Kathmandu people (120) responded that they have new houses after the earthquake who still thought 31-50% livestock were decreased in their area after the earthquake. There was a mean significant (4.64 ± 4.29 , $p < 0.05$) response on houses categorized with the age group. Sankhuwasabha people (165) responded that they have new houses after the earthquake who still thought 31-50% livestock were decreased in their area after the earthquake. 35-45 years respond on the natural capital component that they got the new that house is strongly and positively correlated (Fig. 3).

3.3. Financial Capital

A total of 59 respondents have responded that Gorkha's people source of income status increased is still below 0% and still they are confident that they could repay their loan in below 1 year (Fig. 2). Around 64 people have responded that Sindhupalchowk people source of income status increased is between 21-50% and still they are confident that they could repay their loan in 5 years. A total of 70 respondents have responded that Kathmandu's people source of income status increased is between 51-80% and still they are confident that they could repay their loan in 5 years. There was a

mean significant (4.98 ± 4.62 , $p < 0.05$) respond income categorized with the age group. There was a mean significant (1.61 ± 6.7 , $p < 0.05$) responded on loan categorized with the gender. Around 70 people responded that Sankhuwasabha's people source of income status is below 0% after the earthquake they could take to repay their loan more than 5 years. All age group people response were significantly and positively correlated on the financial capital that their income status is increased up to 20% and could take 5 years to settle their loans (Fig. 3).

3.4. Social and Human Capital

A total of 47 Gorkha people responded that social organisations decreased after the earthquake and most of them (102 respondents) did not receive any training on healthcare and income generation after the earthquake (Fig. 2). A total of 82 Kathmandu people responded that social organisation increased by 20% after the earthquake and most of them (134 respondents) received training on healthcare and income generation after the earthquake. There was a mean significant (1.7 ± 8.5 , $p < 0.001$) responded on social organisations categorized with the gender. Around 40 Sankhuwasabha people responded that the number of social organisation has not been changed after the earthquake and most of them (156 respondents) did not receive any training on healthcare and income generation after the earthquake. The response of all age's group on social and human capital is that there is no change in the number of social organization after the earthquake has found positively correlated (Fig. 3).

4. Discussion of the study

In the context of rural development and Haiti's post-earthquake transformation, agriculture declined from about 10 percent in 2000-2001, which is discussed in a previously published article [8]. While the new aid sources in this study may provide some modest relief, they may offer only limited opportunities to address deep poverty and inequalities in rural areas. After the earthquake in Nepal, the loss of mainly vegetables and the increased risk of landslides exposes the possibility that scarcity and inequality may increase. In a previously published article, though the food security situation is comparable or improved, even after one year of the earthquake, less than half of the households were unable to attend farming on time [9]. This study also showed a similar situation in Gorkha, Sindhupalchowk and Kathmandu. Therefore, it can be assumed that the impact of earthquakes on agriculture will remain the same till long term. The lack of water for irrigation, low agricultural production and barrenness of the soil were occurred due to landslides. In our study the local people are found to be turning to non-agricultural activities for income. As mentioned in their perception of the impact of earthquakes and conservation in the previously published article, the availability of water decreased after the earthquake, which basically reduced agricultural irrigation and led to loss of agricultural production [10]. In all the studied districts, at least one water source has been lost, which seems to have a negative impact not only on the agricultural system, but also on drinking water. The study has revealed that using agro hydrologic remote sensing can help in agro-hydrology and water management related issues to overcome earthquake crises [11]. Among the livelihood risks faced by the earthquake victims categorized by the age group; agricultural crop risk was seen especially in Gorkha,

Sankhuwasabha and Sindhupalchowk. This study is somewhat different from the previous study [12] which showed that social risk is the biggest risk. The country's geography and social environment may have made such a difference. Another study adds that improved concentrated rural settlements are an effective way to achieve sustainable development and resilience [13]. The concentrated rural settlements are in practice and being used in the rural areas of Nepal with the initiation of social motivators.

Earthquake survivors' perceptions of climate change and local knowledge play an important role in informing policies to address climate change risks. A survey and community-based risk discussion conducted in the Melamchi Valley of Nepal has shown that the temperature has increased and the frequency of droughts has also increased [14]. The study elicited responses to climate-related threats affecting agriculture such as livestock, milk shortages, and the need to engage in labor migration, which provided information on how to cope with and adapt to current and future risks from climate change. Due to the devastating earthquake on 21 September 1999, the Chiufenrashan area of Taiwan faced a massive landslide [15]. However, with landslide restoration, the area regained its vegetation as well as natural diversity and richness. This effort has shown that with a little help from humans, nature itself has a strong capacity to restore its original landscape and mitigate the effects of disasters on destroyed ecosystems. After 82 years (the biggest earthquake in 1990), Nepal faced this kind of problem in which a large population was displaced and there was a change in the environmental conditions which showed the lack of knowledge transfer to deal with it. The study on new training related to health services after the earthquake showed that only the urban areas had access to such facilities, especially the Kathmandu area. Housing reconstruction is an important post-disaster activity in developing countries that is promoted by responsible agencies [16]. Most of the respondents responded that their housing was new after the earthquake. We agree with this study that the age group of Kathmandu is optimistic about this. However, there were mixed reactions about this new home and other loans. The respondents from Kathmandu expressed that they would be comfortable if the loan period is 5 years, which is obvious. Their earnings have also increased by 51 to 80 percent compared to before the earthquake. The older adults can contribute substantially to recovery programs based on adaptive responses such as psychological support to overcome and manage the negative consequences of disasters [17]. Older adults could be used for training related activities after the earthquake.

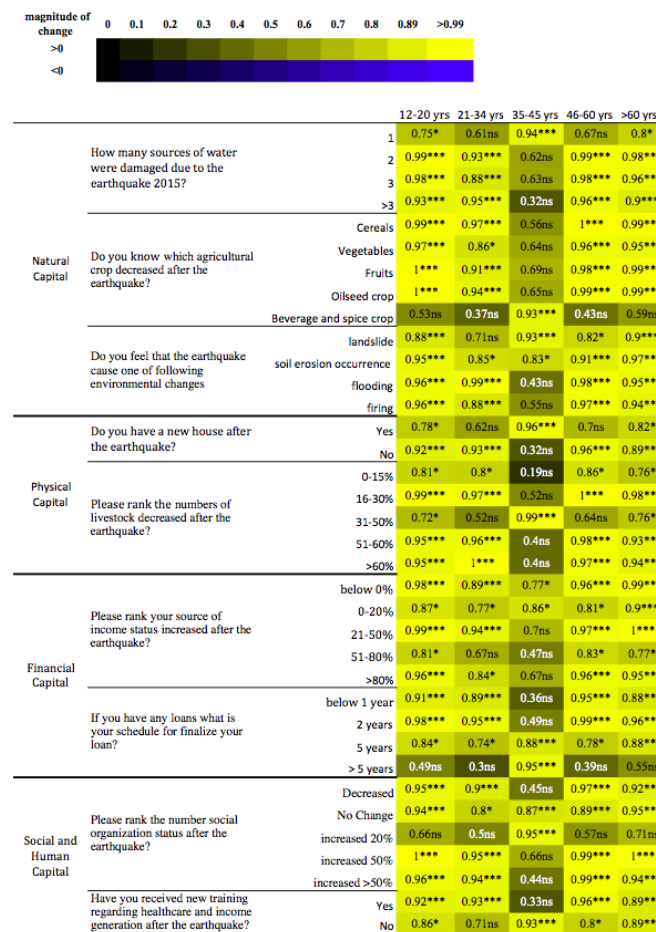


Fig. 3. Repertoire of capitals components correlation. Data are shown as heat map for 5 different age groups. The data are Pearson's correlation response (N=180) from four different district re-spondents. The relation that are shown as ***is 0.001, **is 0.01, and *is 0.05, and ns are non-significant differences in Pearson's correlation analysis.

The previous findings shows that changes in human well-being after earthquakes make rural areas around the world more vulnerable to natural disasters [18]. This study suggests that most livelihood changes have had a negative impact on improving human well-being, rather than facilitating it. To guide management interventions for sustainable development, scientists and policy makers need to better understand the relationship between recovery outcomes after natural disasters and livelihood changes. In one study on the irregular animal behavior after earthquakes in the Umbria-March regions of Italy showed that the cause of decrease in livestock is due to the behavior on local air ionization caused by stress-activated positive holes [19]. Another study recorded significant declines in overall water quality and that used for drinking, aquatic habitats, recreation, irrigation, and livestock following hydrological, geological, and geological changes due to earthquake effects on hydrological balance [20]. This study is in agreement with the

previous findings that decrease of livestock in Kathmandu and Sindhupalchowk around 31-50% after the earthquake may be some of these reasons.

Natural disasters affect income inequality through poverty traps. During the disaster response phase, people with low socioeconomic status were more likely to be unemployed and there was no difference between low and higher levels of socioeconomic status people in terms of the probability of being re-employed after the disaster [21]. However, another study discusses that pre-earthquake damage does not prepare people to adapt to the disaster and has an adverse effect on recovery [22]. The immediate effects of earthquakes, including loss and damage to property and disruptions to livelihoods, have further highlighted the challenges and risks to health and permanent settlements, depriving people of the essential rights that can rely on for recovery. Although low-income households improved significantly after the natural disaster, setting post-earthquake objectives for specific risk reduction activities showed a correlation with household income and wealth levels, and noted that this widened the gap in disaster preparedness between the rich and the poor [23].

A study reported that seismic intensity is associated with severe life events and mental health morbidity in earthquake survivors [24]. It elaborates on the financial burdens arising from earthquakes, the burden of reconstruction debt on previous mortgages and the resulting long-term stress on dual home loans. In the study, it cannot be denied that the lack of proper training and lack of access to survivors in other places than one district can lead to the mentioned mental illness. The article of [25] (1991) has concluded that the damage caused by poor development is a big burden for the government, institutions and population of the country in the identification of the major sustainability problems arising in financial earthquake-related projects. Reinforcement of less earthquake-resistant structures is a major issue for reducing earthquake disasters, and new systems and policies to promote the retrofitting of weak structures have come to some extent as a policy in Nepal. In the retrofitting promotion system, if the directives before the earthquake are followed and implemented, the government guarantees a part of the building repair and reconstruction expenses, which is very beneficial for both the government and civil societies, which has not been done in Nepal so far.

A study emphasizes the need for more localized emergency education to promote long-term awareness and preparedness in rural areas, citing differences in community organization as key factors in social relations, social interaction, and organization during the recovery process [26]. Post-disaster recovery involves social, economic, and physical interdependent factors, and the impact of any one component has a dramatic impact on the other two. Contingencies of these elements must be included for community recovery to be effective. To date, Nepal has not adequately planned for the long-term social and economic impacts of disasters. The impact on cities goes beyond the obvious costs, and long-term community support services such as housing, employment, health and general community well-being are all elements that are absent after a disaster. The researchers have studied these three factors in four capital lists. Fawcett & Oliveira, 2000 study pre-

sents a new approach to the problem of casualty treatment after a large-scale disaster based on a mathematical model of how the health care system responded to an earthquake [27]. In this study, the number and location of survivors, measures of prehospital care, post-earthquake hospital capacity, and transportation system are inputs to the model, which predicts the number of deaths as well as other data about health care system response, such as waiting times before treatment. Nepal can also develop a similar model with different input assumptions to simulate alternative disaster response strategies.

5. Conclusions

This study conducted through a questionnaire in four earthquake affected districts is important to review the social situation after 2015 AD. In this, the four genres that have been viewed through a few questions have managed to draw important conclusions. It was observed that the earthquake in Nepal particularly affected a particular age group rather than women or men. Also, based on the average evaluation of the age group, it was found that almost everyone agreed about agricultural crops and to some extent water sources for their food security. On the other hand, if we look at the words of an old-aged group, it is seen that their words have established a good relationship with other age groups. Therefore, this method is applicable for the post-earthquake recommendation for policy making, sustainable development and resilience in Nepal.

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References

1. Xu, S., Shi, B., Yuxian, J., He, M., Yang, P., Xu, W., & Wang, D. Comparative Analysis of the Wounded in Patients and Deaths in a Hospital Following the Three Major Earthquakes in Western China. *Frontiers in Public Health*, 10. **2022**.
2. Crowley, H., Despotaki, V., Silva, V., Dabbeek, J., Romão, X., Pereira, N., ... & Hancilar, U. Model of seismic design lateral force levels for the existing reinforced concrete European building stock. *Bulletin of Earthquake Engineering* **2021**, 19(7), 2839-2865.
3. Batalha, N., Rodrigues, H., & Varum, H. Seismic performance of RC precast industrial buildings—learning with the past earthquakes. *Innovative infrastructure solutions* **2019**, 4(1), 1-13.
4. Freddi, F., Galasso, C., Cremen, G., Dall'Asta, A., Di Sarno, L., Giaralis, A., ... & Woo, G. Innovations in earthquake risk reduction for resilience: Recent advances and challenges. *International journal of disaster risk reduction* **2021**, 60, 102267.
5. Rapoport, A. Culture and built form—a reconsideration. In *Culture—Meaning—Architecture* **2019**, 175-216. Routledge.
6. Joyklad, P., Ali, N., Yooprasertchai, E., Jaffar, S. T. A., Magbool, H. M., Hussain, Q., & Chaiyasarn, K. An investigative study for the prediction of compressive strength of cement-clay interlocking (CCI) hollow brick masonry walls. *Case Studies in Construction Materials* **2022**, 16, e01001.

7. Cao, X. Y., Shen, D., Feng, D. C., Wang, C. L., Qu, Z., & Wu, G. Seismic retrofitting of existing frame buildings through externally attached sub-structures: State of the art review and future perspectives. *Journal of Building Engineering* **2022**, 57, 104904.
8. Shamsie, Y. Haiti's Post-Earthquake Transformation: What of Agriculture and Rural Development?. *Latin American Politics and Society* **2012**, 54(2), 133-152.
9. Thorne-Lyman, A. L., KC, A., Manohar, S., Shrestha, B., Nonyane, B. A., Neupane, S., ... & West Jr, K. P. Nutritional resilience in Nepal following the earthquake of 2015. *PloS one* **2018**, 13(11), e0205438.
10. Adhikari, S., Harada, K., Dahal, N. K., & Kandel, S. Earthquake Impacts on the Livelihoods of Community Forest Users in Sindhupalchok District, Nepal, and Their Perceptions towards Forest Conservation. *Conservation* **2021**, 1(4), 327-341.
11. Rodriguez, J., Ustin, S., Sandoval-Solis, S., & O'Geen, A. T. Food, water, and fault lines: remote sensing opportunities for earthquake-response management of agricultural water. *Science of the Total Environment* **2016**, 565, 1020-1027.
12. Zeng, X., Guo, S., Deng, X., Zhou, W., & Xu, D. (2021). Livelihood risk and adaptation strategies of farmers in earthquake hazard threatened areas: Evidence from Sichuan province, China. *International Journal of Disaster Risk Reduction*, 53, 101971.
13. Peng, Y., Zhang, F., Jiang, S., Huang, L., Wang, Z., & Xu, Y. (2018). Analysis of farmers' satisfaction towards concentrated rural settlement development after the Wenchuan earthquake. *International journal of disaster risk reduction*, 31, 160-169.
14. Sujakhu, N. M., Ranjitkar, S., Niraula, R. R., Pokharel, B. K., Schmidt-Vogt, D., & Xu, J. (2016). Farmers' perceptions of and adaptations to changing climate in the Melamchi valley of Nepal. *Mountain Research and Development*, 36(1), 15-30.
15. Lin, W. T., Lin, C. Y., Tsai, J. S., & Huang, P. H. (2008). Eco-environmental changes assessment at the Chiufen-ershan landslide area caused by catastrophic earthquake in Central Taiwan. *Ecological Engineering*, 33(3-4), 220-232.
16. Karki, J., Matthewman, S., & Grayman, J. H. (2022). Nayā Ghar (A new house): examining post-earthquake housing reconstruction issues in Nepal. *International Journal of Disaster Risk Reduction*, 78, 103116.
17. Ahmadi, S., Khankeh, H., Sahaf, R., Dalvandi, A., Hosseini, S. A., & Alipour, F. (2018). How did older adults respond to challenges after an earthquake? Results from a qualitative study in Iran. *Archives of gerontology and geriatrics*, 77, 189-195.
18. Yang, H., Dietz, T., Yang, W., Zhang, J., & Liu, J. (2018). Changes in human well-being and rural livelihoods under natural disasters. *Ecological Economics*, 151, 184-194.
19. Fidani, C., Freund, F., & Grant, R. (2014). Cows come down from the mountains before the (Mw= 6.1) earthquake Colfiorito in September 1997; a single case study. *Animals*, 4(2), 292-312.
20. Jakovljević, D., & Lozanov-Crvenković, Z. (2015). Water quality changes after Kraljevo earthquake in 2010. *Natural Hazards*, 79(3), 2033-2053.
21. Ye, M. (2021). Poverty Trap or Status Change? An Empirical Demonstration regarding the Impact of Natural Disasters on Income Inequality Using Japan's 3.11 Earthquake as an Example. *An Empirical Demonstration regarding the Impact of Natural Disasters on Income Inequality Using Japan's*, 3.
22. He, L., Aitchison, J. C., Hussey, K., Wei, Y., & Lo, A. (2018). Accumulation of vulnerabilities in the aftermath of the 2015 Nepal earthquake: Household displacement, livelihood changes and recovery challenges. *International journal of disaster risk reduction*, 31, 68-75.

23. Naoi, M., Seko, M., & Ishino, T. (2012). Earthquake risk in Japan: consumers' risk mitigation responses after the Great East Japan Earthquake. *Journal of Economic Issues*, 46(2), 519-530.
24. Maruyama, S., Kwon, Y. S., & Morimoto, K. (2001). Seismic intensity and mental stress after the Great Hanshin-Awaji Earthquake. *Environmental health and preventive medicine*, 6(3), 165-169.
25. Kreimer, A. (1991). Reconstruction after earthquakes: Sustainability and development. *Earthquake spectra*, 7(1), 97-106.
26. Gismondi, M. (2012). Investigating community behaviour after the 2004 Chuetsu earthquake: a case study of Kawaguchi, Japan. *Social Geography*, 7(1), 1-12.
27. Fawcett, W., & Oliveira, C. S. (2000). Casualty treatment after earthquake disasters: development of a regional simulation model. *Disasters*, 24(3), 271-287.



Article

A Study on Constructing of Online Environment for Strengthening Community Reliance

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Abstract: Entering the era of the 4th Industrial Revolution, countries around the world are experiencing a great digital transformation from the existing analog method. In particular, as citizens' perceptions changed due to COVID-19, online non-face-to-face services became commonplace, speeding up the transition to a digital society. Based on these recent situations, we would like to discuss the need to establish an Internet social network and even an online environment in the disaster field where information such as guidance and safety rules can be obtained and shared regarding various disaster damage such as COVID-19 or typhoons and earthquakes. In particular, based on pre-disaster preparation, damage reduction plans, and post-disaster response and recovery activities centered on the local community, we would like to find ways to establish an online environment to strengthen the disaster resilience of the local community through a resident participation platform.

Keywords: Disaster Resilience; Resident Participation Platform; Local Community; On-Line

1. Introduction

The global spread of Coronavirus disease 2019 (COVID-19), which began in 2019, has brought about changes in daily life. In particular, the implementation of quarantine guidelines such as social distancing or wearing a mask limited the path to meet and communicate with others offline. Previously, daily information could be obtained by visiting an administrative agency and receiving the administrative services they wanted to apply for, or by going to school and talking with teachers and school friends. However, the continued spread of infectious diseases has changed everyone's daily lives. In the case of schools, students had no choice but to take classes in an e-learning system due to social distancing. In addition, the limitations of mutual communication that occur in online class situations have brought problems such as a decrease in students' learning. [1]

Entering the era of the 4th Industrial Revolution, countries around the world are experiencing a great digital transformation from the existing analog method. Already, non-face-to-face online services are spreading in our society. In addition, as citizens' perceptions changed due to COVID-19, online non-face-to-face services became commonplace, speeding up the transition to a digital society. This phenomenon is not a new phenomenon that did not exist, but it is believed that the existing technology has developed through a specific period of time. [2]

As the complexity and unpredictability of disasters increase in modern society, disaster management is understood as one of the important government policy capabilities directly related to the quality of life of the people. [3] Through the recent case of the spread of COVID-19, it was experienced that it was difficult to deliver facilities and services in the event of a disaster or disaster, and control and support may not be smooth as usual in an emergency. Based on these recent situations, the need to establish an Internet social

network and even an online environment in the disaster field should be discussed in the future to obtain and share information on various disaster damage such as infectious diseases such as COVID-19, typhoons, and earthquakes.

Therefore, this study aims to find out about a platform where people can share information in various disaster situations such as the recent outbreak of infectious diseases. Among them, I would like to investigate the resident participation platform currently operated by local governments, which have more contact points with citizens than the central government, and provide residents' lives closely, and see if it can establish an environment to strengthen prior to and after disasters.

2. Research Methods

In order to study the establishment of an online environment to strengthen the local community's resilience, the following research method is to be used.

First, it deals with Theoretical Background based on Literature Review. Through literature research, the concepts of Disaster Resilience, Disaster Safety Management, and Local Community are summarized to lay the foundation for research.

Second, research is conducted based on theoretical discussion. The current status of online Resident participation platforms in the region is investigated along with the basis for why they want to establish an online environment. Newspapers and statistical data are used, and the current status of the resident participation platform is investigated on the website or app of each region.

Finally, in the conclusion of this study, a construction plan is presented based on the current status survey of online residents' participation platforms.

3. Theoretical Background

3.1. Disaster Resilience

Resilience, which is used in terms of scientific terms, is rooted in ecological systems research, but it is also covered as a research topic in various fields such as psychology, histology, and business administration, and can be analyzed at various levels such as individuals, organizations, and communities. [4] In this study, Resilience says that it is common to be discussed mainly at the community or community level. This is because the local community is a site where disaster-sticking effects occur as a point where disasters directly damage and various problems occur. In relation to Resilience, disasters are not only natural events, but also have economic and political attributes and social attributes.

Cho's research focuses on the system operation process and ability of disaster management organizations to prepare for disasters in advance and to minimize damage and change and adapt to a more advanced environment by quickly responding and recovering in the event of a disaster. In the event of a disaster, there is support and participation from the central or higher governments, but various plans, preparations, risk reduction activities, and recovery activities after the disaster are practically carried out by community voluntary community organizations and municipalities. [5]

In the event of a disaster, communities cause irreconcilably large losses, and communities damaged by the disaster must rely on the help of other communities, local governments, or central governments. [6] Meanwhile, Seo(2020) shows that in the event of a disaster, an independent response at the urban government level is needed rather than relying on the central government. Wallace E. Oates says that local governments have more contact points with citizens than central governments, making it easier to grasp the current status and demand of citizens, which is used as a basis for the argument that local governments can supply certain public goods more efficiently than central governments.

Kim(2018) noted that high disaster resilience in the community can bring about the efficiency of disaster management in that the central government can supplement disaster management capabilities.

3.2. Disaster Safety Management

Articles 3 and 4 of the Framework Act On The Management Of Disasters And Safety (June 8, 2021) describe the terms "disaster management" and "safety management". The term "disaster management" in subparagraph 3 means all activities performed for disaster prevention, preparedness, response, and recovery, and the term "safety management" in subparagraph 4 means all activities performed to protect people's lives, bodies, and property from disasters or various other accidents.

Article 4 (1) and (2) of the Disaster Safety Act describe the responsibilities of the State, etc. in relation to disasters. In subparagraph 1, The State and local governments shall be responsible for protecting lives, bodies, and property of people from disasters or various other accidents, shall endeavor to prevent disasters or various other accidents and to mitigate damage therefrom, and shall formulate and implement plans to promptly deal with and recover from the damage. In subparagraph 2, the State and local governments shall actively disclose information on safety, and shall make it convenient for anyone to use it. Therefore, it is necessary to disclose information related to disasters for the purpose of minimizing the scale of disaster damage and protecting the people.

Kim(2017), In case of emergency situations such as disasters and terrorism that threaten the safety of citizens, appropriate responses are needed to establish and operate a quick and effective disaster safety management system. Lee(2019), If the existing disaster management was centered on central government-led orders and controls, it has recently changed to a form of governance based on communication and cooperation between central and local governments. You et al.(2013) stated that policies and studies to prevent similar disaster cases and minimize damage are relatively insufficient, and it is time to study the disclosure or sharing system of disaster safety management information for local residents.

3.3. Local Community

When looking at documents related to disaster resilience, most communities are directly affected by disaster, and local governments and local communities should be put into the process of actual prevention, preparation, response, and recovery before and after the disaster. However, when looking for the theory of disaster safety, studies on how to strengthen the disaster management capabilities of local governments or information sharing of local residents are less than studies centered on central ministries.

Therefore, next, it is necessary to look at the local community. First of all, when it comes to the concept of a community, a community can be defined as a small group voluntarily organized based on a sense of emotional and mental unity or homogeneity of interests among its members [7], and there is a discussion about defining it in a wide variety and complex way.

Hillary (1995) sees communities as groups of residents interacting with a common bond in certain areas, and points out that the presence of a sense of belonging to a group, a sense of unity pursuing a common purpose, a sense of voluntary participation, and a sense of community is important in these communities.

In this way, there are many meanings in defining a community, but Hillary (1995) sees the ① geographic area, ② social interaction, and ③ common tie as key components for the community. [8]

Mattesich. et al (1997) view communities as a collection of people who live within geographically limited areas and have social and psychological ties to the places where they live. [7]

However, the development of IT technology such as the 4th Industrial Revolution has a change in the nature of the geographical area, which is a component of the community. According to the Ministry of the Interior and Safety (2018, 7), the geographical and physical boundaries have collapsed due to the development of information and commu-

nication, but social interaction is becoming more active as community members are diversified and free communication methods are spread through mobile phones and the Internet. In addition, in order to overcome the emotional disconnect caused by indirect relations through the medium of communication, it emphasizes mature social capital, a sense of community, and a sense of solidarity between residents through face-to-face interactions. Therefore, as shown in Figure 1, it can be seen that the components of the local community have changed from traditional concepts(natural, geographical, historical locality, direct interaction, closed joint bond) to modern concepts(weakened locality, indirect interaction, and open joint bond).

Fig 1. Changes in the Meaning of Local Communities

구성요소	전통적 공동체		현대적 공동체
지역성	자연적·지리적·역사적 지역성	⇨	약화된 지역성
상호작용	직접적 상호작용	⇨	간접적 상호작용
공동 유대감	폐쇄적 공동 유대감	⇨	개방적 공동 유대감

*KRILA(2018) 내용 정리

Through previous theoretical discussions, it was found that the concept of community, that is, community, is involved in conducting research on disaster resilience. In addition, it is necessary to increase citizens' disaster sensitivity by disclosing or sharing disaster-related information to citizens, and to increase disaster-related knowledge in advance. Therefore, it is necessary to find a way to strengthen its resilience in the event of a disaster through a local community where mutual networks are established.

Already entering the fourth industrial era, countries around the world are experiencing a major digital transformation from the existing analog method. The recent experience of COVID-19 is showing signs of building data infrastructure and strengthening online services in the administrative field, and this trend is expected to continue in the future.

Therefore, this study seeks to establish an online environment to strengthen the disaster resilience of local communities based on pre-disaster preparation, damage reduction plans, and post-disaster response and recovery activities.

4. Findings

4.1. the increase in mobile phone Supply

The advent of the 4th Industrial Revolution brought about changes in our daily lives by presenting new or advanced technologies to our society. And these new technologies play a role in improving the quality of our lives by combining them with media such as mobile phone and tablet PCs.

According to The Board of Audit and Inspection of Korea(2022), Korea's mobile phone supply rate reached 0.94 units per person as of 2021, and the number of subscription lines reached about 54 million (March 2022). According to the 2021 Broadcast Media Usage Behavior Survey by the Korea Communications Commission, the monilephone ownership rate was 93.4% in total, the 10-50s was saturated (98% or more), and the 60s retention rate was 91.7%, similar to the previous year (91.7%), up 9.3%p from the previous year. From these statistical results, it can be seen that the spread of mobile phone has increased even in the elderly.

For the above reasons, as the supply of mobile phone increases, the government is developing and operating mobile applications such as various "public apps" so that people can conveniently use public services. [9]

These online services have spread further since COVID-19. However, this phenomenon may lead to a widening digital divide. The operation of 'public apps' or social media

is based on the premise that you know how to use them. Therefore, it is necessary to consider the four major groups (disabled, elderly, low-income, farmers and fishermen) and the socially disadvantaged to use disaster-related online services through mobile phone or other electronic devices.

For example, the elderly tend to have relatively low access to information culture and be alienated compared to the youth. [10] In the proportion of mobile phone users in Korea, 73.8% of respondents who do not use mobile phone were over 70 years of age (Korea Communications Commission, 2022). For this reason, in order to narrow the digital gap, the company is implementing a project to distribute "adult-tailored mobile phone" (Seoul in my hand, 2021), or providing education on using mobile phone by local governments.

As another example, according to a study on the perception of mobile phone use by people with physical disabilities, a lot of efforts are being made to develop support services for the disabled using mobile phone at a pan-government level. And the proper use of mobile phone plays an important role in improving the quality of life of people with physical disabilities. However, it is mentioned that the development of technology in mobile phone is centered on non-disabled people, resulting in unexpected inconvenience for the disabled, which eventually leads them to experience a sense of alienation and deprivation in using technology (Jo, 2019: 161-162).

To sum up, with the spread of media such as mobile phone, people are enjoying a more convenient life than before. And in line with this, the government is developing technology to provide services through mobile phone. However, behind the development of technology using mobile phone, negative aspects such as digital gaps were also appearing. Therefore, it is emphasized that these problems should be considered in order to establish an online environment to strengthen disaster resilience.

4.2. Resident participation platform

The interest in resident participation in Korea can be divided into around 1991 when local autonomy was implemented in earnest, and in the early 2000s, the method of participation changed due to the spread and spread of the Internet and resident participation began to occur actively. [11] Even if the government establishes and provides an integrated platform, active participation of residents is required, and when resources (e.g., information, infrastructure) owned by government-local residents are utilized and exchanged, efficiency improvements can be expected. [12]

First, previous studies and portal site search methods were used to find out the current status of resident participation platforms that provide online services. Nam(2021) the cases of government communication platforms as shown in Table 1. The data are organized based on 1st, 6th, 1st Special Self-Governing City, 8th, and 1st Special Self-Governing Province. In this study, the data were modified by reflecting the latest situation. Among them, areas that simply integrate with the 'National Newspaper' to provide only the function of proposing civil complaints were excluded. However, in this case, the platform is not operated at the provincial level, but Cheongju Siseon (siseon.cheongju) a civic communication platform was operated.

Next, the main functions of the resident participation platform were investigated. The main functions were organized by referring to the homepage introduction or category menu. As a result, most of the resident participation platforms were mainly provided as a major function of opinion suggestion and discussion. This is because the resident participation platform was created to induce direct political participation of residents as part of the participatory democracy. These functions induce direct and voluntary activities of residents. Among them, Jeju Special Self-Governing Province's "jejudis" operates a "self-solving group" in which local residents, ICT activists, and local governments participate to discover regional status through collaboration and improve and solve it using digital technology. Other cities and provinces also have policy suggestion functions, but as in the

case of Jeju Island, it is necessary to consider the operation of more specific programs for residents to actively participate in problem-solving activities.

Finally, we investigated whether the application of the resident participation platform was provided. As a result, only three out of a total of 14 services (Busan, Gwangju, and Sejong Special Self-Governing City) were operating the app, except for Ulsan, Chungcheongbuk-do, Jeollanam-do, and Gyeongsangbuk-do, which do not provide a platform for residents to participate. Among them, Sejong City's "Sejong City App" has the characteristic of providing only app services without a website. The application has the slogan 'Easy and valuable communication on urban issues'. Within the app, it plays a role as a governance platform that shares, communicates, and finds solutions together through various services such as policy proposals, living labs, and 'Sejong voting'.

Table 1. Revised the contents of Nam(2021: 37). Ulsan Metropolitan City, Chungcheongbuk-do, Jeollanam-do, and Gyeongsangbuk-do are excluded because they provide only the platform of the National Newspaper.

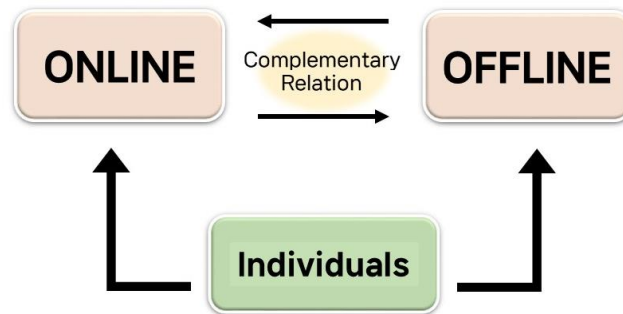
이름(지역)	웹사이트 주소	주요기능	앱 유무
민주주의 서울 (서울특별시)	democracy.seoul.go.kr	시민제안·시민토론	X
부산 민원 120 (부산광역시)	120.busan.go.kr	민원신청·시민제안	O
두드리소 (대구광역시)	dudeuriso.daegu.go.kr	민원신청	X
인천은소통E가득 (인천광역시)	cool.incheon.go.kr	시민제안·민원상담	X
대전시소 (대전광역시)	daejeon.go.kr	시민제안·시민토론	X
마을E척척 (광주광역시)	maeuli.com	마을리빙랩	O
세종시티앱	X	정책제안·세종투표	O

(세종특별자치시)			
도미니 (경기도)	domini.or.kr	공공서비스제안	X
강원톡톡 (강원도)	idea.gwd.go.kr	도민제안	X
만사형통충남 (충청남도)	10004.chung- nam.go.kr	도민제안	X
전북소통대로 (전라북도)	policy.jb.go.kr	도민제안·도민소통	X
경남 1번가 (경상남도)	gyeongnam.go.kr	도민제안·도민토론	X
가치더함 (제주특별자치도)	jejudsi.kr	시민제안·스스로해결 단	X

5. Limitation and Conclusion

The limitations of this study are as follows. It did not suggest a way to prevent online communication due to the destruction of the Internet network. However, for this reason, it is emphasized that the establishment of an online environment should be carried out in a system that complements the offline environment as shown in Figure 2. This extends people's choice by providing two spaces, online and offline. However, the establishment of the online environment follows the social trend, but there is a limitation that it cannot be applied to all disaster situations. Therefore, the system should be reorganized so that offline-based services and online-based services can have smooth interaction on a normal basis.

Fig 2. Online and Offline Complementary System



As a result of the survey on the resident participation platform, the categories related to disasters and places to talk were narrow, such as civic proposals. Instead, there was a separate platform operated as a 'disaster safety platform' such as 'Ansim Haiso' and 'life safety guidance'. In this process, the resident participation platform was organized into a space for communication, and the disaster safety platform was organized into a space where disaster information could be checked.

If so, what perspective should these online platforms be viewed in terms of strengthening disaster resilience? In this study, it is believed that resilience can be strengthened, focusing on communication of residents. To do so, a space such as a resident participation platform must be prepared, and currently, disaster-related information on such a platform can only be found in the same category as policy proposals. There was a limited space for two-way communication where residents could share real-time disaster information. Therefore, it is necessary to activate the field of communication to activate the platform. As more people gather, more demands arise, which can be made with the provision of more services.

Currently, each region provides online services in various fields such as public administration, education, and cultural tourism in addition to the resident participation platform. But people don't use it for reasons such as not knowing its existence, not feeling the need, etc. Also, there are so many apps distributed by field that you may feel tired. The large number of platforms means that there are many accessible channels. However, unnecessary or poorly managed apps need to be modified or integrated with other apps to reduce the time it takes for people to get the right information and start communicating. The success of this platform government ultimately depends on the quality data and information it provides to the public (Robinson, Yu & Felten, 2010).

Finally, it is also necessary to check whether a platform environment that people can trust is well established. In the case of public apps, the security status of 36 public apps with accumulated downloads of more than 1 million as of the end of August last year was investigated, and as many as 30 (83.3%) public apps were diagnosed with security weaknesses. Due to poor removal, at least 3,192 security weaknesses were detected in at least one case per app. This can be an obstacle to the use of the platform for residents who are users.

References

1. Nam, J.; Hu, X.; Park, Y. The Effect of Chinese International Students' Communication Ability on Online Class Satisfaction in the COVID-19 Situation - Focusing on the Mediating Effect of Self-Directed Learning Ability. *Culture and Convergence* 2022, 44(2), 107-126.
2. Kim, J.; Kim, G. A Study on the Improvement Plans to Public Participation Platform in Local Government Level : Focusing on the Online Participation Platform. *Korea Research Institute for Local Administration* 2020, -, 1-182

3. Eom, H.; Eom, K.; Son, S. . R&D Alliance Operation Plan to Strengthen Competitiveness of Disaster Safety Technology Development. *Journal of local government studies* **2020**, 32(1), 87-109
4. Lee, J. Enhancing Disaster Resilience through Innovative Approaches for Restructuring Safe Community Governance in Korea. *Crisisonomy* 2018, 14(3), 75-90.
5. Cho, S. An Analysis on Disaster Management Effectiveness of Preparedness Activities through the Survey on the Local Government Officials' Perceptions: Focusing on the Mediating Effects of Community Disaster Resilience. *Korean Journal of Convergence Science* 2019, 8(1), 188-198.
6. Kim, H. Application of Social Media for Responding to a National Disaster. *Journal of the Korea Entertainment Industry Association(JKEIA)*2011, 5, 147-153.
7. Chae, J. A Study on the Promotion of Social Integration through the Revitalization of Community Basic Research Assignment, Basic research project2014, -, 1-407.
8. Kim, H. The Study of Community-Driven Development Strategy on the Confrontation of Local Community's Crisis, *Crisisonomy*2014, 10(5), 279-201.
9. "The current status of 18.8 billion 'Blood Tax-Eating' public app". *Sunday Times*. Press Release of October 20, 2022
10. Hu, S. Analysis of The Effect of The Digital Divide on The Digital Daily Life of The Elderly. *Journal of Digital Convergence* 2020, 18(9), 9-15.
11. Lee, J. The 1st Meeting: An Analysis on the Participation of Online Residents in 25 Autonomous Areas in Seoul, *Journal of the Korean Society of Public Administration* 2004, -, 202-225.
12. Nam et al. Mobile Platform for Residents' Participation, *KARIS* 2021, -, 33-40.



Article

A Study on analysis of hyperconcentration of population in the capital region and extinction of local areas in Chungbuk province

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Abstract: Recently, due to the outflow of young people from the Chungbuk region to the metropolitan area, the region is experiencing a crisis of extinction. Despite various balanced national development policies, the centralization of the metropolitan area is becoming more and more serious, and it is urgent to prepare countermeasures for this. Chungbuk has achieved remarkable growth over the past 10 years, but is experiencing an economic crisis as the outflow of young people, a key human resource, is intensifying. In order for the Chungbuk region to achieve sustainable development, it is necessary to develop manpower training policies based on innovation that consider global trends, government policies, and conditions and demands in the Chungbuk region. In addition, it is time to evolve from existing industry-academia-government cooperation to regionally-linked industry-academia-government cooperation.

Keywords: Capital region, hyperconcentration of population, extinction of local, sustainability

1. Introduction

Over the years, voices of concern over the gap between the metropolitan area and non-metropolitan areas are growing. People and resources were overcrowded in the metropolitan area, and other areas were forced to collapse naturally. The collapse of the region creates a vicious cycle that leads to the concentration of the metropolitan area again.

As can be seen from the above, the local population moving to the metropolitan area has not stopped recently, and the phenomenon of exodus of young people who graduated from local universities to the metropolitan area is at a very serious level. As a result, competitiveness is lost due to overcrowding in the metropolitan area, and the imbalance between supply and demand of manpower is accelerating in many areas outside the metropolitan area.

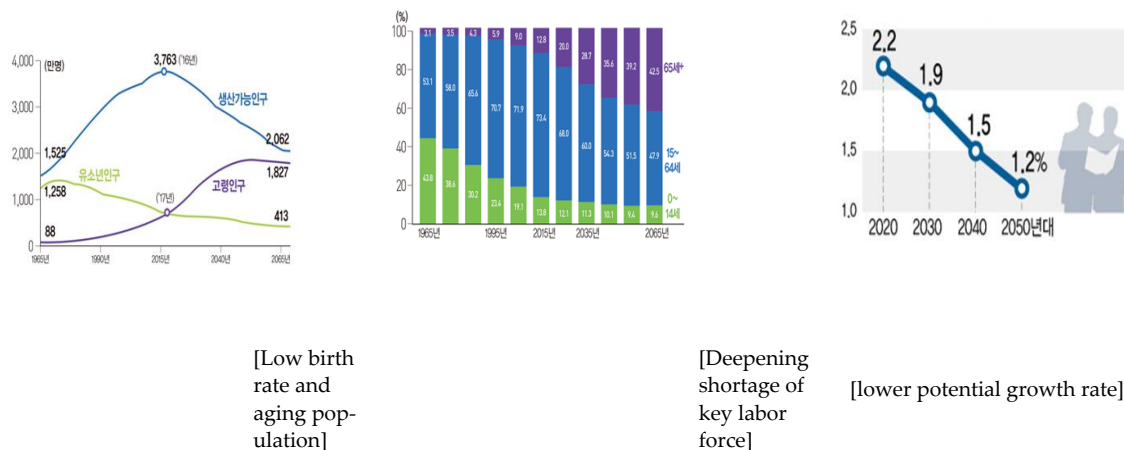
This in turn leads to a stagnation of economic growth. This phenomenon is expected to continue the unavoidable reality of the age of local extinction due to the hyper-concentration of the population in the metropolitan area.

The crisis of local extinction does not stop at rural areas, mountain villages, and fishing villages, but tends to spread rapidly to urban areas in non-metropolitan areas, causing problems in the metropolitan area where the population is concentrated and the non-metropolitan area where the population flows out. In other words, while more than half of the nation's population is concentrated in the metropolitan area, 106 areas, which

account for 46.5% of 228 cities, counties, and districts, are classified as areas at risk of local extinction, and many of them are composed of non-metropolitan areas. situation.

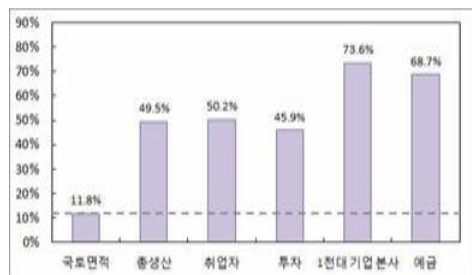
The fundamental cause of fat loss is the low birth rate. In the case of rural areas, as young women leave their hometowns, the birth rate in the region declines, and the working age population (15-64 years old), who contributes to the local economy, flows out to large cities in search of educational environments for their children and good jobs. Loss of fat is accelerated. In the case of rural areas, as young women leave their hometowns, the birth rate in the region declines, and the working age population (15-64 years old), who contributes to the local economy, flows out to large cities in search of educational environments for their children and good jobs. Loss of fat is accelerated.

This low birth rate and deepening population aging lead to a shortage of the core labor force and eventually lead to a decline in the potential growth rate. Therefore, in order to overcome this, it is necessary to improve productivity through the accumulation of human resources.



Picture 1. What is the IMF's outlook for the Korean economy?

However, despite various balanced national development policies, the centralization of the metropolitan area is rather intensifying due to population and economic power and accessibility to living services. Due to the concentration of economic power in the metropolitan area, the movement of key regional talent to the metropolitan area is accelerated, and this result eventually acts as an incentive for the remaining core talent to move. In the end, the imbalance in human resource distribution continues to lead to local extinction.



[Share of economic power in the metropoli-

[Share of job openings by region]

tan area]

Picture 2. The 4th Five-Year Plan for Balanced National Development, Local Talent Recruitment System

In order to overcome the crises that Korea is currently facing, such as low growth polarization and local extinction, and to respond to the trend of the times, such as the 4th industrial revolution, it is necessary to secure sustainability through human resource-centered strategies in addition to physical expansion strategies.

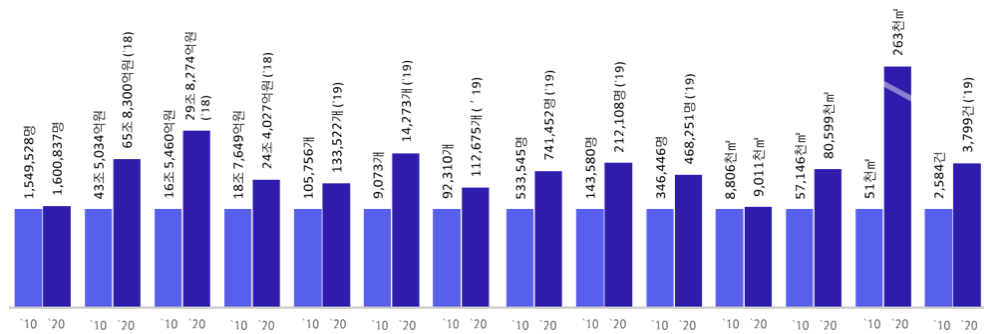
Considering that people-centered balanced development is balanced national development in its true meaning, regional capacity building is a prerequisite, and the core of regional capacity building is human resource development in connection with the region, university, and industry.

2. Status of imbalance in Chungbuk region

Chungbuk has achieved rapid economic growth over the past 10 years (2010-2020). The population increased by 3.3%, the GRDP increased by 51.3%, and the added value of manufacturing and service industries also achieved remarkable growth.

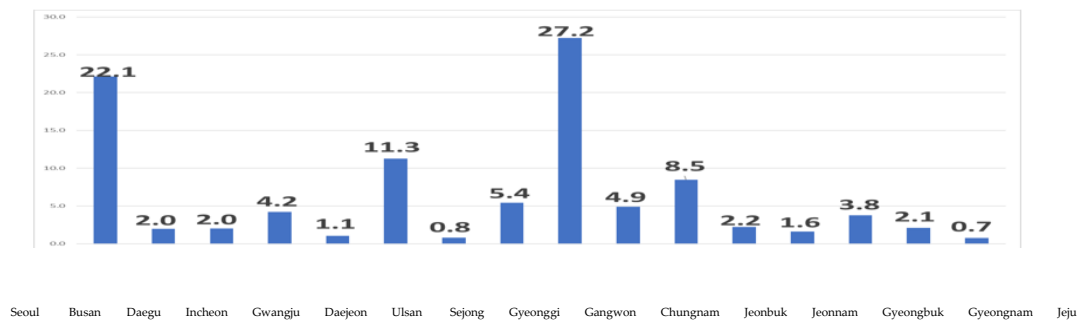


popu- lation	GR DP	manu- facturing added value	ser- vice in- dustr y adde d val- ue	all in- dustri es num- ber of busi- nesses	Number of man- ufactur- ing busi- nesses	ser- vice in- dustri es num- ber of busi- nesses	all in- dustri es num- ber of em- ployees	manu- facturing number of em- ployees	ser- vice in- dustri es num- ber of em- ployees	Area of the Na- tional Indus- trial Com- plex	Area of the Gen- eral indus- trial com- plex	Area of urban high- tech com- plex	Patent appli- cation
3.3%	51.3 %	80.3%	30.0 %	26.3%	57.3%	22.1%	39.0%	47.7%	35.2%	2.3%	41.0%	415.7 %	47.0%



Picture 3. Chungbuk Innovative Growth Zone Creation Strategy

However, the outflow of young people, a core human resource, is gradually intensifying, and as of 2020, more than 50% of the young people moving out of the country have been outflowing to the metropolitan area, accelerating the hyper-concentration in the metropolitan area.



Picture 4. Proportion of youth outflows by region

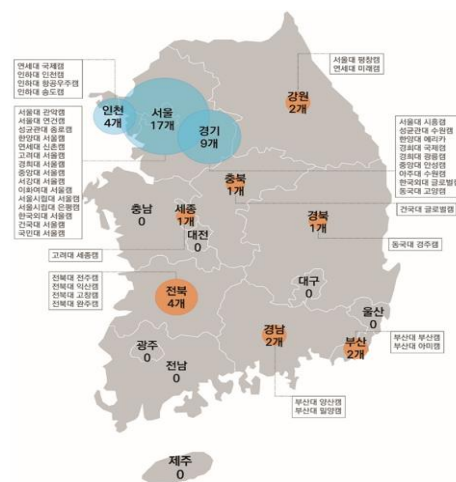
As of 21, there are 19 universities in the Chungbuk region, but the number of enrolled students in universities and colleges is in an overall decreasing trend, so they are facing an overall crisis. Universities in the Chungbuk area are declining by an average of 2.1% per year, and junior colleges are declining by an average of 6.2% per year.

Table 1. The number of enrolled students on the whole country vs. Chungbuk

year	University		College	
	the whole country	Chungbuk	the whole country	Chungbuk
2015	2,113,293	105,577	720,466	25,544
2016	2,084,807	104,706	697,214	23,084

2017	2,050,619	102,420	677,721	23,272
2018	2,030,033	100,042	659,232	21,838
2019	1,988,458	96,720	643,560	20,412
2020	1,964,358	95,738	621,509	19,264
2021	1,938,254	93,136	576,041	17,381
average annual increase(%)	-1.4	-2.1	-3.7	-6.2

Accordingly, it is time to think about ways to attract local talent to universities in the province. In addition, among the top 20 universities in the JoongAng Ilbo University Evaluation in 2019, two non-metropolitan universities, Pusan National University and Chonbuk National University, appeared. Through this, it can be seen that the campuses of universities in the metropolitan area within the top 20 are also concentrated in the metropolitan area. Chungbuk National University stayed at the 28th place.



Picture 5. Universities in the top 20 of university evaluation

It is time to seriously think about whether the Chungbuk region will be able to achieve sustainable growth if this imbalance continues. In the second half of 2019, the number of young people employed in the manufacturing industry was 90,297, accounting for 47.5% of the total employment. The continued outflow of young people will adversely affect the achievement of 5% of the Chungbuk economy.

Table 2. Employment survey microdata by region

classification	the number of employed	20~39	ratio	20~29		30~39	
				number	ratio	number	ratio
manufacturing	190,098	90,297	47.5	36,689	19.3	53,608	28.2
food manufacturing	34,141	13,691	40.1	6,419	18.8	7,272	21.3
beverage manufacturing	2,919	234	8.0	117	4.0	117	4.0
tobacco manufacturing	28	-	-	-	-	-	-
textile manufacturing	1,914	159	8.3	-	-	159	8.3

Manufacture of clothing, clothing accessories and fur products	448	-	-	-	-	-	-
Leather, bag and shoe manufacturing	327	-	-	-	-	-	-
Manufacture of timber and wood products	1,313	146	11.1	-	-	146	11.1
Manufacture of paper and paper products	5,118	2,303	45.0	624	12.2	1,679	32.8
Printing and recording media duplication	1,833	35	1.9	-	-	35	1.9

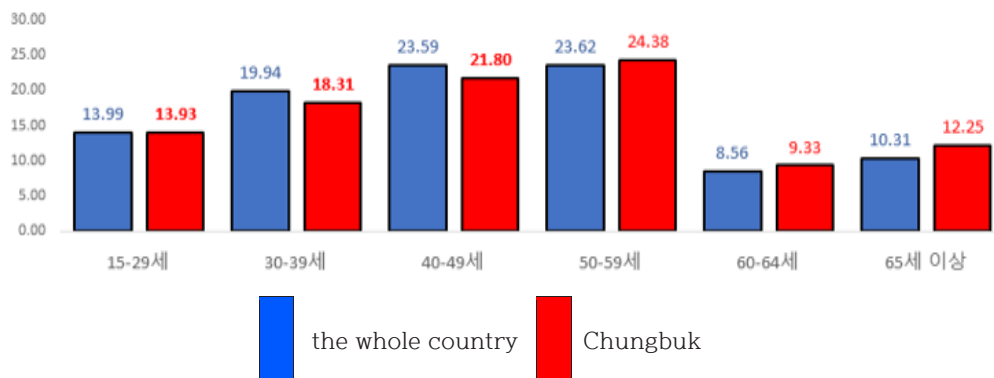
business							
Manufacture of coke, briquettes and petroleum products	85	-	-	-	-	-	-
Chemicals and chemical products manufacturing	14,388	7,410	51.5	3,122	21.7	4,288	29.8
Manufacture of medical substances and pharmaceuticals	7,267	4,745	65.3	2,783	38.3	1,962	27.0
Manufacture of rubber and plastic products	12,195	5,902	48.4	1,854	15.2	4,049	33.2

ucts							
Manufacturing of non-metallic mineral products	12,010	3,963	33.0	997	8.3	2,966	24.7
Primary metal manufacturing	3,195	1,281	40.1	703	22.0	578	18.1
Metal processing product manufacturing	10,247	4,089	39.9	1,127	11.0	2,961	28.9
Manufacture of communication equipment such as electronic parts and computers	30,022	17,233	57.4	6,785	22.6	10,448	34.8

Manufacturing of medical, precision, optical instruments and watches	4,067	2,538	62.4	1,379	33.9	1,159	28.5
electrical equipment manufacturing	15,114	8,524	56.4	3,658	24.2	4,867	32.2
Other machinery and equipment manu- facturing	12,962	6,312	48.7	2,826	21.8	3,487	26.9
Automobile and trailer manufacturing	13,390	8,770	65.5	3,321	24.8	5,450	40.7
Other transportation equipment manu- facturing	1,043	698	66.9	353	33.8	345	33.1

furniture manufacturing	2,495	746	29.9	274	11.0	472	18.9
Other product manufacturing	1,595	467	29.3	-	-	467	29.3
industrial machinery and equipment re- pair business	1,982	1,122	56.6	392	19.8	729	36.8

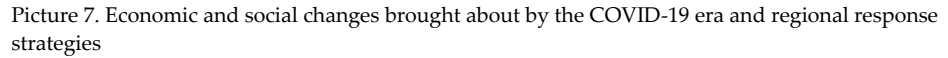
In particular, it is a serious problem that the ratio of those in their 20s to 40s with high output per unit of labor input is lower than the national level, In the second half of 2020, the manpower shortage rate for small and medium-sized manufacturing industries was the fourth highest after Gyeonggi, Gangwon, and Seoul. Additionally, while the rate of shortage of manpower in large corporations is 1.3%, small and medium-sized enterprises (SMEs) are 2.3%.



Picture 6. Ratio of the number of employed in 2020

In summary, the imbalance in manpower supply and demand is deepening due to the outflow of excellent local manpower to other regions. In other words, due to the lack of quality jobs and settlement conditions, they are leaving the metropolitan area. As a result, local companies continue to have difficulties in recruiting human resources, which leads to difficulties in hiring excellent human resources and a decrease in trust

3. conclusions





Article

Implementing Risk Sensitive Land Use Plan for Lamkichuha Municipality, Far Western Province, Nepal

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Abstract: Though Lamkichuha municipality in far western province of Nepal got municipal status in 2014, its economy and built form are still of rural characters. This study focuses on implementation of municipal risk sensitive land use plan (RSLUP). The municipal's major hazards include flood, fire, thunderstorm, river erosion and windstorm including earthquake. The multi-hazard risk assessments were carried out and modeled them in geo-spatial system. Contextual analysis of settlement pattern and spatial growth trend including future population projection were also performed. For a balanced, safer and sustainable development, a nodal development concept was adopted by proposing thirteen nodes (one primary, two secondary and ten tertiary) within a defined boundary through land use zonation for two planning periods: up to 2030 and between 2031-2050. The remaining whole municipal area outside the nodes were considered as two more zones: natural conservation protection and agriculture promotion. Major sectoral development plans along with planning regulation and building byelaws were proposed as implementing tools. Transfer of MHRA and RSLUP into municipal cadastral map, formulation of design guidelines and linking them to incentive mechanism and strengthening of disaster risk reduction capacity are also suggested.

Keywords: Risk sensitive land use planning, Multi-hazard risk assessment, Lamkichuha municipality, development node

1. Introduction

More than 80% of the total population of Nepal is at risk of natural hazards such as floods, landslides, windstorms, hailstorms, fires, earthquakes and glacier lake outburst floods (GLOFs) due to its unique geo-physical setting and the tropical location [1]. Nepal experiences an average annual loss of \$173 million (equivalent to 0.88% of GDP in 2014) as a consequence of natural hazards (i.e., \$143.5 million for floods and \$29.5 million for earthquakes) and the 100 year probable maximum loss is estimated at \$1.4 billion for earthquakes [2]. The economic cost of climate change to agriculture, hydropower, and industries affected by water-induced disasters is estimated to be equal to 2% - 3% of GDP per year by 2050 [3]. Lamkichuha municipality located in Kailali district in far western province of Nepal has a total population of 90,941 (in 2021 census) living over 10 wards in 224.57 sq. km [4]. It got municipal status in 2014 and since then, there has been haphazard urban growth on northern hill side as well as southern plain area, particularly along the East-West Highway and major road network. Disaster preparedness by incorporating disaster risk reduction (DRR) measures in urban development together with land use planning is fundamental to reduce the disaster vulnerability at community, local and municipal level and to build resilient communities [5]. Against such a backdrop, this paper intends to implement risk sensitive land use plan (RSLUP) for Lamkichuha municipality with three fold objectives of carrying out multi-hazard, vulnerability and capacity analysis,

of preparing municipal RSLUP plan and of formulating implementation strategy before drawing a conclusion and proposing some key recommendations.

2. Materials and Methods

To fulfill the above mentioned objectives, the investigation has combined both qualitative and quantitative methods. The government's plans, programs and policies on disaster risk reduction (DRR) and urban development were critically reviewed. The site was visited multiple times for understanding local context, collection of diverse first-hand information through multiple means: consultations with various stakeholders through group discussion, interviews with local people, key informant information and workshops (on Feb 2021 and September 2021). The participants were municipal and ward officials, local communities, representatives from infrastructure providing agencies, security personnel, business sector and experts working on disaster management. Historical disasters data affecting the municipality were also gathered and analyzed. These layers of information were used for scientific modelling of hazard, vulnerability and capacity and mapped them within the municipal boundary. This combined with examination spatial growth trend and population projection were used as basis for RSLP and sectoral development plans.

3. Data Collection and Analysis

3.1 Hazard Ranking and Multi-hazard Assessment

A total of 217 small and large disaster incidents occurred in Lamkichuha municipality in the span of 40 years from 1981 to 2021 claiming the lives of 88 person, with an additional 17 injured persons [6, 7]. These events also caused 6 person missing, 33 family affected and 2,230 no of houses damaged. If the road accident and epidemic were excluded, then the natural disaster alone including fire incident occurred 194 times killing 38 person, injuring 12 persons, missing 5 person, affecting 13 family and damaging 2,230 houses in the same period. Based on the past disaster events and their impacts, flood hazard ranks first followed by fire and river erosion for this municipality (Table 1). The flood event took place 68 times killing 29 person, injuring 4 and missing 5 persons. It also destroyed 1,252 number of houses, besides killing 417 number of domestic animals. The fire hazard (including forest fire) occurred 38 times, which killed 3 persons, injured 1 and 10 more missing. It also killed 32 number of domestic animals. River erosion and windstorms become the second and third most devastating disaster in terms of damaging houses.

Table 1. Hazard ranking based on past disaster events and their impacts

Hazard ranking	No. of events	Disaster type		
		No. of person loss/ injured / missing	No. of houses damaged	No. of live-stock loss
First	68 (flood)	Flood (29/4/5)	Flood 1,252	Flood 417
Second	38 (fire)/ 21 (river erosion)	Fire (3/1/0)	River erosion 638	Fire 32
Third	30 no of windstorms/ 6 no of thunderstorm	Thunderstorm (2/1/0)	Windstorms 296	Wind-storms 17

Source: Compiled from [6, 7]

Using a spatial multi-criteria, a combined hazard map was prepared by allocating different weightages on seven type of hazards (flood, landslide, earthquake, windstorm, animal attacks, heat wave/ cold wave and fire) based on their severity and impacts (Fig. 1). Flood and earthquake were allocated highest weights compared to animal attack and fire. The northern Siwalik hills and river banks (flowing north-south) covering 1,900.35 ha (12.93%) of municipal land were found as high hazardous area whereas the central belt

from north-west and south-east (9,102.20 ha or 40.55%) was identified as moderate hazard zone, with the remaining 46.52% of municipal area as low risk region.

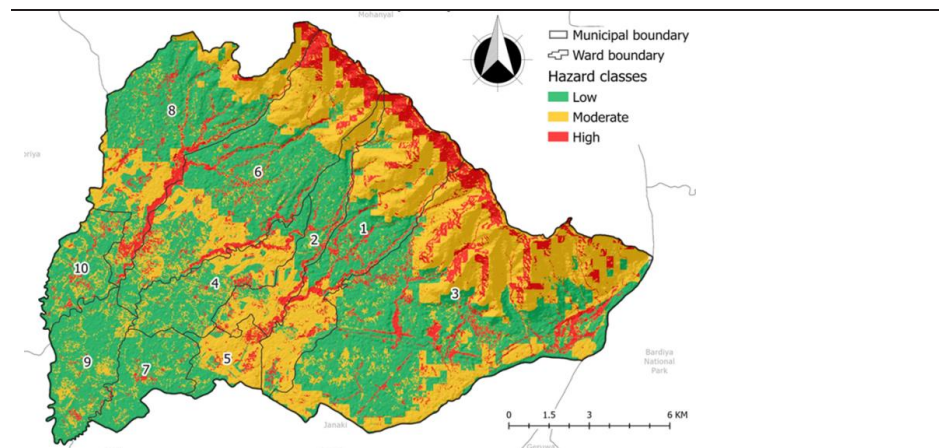


Fig. 1. Multi-hazard map for Lamkichuha municipality

Ward 3 of the municipality will be affected most for any flood with return periods of 20, 50 and 100 years and load bearing structures built with mud and wood will be high vulnerable. Significant size of agriculture land at ward 9 will be destroyed for all three return periods. Ward 3 is also highly susceptible to landslides followed by ward 6, 1 and 8. Except recently built reinforced cement concrete (RCC) buildings, the old structures, agriculture land and the roads particularly on northern side of the municipality (part of wards 1, 3, 5, 6 and 8) are highly vulnerable to landslides. High risk landslide covers only 12.39% (2,780.17 ha) of the total municipal area. Though the earthquake impact was not observed in the last many decades, any mega earthquake on the western part of Kathmandu could cause huge damages on houses and infrastructure, besides possibility of occurrence of landslides and blockage of rivers. In terms of wind hazard, ward 3 is more hazardous followed by wards 6, 8 and 1 respectively for 10, 25 and 50 year return periods. For 50 year period, almost all wards have moderate to high wind hazard. Ward 5 attributed maximum fire susceptibility of 36.81% as high risk followed by wards 3, 8 and 2 respectively. Though the impacts of heat wave and cold wave were insignificant in the past, nonetheless, the incidents are on growing trend. Wards 3 and 6 have been found vulnerable to wild animal attacks like elephant, wild boar, jackals and dogs. Agriculture land in the central part of the municipality has been found high vulnerable from wild elephant.

3.2. Socio-economic Vulnerability

Lamkichuha municipality has still rural socio-economic characters. Its area is dominated by forest (61.83%) with agriculture land accounting 26.83% and built up area 3.40% of total area [8]. Around 80% of population depend on agriculture and animal husbandry profession. Out of 18,409 households, around 47% do not possess any agriculture land whereas 17.22% households do farming without any irrigation facility. Only 51.45% households produce wheat, maize, lentils, vegetables and fruits with the remaining yielding no agriculture product. Only one tenth of the households have sufficient food production and surplus for the whole year. More than half (55.68%) of population has monthly saving less than NRs 1000. Around 30.70% households receive remittance from their family members working abroad. Though the number of schools and health facilities are sufficient and they are accessible from the existing settlements, nonetheless, they lack medical equipment and medicines and some of them are vulnerable due to their locations on flood prone and landslide areas and poor structures. Numerous public open spaces in the

form of playground, premises of youth clubs and community and religious buildings are available but many of them lack drinking water and toilet facilities, poor access road and without fencing. Using them during emergency situation is not possible. As high as 73.88% households rely on tube well, boring water and hand pump for drinking purpose and household works with only 21.60% of the total population using piped water. Vehicular access is available for 89.60% households' houses, however, only 7.88% households are connected through black top roads. Around 60.18% households use wood for cooking their daily foods followed by 31.64% using LP gas. Electricity is used by almost all households (96.82%). Number of female headed households accounts only 8.46% and only 4.34% households own the land in female name. Still 29.98% households practice 'chaupadi pratha' during menstruation period. Menstruating women and girls are forced to live outside of the home in cow sheds or makeshift huts, regardless of weather. Social discrimination on the basis of caste and religion exist and access to resources among various groups is uneven. Dalit and minority group considered as low caste people are bared to enter into some temples, to use public taps and to participate in social and religious gathering. Majority of the households (81.75%) use mobile phone but only 13.02% households are connected to internet.

3.3. Municipal Capacity

Municipal's disaster preparedness is limited to stockpiling of some equipment in ward and municipal offices without any reference to hazard type. Construction of embankment and plantation along the riverbanks are considered as mitigation solutions. Though disaster management committee has been formed in all wards with allocation of budget, however, no disaster preparedness and emergency rescue plan exist. Early warning system has been connected for six rivers, however, reading of water level is not regular due to lack of equipment, trained staffs and poor linkages with upstream areas. Frequency of fire disaster is on rise but municipality is equipment with a single fire brigade with inadequate budget allocation and human resources.

Except newly built houses, 93.46% of buildings in the municipality failed to consider national building code (NBC) during design and construction time and 96.47% houses did not take building permit from the municipality. As a result, 95.17% households acknowledged that their houses were not safe against big earthquakes and flooding. More than one third households are yet to identify safer open spaces nearby their houses in case of big disaster. Also, 95.91% households felt lack of resources and equipment needed during emergency situation.

3.4. Spatial Growth and Future Population Projection

Lamkichuha municipality has settlements mostly developed along the East-West Highway and major road network (such as Lamki-Tikapur road) with scattered villages towards the northern hill side. The built up area of the municipality was just 172.92 ha in 2000, which was increased to 221.33 ha in 2005, 495.82 ha in 2010, 602.50 ha in 2015 and ultimately 700.71 ha in 2021. The settlement expanded at the rate of 9.68 ha (5.06%) each year but reduced to 3.97% between 2010 and 2015 and 3.07% between 2015 and 2021. Average annual population growth rate was just 2.13% from 2000 to 2010 and then further reduced to 1.88% after 2010 till 2021. The average annual population growth of far western province and Kailali district and municipality has been decreasing in the last four decades. The annual growth of Lamkichuha municipality was 2.13% from 2001 to 2011, which was further reduced to just 1.88% during 2011 and 2021. Considering all these facts, the annual population growth for Lamkichuha municipality was assumed 1.88% till 2030 and then it would be 2.25% till 2050. With this growth rate, municipal population will be 107,538 in 2030 and 167,813 in 2050 (Fig. 2).

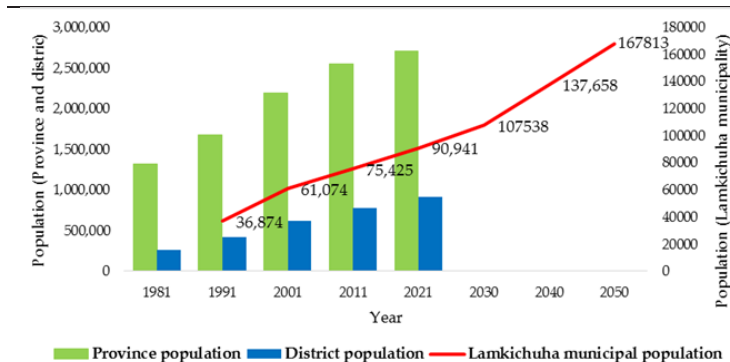


Fig. 2. Population growth trend and projection

4. Results and Discussion

4.1 Risk Sensitive Land Use Plan

As per diverse stakeholders' view expressed during the workshop, strengths of Lamkichuha municipality included natural resources, good transportation network and better social infrastructure. Frequent occurrence of natural disasters, rising unemployment and scattered development were considered as 'weaknesses.' They believed improvement of production sector and expansion of market and promotion of tourism and education and health facilities could be the 'opportunity' of the municipality, which would be not possible without addressing numerous challenges: haphazard urban growth, large number of youth migration and degradation and encroachment of natural resources such as forests and rivers. Different layers of multi-hazard risk assessments (MHRA), spatial growth trend, potential and available land and population growth along with land needed for infrastructure development were analyzed (Fig. 3). The basic concept of RSLUP is to allocate urban activities as per multi-hazard condition of land. Depending up on the severity of land hazard, land use and building construction are defined. A 'nodal' development concept was adopted by proposing thirteen nodes (one primary, two secondary and ten tertiary) within a defined boundary through land use zonation for two planning periods (up to 2030 and from 2031 to till 2050) (Fig. 4). Zones include central business district, institutional and commercial, recreation and sport, culture and tourism promotion and residential development were required for a balanced, inclusive, safer and sustainable development. Their boundaries were drawn to ensure the availability of adequate developable lands (for 2030 and 2050) in the low risk and potential location.

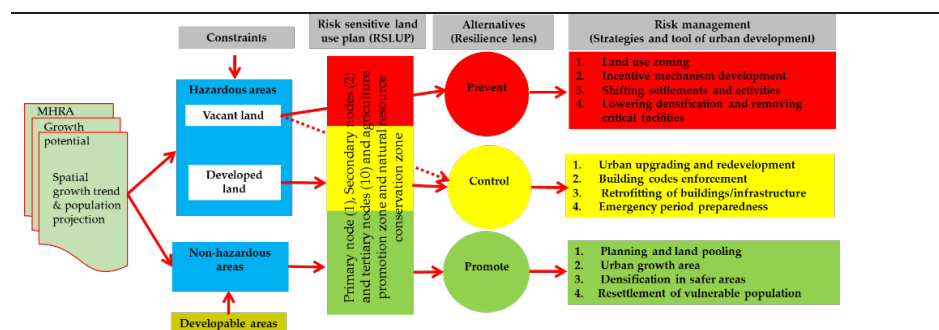


Fig. 3. Concept of risk sensitive land use plan (RSLUP)

Dense urban growth will be promoted in the non-hazardous area. Additional measures such as retrofitting of the existing buildings, preparation of emergency response planning, upgrading and redevelopment of vulnerable areas are proposed for existing settlements located in the medium risk area. Critical facilities (schools and hospitals) and

mass gathering structures are to be relocated on phase-wise from the high risk zone to safer area. No human activities is proposed in such red zone area. Outside the nodes were grouped into two more zones: natural conservation and protection and agriculture promote zone. Such nodal concept prevents present trend of urban sprawl (and ribbon type development), utilizes limited government budget and encourages private sector and donors to concentrate their resources effectively.

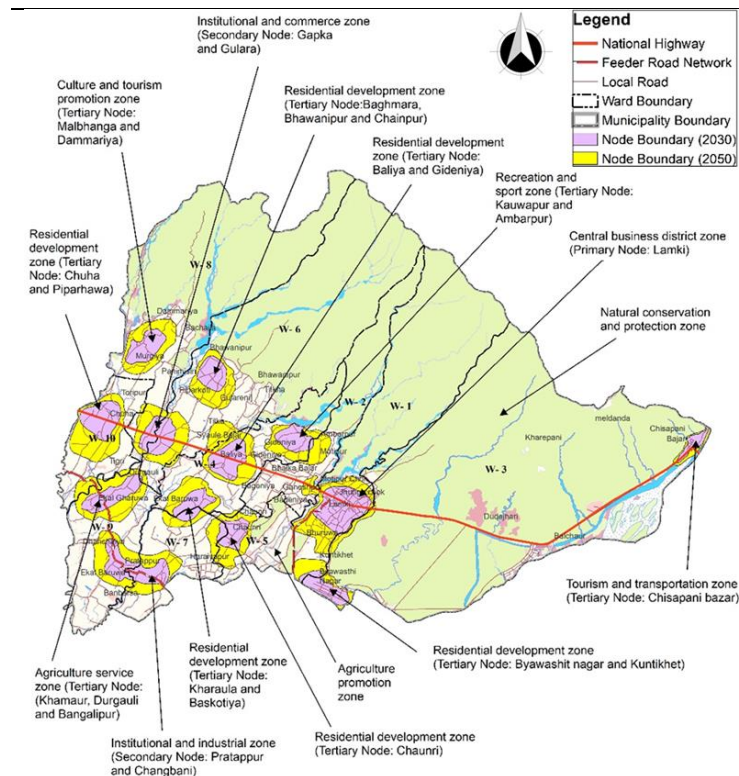


Fig. 4. Proposed risk sensitive land use plan (RSLUP) for Lamkichua municipality

4.2. Implementation Strategy and Tools

Sectoral Development Plans

Practice of traditional farming system, need to rely on sky rain for water and government for seeds, poor market access and inadequate storage facility all have constrained the growth of agriculture (grains, vegetables and fruits) and livestock sector. At present, the farming product after cultivation and harvesting directly goes to market through whole sale and retail shop and then to consumers. With improvement in above mentioned aspects, the products can be processed into different items (frozen, dried and preserved foods) and distributed over wider market including India (Fig. 5). Food processing and distribution process involving various activities such as cleaning, cutting, packaging including quality testing and certification as well as equipment maintenance, repair, business services such as finance, accounting, legal and engineering create diverse job opportunities. Forest and pasture land management practices should be adopted through afforestation and rotational grazing, encouraging community forestry and producing fodder and forage crops. Strategic road network (of 50 m, 30 m and 20 m right of way) is also proposed to connect various functional nodes thereby promoting agriculture, tourism and trade sectors. These roads will have bicycle lane along with landscaping based on climate change and rain water utilization on both sides. River edges covered by flooding of 20 yr. return period is to be protected through check dams and plantation. Agriculture shall be

permitted especially in public land covering 50 yr. of return period and the further public land covering 100 yr. of return period can be allocated for park and recreation facilities with development of temporary low rise structures.

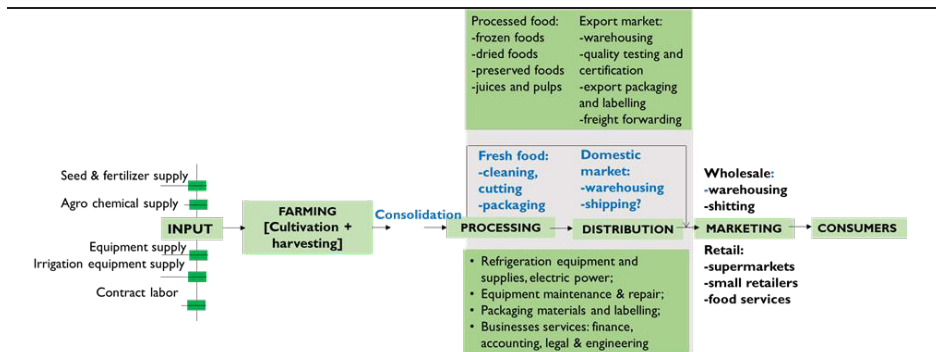


Fig. 5. Proposed agriculture sector development plan

Planning Regulations

For protection of natural resources, safety and public health of inhabitants and ensuring planned urban development, planning regulations particularly setback from various functional uses are fixed. They include setback from different hierarchy of road network, natural resources (river, lakes, wetlands and forest) and cultural properties. A setback of 20 m is required from the edges of forest and major canal for construction of buildings whereas such setback has been fixed as 10m from the pond and minor canals. A density of 300 ppha is proposed for primary node, 200 ppha for secondary nodes and a range between 50 ppha to 125 ppha for different tertiary nodes.

Building Bye-laws

Building byelaws are formulated considering existing building typology and construction practice, future population growth and desirable density. Controlling building height is preferred to regulation of floor area ratio (FAR) mechanism in Lamkichuha. A flexibility is maintained by manipulating ground coverage (GC) and minimum plot area (MPA) requirement for construction of different type of buildings in different nodes in the proposed two planning periods, 2030 and 2050 (Table 2). Construction of buildings in the planning zone between 2031-2050 at present (and up to 2030) is discouraged by requiring larger MPA but given less GC compared to the same building in the planning area up to 2030. However, industrial activities and agriculture related uses have same provisions for both planning periods. High rise buildings are also allowed in the primary and secondary nodes after fulfilling all provisions of National Building Code set for high rise structure.

Table 2. Proposed building regulations for various nodes

Node	Building use	Min. plot area (MPA) (sq. m.)		Ground coverage (GC) (%)		Building height (m)	Building setbacks (m)		
		2030	2050	2030	2050		Front	Sides	Rear
Primary	Banks & offices	1862	2200	50%	45%	19 m (5 story)	10	5	4.5
	Multiplexes	2709	2878	40%	35%	19 m (5 story)	15	7.5	7.5
Secondary	Commercial and offices	1016	1185	40%	35%	15.5 (4 story)	8	5	4.5
	Laboratory/clinic	508	542	60%	60%	15.5 (4 storey)	6	4.5	3.5
	Workshops and garages	2508	2508	30%	30%	9.5m (2 story)	15	7.5	7.5
Tertiary	Health post	678	678	40%	35%	12 m (3 story)	2.5	2	2

Day care centre	508	508	40%	35%	12 m (3 story)	3	2	2
Primary school	847	847	40%	35%	12 m (3 story)	5	2.5	2.5

5. Conclusions and Recommendations

Disaster risk in Lamkichuha municipality is largely a development issue. Its changing hazardscape is due to natural and anthropogenic factors and increasing exposure of people and assets to multi-hazards is because of haphazard urban growth without following building regulation and NBC as well as in the absence of any master plan. The proposed RSLUP acts as a foundation for building a safer city and resilient community by guiding the new growth in a safer location, identifying the existing vulnerable activities and providing mitigation solutions. The following recommendations are suggested.

- (a) Transfer the MHRA and RSLUP land use along with boundary of each nodes for two planning periods into municipal cadastral map. Carry out the land pooling techniques for major nodes for demarcation of road network, public open spaces and social infrastructure. Also ensure that RSLUP is widely shared and used by other agencies responsible for development activities such as infrastructure providing agencies, social and educational institutions and so on;
- (b) Formulate urban and architectural design guidelines and link them to incentive mechanism for implementation of the proposed land use as well as relocation of activities from high risk area and redevelopment of vulnerable places; and
- (c) Strengthen the capacity of municipal staffs and ward officials, and other working for disaster risk reduction sector.

Author Contributions: Conceptualization, B.K.S., S.M. and H.P.D; methodology, B.K.S.; software, project team; validation, project team; formal analysis, B.K.S.; investigation, B.K.S and S.M.; resources, project team; data curation B.K.S. and project team; writing—original draft, B.K.S.; writing—review and editing, B.K.S.; visualization, B.K.S.; supervision, B.K.S, S.M and H.P.D. Both authors have read and agreed to the published version of the manuscript.

References

- MOHA (Ministry of Home Affairs). Nepal Disaster Report 2009: The Hazards and Vulnerability, Ministry of Home Affairs, Government of Nepal, Kathmandu, Nepal, 2009.
- UN (United Nations). Global Assessment Report 2015 Data. Available on line: https://www.preventionweb.net/english/hyogo/gar/2015/en/profiles/GAR_Profile_NPL.pdf. 2015. (accessed on August 2022).
- IDS-Nepal, PAC and GCAP. Economic Impact Assessment of Climate Change In Key Sectors in Nepal. IDS-Nepal, Kathmandu, Nepal, 2014.
- CBS (Central Bureau of Statistics). National Population Census 2078 BS. Preliminary Results. National Planning Commission. Government of Nepal, Kathmandu, 2022 (Magha 2078 BS) (in Nepali).
- World Bank and EMI. Risk Sensitive Land Use Planning. Guidebook. Bangladesh Urban Earthquake Resilience Project. 2014.
- UNDRR DesInventar Sendai. Sendai Framework for Disaster Risk Reduction. Region. Nepal [np]. Available online: <https://www.desinventar.net/DesInventar/profiletab.jsp?countrycode=npl&continue=y>, no date. (accessed on August 2022).
- NDRRP (Nepal Disaster Risk Reduction Portal). *Nepal Disaster Risk Reduction Portal*, Ministry of Home Affairs, Government of Nepal. Available online: <https://www.drrportal.gov.np/> (no date). (accessed on August 2022).
- Lamkichuha municipality. Lamkichuha municipality. Lamkichuha Municipality Profile 2076 BS. Office of Lamkichuha municipality, Far Western Province, Kailali. 2019. (2076 BS) (in Nepali).



Article

In the Era of We Media the New Trend of Government Crisis Management

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Abstract: In the context of the four industrial revolutions, with the continuous development of the Internet and social media, we media entered a stage of rapid development. The frequent occurrence of public crises often parallels the development of We Media. The study found that in the era of we media, there are problems in the process of crisis management: the government has not fully integrated social resources and has not yet diversified crisis management; the importance of crisis prevention and monitoring by using We Media is not high, and emergency plans are lacking; not paying attention to the application of we media in crisis prevention and monitoring lack of contingency plans; the government is not transparent about the crisis information. The following suggestions are put forward for the new trend of government crisis management: build a government we media platform to integrate resources; publicize relevant legal knowledge through we media; increase the application of we media in the crisis prevention stage, quickly mobilize the power of We Media to release early warning information; increase the openness of government information.

Keywords: we media; crisis; crisis management; government

1. Introduction

With the development of science and technology, news media are supported by technology, and the emerging communication technology represented by network media has broken through the limitations of the past traditional media. With its characteristics of interactivity, unboundedness, sharing and openness, it can better carry out emergency communication, which is very useful for public crisis. Its ability to respond to public crises and emergencies has gradually improved, and as an important social force, it plays a role that cannot be ignored in the government's response to catastrophic events and has a huge effect on government crisis management [6, 75, 76].

With the continuous development of social media and big data technology, and the continuous emergence of we-media platforms, the Internet has become an indispensable tool for people's life and work, increasing the speed and method of dissemination of various events [33]. Social media is increasingly important for crisis management as it enables the public to provide information in different forms: text, images and videos that are valuable for crisis management [48]. At the same time, the explosion of social media has also created new roles for ordinary citizens, accelerating the development of we media. Information disseminated from the media extends from journalism to political change to assisting emergency response during crises and natural disasters [26, 55, 61]. Despite these advantages, the use of social media communication through information technology does raise some issues, such as information ethics, public safety, personal freedom, and consequences of abuse [26]. In addition, the public crisis in the network environment has the characteristics of fast spread, widespread and difficult control. The transmission of information through we media not only brings huge challenges to traditional media, but many

management problems dealt with by the government are also exposed one by one along with the public crisis, which also brings new challenges to the current government crisis management [80].

Since the outbreak of the COVID-19, information about the epidemic was overwhelming, and the amount of information from the we media was unprecedented, we media has played an unprecedented role in the crisis management [35]. According to Rosenthal, et. al. [50] study find a public crisis is a serious event that threatens the fundamental values and structures of a social system's code of conduct, governments need to make critical decisions under extreme time pressures and uncertainty. Crisis management is reflected not only in daily social operations, but also when the country and society face major challenges. COVID-19 prevention and control are not only a big test to test the current crisis management ability, but also a big lesson to promote the modernization of national crisis management ability [74]. In the era of we media, the popularization and dissemination of information technology is a double-edged sword. Although the public's awareness of participation in public opinion and social affairs has been promoted, the media and speech have become more and more free and repairing the impact of the public crisis have brought more severe challenges to the government [41].

More and more crisis managers, crisis communicators and laypeople are now using social media to provide or seek crisis information [25], although research on the use of social media for crisis management has emerged, but research is limited, and institutions remain hesitant to use social media [55, 56, 57]. Much of the current research has focused on social media platforms such as Tik Tok, Ins, etc., where the main force of information dissemination is we media, but not given sufficient attention to we media. And the frequent occurrence of public crises parallels the development of new media [75].

The widespread adoption and use of social media by the public worldwide heralds a new era in which emergency managers must adapt the way they work to meet the challenges of this development [1]. Therefore, this study focuses on the difficulties and problems faced by government crisis management in the era of we media and puts forward corresponding countermeasures. To adapt to the development of the we media era, improve government capacity for crisis management to create a more credible government.

2. Theoretical Background

2.1. We Media

With the widespread application of information technology, the Internet has begun to play a very important role. The media can shape public opinion, influence what audiences "think" and "how they think," and determine how we connect disparate information content together as a "cognitive network" of social reality [40, 62]. We media is a new form of social media based on the Internet that has emerged in recent years, which is the result of the combined effect of new media and the economic background of the new era [77]. We media (also known as self-media) is part of social media [80], is a platform on the Internet. It can be divided into three types: text, video, and audio [12]. We-media breaks the inherent mode of traditional media in various fields such as politics, economy, ideology, and culture, and changes people's way of life and social management mode [17, 70].

In July 2003, the Media Center of the American Press Institute published a research report on "we-media" jointly proposed by Bowman and Willis, which includes "we-media" strict definition:

"We Media is a way for the general public to strengthen their digital technology and connect with the global knowledge system, and to begin to understand how the general public can provide and share their own facts and their own news [3]."

In short, it is a carrier used by citizens to publish what they have seen and heard with their own eyes. We-media is that with the help of digital technology, citizens build their

own communication platform through simple communication tools and can provide information and share information independently [41]. We-media disseminate news in a more efficient way and gain a large audience in a short period of time [17].

We-media focuses on ordinary people as audiences, communicators, and users [31]. Any social networking platform that can express one's own views is a social media, and only a platform that independently controls the use of it can be called a self-media (For example, news media are published by professional journalists and academics, and online news media are social media but not we-media.) It is not easy to fully understand the concept of we-media. Because the definition of we-media varies from industry to industry, and even from country to country, and many countries do not even have the form or concept of we-media [77]. China has come up with a precise definition of we-media, the way in which the masses communicate their own facts and news to the outside world through the Internet and other ways. We-media is a way for ordinary people to provide and share their own facts and news after connecting with the global knowledge system through digital technology. The difference between we-media and traditional media lies in information dissemination channels, audience channels and feedback channels, and we-media refers to the media that produces content centered on individuals and has the number of independent users.

According to the 49th Statistical Report on Internet Development in China, December 2021, online video (including short video) users accounted for 90.5% of all netizens, and among mobile Internet short video users, online live broadcast users accounted for 90.5% of the total, 68.2% of the overall netizens, we media has become the preferred interactive communication platform for many people.

2.2. Government crisis management

The speed and scale of changes brought about by the Fourth Industrial Revolution cannot be ignored, and these changes will affect the transformation of national management and governance systems [52, 70]. Industrial societies are vulnerable to catastrophic events, including technological disasters, social and political crises [50].

A public crisis refers to a sudden event that causes heavy losses to social public life and social order in the management of national affairs by the government [36]. Public crisis management refers to the government's handling of public crisis events [64]. The government is the main body of crisis management [39], mastering crisis information in a timely manner and taking appropriate measures to resolve public crises in a timely manner will greatly reduce the losses caused by crisis.

With the development of information and communication technology, technologies such as the Internet and AI have been widely used, technology empowerment of organizations is also a new trend in crisis management, government informatization work is also developing towards online, big data, mobile and intelligent development [32, 37]. The lack or neglect of information dissemination by the government can affect people's perceptions and behaviors, so successful crisis management and policy implementation depends on how the government and relevant stakeholders disseminate information [5]. By network, the government can widely collect opinions from all parties through the Internet platform and conduct interactive exchanges with all parties. On the one hand, it overcomes the drawbacks of one-way communication of traditional environmental information, and it also better understands social conditions and public opinion through interactive communication; the other hand, it gives the public the opportunity to fully express their opinions and suggestions, expand cooperation with the public, and strengthen the government's trust in the public in public crisis management [20].

New media plays an extremely important role in crisis management [67]. It is between the government and the public, affecting the way the government behaves, and its development is also constrained by government policies, by properly handling the relationship with the new media, the government can make it best serve the government's public crisis management [47, 67, 75].

3. Government Crisis Management Present Situation and Problems in We Media Era

3.1. Present Situation

The concept of crisis itself varies according to the social environment and public perception of values [54]. During the crisis, the public's use of social media increased [21]. The widespread use of social media has changed the way citizens and emergency management agencies (EMAs) communicate with each other in times of crisis [14, 42]. Social media has become the most used and active form of communication; however, research focusing on the use of social media in crisis management is in a growth phase [2]. Today is an era of diversified communication with more and more powerful media [41]. We media relies on its own strong social attributes in social communication, which can easily resonate with people [72].

New media plays an extremely important role in crisis management. It is between the government and the public, affecting the way the government behaves, and its development is also constrained by government policies. By properly handling the relationship with the new media, the government can make it serve the government's public crisis management to the greatest extent [66, 68].

News media play an important role in publicizing crises because people around the world can perceive crises through news coverage [76], and the public can use new media to know how to respond in the face of crises [45]. The increasing use of social media is changing the way people communicate. In an emergency, this information can be used to inform the public of the emergency and will not replace an existing source of information but instead provide a new source of data, with many applications in emergency management [4]. Increasingly, crisis managers, crisis communicators and laypeople use social media to provide information seeking [25].

We media was the main way for people to obtain news and information at present [60]. Looking at we-media dissemination during the prevention and control of the COVID-19, taking Chinese Weibo as an example, as a free platform for we-media information dissemination, it provides we-media users with a platform for information release, communication and interaction, and ordinary users can freely discuss public crisis event information [19, 27]. In this interactive process, the experience of citizens participating in government crisis management has been greatly improved, and their trust in the government has been increased. More importantly, the scope of we-media communication is not limited to domestic and can communicate with the world through the form of network and video communication. For example, "Wuhan Diary 2020" on YouTube has been well received at home and abroad. We-media communication goes abroad and realizes "hard" communication in a "soft" form, telling China's anti-epidemic stories from the perspective of ordinary people and fighting back rumors will help shape the image of a major country and increase its international influence [72].

Pan, et.al. [46] pointed out that e-government can simplify communication, facilitate the exchange of information, and in crisis management, can keep the public informed of the latest situation and seek help from various aspects. Currently, the government is setting up accounts on We-Media platforms such as Weibo, WeChat, and short video apps; it will use We-Media as the "main battlefield" for future propaganda. We media has its own real-time communication function, which can realize real-time communication between the government and the public, and finally achieve the harmonious coexistence of the government, the media, and the people.

Sun [58] study pointed out that the interviewed people showed a high degree of acceptance and support for the content of disaster reduction propaganda released by the media and the convenience information released by public officials, which to a certain extent reflects the people's attempts to government agencies in disaster reduction we-media propaganda. It has an attitude of approval and has shown great support and tolerance for this new form of visualization, mobility, interaction, and life-style disaster reduction propaganda.

Social media can provide a large amount of data to help the government effectively respond to online public opinion and monitor adjudication behavior [7, 78]. Food safety, environmental issues, ethical incidents, labor relations, resource allocation, and social and public issues caused by the government frequently occur, and with the development of we-media, the speed of dissemination is getting faster and wider, which also makes the government vulnerable to attack in public crisis management, though we media can analyze the same event from multiple angles, so that information can be more fully displayed in front of the public, but it is also easier to challenge the credibility of the government, making crisis management more difficult [15].

3.2. Problems

If there is an Internet and a mobile phone that can access the Internet, you can immediately upload what happened to the Internet through social platforms such as Weibo, and then reprint it on the Internet, forming a powerful network force [73]. In the era of new media, everyone is we media, and everyone begins to have the right to speak, if the government does not fully understand the power about we-media, and does not mention its ability to handle crises, it will definitely cause even greater crises [66, 71]. At present, most of the government relies on its own strength in the process of crisis management, lacks the integration of social resources, does not fully tap the power of social organizations, and has not yet realized the diversification of crisis management [22].

In the context of the rapid development of we media, the absolute authority and discourse power of traditional paper media and Internet media in crisis management has been threatened. Authority is also affected [23]. As a relatively new medium, many of its derivatives have many oversight gaps in government crisis management.

The COVID-19 crisis once again proves that human beings live in a "global risk society" with a shared destiny, and crisis management in the new era must develop simultaneously with social governance with the help of a new generation of science and technology such as the Internet and social media [10, 30, 35, 58]. During crisis management, people's trust in active social media user speech is higher than in traditional mass media crisis reporting [21, 49, 59]. However, compared with traditional media, it is an objective fact that we media industry is difficult to supervise [35, 58]. Zhang & Yang [79] research pointed out that the legal form of we media lags the development of technology, and people's legal awareness of we media is weak. In the context of new media, the threshold for public participation in information dissemination is low, and the anonymity of we-media makes quite a few users take chances, maliciously fabricate eye-catching events, and publish false news on media platforms [30, 71]. Direct access to all content through social media platforms such as YouTube and Twitter will amplify the spread of rumors and dubious information [10]. There are many Internets governance laws, but these usually exist in the form of working documents and have no practical effect.

The era of we media is an inevitable trend of social development and networking [80]. When there is controversy in the process of government crisis management, the dissemination of self-media news affects decision-making, political communication, and public discourse [51, 56]. However, the current role of we media is limited to functional use and dissemination after crisis events. Lee [28] in the book 《Crisis Management》 pointed out that crisis management is divided into four stages: Prevention, Preparedness, Response, and Recovery. In the era of we media, the establishment of an early warning mechanism should be the first line of defense to solve public crises, but the current public crisis early warning and response mechanism is not perfect, lack of monitoring of public crises, lack of contingency plans, and lack of post-processing in response to public crises More attention, and ignoring pre-monitoring events [67, 80].

To achieve social emotional stability during events, the government often strictly controls the transmission of information that affects social stability. However, in today's era of rapid development of information technology, it is ineffective against changes in

public opinion, and coercive measures usually have the opposite effect and seriously damage the authority and credibility of the government [29].

At present, the regulation of we media is mostly based on administrative means, such as deleting posts by the Internet information department, website banning and other means to reduce the damage and consequences. There is no special law against we-media infringement, and the supervisory authority is relatively simple. Without effective synergy, crisis management we media propaganda platform, as an emerging research field, should formulate self-media management methods and improve laws and regulations [23, 58].

4. How the government crisis management in the era of we media

(1) Build a government we media platform for resource integration.

Citizens' trust in government is essential for them to recognize social risks [38]. Pan, et.al. [46] research pointed out that e-government can simplify communication, facilitate information exchange, and in crisis management, can make the public is informed of the latest situation and seeks help in many ways. In times of crisis, efficient communication channels and shared platforms can enhance decision-making and execution [11]. There are differences in the use of self-media in the level of public crisis management capabilities between different regions and social levels. Establishing we media platform for information exchange and cooperation is one of the main ways for the government to carry out social management [71, 80].

The journey from the onset to the end of a public crisis is a complex and constantly changing process. As the main executive branch, it is difficult for the government to control all aspects of the development of the situation. Combining the power of "mainstream media + netizens" can create more efficient and in-depth news [30]. Therefore, there is a unified information disclosure system, a self-media platform that timely and authoritatively discloses and transmits the latest information, responds to public opinion in a timely manner, avoids the form of preaching, and gets rid of the stereotype and solid thinking of government agencies, which is convenient in the event of a public crisis. Under the new media era, the government will continue to demonstrate the leadership, action, and affinity of the government, and create a more positive and harmonious crisis management atmosphere. To deepen the public's understanding of the crisis itself, recognize the government's response measures, and cooperate with the government's relevant recommendations.

(2) Use the government's we media platform to publicize relevant legal knowledge.

With the rapid development of the network, the security of network technology has become the focus of people's concern [9, 31, 53]. Poor information management can lead to a deep distrust of government. Insufficient platform supervision and imperfect disciplinary regulations have led to public participation in information dissemination. Due to lack of legal knowledge and weak legal concept, some netizens maliciously spread rumors and released information that violated the law [63, 65].

Therefore, relevant departments can use we media platform to allow netizens to further learn about network security, network laws and regulations while surfing the Internet, improve the comprehensive quality of netizens, cultivate network consciousness and self-discipline. Awareness of legal responsibility, sticking to the legal bottom line and principles in the application of we media to communication, can effectively avoid the risk of communication ethics anomie, build a harmonious and healthy network environment, and facilitate the government to manage crisis.

(3) Increase the application of we media in the prevention stage to assist the government in crisis response, decision-making and governance.

By found some studies examples of the role social media can play in crisis management include providing evidence of pre-crisis activities [9]; near real-time notification of a crisis as it occurs [18]; first-hand reporting of the impact of a crisis [43]; and measuring

community responses to emergency alerts [34]. Early response to events is a "golden period" for crisis management [80]. But at present, in response to public crises, the government often pays attention to rescue operations after the incident, ignoring the prior management such as early warning [41, 43, 44]. Although the rapid response and emergency measures after the occurrence of crisis events play an important role in the whole process of public crisis management, the focus of all crisis management has been completely shifted to the post-event crisis response, which can only play a role of compensation rather than effective management. We-media content is often illustrated and easy to understand, easy to catch readers' attention, and easily spread spontaneously by the public in crises management, playing a role in information regulation for public crisis response and decision-making [24, 35].

The government needs to use new media to release some public crisis prevention information, and it also needs to release relevant early warning messages through we-media platforms during the incubation period of public crises. For example, for some natural disasters, it is very necessary to improve related technologies and do a good job in crisis early warning; secondly, for some social problems, the masses are often the first to discover them and publish them through we-media platforms, so the government needs to pay close attention to media reports trends to obtain the latest information, master first-hand information, and quickly mobilize the power of major media to release early warning information to the public.

(4) Using We Media to Increase the Publicity of Government Information

When a crisis occurs, parts of the government abuse their power to suppress and block unfavorable news coverage and prevent the media and the public from getting a true picture of the situation. The timely release of relevant authoritative information on official new media platforms will better demonstrate the country's ability to guide public opinion in the modernization of information governance [8, 35]. Citizens have the right to know. In the disclosure of government information, disclosure is the general principle, and non-disclosure is the exception [16]. Protecting the public's right to know and stimulating the public's sense of social responsibility can enhance social cohesion and create favorable conditions for dealing with crisis management.

In the past, management models such as "intercepting" and "blocking" have become less and less suitable for the public's requirements in the era of we-media. Timely publishing the truth, grasping the direction of public opinion, having the courage to face social doubts, and broadening communication channels are the real way out. The government's rapid disclosure of information through we media can quickly gather social forces and facilitate the rapid resolution of the crisis. Government departments should also strengthen supervision over their own actions and responsibilities, should pay attention to the dissemination role of the we media, give full play to the positive role of the we media in crisis management, increase the transparency of information, and stabilize the social order. Information disclosure can eliminate rumors as soon as possible, stabilize people's hearts, and facilitate the cooperation between citizens and the government to jointly resist the crisis and minimize losses.

5. Conclusions

In the era of we media, YouTube, INS, and TikTok have been widely used. It is also in such a large environment that strengthening the standardized management and scientific guidance of the we media is the general trend, and it is also the embodiment of the government's governance capacity, and it is the focus of strengthening public crisis response. This study believes that we media is an important research topic, and the government can use we media to design more effective and tailored strategies for crisis management in times of crisis.

To strengthen the government crisis management in the we media era, we must not only promote the integrated development of traditional media and new media, but also strive to create a new media system with advanced technology, diverse forms, strong

credibility and strong communication [7]; it is also necessary to start from legislation, law enforcement and talent team building to achieve the healthy development of the Internet and the effective guidance and management of online public opinion [69].

Now we media has not yet matured, there are still certain difficulties in communication and related laws and regulations, and there are still many irrational and non-professional problems among netizens. This requires the government, netizens, and we media platforms to work together to solve them. To improve the moral quality and media literacy of netizens themselves, we media platforms should accelerate the improvement of the platform supervision system, and relevant government departments must strengthen the construction of laws and regulations, to form an effective communication path, jointly build a harmonious we media ecosystem and create more the large-benefit news dissemination pattern promotes we media to play a more active role in government crisis management.

References

- Alexander, D. E. Social media in disaster risk reduction and crisis management. *Science and engineering ethics*. 2014, 20(3), 717-733.
- Apuke, O. D.; Tunca, E. A. Social media and crisis management: a review and analysis of existing studies. *LAÜ Sosyal Bilimler Dergisi*. 2018, 9(2), 199-215.
- Bowman, S.; Willis, C. *We media: How audiences are shaping the future of news and information*. American Press Institute. 2003.
- Cameron, M. A.; Power, R.; Robinson, B.; Yin, J. Emergency situation awareness from twitter for crisis management. In *Proceedings of the 21st international conference on world wide web*. 2012, April, 695-698.
- Carlson, M.; Jakli, L.; Linos, K. Rumors and refugees: how government-created information vacuums undermine effective crisis management. *International Studies Quarterly*. 2018, 62(3), 671-685.
- Carr, C. T.; Hayes, R. A. Social media: Defining, developing, and divining. *Atlantic journal of communication*. 2015, 23(1), 46-65.
- Chen, Dan. Changes and Changes of Weibo News in the New Media Era. *News Lovers*. 2013, (10), 68-71.
- Chen, Lingxia; Yi, Chenhe. Research on the Coping Strategies of Emergencies' Network Public Opinion from the Perspective of Microblog, WeChat and Mobile Client's User Behavior[J]. *Library and Information Guide*. 2018, 3(03): 74-78.
- Cheng, Y. How social media is changing crisis communication strategies: Evidence from the updated literature. *Journal of contingencies and crisis management*. 2018, 26(1), 58-68.
- Cinelli, M.; Quattrociocchi, W.; Galeazzi, A.; Valensise, C. M.; Brugnoli, E.; Schmidt, A. L.; ... Scala, A. The COVID-19 social media infodemic. *Scientific reports*. 2020, 10(1), 1-10.
- Civelek, M. E.; Çemberci, M.; Eralp, N. E. The role of social media in crisis communication and crisis management. *International Journal of Research in Business & Social Science*. 2016, 5(3).
- CMMS. China We-Media Marketing Market: Size & Forecasts with Impact Analysis of COVID-19 (2021-2025). *Research and Markets*. 2021-03-01. 1-63. <https://www.researchandmarkets.com/reports/5265114/>.
- CNNIC. The 49th "Statistical Report on Internet Development in China". 2022.02.25.
- Ehnis, C.; Bunker, D. Social media in disaster response: Queensland police service-public engagement during the 2011 floods. 2012.
- Ge, Xin. Research on public safety management of large-scale urban mass activities. Master's Thesis. Nanjing Normal University. 2018.
- General Office of the State Council of China. Regulations of the People's Republic of China on the Disclosure of Government Information [EB/OL]. 2018-02-10. www.gov.cn/xxgk/pub/govpublic/tiaoli.html.
- Gillmor, D. We the media: The rise of citizen journalists. *National Civic Review*. 2004, 93(3), 58-63.
- Girtelschmid, S.; Salfinger, A.; Pröll, B.; Retschitzegger, W.; Schwinger, W. Near real-time detection of crisis situations. In *2016 39th International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO)*. . 2016, 247-252. IEEE.
- Gu, Qin. Sina Weibo: A Mutual Communication Apparatus between the Chinese Government and Chinese Citizens. *China Media Research*. 2014, 10(2).
- Han, Chunling. Opportunities and Challenges for Public Crisis Management in Network Environment. *China Market*. 2016 (48), 115-117.
- Horrigan J. B.; Morris S.. Data memo. Pew Internet and American Life Project. 2005, <http://www.pewinternet.org>
- Huang, Linfu; Chen, Mei. The Dilemma and Responsibilities of the Government in Public Crisis Management. *Management Watch*. 2014, (09), 163-164.

23. Jiang, Ruiya. Research on governance of network public opinion in We-media era[J]. Tibet Development Forum. 2022, (05):81-86.
24. Jin, Y.; Liu, B. F.; Austin, L. L. Examining the role of social media in effective crisis management: The effects of crisis origin, information form, and source on publics' crisis responses. *Communication research*. 2014, 41(1), 74-94.
25. Kreiner, K.; Immonen, A.; Suominen, H. Crisis management knowledge from social media. In *Proceedings of the 18th Australasian Document Computing Symposium*. 2013, 105-108.
26. KOTSIOPOULOS, Ioannis. Social media in crisis management: Role, potential, and risk. In: *2014 IEEE/ACM 7th International Conference on Utility and Cloud Computing*. IEEE. 2014, p. 681-686.
27. Le, Ziyang; W. Y. L. H.; Mengshan, C. B. L. Governance Strategy and Supervision Mechanism of We-Media Public Opinion in Universities. *International Journal of Educational Administration*. 2018, 10(1), 17-28.
28. Lee, Jae Eun. 2018. *Crisisonomy*. 2nd ed. Paju: Daeyoungmunhwa-sa.
29. Liang, Yijing. Problems and countermeasures of emergency management of urban public safety in China [J]. *China Management Information*. 2019, 22(17): 209-210.
30. Li, Huining. Analysis on the development of self-media communication norms[J]. *Journal of Journalism Research*. 2022, 13(15): 92-94.
31. Li, J.; Zou, S.; Yang, H. How does "storytelling" influence consumer trust in we media advertorials? An investigation in China. *Journal of Global Marketing*. 2019, 32(5), 319-334.
32. Li, Ruichang. Path to Integrated Emergency Management of Technology-Enabled Cities. *Solicitation*. 2021, (03): 118-125.
33. Li, Yan. 2020. New Trend of Public Crisis Management in Tourism Cities in We-Media Age[J]. *Management & Technology of SME*. 2021, (10): 34-35.
34. Lindsay, B. R. Social media and disasters: Current uses, future options, and policy considerations. 2011, 1-10.
35. Ma, Liang; Tom, Christensen. "Government trust, social trust, and citizens' risk concerns: Evidence from crisis management in China." *Public Performance & Management Review*. 2019, 42(2): 383-404.
36. Middleton, S. E.; Middleton, L.; Modafferi, S. Real-time crisis mapping of natural disasters using social media. *IEEE Intelligent Systems*. 2013, 29(2), 9-17.
37. Liu, Yan. The role of the media in responding to public crises. *Journal of Anqing Normal University, Social Sciences Edition* 2020, (03), 55 - 58.
38. Liu, Yuhang; Wang, Jianwen; Bao, Yong. Study on Public Crisis Management Problems of Chinese Government—A Case of Explosion Event in Tanggu of Tianjin. *Anhui Agricultural Science*. 2016, (35), 224-227.
39. Lu, Yuwen; Guofang, Zhai. Applications and Exploration of Artificial Intelligence Technology in Urban Disaster Risk Management. *International Urban Planning*. 2021, 36(02):22-31+39.
40. McConnell, A. Overview: Crisis management, influences, responses and evaluation. *Parliamentary affairs*. 2003, 56(3), 363-409.
41. McCombs, M. E.; Shaw, D. L. The Agenda-Setting Function of Mass Media. *Public Opinion Quarterly*. 1972, 36(2), 176-187.
42. Meng, Lingyuan. Research on Local Government Public Crisis Management under the Supervision of Public Opinion by We Media -- A Case study of Xi'an Municipal Government. Master's thesis. Northwest University. 2020.
43. Mirbabaie, M.; Ehnis, C.; Stieglitz, S.; Bunker, D. "Communication Roles in Public Events: A Case Study on Twitter Communications." In: *Proceedings of the Working Conference on Information Systems and Organizations*. Auckland: New Zealand. 2014, p. 207-218.
44. Morris, S.; Horrigan, J. B. 13 million Americans made donations online after Hurricanes Katrina and Rita. 2005.
45. Pan, P. L.; Meng, J. Media frames across stages of health crisis: A crisis management approach to news coverage of flu pandemic. *Journal of Contingencies and Crisis Management*. 2016, 24(2), 95-106.
46. Pan, S. L.; Pan, G.; Devadoss, P. R. E-government capabilities and crisis management: Lessons from combating SARS in Singapore. *MIS Quarterly Executive*. 2005, 4(4), 385.
47. Pew Internet and American Life Project. 2006. Blogger callback survey. <http://www.pewinternet.org>.
48. Pohl, D.; Bouchachia, A.; Hellwagner, H. Social media for crisis management: clustering approaches for sub-event detection. *Multimedia tools and applications*. 2015, 74(11), 3901-3932.
49. Procopio C. H.; Procopio S. T. Do you know what it means to miss New Orleans? Internet communication, geographic community, and social capital in crisis. *Journal of Applied Communication Research*. 2007, 35(1), 67-87.
50. Rosenthal, U.; Kouzmin, A. Crises and crisis management: Toward comprehensive government decision making. *Journal of Public Administration Research and Theory*. 1997, 7(2), 277-304.
51. Schmidt, A. L.; Zollo, F.; Del Vicario, M.; Bessi, A.; Scala, A.; Caldarelli, G.; ... Quattrociocchi, W. Anatomy of news consumption on Facebook. *Proceedings of the National Academy of Sciences*. 2017, 114(12), 3035-3039.
52. Schwab, K. The Fourth Industrial Revolution, What It Means and How to Respond Retrieved from Foreign Affairs. Available on: <https://www.foreignaffairs.com/articles/2015-12-12/fourth-industrial-revolution>.
53. Shen, F. 'Effects of News Frames and Schemas on Individual's Issue Interpretations and Attitudes', *Journalism & Mass Communication Quarterly*, Volume 81. 2004, Number 2. 400-416.
54. Shi, Huaijing. Research on Online Public Opinion Management Mechanism of Public Security Emergencies in Micro-communication Environment. Master's Thesis. Sichuan International Studies University. 2019.
55. Stamp, G. English riots: social media were 'force for good'. 2011, BBC News, 5.

56. Starnini, M.; Frasca, M.; Baronchelli, A. Emergence of metapopulations and echo chambers in mobile agents. *Scientific reports*. 2016, 6(1), 1-8.
57. Stieglitz, S.; Mirbabaie, M.; Fromm, J.; Melzer, S. The Adoption of social media analytics for crisis management—Challenges and Opportunities. 2018
58. Sun, Jingzhi. An exploration of establishing a new propaganda platform for flood control and drought relief based on we media [J/OL]. *China Flood Control and Drought Relief*. 2022, 1-3.
59. Sweetser K. D.; Metzgar E. Communicating during crisis: Use of blogs as a relationship management tool. *Public Relations Review*. 2007, 33(3), 340-342.
60. Tang, Dihua. "The New Situation of Marketing in the Self-Media Era-Taking Tik Tok as an Example." 2nd International Wprkshop on Advance in Social Science (IWASS 2019): 1557-1560.
61. Valentini, C.; Kruckeberg, D. "Iran's Twitter Revolution" from a Publics1 Relations Standpoint. *Case studies in crisis communication: International perspectives on hits and misses*. 1997, 383.
62. Vu, H. T.; Guo, L.; McCombs, M. E. Exploring "the world outside and the pictures in our heads" A network agenda-setting study. *ournalism & Mass Communication Quarterly*. 2014, 91(4), 669-686.
63. Wang, Jing. Research on Coordination and Interaction Mechanism in Crisis Management of Chinese Government. Master's thesis. Qingdao University. 2014.
64. Wang, Yayun. Research on China's Government Crisis Public Relations. Master's Thesis. Yunnan University of Finance and Economics. 2012.
65. Wang, Zijiao. Ethical norms of news communication in the new media era [J]. *Journalist Cradle*. 2021, (4): 24-25.
66. Wen, Liyu. On Public Crisis Management of Chinese Government in the Age of New Media. Master's Thesis. Central China Normal University. 2013.
67. Wickler, G.; Tate, A.; Potter, S.; Hansberger, J. The virtual collaboration environment: New media for crisis response. ARMY RESEARCH LAB ADELPHI MD. 2011.
68. Wu, Yixuan. *Crisis Communication: Theory and Empirical Views on Public Relations and Language Arts*, Soochow University Press. 2005, 35-60.
69. Xi, Jinping. Delivered an important speech at the National Propaganda and Ideological Work Conference. 2013-08-19.
70. Xu, M.; David, J. M.; Kim, S. H. The fourth industrial revolution: Opportunities and challenges. *International journal of financial research*. 2018, 9(2), 90-95.
71. Xu, Zhenyuan. Research on The Government's Public Opinion Coping in Public Critical Incident in We-media Era. Master's Thesis. Shandong University of Finance and Economics. 2018.
72. Xu, Ziyi. The recording and presentation of facts by the media in public health emergencies—Taking "Wuhan Diary 2020" as an example. *Media Forum*. 2022, (14), 15-17.
73. Yi, Yimei. "New Theory of New Media", Chinese People's Publishing House. 2012, 20.
74. Zhang, Jing; Tian, Chong. Public crisis management in the context of new media. *Business*. 2016, (16), 68.
75. Zhao, Xiaochuan. The role of news media in public crisis management—Taking the "8.12 Tianjin Binhai Big Bang" accident as an example. *Journal of News Research*. 2016, (22), 204.
76. Zhang, Yanqiu. Analysis of the Appearance, Development and Influence of Self-Media From the Perspective of Communication. Master's thesis. Belarusian State University. 2021.
77. Zhai, Linpei; Jae Eun, Lee. Improving Crisis & Emergency Management Capability of Government by Using Big Data Technology - China's Response to the COVID-19 -. *Crisisonomy*. 2021, 17(9), 19-38.
78. Zhang, Qiangfeng; Yang, Lei. "A Study on Copyright Infringement of Chinese We-Media Content in the New Media Environment". *Humanities Society* 21. 2021, vol.12, no.6. p.1227-1242.
79. Zhu, Y. Q.; Chen, H. G. Social media and human need satisfaction: Implications for social media marketing. *Business horizons*. 2015, 58(3): 335-345.
80. Zou, Zhiwei. Research on the Problems and Solutions of Government Public Crisis Management in the Era of We Media. *Science & Technology Information*. 2021, (13): 236-238.



Article

A Review of Disaster Response in the Smart Era: Focusing on Resident Evacuation

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Abstract: Korea is making efforts to establish a smart disaster management system that predicts risk situations in advance from the beginning of a disaster and devises appropriate countermeasures. This study focuses on the establishment of a smart disaster management system and the evacuation of residents during disaster response. In addition, measures to efficiently utilize it in the local community were reviewed. In this study, a survey and in-depth interview were conducted with a focus on university students in Daegu and Busan who experienced Typhoon Hinnamnor in September 2022. As a result of the analysis, it was found that university students in Daegu and Busan were sufficiently aware of the dangers of the region. The conclusion shows that even if the Smart disaster management system is thoroughly operated, residents may not take appropriate actions accordingly, and that the Smart disaster management system that does not consider the residents' psychological and behavioral patterns may not be useful. This conclusion also shows that disaster management is not a problem that can be solved immediately by applying smart information technology. Although the Smart disaster management system is trying to improve the speed and accuracy of information delivery, it is important to identify the factors of people who do not evacuate, and it has been found that there is a need to further analyze the behavioral system of residents who do not evacuate.

Keywords: Evacuation, Smart disaster management system, Typhoon Hinnamnor, Korea

1. Introduction

Korea has been working hard to build a smart disaster management system since 2019. Smart disaster management system refers to a situation management system that predicts potential and sudden risk situations in advance from the beginning of a disaster and devises appropriate countermeasures according to the development and spread of the situation [1].

Currently, the idea that disaster damage can be minimized and completely prevented is widespread if a smart disaster management system is built. In previous studies, there are many papers on the promptness and construction system of the Smart disaster management system. In addition, in many cases, the focus is on whether the goal of the smart disaster management system is achieved. Smart disaster management system is just a tool to predict disasters in advance and respond anytime, anywhere when they occur. In reality, the response is made by the residents, who are the primary victims of disasters. This is because the disaster prevention administration and the local community must demonstrate a compassionate community spirit in order to effectively respond to disasters [2][3][4].

This study examines ways to efficiently utilize the smart disaster management system in the community even if it is established. Since evacuation is one of the most reliable

non-structural measures to protect human life from disasters, evacuation among residents' disaster response is particularly focused. In particular, evacuation can be effective only when stakeholders in various communities quickly consolidate their response capabilities after a disaster occurs [5][6][7].

2. Materials and Methods

In this study, two issues were considered. First, the smart disaster management system is always able to deliver information well. Smart disaster management system is an area where information technology is key and most needed [1][8]. Samaddar et al. [9][10][11] defined information as the most necessary thing to cope with a crisis situation where rational response is impossible. However, in times of crisis such as disasters, the most scarce thing is also information [12][13]. Efficient delivery of disaster situations is also the purpose of a smart disaster management system.

From 2013, the Korean government began to apply ICT tools such as GIS, enabling rapid acquisition of disaster information. However, when a large-scale disaster occurs, such as the 2009 Hokkaido earthquake blackout, power outages may occur and the function of the information delivery system may be paralyzed.

Second, if information is delivered, can residents be evacuated? In order to clarify this, this study first conducted a survey and in-depth interviews with about 430 university students studying disaster management in Daegu and Busan, which can be said to be relatively well-equipped places in Korea with a smart disaster information system. In particular, the Daegu and Busan regions, which are also the typhoon path of Typhoon Hinnamnor, were considered as the subject of investigation.

In South Korea, Hinnamnor invaded in September 2022, killing 14 people and injuring 6 others. A total of 162 cases and 66,341 households were affected by power outages nationwide. A total of 2,906 residents were temporarily evacuated to temporary housing facilities due to flood damage, etc.

3. Data collection and analysis

Although Daegu and Busan are habitual typhoons, only 2.8% of them evacuated at the time of Hinnamno. In other words, it was found that even if awareness of disaster risk is high, it is meaningless if there is no evacuation. In addition, the Ministry of the Interior and Safety instructs to think about how to evacuate by figuring out the typhoon's course and arrival time in the correct action guideline for typhoon evacuation. In addition, in low-lying areas, habitually flooded areas, landslide risk areas, underground spaces, or deteriorated houses and buildings that are at risk of collapse, they inform people around them and instruct them to move to a safe place. Of the 2.8% of the evacuated rate, the rate of correct behavior was evacuated at only 35.7%, that is, only 1% of the total survey sample. It was found that the majority evacuated thinking of the vacant lot mentioned in the earthquake as a shelter.

When asked if damage such as flooding or collapsing building exterior walls comes to mind when a large typhoon occurs, 77% of respondents answered "yes". If so, do you think the damage will be done to your town? In response to the question, 19% said yes and 39% said there is a possibility of coming, a total of 59% thought it would happen. In response to the question "Do you think it would be dangerous if such damage occurred in the village?", 14% said it was dangerous and 18% said it was likely to cause danger, and about 33% thought it was dangerous.

Table 1. Descriptive statistics (N = 428).

Characteristics	n (%)
Sex	
Male	217 (50.7)

Female	211 (49.3)
Evacuation	
Evacuated	14 (3.3)
Not evacuated	414 (96.7)
Proper evacuation based on the National Action Guidelines or not	
Yes	5 (35.7)
No	9 (64.3)
When a large-scale typhoon occurs, do flooding or collapse of building exterior walls come to mind?	
Yes	332 (77.6)
No	52 (12.1)
I do not know	44 (10.3)
If so, do you think the damage is happening in your town as well?	
Yes	84 (19.6)
likely to occur	167 (39)
unlikely to occur	177 (41.4)
Do you think it would be dangerous if such damage were to happen to the town?	
Dangerous	61 (14.3)
risk is high	80 (18.7)
risk is low	186 (43.5)
Not dangerous	101 (23.6)

Before the analysis, the concepts of normalcy bias and cognitive dissonance are clarified. First of all, the normalcy bias is that even if people say that the environment around them suddenly and drastically changes, people tends to think 'I will be fine even if danger occurs...'. In other words, it is a phenomenon in which self-defensive psychology occurs even when faced with a disaster or a large-scale accident [14][15]. Cognitive dissonance is what people think in their heads but don't put into action. In other words, they know that they must evacuate in advance before a disaster occurs, but they do not do it [16][17][18].

University students in Daegu and Gyeongbuk were fully aware of the dangers of the region and they were aware that they had to evacuate when an alert was issued. However, they did not think that 'today is the day, the time of danger due to the great wind'. This behavior reflects the normalcy bias. In addition, cognitive dissonance justified themselves for not evacuating even though they knew that they had to evacuate. There are many reasons to justify oneself for not evacuating, such as 'There was a typhoon warning or evacuation advisory, but no typhoon occurred', 'There was no information on TV or radio (I couldn't hear it)', and 'Neighbors did not evacuate' [19][20][21].

To summarize, where the smart disaster management system was developed, some did not evacuate due to 'normalization prejudice', and there was evacuation information, and although they collected it, they did not evacuate, the subjects justified themselves for not evacuating due to 'cognitive dissonance'. Through this process, most of the investigators did not evacuate in Daegu and Busan.

4. Conclusions

4.1. Summary

In Korea, the smart disaster management system is being actively promoted by the government, and it can be said to be a trend in disaster management. In other words, it is pursuing an all-hazard approach system that predicts disasters in advance and seeks countermeasures according to the spread of disasters. It is widely believed that if a smart

disaster management system is perfectly established, disaster damage can be minimized and become zero damage.

This study shows the possibility that residents may not take appropriate actions even if the smart disaster management system is thoroughly operated, and suggests counter-measures for it. It is doubtful whether a smart disaster management system that does not consider residents' psychological and behavioral patterns will be useful. This is because disaster management is not a problem that can be solved immediately by applying smart information technology. Above all, smart information technology is a necessary but not sufficient condition for disaster management.

Residents may be fully aware of the importance of evacuation, which is one of the basic goals of the smart disaster management system. However, it is also important to know the factors of those who do not evacuate. The smart disaster management system is trying to improve the speed and accuracy of information delivery, but there is a need to further analyze the behavioral system in which residents do not evacuate in the future.

4.2 Implication

First, excessive reliance on smart disaster management systems should be avoided. There is no doubt that building a smart disaster management system is a major national disaster management task, but it requires a huge budget, so it is not something that can be solved by the power of the private sector. In addition, this system alone cannot completely protect local residents, and disaster management must consider the actions of residents along with disaster prevention administration.

Second, residents' concerns should be well reflected in the smart disaster management system to seek independent evacuation plans. Even if the smart disaster management system implements the disaster risk area in a three-dimensional dimension such as 3D, the understanding of residents living in reality may be higher. First of all, it should be recognized that administratively dependent evacuation has limitations. As in the case of Japan, it has been reported that residents did not respond that there was no disaster information through the smart disaster management system, such as sudden typhoons and earthquakes.

Third, the disaster management cooperation system should be formed through repeated learning and training in advance. Even if a smart disaster management system is sufficiently equipped, there is a possibility that appropriate responses may not be made if local residents lack awareness.

Lastly, the effective operation of the smart disaster management system should start from reexamining the relationship between disaster prevention administration and residents. The smart disaster management system is not omnipotent in disaster management, and it is desirable to have a basic structure that supports the factors that residents cannot or do not know as much as possible.

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References

1. Song, W.; Choi, J.; Lee, D.; Choi, C. Development of a Customer Friendly GIS-based Disaster Management System in South Korea. *Journal of Distribution Science* **2019**, *17*(11), 27-34.

2. Lee, J. How to Improve Disaster Resilience in the Climate Crisis. *Journal of Safety and Crisis Management* 2022, 12(10), 25-35.
3. Choi, C.; Choi, J. Development and distribution of risk governance framework in terms of socially viable solutions. *Journal of Asian Finance Economics and Business* 2018, 5(3), 185-193.
4. Matsuda, Y.; Okada, N. Community Diagnosis for Sustainable Disaster Preparedness. *Journal of Natural Disaster Science* 2006, 28(1), 25-33.
5. Choi, C.; Choi, J. Distribution and application of community-based disaster risk information: Lessons from Shiga Prefecture in Japan. *Journal of Distribution Science* 2018, 16(6), 15-23.
6. Choi, C.; Tatano, H.; Choi, J.; Development and application of a sensemaking approach to community-based disaster risk governance. *Journal of Asian Finance, Economics and Business* 2019, 6(1), 289-301.
7. Samaddar, S.; Okada, N.; Choi, J.; Tatano, H. What Constitutes Successful Participatory Disaster Risk Management?. Insights from Post-earthquake Reconstruction Work in Rural Gujarat, India. *Natural Hazards* 2017, 85(1), 111-138.
8. Choi, C.; Choi, J.; Kim, C.; Lee, D. The Smart City Evolution in South Korea: Findings from Big Data Analytics. *Journal of Asian Finance, Economics and Business* 2020, 7(1), 301-311.
9. Samaddar, S.; Okada, N.; Xiang, X.; Tatano H. Who are Pioneers of Disaster Preparedness? -Insights from Rainwater Harvesting Dissemination in Bangladesh-. *Environmental Management* 2018, 62(3), 474-488.
10. Samaddar, S.; Choi, J.; Misra, B.A.; Tatano, H. Insights on Social Learning and Collaborative Action Plan Development for Disaster Risk Reduction: Practicing Yonmenkaigi System Method(YSM)in Flood-prone Mumbai. *Natural Hazards* 2015, 75(2), 1531-1554.
11. Samaddar, S.; Yokomatsu, M.; Dzivenu, T.; Oteng-Ababio, M.; et al. Evaluating effective public participation in disaster management and climate change adaptation: Insights from northern Ghana through a user-based approach. *Risk, Hazards & Crisis in Public Policy* 2015, 6(1), 117-143.
12. Alexander, D. Towards the development of standards in emergency management training and education. *Disaster Prevention and Management* 2003, 12(2), 113-123.
13. Samaddar, S.; Oteng-Ababio, M.; Dayour, F.; Ayaribila, A.; et al. Successful community participation in climate change adaptation programs: On whose terms?. *Environmental Management* 2021, 67(4), 747-762.
14. Yamori, K. Action Research on Disaster Reduction Education: Building a "Community of Practice" through a Gaming Approach. *Journal of Natural Disaster Science* 2009, 30(2), 83-96.
15. Yamori, K. Disaster Education and its Future Perspectives in Japan Following the Great Hanshin-Awaji Earthquake. *Journal of Japan Society for Natural Disaster Science* 2010, 29(3), 291-302.
16. Yamori, K. The Roles and Tasks of Implementation Science on Disaster Prevention and Reduction Knowledge and Technology: From Efficient Application to Collaborative Generation. *Journal of Integrated Disaster Risk Management* 2011, 1(1), 48-58.
17. Yamori, K. Using games in community disaster prevention exercises. *Group Decision and Negotiation* 2012, 21(4), 571-583.
18. Katada, T.; Kanai, M. The School Education Improve the Disaster Response Capacity: A Case of "Kamaishi Miracle". *Journal of Disaster Research* 2016, 11(5), 845-856.
19. Katada, T.; Kanai, M. Implementation of Tsunami Disaster Education for Children and Their Parents at Elementary School Solutions to Coastal Disasters. *Tsunamis* 2008, 39-48.
20. Katada, T.; Kodama, M.; Saeki, H. Study on Residents' Recognition of A Flood Hazard Map and Promotion Measures of Its Recognition. *Proceeding of Hydraulic Engineering* 2004, 48, 433-438 (in Japanese). [
21. Katada, T.; Kanai, M.; Hosoi, K.; Kuwasawa, N. Issues of Implementations to Be Intended for Only Applicants for Bousai Seminar – According to Seminar to Guide How to Evacuation from Tsunamis. *Journal of JSCE* 2011, 67(1), 1-13 (in Japanese).

Article

Evacuation Issues and Location Factors of Shelters in the Catastrophe-Focused on the Disaster Response Base Operation Plan

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Abstract: Social distancing, shutdown, and lockdown policies have recently been implemented worldwide to help slow the spread of the Coronavirus disease 2019 (COVID-19), which has caused economic, social, and cultural crises on a global scale. To help create safe communities, we aimed to analyze the factors affecting the public's anxiety and efficacy to overcome crises. The results show that efficacy is associated with sex, education, central government support, the public hygiene environment, and public hygiene behaviors. Anxiety was shown to have a negative relationship with central government support, a positive relationship with civilian support, and a negative relationship with efficacy. For a country to prevent the spread of a novel infectious disease, alleviate the anxiety of the population, and construct a safe community in the midst of a global pandemic, active central government support and response, protection of vulnerable populations, publicization of policies, and crisis management communication are essential. In particular, identifying an evidence-based method to understand and address the psychological and social influences of COVID-19, such as excessive fear and discrimination, providing insight into risk factors associated with future society for policy makers, and establishing potential and sustainable public health communication strategies are of paramount importance.

Keywords: disaster management; location factors; disaster response base; catastrophe; Japan

1. Introduction

The government's successful response to disasters lies in the delivery of response activities and relief and recovery services required in a short period of time at the time of the disaster. This means that necessary resources, equipment, and manpower are connected to disaster-stricken areas in a timely and balanced manner and quickly.

From the perspective of efficient distribution of disaster resources, disaster logistics has the meaning of a bridge between resources and the affected areas, and on the contrary, disaster logistics guarantees efficient flow to disaster areas[1]. Disaster logistics focuses on minimizing disaster damage in terms of maximizing the distribution and delivery of goods, manpower, and information among a series of actions to respond to disaster situations before, during, and after a disaster.

In particular, it is necessary to discuss how to efficiently operate and manage disaster management resources in the entire process of disaster response, relief, and recovery after a disaster, beyond the collection of disaster management resources and transportation to disaster sites.

Therefore, this study aims to examine the location factors and operation directions of disaster response base through literature review in connection with evacuation center relief services in catastrophe.

2. Disaster Response Base

2.1. Necessity

During the disaster, damage is inevitably accompanied by human and property damage, and the government's disaster response requires a wide range of activities, including emergency response to prevent the spread of damage on the site, as well as minimizing the impact of loss of life and property[2]. And in this process, the government plays a role in minimizing the damage impact of disaster-stricken areas by efficiently mobilizing necessary resources and solving urgent problems for victims.

Therefore, despite its concept, the government's successful disaster response lies in the delivery of necessary response activities, relief and recovery services in a short period of time at the time of a disaster, which links necessary resources, equipment, and manpower to disaster-stricken areas in a balanced and quick manner. In other words, from the perspective of efficient distribution of disaster resources, disaster logistics has the meaning of a bridge between resources and damaged areas, and on the contrary, disaster logistics guarantees efficient flow to disaster areas.

In addition, in order to ensure the efficient movement of these disaster resources, it is necessary to discuss disaster response base.

2.2. Definition of Disaster Response Base

In general, the dictionary meaning of 'base' refers to an important point as the basis for an activity. Therefore, the disaster response base has an important place meaning in which the entire process of government activities in response to a disaster occurs. However, as described above, the disaster response base means a place, and does not mean that there should be a specific facility for disaster prevention purposes in itself.

Japan's wide-area disaster prevention center is introduced as a place for aid and transportation to the affected area while meeting the requirements of stockpiling disaster management resources in case of catastrophe, and the U.S. also installed a base camp and logistics base temporarily at the disaster site, suggesting that the difference from the fixed disaster response facilities.

3. Location Factors of Disaster Response Base in Japan

Japan's disaster response base presupposes the use of existing facilities as much as possible rather than the introduction of new facilities, and the installation of new facilities is premised when it is difficult to set up according to the requirements of the disaster response base[3]. Due to the nature of disasters with high uncertainty about the facilities constituting the disaster response base, the purpose of this is to minimize the financial constraints of local governments and increase the usefulness in the event of a disaster through intensive investment.

Although earthquake resistance is an essential factor for certain disasters, such as Japan, it is practically difficult to force existing facilities to be additionally strengthened beyond Japanese building standards, and if new facilities are installed through long-term financial investment, it may be difficult to respond to disasters.

3.1. *Setting Requirements*

As a condition for the deployment of disaster response bases for each metropolitan unit, the Japanese Cabinet first requires the location of each base in consideration of the urban structure so that it is advantageous to secure access from disaster areas or replacement of transportation in the event of a disaster. Second, in the event of a disaster, a base is placed in the periphery where dense urban areas are connected so that confusion inside the city area can be avoided and a quick response to the disaster area can be made. Third, in order to secure access from other metropolitan areas, the main deployment base is near the nodule point of land transportation, near an important port capable of maritime transport, or near an airport capable of air transportation.

In addition, facilities within disaster response bases are recommended by the Japanese Ministry of Internal Affairs and Communications, and they are based on three main criteria for establishing disaster response bases. First, convenience does not interfere with the recruitment of major factors (human resources, materials, materials, fuels, etc.), and it is easy to access from transportation institutions such as land, sea, and sky where information and communication facilities are maintained. Second, self-reliance means that it is a facility that has less risk of tsunami damage, liquefaction (effect of earthquake), and can withstand disasters, and must have safety management and protection against all risks. Third, substitutionality should ensure alternative functions of transportation and transportation, and should include functions that can or can be replaced by energy or water on their own even in the event of a disaster.

Finally, from the perspective of local governments, when establishing disaster prevention centers, they are distributed and deployed in wide-area administrative districts, and facilities located in disaster risk zones are excluded from the target.

On the other hand, in order to respond to large-scale disasters centered on disaster response bases, only the government and local governments have limitations, and accordingly, pre-design based on disaster response agreements with private operators for disaster logistics is premised.

This includes major contractors for checking damage conditions or emergency measures, and related operators for ship mooring or emergency goods transportation, not single companies, on the premise of regular disaster drills for rapid response based on BCP plans of major facilities. In addition, in order to maintain the emergency contact network in the event of a large-scale disaster, not only ground lines but also (satellite) mobile phones and e-mail addresses that take into account contingencies must be included. On the other hand, Japan includes alternative facilities and emergency recovery measures in consideration of cases in which disaster prevention bases suffer disaster damage.

3.2. *Operation Plan*

Despite the facility requirements constituting the disaster response base, Japan avoids facilities that are used only in the event of a catastrophe, and thus considers the availability of the general public in normal times. Therefore, in the event of a catastrophe, a management and operation plan for each facility is established and used to the extent that it does not interfere with activities such as transportation, relief, and recovery of emergency materials[4].

First, coastal facilities reflecting earthquake resistance are usually used as general cargo transportation spaces, but they are designed to allow rapid movement of anchored cargo, materials, and parking vehicles to transport emergency goods in the event of a large-scale disaster, and the use of heavy cargo is restricted. In particular, in the case of a large-scale disaster, clear attention is delivered to users through major guidance and signs such as facility names, locations, and precautions.

Second, in the case of open space, the green area occupies a large part of the area, so it is used for large-scale events, and at the same time, it is used as a place for visitors to promote or educate that the space and facilities play a role as a disaster response base.

Third, traffic networks such as roads are usually free to use, but illegal parking measures are thoroughly implemented. In case of a large-scale disaster, a vehicle moving place or a manager to guide the traffic is secured and included in the BCP plan.

Fourth, retreat evacuation facilities from disaster areas are often designated as passenger terminals, and facilities other than passenger terminals are included in the BCP plan to secure necessary space in the event of a disaster by estimating specific users.

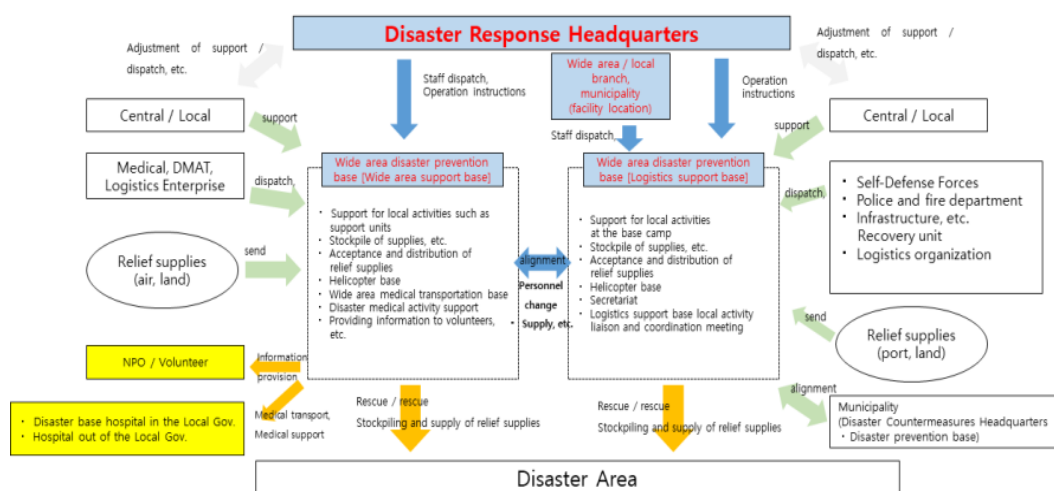
Fifth, like an open space, the facility for storing and storing emergency materials is a facility that does not change its purpose or shape in the event of a large-scale disaster, and focuses on quickly moving stored cargo in the event of a large-scale disaster. However, in the case of Japan's coastal disaster prevention base, additional available stockpiling facilities are secured, such as replacing convention facilities located in the coastal area with emergency storage facilities, and emergency supplies are placed according to the storage standards of stockpiles, and food items are regularly replaced.

However, in the event of a disaster, the Japanese disaster response base is operated in the event of a catastrophe, and operates based on regional disaster prevention plans or BCPs of major infrastructure (ports). However, the disaster response base does not function as a disaster response base due to a catastrophe, and the impact of the disaster response base and the availability of each facility in the disaster response base are comprehensively judged and used. In particular, it is essential to implement the use of a disaster response base after sufficient consultation with officials of the relevant region and facilities, despite the regional disaster prevention plan.

On the other hand, the disaster response base established at the metropolitan unit performs the function of a linkage base for cheering not only within the metropolitan area but also between metropolitan areas. In particular, the disaster response base is required to establish an operation plan in consideration of synergy effects through connection with the neighborhood disaster response base. Therefore, in general, disaster response centers play the role of each base and plan for planning and maintenance at the metropolitan unit

where the base is located, but if the disaster response center in the area is not available, it is set up to include backup functions. For example, a key regional disaster response base, such as a Japanese maritime disaster prevention base, plans to collect emergency supplies, unload and store emergency supplies, but it is understood that synergy can be expected if it is used in conjunction with another regional disaster prevention base depending on the development of the disaster.

Figure 2. Concept diagram of wide area disaster prevention base



※ Source: <https://www.mlit.go.jp> (2021. 11. 30.)

4. Discussion

Recently, Korea has introduced disaster response bases for each metropolitan government. However, in a strict sense, the current facility is a stockpile warehouse concept, and from a logistics perspective, the evaluation of the transport efficiency from the collection place of resources to the affected area is insufficient. For this reason, it is true that the verification of the effectiveness of operation in the event of a disaster is also insufficient.

Therefore, it is necessary to secure implementation power by including comprehensive grounds for the concept of disaster response bases, the establishment of disaster response bases designation and operation plans, and the provisions of private cooperation and agreements in law. Through this, it is necessary for local governments to secure a basis for periodic inspection, management, and support for the availability of the disaster response base, and to allow public institutions or the private sector to plan considerations when using the facility in accordance with the agreement.

5. Limitations and Conclusions

This study aims to present the policy implications and direction of the introduction of disaster prevention facilities for the efficient operation of domestic disaster management resources by analyzing the functions and operation plans of Japanese disaster prevention facilities.

In the event of a large-scale disaster, Korea lacks experience or consideration for the possibility of damage, such as congestion, confusion, and loss of transportation networks. Therefore, it is necessary to consider the characteristics of Japanese cases, such as accessibility, transportation network, and openness required in the disaster prevention base operation plan. However, this study does not present a specific methodology for determining the location of disaster prevention bases, so future research on this is needed.

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References

1. Köseoğlu, A. M. 2011. The Lifeblood of Disaster Management: Logistics. Uluslararası Lojistik ve Tedarik Zinciri Kongresi (İzmir).
2. Ministry of Land, Infrastructure, Transport and Tourism (Japan). 2016. Seaside Disaster Prevention Base Manual (renewal).
3. Ministry of Land, Infrastructure, Transport and Tourism (Japan). 2016. Seaside Disaster Prevention Base Manual (renewal).
4. Ministry of Public Safety and Security. 2016. Research on Establishment of Management Plan for Social Disaster Management Resources through Domestic and Foreign Case Analysis

Article

Effects of the 4th Industrial Revolution on the Resilience of Local Communities: focusing on the digital twin disaster management system in Asan and Incheon.

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Abstract: While the paradigm of disaster management focuses on finding the cause of a disaster and prevent, prepare, respond, and recover, unpredictable disasters continued. This is the reason why the disaster management paradigm shifted to resilience that can withstand disasters well. At the same time, attempts are being made to develop disaster management capabilities by introducing cutting-edge technologies from the 4th industrial revolution in local communities. This study aimed to identify how advanced technology can affect resilience through digital twin-based disaster management platforms in Asan and Incheon. The platform development team leaders of Asan City and Incheon City, the policy manager of the Ministry of Land, Infrastructure and Transport, and the developer of LX's digital twin platform. Through this, it was confirmed how resilience was strengthened in case study. This study also tried to identify the challenges that advanced technology will have influenced the continuous strengthening of resilience capabilities.

Keywords: resilience; digital twin; local government; capability; disaster management; Asan; Incheon

1. Introduction

The paradigm of disaster management is shifting from vulnerability to resilience. Disaster management has focused on finding vulnerabilities and performing prevention-preparation-response-recovery activities until now. However, as the unpredictability of disasters increases, awareness of the need to increase the resilience of communities to disasters is spreading. Research to graft the resilience, which started from a biological concept, onto disaster management is active (Lee and Kwon, 2017:475). A consensus was formed among researchers that local communities should have disaster resilience to respond efficiently to unpredictable and frequent disasters (Kim, et al., 2012; Cho, 2019: 190).

Another axis of the shift in disaster management is the fourth industrial revolution. In order to manage disasters effectively, organizations and companies are trying to utilize the intelligent information and communication technology (ICT)-based disaster management system (Park, et al., 2021:62). The Korean government also is also conducting the policy for the disaster management based on the forefront technology following the fourth industrial revolution.

In particular, the digital twin system is remarkable as a new trend for the disaster management by the administrations and the local government. They have announced or are making plans to build a digital twin-based disaster management system (Park, 2022; ME, 2022; MOLIT, 2021;2022).

The digital twin is a platform that has the function of visually implementing the real world in the virtual world like twins to find problems and simulate solutions. Attempts

are being conducted to solve social issues such as disasters and traffic problems both in Korea and other countries by applying digital twins (Seo, 2021).

How can the digital twin, which is being built by many organizations as a new disaster management system, help in disaster management? The purpose of this study is to obtain policy implications for the intermediary relationship between the newly introduced state-of-the-art disaster management system and regional resilience, which is the center of the disaster management paradigm.

Firstly, this study examines how the fourth Industrial Revolution can affect the disaster management resilience of local communities through literature research. Next, through case studies on digital twin disaster management in Asan and Incheon, this study conducts research to understand specifically how it relates to local community resilience and how organizations can strengthen their resilience capabilities.

Through the digital twin pilot project of the Ministry of Land, Infrastructure and Transport (MOLIT) for about a year from 2021 to 2022, Incheon Metropolitan City built an integrated platform for fire response field command, and Asan City built an intelligent river management system. In this study, the policy manager of MOLIT, the digital twin system general manager of Asan City, the platform establishment team leader of Incheon City, and the digital twin platform development staff of Korea Land and Geospatial Information Corporation (LX) were interviewed. The advantages and limitations of digital twins in strengthening community resilience are studied.

2. Literature Review

2.1. Resilience on the Disaster Management

Disaster management refers to all activities related to prevention-preparation-response-recovery to minimize damage caused by disasters (Kim, et al., 2014 : 23). Disasters are defined as what causes or can cause damage to the country and people's lives, bodies and property. They can be divided into natural disasters and social disasters (Article 3 of the Framework Act on Disaster and Safety Management). Storm and flood damage is a representative example of a natural disaster, and fire is a representative example of a social disaster.

Despite a lot of disaster management activities, it has been realized that disasters cannot be completely prevented or avoided as uncertainty and unpredictability increase with social changes. The awareness that we must find a way to live with disasters from within has spread. This is the background of the emergence of the concept of resilience in disaster management (Cho, 2017:11).

Resilience in the dictionary means 'the ability to overcome damage caused by shock and restore system function'. The concept is the similar phenomenon that when a ball is dropped on the floor, if the floor has good elasticity, the shock caused by the ball can be easily recovered. The concept of resilience was first described by biologist Holling (1973: 14) as a concept compared to stability and was used as “a concept to measure the ability of an ecosystem to continue while adapting to change” (Holling, 1973: 14; Jo and Lee, 2021:9). The concept of resilience was first used in the field of disaster management by Timmerman in 1981, and it was defined as “the ability to absorb and recover from disasters” (Hong, 2018: 30). Vugrin, et al. (2011:280) defined disaster management as “the ability of a region to minimize the damage effects of disasters on systems and to minimize the effort required to restore damaged systems.” To compare disaster management to the human body, vulnerability-oriented disaster management is like finding all causes of illness and preventing them. It can be said that disaster resilience is to maintain the body healthy to defend or recover from any accident or bacterial invasion (Hong, 2018).

In the 2000s, the concept of resilience further spread due to large-scale disasters. After going through compound disasters such as Hurricane Katrina in the US in 2005 and the Fukushima nuclear power plant accident in Japan in 2011, the awareness of the need for

a change in the fundamental premise of the existing disaster management system has grown. Disasters are occurring in which it is difficult to define the cause of damage as a single factor, so it is necessary to approach in terms of solving structural problems that repeat damages rather than simply returning to the stage before the damage occurred (Lee and Son, 2022). In this regard, the UN adopted the concept of resilience in the Hyogo Framework for Action (HFA) 2005-2015 that suggested to build the resilience of nations and communities to disaster in 2007 (UN, 2007).

Resilience is a concept used in various disciplines such as biology, physics, and engineering, but has also been researched from various perspectives in disaster management. Some studies divide the character of resilience depending on the subject that has resilience such as person, organization, or system (Hong, 2018:31-32). Others divide it into what properties resilience has in the other aspect. There was also a study on the mediating relationship between resilience and disaster activities (Cho, 2019:195).

The Disaster Safety Research Center of the Chungnam Institute (2019) cited Bruneau, et al. (2003) to classify resilience's character focusing on the 4Rs such as Robustness, Resourcefulness, Rapidity, and Redundancy. The robustness of systems or facilities means the ability to withstand shocks. Resourcefulness refers the availability of resources that can be used by replacing elements when shock causes damage. Rapidity is the speed to respond and recover quickly. Redundancy is the ability to play a role in disaster situations that normally overlaps with other resources.

Researchers also tried to define what the core capabilities of resilience are in the point of resilience engineering. Hollnagel (2011) conducted the study of resilience engineering, organized the core competencies of resilience into pre-prediction, pre-monitoring, pre-response, and safety learning. Organizations with resilience can predict and proactively monitor incidents from a long-term perspective, learn from experiences accumulated in the process of responding to incidents, and improve through feedback (Hong, 2018: 35).

Disaster management has been viewed as a prevention-preparation-response-recovery process, but in order to strengthen resilience, a disaster management process can be built around these competencies. In this point, some argue that the prevention-preparation-response-recovery process should be converted into a 6-step system, including prediction-prevention-preparation-response-recovery-survey and analysis, with an emphasis on advance prediction (Kim, et al., 2021 ; Jung, 2022:20-21). In Korea, 'the 3rd Comprehensive Plan for Disaster and Safety Management Technology Development' jointly submitted by the Ministry of Public Administration and Security and the Ministry of Science and ICT in 2018 also includes disaster safety risk prediction and impact assessment technology development as important elements (National Science Technical Review Committee, 2018).

Prediction and evaluation technology is connected to the technology represented by the 4th industrial revolution. There is a study that the development of innovative technology due to the advent of the 4th industrial revolution also affects the strengthening of resilience (Kim, et al., 2010). Advanced technologies have strengths in resilience capabilities or newly added forecasting and impact assessments in the 6 step disaster management. Artificial intelligence (AI) is a technology that can predict risk factors by analyzing big data based on existing history. Prediction can strengthen prior surveillance, and the ability to respond in advance to preparedness can also be strengthened. It helps to strengthen safety learning ability through records of various processes.

2.2. Digital Twin on the Disaster Management

Disaster information that directly affects human life and property damage is important information that needs to be disseminated and shared very quickly. This is why the government is building a disaster management system using information and communication technology (ICT). Along with the development of advanced technologies such as ICT, a smart disaster management system using it has also developed (Kang, et al., 2012).

With the advent of the 4th industrial revolution era, information technology has also developed by leaps and bounds. It is also possible to implement an intensive smart safety management platform that can systematically and efficiently manage all stages of disaster management, including prevention, response, and recovery (Jung, 2017).

For example, in the past, if flood was predicted based on the level of rainfall announced by the Korea Meteorological Administration, it became possible to build a system that collects and analyzes vast amounts of data on various factors such as sewage capacity and facility height. The accuracy of prediction or simulation has been further improved. In fire response, not only the exact appearance of the scene through CCTV, but also the exact structure of the building or space where the fire occurred can be grasped through digital spatial information (MOLIT, 2022).

The core of the smart revolution lies in the participation and utilization of not only national institutions but also individuals in the production and provision of information. Disaster management also requires the participation of individuals, including through social media. In August 2022, when the fire department or the media were unable to access the flooded area during heavy rain in Seoul, citizens at the disaster site rapidly spread disaster information through social media. Even media company got the photo from citizens and broadcasted the news nationwide in real time.

ICT-based participatory disaster response can be a tool for strengthening cooperation. SNS is a means of communication between victims who need support and volunteers who want to support in the event of a crisis or disaster, and it is possible to share information on necessary items and places (Kang, et al., 2012).

The digital twin, which is a convergence of AI, big data, and spatial information, focuses on strengthening predictive and response technology. The digital twin is a platform that visually implements the real world in the virtual world like twins, finds problems and simulates solutions (MOLIT, 2022). Several ministries, including MOLIT and ME, are promoting a pilot project to establish a disaster management system using digital twins. It is still at the level of a pilot project, and some local governments are interested in introducing a disaster management system using digital twins under the Korean government support. Digital twins can be used by implementing different functions in the stages before disaster prevention, preparation, response, and recovery through functions such as simulation, prediction, and analysis (Interview with Kang).

3. Case Studies.

3.1. Intelligent River Management System Based on Digital Twin in Asan City.

In 2020, Asan City suffered property damage of KRW 3.39 billion due to the flooding of the Onyangcheon Stream due to the record-breaking rainfall of more than 200mm following localized heavy rain (Asan City, 2022). Even before that, in Asan City, Gokgyocheon and Onyangcheon were frequently flooded, so the local government mobilized various technologies to manage them. For example, in 2019, as a pilot project of MOLIT, the ‘National River Sluice Gate Smart Infrastructure Construction Project’ was conducted. In the past, when it rained heavily, the head of the village had to wear a raincoat and close the floodgates. The government offered the budget for the facilities of remote control system of the floodgates. After the smart remote control system, in a comprehensive emergency operation room, water gate automation equipment, CCTV and equipment for automatic water level and communication connection between the water gate and the operation room were built (Mihye Cha, 2019). The government fully supported the project cost of 3.5 billion won and completed the facilities at 34 floodgates from 2019 to December 2020 (Yoo, 2020).

The digital twin-based intelligent river management system is a project to develop a digital twin platform for intelligent river management for Gokgyo Stream and Onyang

Stream located in Asan City. High-precision river spatial information was established using aerial and water drones and aerial lidar. Public officers of Asan City can support river administrative work from the office as if they were on-site.

Although the drone operation team promoted the digital twin business, the drone operation team is the department that leads the development of the platform and the division where actual application should be applied is the river management or natural disaster department. Asan City has a river management team in the construction department and a natural disaster team in the safety general department. They decided to manage the river with a digital twin and collaborated with two teams.

The digital twin pilot project was carried out by subcontractors. It is a 1.4 billion won project, and it took 700 million won to build a database (DB) and 700 million won to build a platform. As a matching project between local governments and the central government, MOLIT supported 700 million won. The platform previously established by LX was used. LX's digital twin platform is a platform for the national land. Asan City's intelligent river management system is a service specialized only for rivers, and it cost money to build the necessary services, interfaces, and DB. This platform is equipped with 3D data of rainfall data in nearby areas acquired from the Korea Meteorological Administration and real-time water level change data through an Internet of Things (IoT) sensor. The person in charge of related tasks monitors river changes remotely from the control center and uses the flood simulation function to help prepare for floods quickly. Scientific river management tasks such as supporting smart floodgate remote control tasks in connection with CCTVs and water level sensors installed at floodgates are possible.

Although the platform was built, 1.4 billion won was not enough to create a system that made accurate predictions. The more sensors there are, the more data and accurate predictions are possible, but Asan City diagnoses that the number of sensors is insufficient. Since there are only 4 rainfall sensors, it is possible to calculate data that identifies the condition of the river only at 4 points. It is already possible to control the sluice gates remotely rather than manually with the smart sluice system. There are dozens of sluice gates in the river, and now the control center determines at what time the sluice gates should be closed by the person in charge of managing the river by watching the CCTV. When flood prediction becomes possible, it becomes possible to predict when the floodgates should be closed to a certain extent, rather than monitoring CCTV 365 days a year. However, rivers overflow due to various factors, not just rainfall at a few points. The dam may burst, so you must check it with CCTV. This is why you cannot rely solely on digital twins. It is not easy to make accurate predictions due to the lack of sensors and data, and the real-time status cannot be viewed as a digital twin (Interview with Lee).



Intelligent River Management System Based on Digital Twin in Asan City. Source : Asan City

3.2. Digital twin-based fire response on-site command integrated platform in Incheon Metropolitan City.

Incheon Metropolitan City has many industrial complexes. Industrial facility fires caused property damage of about KRW 11.4 billion and 36 casualties from 2016 to 2021 (Incheon City, 2022). Establishing preemptive countermeasures against large-scale and special fires was a concern of Incheon City. A fire in an industrial facility is not just a building fire, but it can also lead to an explosion of hazardous materials, so it is urgent to respond as quickly as possible. However, before 2020, as the emergency operation room gave instructions without accurately grasping the site, there were many cases where the command did not match with the site and there were many times when expanded support was not provided in time. In the past, the leader received a report from the operation room looking at the map and communicated with the dispatchers via walkie-talkie while giving instructions. Because the report was received only by voice, there was a limit to grasping the exact situation.

Incheon City's smartcity team thought that implementing a digital twin that can check real-time video would make the field command system much more precise and easier. Incheon City designed the platform by discussing with the fire department from the platform planning. 'The digital twin-based fire response field command integrated platform' was developed to effectively respond to complex fires/disasters. It is a project that not only supports efficient suppression of actual fires, but also uses it for on-the-road training.

Even if a fire breaks out and mobilizes, if an accurate situation is not judged, the fire suppression may be delayed. It is also necessary to know the exact entrance where the hazardous materials are located in the building, and depending on the characteristics of the hazardous materials, it is divided into whether to use water or gas when extinguishing a fire.

In addition, time was delayed due to navigation directions that did not match the length of the fire truck, and several vehicles were simultaneously dispatched to an area where there was not enough space for the fire truck to wait, and sometimes they were unable to properly enter the site due to their queue. Incheon City listened to the difficulties of the fire department and developed a platform to help them (Interview with Jo Gi-Woong).

Digital twin-based fire response on-site command integrated platform.

Source : Incheon City



Incheon City built a platform for the Namdong industrial complex from January, 2021 to August, 2022. △9 types of digital twin-based data dam construction for fire-fighting △5 types of GNSS IOT location-based integrated platform administrative model

development △2 types of wayfinding search engine implementation (vehicle/pedestrian) △2 types of real-time video monitoring implementation were developed (Incheon City, 2022).

In the event of an emergency, the length and width of the fire vehicle dispatched to the site are converted into data to provide route guidance services specialized for dispatch vehicles, and detailed locations, types, fire extinguishing methods, etc. Various attribute information was loaded as 3D data. In addition, the precise location of the dispatch vehicle, CCTV images of the surrounding area, and firefighters' body cam information were converged in real time to support fire suppression command (MOLIT, 2022).

The exact address of things such as bus stops are necessary. Since it is an industrial complex, the platform includes the information of many factories that handle hazardous substances, and indoor map as well as the entrance and exit information of the space. Buildings and structures mapped with the official document. A 360-degree VR panorama for hazardous facilities is added. It also includes information on outdoor and indoor fire-fighting facilities. A navigation system searches the route of each firefighting vehicle. Depending on the width and length of the vehicle, some vehicles can turn in one lane, and vehicles with a vehicle length of 12 m must turn from one lane to three lanes. It means that navigation guide should be different depending on the roads and vehicles.

The commander can designate that the first vehicle goes in one direction, and next vehicle goes in the other direction, which can be controlled from the operation room. The commander can watch the video of the fire scene in the situation room, so the member in the operation room can utilize external resources if additional support is needed.

Since the platform has only the Namdong Industrial Complex information, there is a limit. Therefore, it must be spread regionally. The regular update about hazardous materials should be conducted in case of changing the location.(Interview with Jo Gi-Woong)

6. Conclusions

Many researches have pointed out that due to the unpredictable nature of disasters, it is necessary to strengthen resilience as well as prevention-preparation-response-recovery activities in disaster management. In addition to prevention-preparation-response-recovery, Kim, et al.(2021), National Science and Technology Deliberation Committee (2018), and Jung(2022) consider prediction-prevention-preparation-response-recovery-assessment 6 Step activities as a disaster management process. Hong (2018) introduced resilience engineering into disaster management and explained that the ability to predict in advance - the ability to monitor in advance - the ability to respond in advance - and the ability to learn safety is the resilience competency. Bruneau, et al. (2003) said the attributes of community resilience against disasters were robustness, rapidity, redundancy, resourcefulness.

Asan City's 'Intelligent River Management System Based on Digital Twin' supports remote opening of floodgates by flood forecasting and premonitory capabilities. It can be said that it is a technology that strengthens the ability to respond in advance in that floodgates can be opened at the right time to prevent flooding.

Incheon City's fire response platform does not strengthen the ability to predict fires, but it allows advance monitoring through CCTVs throughout the industrial complex in the emergency operation room. It can also be said to strengthen the ability to respond in advance by supporting activities such as detecting dangerous materials in advance and blocking passages so that fire does not lead to an explosion. It is also used for on-road training to strengthen safety learning capabilities. Through the fire response platform, it strengthens the fire to prevent a weak fire from spreading to a large fire, and helps to provide directions so that a quick response is possible. It also allows the sharing of resources by sharing the video to nearby fire stations.

Through this study, it was possible to conclude that advanced technologies such as digital twins have an impact on strengthening community resilience. However, it was also

found that this technology also required constant management and update for the new technology in order to play its role.

References

1. Asan City. An intelligent river management system. Presentation at 2022 Smart Geo Expo (3 November 2022).
2. Bruneau, M.; Chang, S.E.; Eguchi, R.T.; Lee, G.C.; O'Rourke, T.D.; Reinhorn, A.M.; von Winterfeldt, D. A framework to quantitatively assess and enhance the seismic resilience of communities. *Earthquake Spectra* **2003** 19(4), 733–752
3. Cha, Mi-Hye. MOLIT applies ICT technology for national river sluice and water level management. Global Economy News. Available online : <https://www.getnews.co.kr/news/articleView.html?idxno=160398> (Accessed on 28 October 2022).
4. Cho, Seong. Local Government Disaster Preparedness and Disaster Organization Resilience: Focusing on the Relationship between Disaster Preparedness Activities and Disaster Resilience. *Proceedings presented at the Summer Academic Conference of the Korean Association for Policy Studies* **2017**, 11-17.
5. Cho, Seong. An Analysis on Disaster Management Effectiveness of Preparedness Activities through the Survey on the Local Government Officials' Perceptions: Focusing on the Mediating Effects of Community Disaster Resilience. *Korean Journal of Convergence Science* **2019**, 8(1), 188-198.
6. Holling, C.S. Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics* **1973**, 4 (1), 1–23.
7. Hollnagel, E. Resilience Engineering in Practice, *Ashgate* **2011**.
8. Incheon Metropolitan City. Digital twin-based fire response on-site command integrated platform. Presentation at 2022 Smart Geo Expo (3 November 2022)
9. Jo, Yeong Seok.; Lee, Jae Eun. A Core System Approach to Improving Local Community Disaster Resilience: Focusing on the COVID-19 Pandemic. *Crisisonomy* **2021**, 17(10), 1-27.
10. Chung, Hyo-Yon. A Study on the Smart Disaster Safety Management using Information Communication Technology. Master's dissertation. *Mokwon University* **2017**, Daejeon.
11. Jung, Jae Woong. A study on the effective application of ICT to improve resilience in the event of fire accidents. Master's dissertation. *Yonsei University* **2022**, Seoul.
12. Kang, Heau-Jo.; Choi, Jae-Myeong.; You, Jae-Myoung. A Study on the Smart Disaster Management System. *Proceedings of KIIT Conference* **2012**, 39-44.
13. Kim, H.J.; Jung, S.H.; Shin, J.D. A Study on deriving facilities of safety management by fire vulnerability analysis. *Korean Society Of Hazard Mitigation* **2012**, 29-29.
14. Kim, Inbeom.; Ryu, Sangil.; Song, Yoonseok.; Lee, Dongkyu.; Lee, Joo-ho.; Hong, Young-geun. Disaster management theory. *Daeyoung Cultural History* **2014**.
15. Kim, T.H.; Kim, H.J.; Lee, K.J. The Concept and Functional Objectives of the Urban Resilience for Disaster Management. *Journal of the Korean Society of Safety* **2011**, 26(1), 65–70.
16. Kim, Yong-kyun.; Son, Hong-kyu.; Ahn, Jae-hyun.; Yoon, Wan-cheol.; Lee, Tae-seok.; Jeong, Jong-je. Disaster Prevention Safety(1). *B&M Books* **2021**.
17. Lee, Dae Woong.; Kwon, Gi Heon. An Analysis on the Determinants of Disaster Resilience: Focused on Natural Disaster. *Korean Policy Studies Review* **2017**, 26(2), 475-510.
18. Lee, Kangwon.; Son, Howoong. Naver Knowledge Encyclopedia - Geospatial Information System Glossary 'Resilience' Available online : <https://terms.naver.com/entry.naver?docId=3481826&cid=58439&categoryId=58439> (accessed on 24 September 2022).
19. ME(The Ministry of Environment). The Me announces measures to prevent flooding in cities and rivers. *Press Release* (announced on 25 August 2022).
20. MOLIT(The Ministry of Land, Infrastructure and Transportation). The first step towards digital twin national territory...selected 10 pilot projects. *Press Release* (announced on 11 August 2021).
21. MOLIT(The Ministry of Land, Infrastructure and Transportation). The Molit launches the Digital Twin Society. *Press Release* (announced on 5 October 2022).
22. National Science and Technology Review Committee. The 3rd Comprehensive Plan for Disaster and Safety Management Technology Development. *Republic of Korea Government Document* **2018**.
23. Park, Dong Sun. Meeting of water management and digital twin technology in the Seomjin River basin. *Water for future* **2022**, 55(6), 8-19.
24. Park, So Yeong.; Jeon, Ji Hoon.; Kim, Soo Chul.; Lee, Kang Bok. Disaster detection and future development direction using ICT technology. *The Journal of The Korean Institute of Communication Sciences* **2021**, 38(6), 62-69.
25. Seo, Ki Hwan. Digital twin policy trends and implications in major countries (Singapore, UK, Australia). Available online: http://www.ricon.re.kr/board/view.php?no=3867&group=issue&page=global_policy (accessed on 8 October 2022).
26. The Framework Act on Disaster and Safety Management. **2022**.

27. Hong, Seong-ho. Influence of Resilience Capability on Organizational Effectiveness of Disaster Management Organizations. Doctoral dissertation. *Kwangwoon University* **2019**. Seoul.
28. UN. Hyogo Framework for Action 2005-2015, 2017. Available online :<https://www.preventionweb.net/publication/hyogo-framework-action-2005-2015-building-resilience-nations-and-communities-disasters> (accessed on 20 September 2022).
29. Vugrin, E. D.; Waren, D. E.; Ehlen, M. A. A Resilience Assessment Framework for Infrastructure and Economic Systems: Quantitative and Qualitative Resilience Analysis of Petrochemical Supply Chains to a Hurricane. *Process Safety Progress* **2011**. 30(3): 280-290.
30. Yoo, Myeon-Hwan. Asan City completes national river sluice gate smart infrastructure construction project. Chungnamilbo. Available online : <http://www.chungnamilbo.co.kr/news/articleView.html?idxno=550504> (Accessed on 28 October 2022).

Interviews

1. Kang, Ju-Yeop. Director General for Spatial Information Policy of MOLIT (at National Geographic Information Institute on 13 October 2022).
2. Lee, Kyeong-Su. Leader of Drone Operation Team of Asan City (at Asan City on 21 October 2022)
3. Jo, Gi-Woong. Leader of Smart GIS Team of Incheon Metropolitan City(at Smart GIO Expo on 3 November 2022)
4. Choi, Jong-Mook. Leader of Digital Twin Division of LX(at LX office on 8 August 2022)
5. Kim, Ick-Hoi, Leader of Smart Space Research Center of KRIHS(at Smart GIO Expo on 3 November 2022)



Article

Research on crisis Management of Tourism—COVID-19 and Communication Theory

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Abstract: Tourism has the characteristics of high comprehensive and close relevance which also determines its weakness of the vulnerability and the sensitivity. Caused by these weaknesses, tourism crisis is an inevitable phenomenon in the development of tourism industry. At present, the research for the tourism crisis management has become the important work of tourists destination countries and the government.

The COVID-19 has brought a huge negative impact to the tourism industry in China and the world, changing the trend of rapid development of the tourism industry in China and the world. On the basis of the study at home and abroad about tourism crisis literature, I put forward the concept of studying tourism crisis information dissemination and crisis management from the view of Communication.

Keywords: COVID-19; crisis management; Communication.

1. Introduction

In 2020, COVID-19 broke out globally. The outbreak has triggered a crisis in the tourism industry and has had a huge impact on the tourism industry in China and around the world. In the short term, COVID-19 has resulted in a sharp reduction in global population mobility and a significant drop in global tourism revenue. In the long run, the COVID-19 has broken the original development mode of various subsectors in the tourism industry, and some permanent, structural and fundamental changes have taken place or will take place in the tourism industry[2022: 36]. This makes the new outbreak different from any previous tourism crisis, such as "911" terrorist attacks, SARS, etc. as the latter short duration, the scope of the small effect, fast recovery, and the world the development degree of tourism, and the importance on the economy is relatively low.

After more than 20 years of development, China's tourism has become the important strength to promote China's economy to develop soundly and rapidly. But by the development of short time, their own vulnerability, global economic integration and other factors, the future diversity crisis is testing the ability of replying tourism industry crisis and sustainability in our country in all aspects.

2. Materials and Methods

By comparing and analyzing the supporting policies issued by the governments of China and the major economies in the world, such as the United States, Japan, and Italy, which are also important tourism market destinations, this paper suggests that the object of financial assistance and the amount of support should be determined from two dimensions, namely, the scale of tourism operators and the degree of damage. In addition, when formulating consumption incentive policies, the government must take into account the pressure brought by the policies on epidemic prevention and control, so the main incentive object should be to encourage local consumption[17-22].

First, the essay analyses the related concepts of Communication, the communication principles related with tourism crisis and the elements of information dissemination process related with tourism crisis in order to lay the theoretical foundation for further research. Second, as for the development of tourism crisis, we should establish early warning mechanism before crisis, strengthen information communication and disclosure in the crisis, focus on the image transmission after the crisis to formate the word of mouth. Last, drawing on the large-scale tourism crisis over the past decade occurred a home and abroad, we should absorb experience and lessons through the analysis of government departments and corporate crisis information dissemination and management measures.

3. scope

This study shows that due to COVID-19, tourism crisis and crisis are an eternal topic with a strong periodicity, and the emergence of crisis occurs along with the emergence of human society. In particular, the speed of the spread of the crisis has improved significantly under the background of accelerating information warfare due to the current integration of politics and economy. Firstly, "communication" related concepts, communication principles and factors related to the tourism crisis during the dissemination process of information are analyzed, laying a theoretical foundation for the follow-up study. Secondly, regarding the development of tourism crisis events, we should establish a warning mechanism in advance of crisis, strengthen information communication and announcement during crisis, and attach importance to image communication after crisis to form oral effect. Based on examples such as the May 12 special earthquake in China in 2008 and the March 12 Earthquake in Japan in 2011, experiences and lessons are taken through analysis of crisis information dissemination and management measures by government sectors and companies.

4. Conclusions

The COVID-19 pandemic has had a serious negative impact on the tourism industry in China and around the world, which had been enjoying rapid development and gradually increasing its role in the economy. For listed companies in China's tourism industry, the COVID-19 pandemic has caused huge losses in all segments of the tourism industry.

Tourism crisis management is a complex systematic project, mainly because the research involves a wide range of fields, and the occurrence probability of unexpected crisis in the future is increasing. Influenced by a series of crisis events, the study of tourism crisis has become the focus of academic research at home and abroad.

After years of development, China's tourism industry has made great achievements. The healthy and sustainable development of tourism is the common desire of tourism administration

departments, tourism enterprises and the public. Crisis is an objective existence that everyone does not want to face but cannot be avoided. Tourism crisis is an inevitable phenomenon in the development of tourism industry. It should be noted that from the fear of terrorism and infectious diseases 20 years ago to the calm calm in the face of natural disasters in recent years, the mentality of the government and the public has changed, and the way of crisis management has also changed. This is a great progress. However, due to the lack of a set of perfect crisis management system, compared with foreign countries, especially developed countries, China's tourism crisis management has many gaps in theoretical research and practice.

It is hoped that this study can play a role of throwing a brick to attract a marble, and truly build a perfect information communication and management system of tourism crisis, which can benefit the crisis management of government management departments and tourism enterprises and the sustainable and healthy development of China's tourism industry.

References

1. Li Feng. (2010). Destination Tourism Crisis Management Mechanism, Evaluation and Control Beijing: China Economic Publishing House. 2010: 13.
2. Hu et al. (2012). "Tourism Crisis Management System Based on Ecological Mechanism," Journal of Software vol. 7, no. 12, pp.2012: 2808-2815
3. Zhang Yuexi. (2017). Tourism crisis Management. 2017: 17-22
4. Malcolm Cooper. (2006). Japanese Tourism and the SARS Epidemic of 2003, Journal of Travel & Tourism Marketing. 19:2-3, 117-131.
5. <http://baike.baidu.com/view/41084.htm>019(12): 43-48.

Article

Research on the Prevention and Control Mechanism to College Internet Public Opinion

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Abstract: In recent years, online public opinion in colleges and universities has been happening constantly, and online public opinion cases triggered by students' release have often occurred. The college Internet public opinion, which has the characteristics of fast transmission, wide range channels, multiplicity Being highly concerned, poses a serious challenge to college security management. The enhancement of people's right protection and issue awareness, along with the convenience and promptness of We-Media information release, are important reasons for the online public opinion. Participation in college issues have become an important way for online public opinion to continuously upgrade. Relevant college administrators should improve their ability to identify, prevent and deal with risks and emergencies, and improve the response mechanism to online public opinion to safe and harmonious education and teaching environment in colleges and universities ties.

Keywords: College students; Network public opinion; Prevention and control mechanism

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The 50th Statistical Report on China's Internet Development (2022) shows that by June 2022, the number of Internet users in China has reached 1.051 billion, and the Internet penetration rate has reached 74.4%. [1] In the past three years, due to the impact of the Covid-19, almost all kinds of students in the country have taken classes online, which show the huge number of student Internet users. The university student group has a special nature and a large base, which is not only vulnerable to the impact of the complex Internet environment, but also the main force of online media. They often use microblog, WeChat, forums, Tiktok and other online communication tools to express their opinions and emotions on social cases and even school policies related to their own interests, causing widespread concern in society. If it is positive network public opinion, it should be encouraged. However, this kind of network public opinion is often negative. Failure to cope with it promptly or improper management and control will not only affect the ecological environment of normal education and teaching in colleges and universities, but also have a negative social impact on it, and even affect the ideological security of colleges and universities. We must prepare in advance. School should actively identify, study and judge the risks of online public opinion, predict and judge in advance, and build an effective control mechanism to college online public opinion.

1. Elements and Characteristics of College Network Public Opinion

1.1. Elements of College Network Public Opinion

Network public opinion is a kind of ideological interaction behavior of network society in a special field. It is formed by the joint action of specific interaction subject, inter-

action object, interaction content, interaction path and other elements. The college network public opinion is a form of expression of various network public opinions. To deal with the college network public opinion, we must first clarify its constituent elements, clarify the interaction between them, and identify the public opinion risk as soon as possible.

Like other elements of network public opinion, college network public opinion is also composed of interactive subject, interactive object, interactive approach and interactive content. The interactive subject of college network public opinion refers to those who participate in the interaction of a certain network case, including college teachers and students, as well as other people who are interested in and express their opinions about the network case, but mainly college teachers and students. When they express their opinions about a network case, they either express feelings according to their own value judgments, or are followed by opinion leaders. The interactive object of college network public opinion refers to the source of network cases spreading in the interaction process. It mainly refers to various hot topics and cases related to colleges and universities, such as political issues, ideological issues and campus incidents (campus life, teachers' ethics, academic fraud, campus violence, school governance, etc.). The interaction approach of college online public opinion refers to contemporary online media and We-Media such as Tiktok, Bilibili, Weibo, QQ, WeChat and other social platforms, by which interactive subject publishes and spreads the source of college online cases(interactive object) Various contemporary network platforms have basically achieved deep integration. Once a university network case occur, words, pictures, audios and videos related to it will soon appear in various network platforms. The high speed and wide scope of transmission are beyond many people's recognition. The interactive content of college network public opinion refers to a kind of ideological interaction behavior in which the interactive subject expresses their views, opinions and attitudes about the interactive object by means of interactive channels. The interactive subject may have the same and similar ideas and values, or the opposite ones. If the views or opinions related to a certain school network case source are basically the same, it will inevitably cause a serious network public opinion event in colleges and universities. How to properly and rationally deal with it is really a test to schools' emergency response capability and emergency management level.

The elements of college network public opinion are not statically isolated, but a dynamic process of interaction and influence. College emergencies can easily become the focus and hot topic of public opinion. Interactive subjects often express their opinions, exchange views, and even discuss and argue enthusiastically through social platforms based on their own understanding, thus forming online public opinion cases. If we clarify the elements of college network public opinion and their functions and roles in network public opinion, we can identify risks pertinently.

2.2 Characteristics of College Network Public Opinion

As a part of educational public opinion and social public opinion, college network public opinion has the common characteristics of various public opinions as well as its own features.

First, the particularity of the interactive subject of college online public opinion. As mentioned above, the interactive subjects of college online public opinion are mainly college teachers and students. With high scientific and technological quality and high educational level, they are the high-quality groups in society. College students are also quick and active in thinking and keep up with the trend of the times. Although their proportion is not high, the total number of teachers and students in colleges and universities in China only make up 3.1% of the total population in 2020 and 4.43% of the Internet users [2]. However, their questions, opinions, perspective of thinking, operation and application of the network, and possession of information are beyond the reach of other ordinary groups. College teachers and students are the main participants and active promoters of college network public opinion. Once the campus events become the hot or sensitive topics on the

campus network, college network public opinion will be spread and transmitted through multiple channels and forms. Social platforms such as WeChat, Weibo and QQ have accelerated the spread of public opinion and expanded the scope of public opinion, consequently, have a small case spread to every corner of the world in a short time and become a hot social topic. Especially college students' outlook of world, view of life and values are still in the process of forming. Their understanding of things is not objective enough, and their emotions are more impulsive. It is very likely that there will be widespread discussion about a certain social case or hot issue, and even rumor spreading. Under the rapid fermentation of the Internet, it will have a negative impact on college management and other students' normal study and life.

Second, the complexity of the interactive object of college network public opinion. The particularity of the interactive subject of university network public opinion determines that its interactive object must be diverse and complex. Hot topics of current affairs, teachers' ethics, ideology, campus security, school management and daily life can all enter the vision of the interactive subject, and become a hot public opinion issue to the interactive subject. As for the risk sources of college public opinion, 19% of them are involved with teachers' ethics. [3] For example, "The volunteer teacher from Dalian University of Technology scolded students for being 'foolish and stupid'" A male teacher of Zhengzhou Business College harasses students and is dismissed "and so on. All these belong to such incidents. Campus security is also the hot topic. Thus, colleges and universities have also become an important part of the risk society. College security incidents often happen, the death of a graduate student from Lanzhou Jiaotong University, the poisoning case of Lin Senhao in Fudan University, and the campus tragedy of a female college student in Anhui due to puppy love and other campus security events make up 13% of the college network public opinion. The college public opinion events related to campus management make up 16%, mainly including various public opinion events and subsequent impacts caused by school daily management and operation, campus rules and regulations, such as several public opinion cases caused by food delivery during epidemic control period, foreign students' partners in Shandong University, and students from Xi'an International Studies University yelled in the dormitory building collectively for being dissatisfied with the long-term closure. The proportion of ideological events is only 5%, but such events have huge influence in the field of public opinion and ideology. For example, Liang Yanping from Hubei University made wrong remarks on the social platform, and a teacher from Shanghai Zhendan vocational College questioned "Nanjing Massacre 300,000 victims" in class. Of course, not all the events are caused by the public opinion fermentation of problem events. One third of online discussions are non-emergency events, such as entertainment cases and other daily life cases.

Third, the non-rationality of the interactive content of college network public opinion. The interactive content of online public opinion not only has the rational characteristics of thinking, discussing, and expressing opinions according to the evolution of events and rational logic, but also has the irrational characteristics of expressing thoughts and venting emotions without logic thinking of events. This is closely related to people's irrational recognition. When Involved in the network public opinion, most people, including the college students who are still in the formation period of world outlook, view of life and values, will emotionally make comments. They may make a very simple and tiny event complicated on the Internet, or even trigger online public opinion. For example, the online public opinion event caused by the need to isolate dormitories for epidemic prevention and control in a university in Zhengzhou, in which a female student not only made abusive remarks " school leaders, please be human beings" on the Internet, but also posted online calling for collective boycott; there is another case that a freshman girl published in her Wechat Moments that "I will not eat this breakfast even if I am starving to death" and that "the cheap breakfast make me sick?" to express their dissatisfaction with the breakfast delivered by the teacher. Afterwards, the students apologized in public. This

kind of public opinion shows that the subject of college online public opinion, when expressing opinions on some interactive objects, is arbitrary and irrational

Fourth, the college public opinion events have received high social attention. The sexual harassment incident of Zhang Peng, a professor of Sun Yat-sen University, and Professor Wu from Inner Mongolia University of Finance and Economics were exposed through the WeChat. Zhai Tianlin, a postdoctoral actor of Peking University, doesn't know what CNKI is, which was exposed through the live broadcast platform. Later netizens exposed that the repetition rate of his graduation thesis was as high as 40%, and then his well-educated profile was collapsed; a dean of South China University of Technology tampered with the postgraduate entrance examination grades, which was exposed through microblog. In terms of the source communication, the college public opinion is not only spread through personal accounts such as microblog and WeChat, but also in public gathering areas such as WeChat public platform, Zhihu and forums with the characteristics of diversified communication channels. In terms of the informant, the public opinion disclosure also shows the characteristics of public participation. From the perspective of the types of public opinion events, topics such as school management, campus security, education fairness, teachers' words and deeds, and violations of discipline have attracted the attention of netizens. [4] In the reality of diversified values, after a social event is "detonated" on the Internet, it is often transmitted in an interactive rather than linear way involving thousands of people, with college students as the main force of communication. College students' thinking is extremely active, and they are at the stage of increasing their knowledge. They are highly curious about new things. However, some of them are not self-disciplined, and are vulnerable to the influence of wrong ideas or concepts. Once the psychology of college students' netizens is motivated, the college online social public opinion will rapidly ferment and spread. Without effective control, the college network public opinion will easily damage the ecological network environment in colleges and universities.

2. Problems in risk control of college online public opinion

The online interaction meets college students' needs to express their opinions freely, conveniently and emotionally, but it also brings many negative effects, such as rumor spread, online violence, which affects college students' physical and mental health, increases the difficulty of campus management and control, and impacts the safe, stable and harmonious ecology of campus. At present, colleges and universities have the following problems in public opinion risk management and control.

2.1 Inadequate active guidance of online public opinion

Colleges' ineffective response is not only reflected in how to deal with the public opinion after the event happened, but also in how to actively guide it before the event. As President Xi said that "the mainstream media has to control the dominant public opinion." According to the disposal of college network public opinion events, the emphasis is on passive disposal afterwards. First, most colleges and universities are still in the passive response stage, and some even "keep silent" when facing negative news, which make colleges' statements incredible to teachers, students and social netizens. For example, the "student partner" event happened in Shandong University in 2019, a netizen firstly broke the news on the social platform on July 6, to July 10, the event was reported on all well-known websites, mainstream media and We-Media, the "student partner" event continued to ferment, but the school never actively responded to it, let alone active guidance; five days later, Shandong University published a statement and apologized on the official microblog. However, many netizens did not agree to it, and the public opinion still tended to "Shandong University worships foreign things and fawn on foreigners". Second, although relevant school leaders realize that they have the most responsibility to handle online public opinion events, they ignore that campuses are also the risk source of online

public opinion events. Due to the lack of active and effective ideological and moral guidance in the early stage, ideological and political education has not been implemented into students' daily behaviors. Sometimes relevant managers protect students' illegal behaviors, providing a space for the growth of negative effects in the process of online public opinion transmission. Thus, it is at a disadvantaged position in the later treatment process.

2.2 Irregular disposal procedure of network public opinion

After the emergence of online public opinion, most colleges and universities can take proactive, compliant and reasonable steps, restore the whole process and handling results of the event through public opinion, and respond to public suspicion in time to avoid online rumors; the school should be internally managed according to the laws and regulations, and relevant events should be handled legally and reasonably in accordance with the laws, school rules and disciplines. Faced with the rapid development of online media, some colleges and universities not only lack risk identification, research and judgment on possible online public opinion, but also lead to improper disposal due to their imperfect public opinion management mechanism after the occurrence of online public opinion events, which brings a lot of trouble to effective online public opinion management. The anomie of online public opinion processing procedure is mainly manifested in the following aspects: first, using public opinion to cover up the fault, affecting the progress of public opinion event management and control. When an online public opinion event occurs, some colleges and universities do not restore the truth of the event at the first time but find excuses to cover up the truth of the public opinion. For example, in the early stage of the public opinion event of "Sun Yat-sen University professor sexual harassment", the relevant departments kept silent and deleted posts. Later, the university did not respond to the event through relevant school media, which led to further fermentation of the event, and school was reprimanded, whoes actions of deleting posts and questioning the punishment became the main focus to netizens, and call on colleges and universities to establish a defense mechanism. Second, there was no standardized control mechanism for online public opinion before, during and after the event, or even closed the communication channel, waiting for the public opinion to resolve itself. This problem existed in the handling of the "student partner" incident. The campus closed the post bar, microblog comments and messages, etc., and consequently lost the best opportunity to deal with the public opinion event. Third, there are some misplacements and deviations in the online public opinion disposal procedures, which cause the credibility of colleges and universities to be questioned, increasing the possibility of a second outbreak of public opinion events, such as "student partner" public opinion event, and Sun Yat-sen University's handling of the "sexual harassment" public opinion event.

2.3 Time lage of Network public opinion control measures

The supervision of public opinion is a part of the college network public opinion, which has the characteristics of openness, timeliness, and the courage to tell the truth. These characteristics greatly mobilize the enthusiasm and initiative of college teachers and students to participate in school management, so that teachers and students also have their own voice, and teachers and students can truly and fully express their wishes and views. At the same time, we should also see that the network is still a space for some teachers and students to vent their emotions and spread bad public opinion, otherwise, once the network public opinion event suddenly occurs, colleges and universities will be unable to cope with it. In fact, colleges and universities often lack fast, effective and specific governance measures when dealing with online public opinion events, which make it difficult to deal with the rapid fission effect of online public opinion. First, we did not respond promptly and quickly. In 2017, when the doctoral student of Xi'an Jiaotong University committed suicide by throwing himself into the river, his family members released a complaint on Weibo, which triggered a wave of public opinion. It took nearly half a

month for the school to make its first response. Second, the response measures are lagging behind. Once a public opinion event occurs, some colleges and universities are just at the end of the response chain. They pay more attention to block the online public opinion event than to deal with it. They usually use the time-consuming and inefficient methods of talking one by one, blocking information, stopping speech, etc., lacking effective measures to control the event. For example the Taochongyuan case of Wuhan University of Technology. It received high online attention. The school did not respond to it officially but deleted the post at the first time and the closure of the comment function of this micro blog has aroused strong resentment among netizens. Third, lack of risk research and judgment. Colleges and universities generally lack real-time monitoring of risk cases, and cannot effectively control the changes of it in time. There is also a lack of experience summary after public opinion cases, or students involved are only handled according to school rules and disciplines.

3. Causes of College Network Public Opinion Cases

3.1 Inadequate identification of college public opinion risk promotes crisis escalation

The lack of college public opinion risk identification is mainly manifested in two aspects: first, there is no effective public opinion monitoring to public opinion case risk points, which leads to the lag discovery of public opinion. Although the public opinion risk points are hidden, they can be detected. In the management of college public opinion cases, common high-frequency risk points have certain time rules and generation rules. Colleges and universities can effectively monitor public opinion risk points based on the understanding of public opinion cases. For example, in the case of "professor Chen sexual harassment [5]" in a university in Beijing, on October 13, 2017, an insider put on a post on Zhihu and exposed Chen's suspicion of sexual harassment. On October 15, Luo, another insider, replied to Zhihu about his experience, and later the post was deleted. On January 1, 2018, Luo published a real-name blog on Sina Weibo, claiming that Chen, a professor of a university in Beijing and a Changjiang scholar, sexually harassed his female students. Once the article was released, it caused hot discussions, and public opinion explored. The public opinion risk point in the case was hidden in the popular new media platform for three months. The university did not timely and effectively monitor the risk point, leading to a greater outbreak of public opinion. Second, colleges and universities did not pay enough attention to the existing public opinion risk points, and missed the best time to deal with public opinion. In the case of "Zhai's academic fraud" [6] in February 2018, a netizen revealed through social media that a paper published by Professor Huang, a university in Anhui, was suspected of plagiarizing a paper published in 2006. The school did not pay attention to the public opinion risk points until February 8, 2019, when Zhai said "What is the CNKI?" and other reports such as "Zhai does not know the CNKI?" immediately became a hot topic, and then the People's Daily and other official media forwarded comments one after another. The public opinion broke out in a large scale. The school officially responded to the public opinion several days after the outbreak. If colleges and universities can pay attention to the public opinion risk points that have been exposed before, and dispose of the risk points before the formation, the impact of public opinion cases may not continue to spread.

3.2 College students' psychological needs promote the spread of online public opinion cases

As an informal information dissemination, the dissemination of online public opinion cases is poorly constrained by the laws and regulations and has a low demand for interaction. However, as the main body of communication, college students' consciousness of subjectivity has been constantly enhanced, and the emergence of various new media has met their interactive needs to seek differences, novelty, and promptness, which increase the frequency of college students' participation in the social network interaction. College students are the main internet users. Their studying, living or entertaining and

obtaining information are deeply involved in the network. Compared with traditional information carriers such as books or traditional media such as newspapers and periodicals, college students are more inclined to obtain information conveniently by choosing the network to meet their various needs. For example, online social platforms such as "Zhihu", which is a Q-A app, are based on the young college students' needs, which rely on the network to seek knowledge. College students are basically between the ages of 18 and 24. They have strong extraversion in social interaction and tend to seek space to express their new and strange views, opinions and attitudes in online interaction. Therefore, on the one hand, college students, as information receivers, participate in the dissemination of cases, meeting their diversified information needs; on the other hand, college students, as information senders, can freely express themselves, strengthen their sense of social subjectivity, and obtain certain social attention through network communication, meeting the special psychological needs of this age stage. Although this interaction enhances college students' subjective consciousness, young students, limited by the characteristics of emotion and recognition, are very easy to express his understanding to case, making public opinion cases distorted in the process of transmission, and even causing rumors. [7]

3.3 Group information exchange accelerates the spread of network public opinion cases

The precondition for the emergence of online public opinion is the interaction between information disseminators. The interaction is mainly manifested in the cooperation between information producers and disseminators. After obtaining the extra content, the information receiver will try to obtain much more through discussion and exchange. This exchange shows cooperation in social interaction, through which more rich information can be obtained. The main form of social network interaction among college students is cooperation and interaction. The Internet provides technical support for college students' social cooperation and interaction. The Internet information platform breaks the boundaries of time and space, reduces the communication cost, provides a convenient platform for public opinion communication, and realizes the public opinion information exchange anytime and anywhere. College students themselves provide emotional support for the cooperative behavior. College students have some common in the process of network interaction, and are easy to attract each other, which is an important emotional factor to achieve cooperation. Affected by interest and age, college students are easy to form various temporary informal organizations on the network to share and circulate internal information. The cooperation and interaction of information exchange make up for the blind spots of young students' information acquisition. However, in the process of communication, communicators constantly process information. In the process of expressing their own ideas and attitudes, they are very easy to attract people with the same or similar views. The greater the aggregation becomes, the more satisfied the demands get. Therefore, under the pressure of external public opinion, communicators will process the content to arouse more people's recognition and meet their psychological needs. As a result of this chain effect, the spread of online public opinion has gradually been beyond control, and individual behavior has gradually become collective behavior. This kind of group pressure makes young students lack rational judgment in communication, more vulnerable to the influence of emotions, and easily lead to rumors. It can be seen that from the perspective of social interaction, with the young college students as the main participation group, college online interaction has accelerated the spread of online public opinion cases through interactions within individual, among individuals, and between groups, and has also increased the difficulty in controlling online public opinion cases.

4. Prevention and Control Strategy of College Network Public Opinion Risk

As president Xi Jinping said: "The network is a double-edged sword. A picture or a video can form explosive communication within a few hours through full media, which has a great impact on the public opinion field." [8] As an open platform, the Internet is

not only a place for various ideological and cultural conflicts, but also an important space for ideological work. Paying attention to timing, taking care of sensitive content, and adopting scientific and reasonable monitoring means are important prerequisites for effective prevention, control and channelling college students' online public opinion. At the same time, we should also be deeply aware that "doing well in online public opinion is a long-term task". [9] In the face of the current situation of the development of college network public opinion, we should build the prevention, control and guidance strategies for college students' network public opinion. First, we should form a scientific and reasonable monitoring process, design a practical and effective analysis model, and comprehensively use computer technology, statistical analysis technology and other technical means to achieve early warning; The second is to conduct rational and prudent research and judgment, and implement public opinion guidance by focusing on special timing and mobilizing the strength of all parties.

4.1 Improve public opinion risk identification mechanism

Colleges and universities should build a digital campus system, set up public opinion monitoring centers to carry out daily public opinion monitoring work, and focus on monitoring the university's microblog platform, Tiktok, We Media account, post bar, forum, etc. so as to timely grasp the information of public opinion risk points, identify public opinion signs as soon as possible based on online and offline information, predict possible public opinion risks, and resolve its hidden dangers in the germination period, prevention and response measures should be taken in advance to avoid the continuous fermentation of negative emotions of teachers and students, and the three-dimensional public opinion monitoring system should be improved vertically and horizontally. Once public opinion risk points are found or abnormal data of public opinion are monitored, a public opinion response team shall be established to carefully study and analyze the trend of online public opinion cases, build an indicator set for core elements of online public opinion risk propagation, and transform the models involved in emotional calculation, variable extraction, data fitting and risk calculation into automatic and intelligent calculation of online public opinion risk monitoring, and handle the small probability problems with large probability thinking. While saving the time of public opinion risk calculation, it ensures the integrity of public opinion monitoring data and the accuracy of risk identification, thus promoting the integration of "in-depth analysis plus monitoring abnormality" of public opinion risk. In addition, in the fading period of the risk evolution of network public opinion case, we should still be on guard all the time. We should track the dynamics, development and changes of network public opinion related cases in real time, identify the trigger points that cause similar events, identify public opinion risk factors in time, and prevent the "ashes of public opinion" from re-burning, so as to minimize the impact of public emergencies on college teachers and students.

4.2 Build early warning and response mechanism of public opinion

To build an early warning mechanism, on the one hand, the college network information department can take the lead to build an early warning platform for the analysis of campus network public opinion, implement the dynamic monitoring of college students' network public opinion, comprehensively realize the daily analysis and research of college students' network public opinion, regularly submit public opinion analysis reports to leaders of relevant departments and front-line ideological and political workers in colleges and universities, and promote the normalization of college network public opinion risk prevention and control. It provides decision-making reference for the specific implementation of ideological and political work in colleges and universities. On the other hand, we can build a cooperation platform among universities and enterprises, establish a professional public opinion analysis working group, invite authoritative experts to participate in daily public opinion information analysis, jointly develop a dynamic monitoring

system for online public opinion, build a monitoring database for college online public opinion, and conduct data mining for college online public opinion. It can regularly form online public opinion analysis reports, summarize the distribution rules of public opinion, provide decision-making basis for ideological and political work in colleges and universities, and ensure the comprehensiveness, scientificity and authority of public opinion research and judgment. In building the emergency response mechanism, on the one hand, it is necessary to improve the staff's ability to crisis management in colleges and universities' propaganda, so that they can orderly control the crisis when the response to public opinion emergencies in the Internet era is shortened from "golden 24 hours" to "golden 4 hours". On the other hand, it is necessary to form and improve the emergency response plan for college students' online public opinion cases, including clarifying the nature of the case, determining the crisis level, conducting risk assessment, defining the responsible subject, providing information support and security, coordinating multi-level linkage, and carrying out late closure, etc. It is also necessary to summarize experience and lessons from the case and update the plan in time.

4.3 Cultivating a professional team to prevent, control and guide public opinion

To establish a full-time and part-time team for public opinion prevention, control and persuasion, we should first take the cooperation spirit Collaborative operation is not a simple combination, but a real cohesion of the best talents and the most advantageous resources and through system innovation to form a team with combat effectiveness, openness and stability for a long time. It is necessary to organically combine flexible academic power with rigid administrative power, establish a coordination mechanism of "advantages winning, orderly development and common growth", integrate superior resources, attract talents from different disciplines, build a "jungle team", achieve "the team goal and individual development", to ensure that team members can fight alone as well as fight in groups, and truly achieve "1+1>2", to enable everyone to participate passionately, create interactively, and constantly sublimate the spirit of cooperation in pursuit of excellence in the optimal environment of symbiosis and growth. In terms of specific measures, it is necessary to establish a school public opinion work committee under the school leaders' responsibility, integrate the department of the party committee, the student office, the school youth league committee, the network center, the security office, the secondary college and other departments, establish a full-time and part-time public opinion work team, form a public opinion work network with clear division of labor, horizontal communication, vertical management, information sharing and coverage of the whole school, to ensure the effectiveness of public opinion management, public opinion guidance and public opinion research. We should build a network public opinion team that "schools have leaders, departments have experts, and students have leaders", face up to the changes in the ecological environment of public opinion work, do well in cultivating network information commentators, network technicians, and network opinion leaders, and cultivate a positive network team. At the same time, we should also give full play to the advantages of big data, strengthen the research on the model of big data application in ideological and political education. In terms of data application, we should not only pay attention to the horizontal dimensions such as learning, life and employment of educational objects, but also pay attention to the vertical dimensions such as education level and growth psychological characteristics of educational objects at different stages, so as to maximize the role of big data and help us understand and accurately grasp the evolution law of college online public opinion and start targeted education work.

4.4 Implement online and offline ideological and political education

College students are inevitably confronted with online language violence, infringement of personal rights and even ideological penetration in the Internet. In coping with it, college students may feel uneasy, lost, depressed and confused, and even have psychological problems. Therefore, it is necessary to promote online and off-line ideological and

political education, and regard "maintaining the security of network ideology as an important mission [10]". College students are supposed to form a correct understanding of the role, advantages and harms of the Internet, to be able to rationally and objectively analyze various phenomena on the Internet, especially on public opinion cases related to ideological security, to firmly stand or even consciously fight against such phenomena, and to become the civilized internet users. It is necessary to popularize legal knowledge and common sense, and guide college students to form a sense of self-protection. This will not only enable college students to maintain their rights and interests reasonably and legally when they are violated, but also enable college students to form a sense of network security, understand that the Internet is in under the law and consciously abide by the law; we should strengthen the emotional guidance of college students, give them humanistic care in real life, help them solve the troubles and frustrations encountered in their growth with love and responsibility, and avoid excessive emotional dependence on the Internet; we should have the courage to speak out on the internet, implement correct value guidance for college students, cultivate college students' dialectical thinking and enable college students to participate in life and study with a more positive attitude.

References

1. China Internet Network Information Center. The 50th Statistical Report on Internet Development in China [EB/OL]. (2022-08-31) <http://www.cnnic.net.cn/n4/2022/0914/c88-10226.html>.
2. The 47th Statistical Report on China's Internet Development [EB/OL]. (2021-02-03) <http://www.cnnic.net.cn/n4/2022/0401/c88-1125.html>
3. Lang Han laughs Research on the Current Situation of Public Opinion in Colleges and Universities in China and Its Countermeasures [D]. Lanzhou University, 2022. DOI: 10.27204/d.cnki.glzhu.2022.000837
4. Zhang, Lei; Liu, Xiaoli. Research on governance dilemma and coping mechanism of negative public opinion derived from college emergencies in the new era [J]. Journal of Social Sciences of Shanxi Universities, 2022,34 (04): 43-46+53. DOI: 10.16396/j.cnki.sxgskxb.2022.04.008
5. Beihang: Professor Chen Xiaowu was disqualified from teaching because of sexual harassment [EB/OL]. (2018-01-12) <https://baijiahao.baidu.com/s?id=1589370109389759848&wfr=spider&for=pc>.
6. People's Online Review: Doctor Cracking Down on Counterfeit and Making Academic Pure [EB/OL]. (2019-02-13) <http://opinion.people.com.cn/n1/2019/0213/c1003-30662047.html>.
7. Li, Huijie. Research on Countermeasures of Network Public Opinion for Emergencies in the New Media Era [J]. News Communication, 2022 (06): 115-116.
8. Excerpt from Xi Jinping's discussion on preventing risk challenges and responding to emergencies [M]. Central Literature Publishing House, 2020, 46.
9. Xi, Jinping. Speech at the First Meeting of the Central Leading Group for Network Security and informationize. [EB/OL]. (2014-02-27) [2022-06-26]. <http://cpc.people.com.cn/n/2014/0227/c64094-24486402.html>.
10. Excerpt from Xi Jinping's discussion on preventing risk challenges and responding to emergencies [M]. Central Literature Publishing House, 2020, 40.

Article

Improving Disaster Resource Allocation in Smart Cities Based on Social Media

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Abstract: The disaster resources allocation is an important part of promoting the disaster management in smart cities. Under the background of big data era, building emergency material allocation mode based on real-time information update of social media data can effectively solve the problem of emergency material allocation in the past to achieving the goal of accurate allocation of disaster emergency relief resources. In this paper, combined with social media, the configuration mode of emergency resources for sudden disasters is constructed based on four specific modules: demand prediction, scheduling optimization, targeted distribution and satisfaction survey of disaster victims; It is pointed out that to realize the effective operation of this configuration mode, this mode can promote the traditional disaster emergency management to develop in the direction of refinement and precision.

Keywords: disaster resources allocation; smart cities; disaster management; social media

1. Introduction

In recent years, various major emergencies have occurred frequently, with natural disasters such as earthquakes and torrential rains, and medical and health events such as the New Crown epidemic all bringing huge disaster losses to people's production and life. With economic development and social prosperity, all kinds of disasters that appear at this stage may have a serious impact on the country's economic and social development and also putting forward new requirements for the government and related departments to actively respond to emergencies and improve their emergency management capabilities. Emergency management is one of the important functions of the government. In the face of disasters that may come at any time, how to manage emergency supplies is also an important manifestation of the government's administrative capabilities.

In recent years, the Internet of Things (IoT) has introduced a whole new set of challenges and opportunities by transforming objects of everyday life in communicating devices [1]. Moreover, with the advent of the IoT, the concept of Smart City has become even more popular in the last few years [2]. Smart City applications will transform a wide range of services in different domains of urban life, for instance, by creating intelligent smart grid networks, improving public transportation, developing smart car parking and real-time industrial automation applications and reducing traffic congestion. In recent years, with the rapid development of network information technology, such as IoT, cloud computing, big data and so on, city presents a development trend of networking, distributed, intelligence [3]. And the new concept and development model called smart city (SC) has been proposed and become the subject of increasing attention and it now appears as a new paradigm of intelligent city development and sustainable socio-economic growth [4].

As we know, a smart city should be able to optimize the use and exploitation of both tangible (e.g., transport infrastructures, energy distribution networks, natural resources)

and intangible assets (e.g., human capital, intellectual capital of companies, and organizational capital in public administration bodies) in real time anywhere. It opens up a wealth of opportunities for different emergency management applications, such as flood, fire, earthquake emergency rescue and disaster relief, anti-terrorism, remote control of hazardous area and so on [5]. More attention has been paid to the emergency resource scheduling and allocation, and the smart city is no longer confined to the traditional area, which can predict the coming emergency event and real time management by using the new information technology and smart city system that cannot be realized in the past. Emergency resource is the supporting element after the accident, the efficiency of its allocation and scheduling is one of the primary embodiments of emergency response capacity [6, 7]. Besides the object of emergency management is to get the whole success because the derivative emergency often occurs and many kinds of danger are interweaved. The time that resource reaches the demand and the amount are the most important factors related to the efficiency of emergency management [8, 9].

In particular, with the development of the Internet and the popularity of smart phones in recent years, the number of Internet users in China is increasing. Once an emergency occurs, social networks and various online media platforms can easily attract widespread attention from the society and trigger public discussion. At the same time, in emergency response, the online network can quickly update and cover all aspects of emergency information by disseminating information about the disaster location and material demand, facilitate the provision of point-to-point material assistance for the disaster affected points in real time, provide important clues for real-time disaster perception and real-time broadcast of rescue progress, and improve the efficiency of emergency material allocation. Therefore, the purpose of this paper is to improve emergency resources allocation based on social media.

2. Theoretical Background

2.1 Smart City

smart cities are viewed as urban places with ubiquitous computing and digitally instrumented devices built into the very fabric of urban environments. Examples include wireless telecom networks, digitally controlled utility services and transport infrastructure, sensor and camera networks, building management systems, smart phones producing data about resident's location, and activity etc. [10]. These can make a city “knowable and controllable” and ultimately improve the performance and delivery of public services. A second view of smart cities is broader: this is seen as the development of knowledge economy within a city driven by ICT as a central platform. The entire ecosystem (economy, community, infrastructure, environment) should be managed having ICT as one of the central platform [11]. Smart city and argued that smart cities should include smart economy (competitiveness and entrepreneurship), smart people (social and human capital), smart governance (participation in decision making), smart mobility (transport and ICT), smart environment (sustainable resource management and smart living (quality of life)). In both schools of thought, however, a common theme is the need to enhance the sustainability and resilience of the city as a whole.

2.2 Emergency Resources

The emergency resources mainly refer to the resources that must be met in order to timely and properly resettle the affected people after major natural disasters or public emergencies [12]. At present, there are four common classification methods for emergency resources: (1) Classified according to emergency. When unexpected events occur, the urgency and time of emergency resources demand are different, which constitutes different emergencies of emergency resources. Specifically, it can be divided into three different levels: general, serious and emergency [13]. (2) Classified according to the scope of use. According to the scope of use, emergency resources can be classified into two different

categories: general and special. For general resources, it mainly refers to emergency resources that can be applied to most emergencies after the occurrence of emergencies, such as drinking water, medicine, food, etc. Special resources mainly refer to resources equipped around a specific event or with special needs. For example, medical resources and vaccines are special resources [14]. (3) Classification according to disaster category. Different disasters require different types of emergency supplies. From this perspective, it mainly includes natural disasters, public health events, social disasters, economic security events and other different ways. Each type of emergency resources corresponds to the resources needed for this type of emergency, such as resources for natural disasters, which are mainly related to the types of resources that need to be supplemented in the event of natural disasters [15]. Specifically, they can be subdivided, such as earthquake disasters, floods and fires. (4) Classified by physical use. For emergency resources, different types play different roles. In combination with the relevant use requirements of emergency resources, the Chinese government has divided emergency resources into three major categories, 16 medium categories and 65 sub categories [16].

2.3 Social Media

Social media is a broad term for a variety of web-based platforms and services that allow users to develop public or semi-public profiles and content, and to connect with other users' profiles and content [17]. Social media is a virtual community where in one can share information and thoughts and enable people to conduct online communications intended for interaction, community input, and collaboration [18]. As of 2021, over 4.26 billion people were using social media, a number projected to increase to almost 6 billion in 2027 as infrastructure development and the availability of mobile devices. Social media is an integral part of daily internet usage. On average, internet users spend 144 minutes per day on social media and messaging apps, an increase of more than half an hour since 2015. Due to the COVID-19 outbreak in 2020, all major social media platforms saw an increase in daily usage [19].

Under the traditional disaster emergency management mode, the decision of emergency material allocation is mostly based on the intuitive decision of personal experience and the case reasoning decision of historical experience. In the fourth industrial revolution era, the laws and forms of sudden disasters are also changing gradually. Social media can release and track effective information with important decision-making value, which can provide a basis for the accurate allocation of disaster emergency resources and its model construction. With the help of social media, the information in the stages of material demand, scheduling and distribution in the disaster response process can be transformed into various forms of big data. By analyzing the disaster situation and public opinion information big data sets, you can design the optimal distribution route of emergency resources under the disaster scenario, and then optimize the allocation of resources according to the time-space law of disaster occurrence [20]. It can be seen that the application of social media to the construction of emergency material allocation model can make it possible to improve the accuracy of emergency material allocation decisions under the background of high time pressure and high uncertainty, and provide decision-making and management tools for refined emergency management.

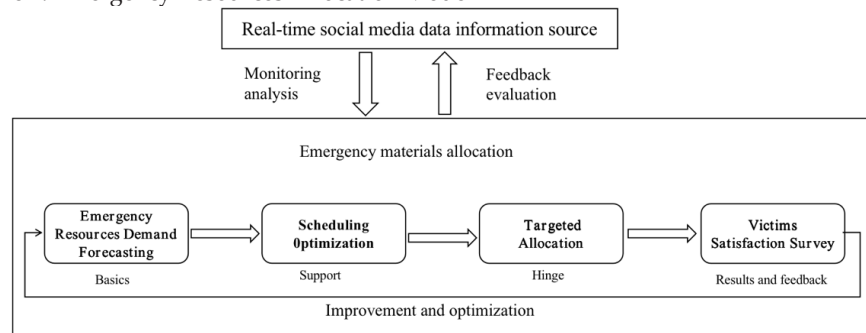
3. Emergency Resources Allocation Mode using Social Media

In order to solve many problems such as mismatch between supply and demand of resources, insufficient emergency decision-making targeting capability, and error in emergency management, the demand estimation is inaccurate due to the lack of information on disasters, disaster situations, and victims in the process of emergency rescue resources allocation at this stage. With the accuracy of emergency material allocation as the primary goal, build a disaster emergency material allocation mode based on real-time information update of social media data. Realize the collection, storage, analysis, early warning, response and decision-making of emergency disaster information data. With the help of the

synchronization between the update and evolution of social media information sources and information mining, accurately locate the material demand groups and their actual material needs, improve the accuracy and efficiency of emergency material allocation, and effectively solve the problem of supply and demand mismatch between the government's emergency material allocation and the needs of disaster victims, Reduce all kinds of losses caused by material shortage in disaster areas, so as to promote the accurate development of disaster emergency management [20].

The accurate allocation mode of disaster emergency resources based on real-time information update of social media is mainly divided into four specific modules, emergency resources demand forecasting, scheduling optimization, targeted allocation and victims satisfaction survey.

Figure 1. Emergency Resources Allocation Mode



(1) Emergency resources demand forecasting. With the gradual development of rescue activities, disaster information is constantly changing. In order to improve the accuracy of emergency material demand prediction, relevant decision makers must combine social media technology to collect real-time demand information of victims and update the existing disaster data information in real time. First, through the government portal, microblog, WeChat, and other social media platforms, as well as news media, GPS and other Internet of Things information channels such as sudden disaster information, a multi-dimensional multi-source real-time dynamic information source is formed, and big data analysis technology is used to deeply explore the demand characteristics of disaster areas; Secondly, the time and geographical location information contained in the social media data can detect the microblog text seeking help in disasters, draw the continuous evolution trend chart of material demand in disaster areas, and provide decision-making basis for accurate distribution of relief resources.

(2) Scheduling optimization. Use social media data technology to obtain real-time geographic information and real-time disaster information such as disaster level, scope of influence, road damage, etc. Reasonably adjust material dispatching logistics through real-time massive data extraction and analysis. At the same time, according to the collected real-time disaster situation, victims, rescue, and material demand information, timely modify the path constraints of material scheduling, determine the targeted supply order of emergency rescue at the disaster site, reasonably plan the rescue route of emergency vehicles, deeply explore the optimization mechanism of accurate scheduling of emergency resources with multiple rescue points and multiple demand points, and explore the optimization scheme to effectively improve the efficiency of emergency material scheduling.

(3) Scheduling optimization. Identify and extract disaster information through social media data to form a real-time big data disaster information source, capture personalized data in real time, track the personalized needs of different disaster stricken areas, and then provide more targeted material assistance and services according to the characteristics of different disaster victims, and form an integrated and coordinated disaster stricken area

material distribution scheme in combination with the initial recommendation scheme to achieve accurate targeted distribution of emergency resources.

(4) Victims satisfaction survey. The survey on the satisfaction of disaster victims in the process of disaster emergency material allocation will help to identify the shortcomings in the process of disaster emergency material allocation and continuously optimize the material allocation mode. Obtain the big data of disaster victims' satisfaction through sampling survey, online survey, interview and other methods, collect, analyze, summarize and evaluate the actual disaster emergency material allocation process, effect and disaster victims' satisfaction, find problems and timely feed back, and then summarize and propose the improvement and optimization strategy of the accurate configuration mode of disaster emergency resources based on the real-time information update of social media data.

4. Conclusions

The research and promotion of disaster emergency material allocation mode under the social media data environment in the smart city is the only way to promote the development of disaster emergency management towards refinement and precision. This paper first analyzes smart cities, disaster emergency resources and social media data pairs, and then constructs a disaster emergency resources configuration mode from four specific modules: demand prediction, scheduling optimization, targeted distribution and disaster satisfaction survey of emergency resources. However, the allocation of emergency resources in smart cities is a dynamic and multi-stage process. The research on the allocation mode of emergency resources is a complex systematic project, and its mode construction and operation are affected by many factors. We should keep pace with the times to explore the accurate allocation mode of emergency resources and the implementation path of the mode, and effectively use social media data to carry out disaster emergency material allocation. It is the only way to improve the level of emergency management and achieve accurate emergency management.

References

1. A. Zanella; N. Bui; A. Castellani; L. Vangelista; M. Zorzi. Internet of things for smart cities. *IEEE Internet of Things journal* **2014**, 1(1), 22–32.
2. V. Albino; U. Berardi; R. M. Dangelico. Smart cities: Definitions, dimensions, performance, and initiatives. *Journal of Urban Technology* **2015**, 22(1), 3–21.
3. P. Vlacheas; R. Giaffreda; V. Stavroulaki; et al. Enabling smart cities through a cognitive management framework for the internet of things. *Communications Magazine, IEEE*, **2013**, 51(6), 1–13.
4. J. M. Shapiro. Smart cities: quality of life, productivity, and the growth effects of human capital. *The review of economics and statistics* **2006**, 88(2), 324–335.
5. T. Nam; T. A. Pardo. Smart city as urban innovation: Focusing on management, policy, and context. *Proceedings of the 5th International Conference on Theory and Practice of Electronic Governance, ACM* **2011**, 185–194.
6. N. Komninos; H. Schaffers; M. Pallot. Developing a Policy road map for Smart Cities and the future internet. *e-Challenges e-2011 Conference Proceedings, IIMC International Information Management Corporation, IMC International Information Management Corporation* **2011**.
7. Emergency Management: The American Experience 1900–2010. *CRC Press* **2012**.
8. J. H. Hu; G. P. Zhong; G. C. Yan. Design and implementation of dynamic emergency resource scheduling based on GIS. *Application Research of Computers* **2012**, 1, 057.
9. L. Zhang; Y. Lin; G. Yang; et al. Emergency resources scheduling based on adaptively mutate genetic algorithm. *Computers in human behavior* **2011**, 27(5), 1493–1498.
10. Kitchin, R. The real-time city? Big data and smart urbanism. *GeoJournal* **2014**, 79, 1–14.
11. Hollands, R. G. Will the real smart city please stand up? Intelligent, progressive or entrepreneurial? *City* **2008**, 12, 303–320.
12. Zhang Hong. Improvement of emergency supplies reserve system. *China Public Administration* **2009**, 3, 44–47.
13. Zhang Yongling. Evaluation study on governmental emergency material ensuring capability. *Journal of Natural Disaster* **2012**, 21(1): 78–84.
14. Yu Chong; Zhao Qilan. Discussion on the mode of emergency supplies reserve. *Logistics technology* **2010**, 2: 51–55.

15. Guo Ying. Research on the Management Strategy of Emergency Material Reserve under Some Demand Distribution Information. Shang Dong University. 2020.
16. Shi Kaiju. Study on the reserve of emergency resources before major emergencies in China. Yan Shan University. 2013.
17. J. B. Houston; J. Hawthorne; M. F. Perreault; E. H. Park; M. G. Hode; M. R. Halliwell; S. T. McGowen; R. Davis; S. Vaid; J. A. Mcelderry; S. A. Griffith. Social Media and Disasters: A Functional Framework for Social Media Use in Disaster Planning, Response, and Research. *Disasters* **2015**, 39(1), 1-22.
18. Z. H. Tang; L. G. Zhang; F. Ha. Xu; H. Vo. Examining the Role of Social Media in California's Drought Risk Management in 2014. *Natural Hazards* **2015**, 79(2), 171-193.
19. Statista. Number of social media users worldwide from 2018 to 2027. Available online: <https://www.statista.com/statistics/278414/number-of-worldwide-social-network-users/>.
20. Wang Yanyan; Sun Baiqing. Research on Emergency Material Allocation Mode for Sudden Disaster Under Big Data Environment. *Science and Technology Management Research* **2019**, 7: 226-233.

Article

A Preliminary Study on the Improvement of Social Disaster Response and Recovery Policy

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Abstract: This study was conducted as a basic study of disaster policy insurance to secure the rationality and objectivity of disaster preparation and recovery. In a situation where the types of social disasters are diversifying recently, the government, local governments, and individuals' roles and responsibilities were investigated, and the possibility of using disaster preparation policies was considered through literature surveys and statistical surveys of crop disaster insurance. To this end, among the nine cases of social disasters declared as special disaster areas, crop disaster insurance and policy utilization measures were considered, focusing on forest fires, the type of social disaster that occurred the most three times. Policy insurance has several limitations due to the inevitable market economy principle. It is a matter of moral hazard, reverse choice, and fairness. Moral hazard and adverse selection are caused by information asymmetry between insurance policyholders of insurance companies, and from the perspective of insurance companies that do not have information, insurance policyholders with information tend to behave undesirable. The problem of fairness arises because disaster management and safety are public. There may be situations in which people who do not conduct preventive projects benefit. In the future, the role of the government, local governments, and individuals, which can be said to be the subject of disaster preparation, should be considered from the perspective of insurance subscription and policy support.

Keywords: Social Disaster; Disaster Management; Response; Recovery

1. Introduction

In April 2019, a large forest fire in the east coast of Gangwon caused damage such as 111 million won in crops, 845 million won in livestock, 1,470 million won in agricultural facilities, 1461 million won in livestock facilities, and 6,306 million won in agricultural machinery[12]. As such, disasters cause great damage to individual lives and property, and furthermore, they have a direct impact on the local community, so it is necessary to prepare thoroughly. Disaster-related insurance can be used as a way to prepare for disasters for individuals, local governments, and governments independently. Currently, disaster-related laws include Storm and Flood Insurance(Storm and Flood Insurance Act), Fire Insurance(Act On The Indemnification For Fire-caused Loss And The Purchase Of Insurance Policies), Agricultural and Fishery Insurance(Agricultural And Fishery Disaster Insurance Act, Act On Safety Insurance For Farmers And Fishers And Prevention Of Work Accidents, Act On Accident Compensation Insurance For Fishers And Fishing Vessels etc.) and Industrial Accident Insurance(Industrial Accident Compensation Insurance Act).

However, according to recent news, small business owners have only 7.1 percent of storm and flood insurance coverage, and some point out that insurer companies are passive in signing up because it is difficult to make profits[4]. In the case of other policy insurance, the 21-year crop insurance subscription rate is 49.4%, and the livestock accident

insurance subscription rate is 93.7%. As of September 22, 6 related insurances, including farmer safety accident insurance, agricultural disaster insurance, re-insurance, fishery accident insurance, fishermen's safety insurance, and storm and flood insurance, were included in the government's disaster and safety management budget in 2021, but increased to 1.16 trillion won in 2023[1].

According to the Framework Act on The Management of Disasters and Safety, fires, collapses, explosions, and traffic accidents are classified as social disasters. The number of such social disasters increased from 7 in 2015 to 25 in 2020, and the number of casualties caused by disasters increased significantly from 197 to 1,091. To recover from such disasters, Article 66 of the Framework Act on The Management of Disasters and Safety stipulates that in case of a declared as a special disaster area, all or part of the cost can bear all or part of the cost if necessary for the smooth recovery of disasters. In the case of natural disasters, pursuant to Article 5 (1) of the Regulations on Natural Disaster Relief and Recovery Cost Burden, the regulation for declaring a special disaster area is set as the standard amount for damage. In the case of social disasters, according to Article 69 of the Enforcement Decree of the Framework Act on The Management of Disasters, it is difficult to handle the disaster due to the administrative or financial ability of the local government.

As such, it is difficult to clarify the criteria for declaring a special disaster area because there are various types of social disasters and it is difficult to calculate the scale of damage losses. In addition, in the case of damage recovery costs, there is criticism that there is a sense of separation from reality, so realistic preparation and recovery measures are needed[4].

The purpose of this study is to conduct a preliminary study to secure the rationality and objectivity of disaster preparedness and recovery management. In this study, we will investigate disaster-related insurance research and trends in relation to the roles and responsibilities of the government, local governments, and individuals, which can be said to be the subject of disaster preparation, and consider ways to link disaster-related policies and policy insurance. To this end, crop insurance and policy utilization measures were to be considered, focusing on forest fires, the most common type of social disaster that occurred 3 times, the most among the 9 cases of social disasters declared as special disaster areas.

2. Insurance for Social Disaster Recovery – Forest Fire and Agricultural Insurance

2.1. Characteristics of Social Disasters

The Framework Act on the Management of Disaster and Safety defines social disasters as damage caused by fires, collapses, explosions, traffic accidents (including aviation accidents).

Table 1. Disasters pursuant to framework act on the management of disasters and safety

Natural disasters		Social accidents	Overseas disaster
<ul style="list-style-type: none"> • Typhoon • Flood • Downpour • Strong wind • Wind and waves • Tidal wave • Heavy snowfall • Lightning • Drought • Earthquake • Sandy dust 	<ul style="list-style-type: none"> • Hypertrophy of algae • Ebb and flow • Volcanic activity • Crash or collision of a natural space object such as an asteroid and meteoroid • Other natural phenomena equivalent thereto 	<ul style="list-style-type: none"> • Fire • Collapse • Explosion • Traffic accidents (including aviation accidents and marine accidents) • Chemical, biological, and radioactive accidents, environmental pollution incidents, etc. • Infectious diseases under the Infectious Disease Control and Prevention Act • Contagious animal diseases under the Act on the Prevention of Contagious Animal Diseases • Fine dust under the special act on the reduction and management of fine dust 	<ul style="list-style-type: none"> • Disaster that actually causes or is likely to cause any harm to the lives, bodies, and property of citizens of the Republic of Korea outside the territory of the Republic of Korea, and which shall be handled by the Government

accidents), chemical and environmental pollution, paralysis of the national core infrastructure, spread of infectious or livestock infectious diseases, and fine dust. Table 1 summarizes the types of disasters under the Framework Act on Disaster and Safety Management. In addition, the types of social disasters are diversified, according to the Comprehensive Emergency Management Plan (CEMP) of New York State, various social risk factors such as cyber attacks and drone attacks are presented as shown in Table 2 [13][14][15] [16].

Such social disasters are characterized by large socioeconomic damage along with physical damage. According to a study by the National Disaster Management Research Institute in 2016, the damage when MERS, an infectious disease, occurred in 2015, can be divided into direct and indirect damage. Direct damage is the primary damage caused by social disasters such as disease-related treatment costs and loss support due to isolation or treatment. Indirect damage can be divided into primary and secondary indirect damage. The first indirect damage was defined as the impact cost of social damage after the disaster of the directly affected target, i.e., socioeconomic dysfunction, supply reduction, and production capacity reduction, and the second indirect damage was defined as the trigger effect of the first indirect damage [2][9].

Table 2. Hazards from the Hazard Analysis Report, State Homeland Security Strategy, and NYS Hazard Mitigation Plan

Rank	Hazard	Rank	Hazard	Rank	Hazard
1	Cyber Attack on Critical Infrastructure	15	Food Contamination	29	Major Fire
2	Flood	16	Wind	30	Major Transportation Accident
3	Complex Coordinated Terrorist Attack	17	Improvised Nuclear Device (IND)	31	Lightning
4	Improvised Explosive Device (IED)	18	Ice Storm	32	Vehicle Ramming Attack
5	Vehicle-Born IED	19	Civil Unrest	33	Tsunami/Seiche
6	Severe Winter Storm	20	Hazardous Materials Release-In-Transit	34	Coastal Erosion/Sea Level Rise
7	Epidemic	21	Radiological	35	Hail
8	Coastal Storm Surge	22	Hazardous Materials Release-Fixed Site	36	Wildfire
9	Earthquake	23	Extreme Temperatures (Heat/Cold)	37	Sustained Power Outage
10	Hurricane/Coastal Storm	24	Severe Storms	38	Radiological Dispersal Device (RDD)
11	Dam Failure	25	Tornado	39	Drought
12	Pandemic	26	Active Shooter	40	Avalanche
13	Critical Infrastructure Failure	27	Biological Agent Release	41	Landslide
14	Drone (UAS) Attack	28	Animal Disease	42	Volcano

2.2. Agricultural Policy Insurance

Agricultural policy insurance is an insurance that guarantees real income to farmers and provides some or all of the premiums for management stability by receiving compensation for damage to crops and livestock in case of abnormal weather or natural disasters. It is based on the Agricultural and Fishery Disaster Insurance Act and is divided into crop insurance and livestock accident insurance.

Crop Insurance is a concept that refers to various insurance systems that compensate for damages caused by natural disasters related to crop production. It was introduced in 2001 for the purpose of contributing to the stability of agricultural management and the improvement of agricultural productivity. Compensation can be made in the event of damage caused by natural disasters, tidal damage, and fires, and 60-90% of the subscription amount is guaranteed[3].

Livestock accident insurance is a policy insurance first introduced in 1997 when the National Federation of Livestock Industry Cooperatives began to deduct livestock as a pilot project. It compensates for damages such as wind damage, flood damage, snow damage, disease, fire, and heat wave (famine)[19].

2.3. Agricultural Policy Insurance Subscription and Insurance Premium Status

Looking at the statistics of agricultural policy insurance over the past 4years, it can be seen that the subscription area increased from 376,593ha in 2018 to 594,250ha, and the number of subscribed farmers also increased by 60.9% from 275,133 to 497,884. In addition, net insurance premiums and state subsidies for farmers increased together, but the insurance premium borne by farmers per ha has remained below 200,000 won since falling by 64.7% in 2019.

Table 3. Agricultural Insurance Subscription Status

	Insurance coverage area	Number of subscribed farms	A net premium	State coffers	Farm insurance premiums	Net premium per ha	Farm insurance premiums per ha
2018	376,593	275,133	550,149	271,334	93,984	1,460,859	249,564
2019	456,024	339,582	511,147	252,154	73,688	1,120,876	161,587
2020	550,174	440,173	722,223	355,306	101,994	1,312,718	185,385
2021	594,250	497,884	848,524	417,546	117,595	1,427,890	197,888

2.4. Trends in Human Resources in the Insurance Service among the Disaster Safety Industries

According to the Disaster Safety Industry Survey conducted since 2017, the total number of workers in the disaster safety industry has increased by 1.19% from 311,584 in 2017 to 315,289 in 2020. The industries of the disaster safety industry are divided into 5 major categories and 16 middle categories. Looking at the change in the number of workers over the past 4 years, the number of workers in the disaster insurance service industry increased by 139.6% among the 16 middle categories. The manpower of the disaster safety industry is also related to social issues and social needs.

3. Limitations of Policy Insurance on the Principles of Market Economy

3.1. Moral Hazard and Adverse Selection

Policy insurance can have problems of moral hazard and reverse choice. Moral hazard is caused by information asymmetry between insurance company and policyholders, and from the perspective of insurance company that do not have information, insurance subscribers with information tend to behave undesirable. The form of moral hazard that can occur in Korea's crop insurance can be divided into cases where insured farmers neglect their efforts to prevent disasters and cases where fairness is damaged in the damage assessment process of the damage assessor. The existence of moral hazard worsens the management balance of insurance company and causes an increase in insurance

Table 4. Number of Employees by Industry

Classification of Industries	2017	2018	2019	2020	The Growth Rate in 2020 Compared to 2017
Disaster-related education, Counseling, and Consulting business	25,361	11,034	8,219	7,565	-70.2%
Disaster response medical and Quarantine related industries	63,974	28,358	14,408	27,058	-57.7%
Traffic accident-related social disaster prevention industry	24,658	21,071	18,874	16,351	-33.7%
Disaster-related safety facilities management, Storage of dangerous goods, Security business	17,856	17,691	16,747	16,551	-7.3%
Other natural disasters (yellow dust, heavy snow, heat waves, etc.) prevention industries	8,679	8,668	6,798	8,289	-4.5%
Search and rescue and emergency support industries in disaster areas	29,551	37,148	40,965	31,005	4.9%
Disaster-related system development and management business	9,001	8,375	11,663	9,757	8.4%
Other safety accidents prevention industries (industrial accidents, crimes, security, etc.)	19,144	21,936	20,426	22,061	15.2%
Disaster site maintenance industry	14,550	8,324	9,959	17,734	21.9%
storm and flood-related natural disaster prevention industry	11,995	14,797	15,066	15,123	26.1%
Earthquake and volcanic-related natural disaster prevention industry	10,633	9,963	12,691	13,807	29.9%
Fire, explosion, and collapse-related social disaster prevention industry	25,878	33,516	46,802	41,939	62.1%
Disaster situation management industries	23,898	36,980	44,027	39,484	65.2%
Facility recovery industry	18,256	40,836	36,721	30,254	65.7%
Infectious diseases, chemical and environmental pollution related industry	2,795	3,163	3,183	5,475	95.9%
Disaster Insurance service industry	5,357	7,851	9,846	12,837	139.6%

premiums, damaging normal insurance consumers in good faith, and ultimately negatively affecting the introduction and successful settlement of disaster insurance[3].

Adverse Selection, like moral hazard, is a phenomenon in which areas, farms, or parcels (or orchards) that are caused by asymmetric information and have an actual risk rate higher than insurance rates mainly subscribe to crop disaster insurance. In other words, since insurance consumers have all of the information on risk, insurance managers use all of the information to determine the degree of risk, but insurance managers use limited information to charge insurance rates. If the risk level evaluated by insurance consumers is greater than the standard risk level of the insurance rate, there is a high possibility of subscribing to crop insurance, and if it is the opposite, a reverse choice occurs[10]. Due to the asymmetry of this information, research on market failure in the insurance market and research on insurance rates are being actively conducted. A study simulating the government's role in the agricultural insurance market, where information asymmetry exists, concluded that government intervention is difficult to succeed if consumers' hedging propensity is too large. Therefore, each policy direction tailored to the consumer's tendency should be sought[5].

3.2. Fairness Issue

In the case of social disasters with characteristics caused by people, there is a limit to state intervention, and there is a difficulty in preventing activities in that it is a private

area. Despite the principle of burdening the cause, recent social disasters are likely to cause enormous economic damage and spread to nearby areas, causing indirect damage and economic, political, and psychological aftereffects[10]. In addition, in the event of a disaster, the person who caused the disaster should be responsible, but the person in charge of the accident lacks the ability to handle the accident, causing social confusion, which will be handled by the government. In this case, the government will bear the victim's loss, which can be a means to replace the responsibility of the accident-causing person with national taxes. In the end, there is a problem that unprotected people benefit, while those who have continuously promoted disaster prevention may suffer relatively little damage and government support may be reduced if the same disaster occurs.

4. Conclusions

The purpose of this study was to conduct a preliminary study to secure the rationality and objectivity of disaster preparation and recovery. In this study, disaster-related insurance research and trends were investigated in relation to the roles and responsibilities of the government, local governments, and individuals, which can be said to be the subject of disaster preparation, and disaster-related policy insurance utilization measures were considered. To this end, it was intended to study crop insurance and policy utilization plans, focusing on forest fires during social disasters. It is necessary to present specific standards and scope that can fill the gap in recovery costs between the state and local governments' countermeasures, and to facilitate the management of large social disasters through policy linkage.

References

1. Agricultural Policy Insurance & Finance Service, URL: <https://www.apfs.kr/front/user/main.do>, 2022.
2. Chung, Jae hak, et. al. The Damage Cost Estimation for Blackout & Great Logistical Disturbance. National Institute for Disaster Prevention. 2015.
3. Dong Han, C.; Kwang Hyun, Y. A Study on the Reform of Crop Insurance, *Institute for Business and Economic Research* 2004, 29(1), 21-46.
4. GwangJin, C., JungHea, K. Typhoon Hinamno's Damage Recovery Costs have Increased, but...Residents Complain about the Difference with Reality, 2022.10.25, Hankookilbo.
5. Jae Hwa, P.; Chung Sil, K. A Study on Policy Simulation Model for Government Reinsurance under Cop Insurance Program. *Korean Journal of Agricultural Management and Policy*, 33(2), 405-423.
6. Jung, Jong-Jae, Kim, Gwang-Yong, Kim, Younhee, Lee, Jong-Seol, and Ji, Yong-Gu. *U.S. Federal Emergency Management*. bnm book. 2017.
7. Kyo-Sik, J.; Seong-Hui, Y. A Study on the Approach to Improve Livestock Disaster Insurance System, *Public Land Law Review* 2015, 68, 255-281.
8. Lee, Jae Eun. *Crisisonomy*. Dae Young Co. 2018.
9. Lee, Jung Han, Kim, Hyunjung, Lee, Yu Rim, Kang, Da Seul and Hong, ChaeEun. The Development of Guideline for Damage Cost Estimating from Social Disaster. National Institute for Disaster Prevention (NDMI). 2016.
10. Lim, Seungbin, et. al. Development of Estimating Techniques for Spreading Influence and Damage Loss by Industry Disaster. National Disaster Management Research Institute (NDMI). 2016.
11. Ministry of the Interior and Safety. A Survey on the Disaster and Safety Industry. 2017~2020.
12. Ministry of the Interior and Safety. Gangwon East Coast Forest Fire White Paper. 2019.
13. New York State Division of Homeland security and emergency services. New York State Comprehensive Emergency Management Plan Volume 1: New York State Hazard Mitigation Plan. 2019.
14. New York State Division of Homeland security and emergency services. New York State Comprehensive Emergency Management Plan Volume 2: Response and Short-Term Recovery. 2021.
15. New York State Division of Homeland security and emergency services. 2021. New York State Comprehensive Emergency Management Plan Volume 3: Long-Term Recovery Plan. 2021.
16. New York State. Executive Order: Declaring a Statewide Disaster Emergency Due to Healthcare Staffing Shortages in the State of New York. 2021.
17. Oh, Keum-ho, Jung, Woo-young and Park, Min-kyu. A Study on the Declaration Criteria of Special Disaster Zone of the Man-Made Disaster. National Institute for Disaster Prevention (NDMI). 2006.
18. Sungjin, L.; Jin Sung, K. The Role of Government in Crop Insurance Markets, *Life Science Natural Resources Research* 2003, 11, 202-212.

ICCEM2022

19. Sunhee, Y. "Low Profit and Big Loss"... A Storm and Flood Damage Insurance that has Become a Nuisance, 2022.09.19, The DigitalTimes.

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Article

Delineating Climatic Causes of Floods in 2022 in Pakistan: The way forward,

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Abstract: Since June 2022, Pakistan has experienced an unprecedented climate-induced disaster that has killed numerous people, killed cattle, damaged and destroyed governmental and private infrastructure, and caused widespread destruction. This disaster was brought on by heavy rains and a combination of riverine, urban, and flash floods. Local ecosystems have been impacted by landslides and floods brought on by rain that have also destroyed forests and agricultural land. The Indus River, a water system that is prone to flooding in July and August during the monsoon season, is where the majority of Pakistan's 230 million inhabitants reside. The largest number of glaciers outside of the Polar Regions, 7,200, are found in Pakistan. 1,730 people died in the floods along the Indus River this summer as a result of the extremely large glacier runoff caused by this summer's intense heat waves. According to the UN Satellite Center, approximately 30,000 square miles roughly two-thirds of them cropland were flooded. More difficulties are in store for the nation as the water levels drop during the ensuing months. Water-borne and vector-borne illnesses are being fueled by stagnant waterways. The damage of 9.4 million acres of agricultural land by the floods and the death of 1.2 million cattle are projected to result in food shortages. Many of the most hit villages will be impossible to access because of the roughly 8,000 miles of destroyed roads and bridges and the already inadequate healthcare infrastructure. According to a Post-Disaster Needs Assessment (PDNA) conducted in Pakistan by the Ministry of Planning, Development, and Special Initiatives, there are 20.6 million people who need humanitarian aid, nearly 7 million children who urgently need access to nutrition services, and 5.5 million people who do not have access to safe drinking water. According to the PDNA, the cost of rebuilding and rehabilitation is above \$16 billion, while the overall amount of damages and economic losses exceeds \$30 billion. Overcoming this kind of devastation will be difficult for Pakistan, a nation with few resources. More frequent, intense, and long-lasting extreme weather disasters will continue to devastate nations, disproportionately and excessively harming vulnerable groups. Community-driven cooperation and decision-making are necessary in Pakistan's environmental crises to promote resilient and sustainable environmental change and develop coping mechanisms.

Keywords: COVID-19; pandemic; crisis management; efficacy; anxiety

1. Introduction

One of the most significant non-traditional security risks today is climate change, which has a direct impact on the nation's water and food security. Rainfall patterns since June have deviated from the typical seasonal pattern, dropping in regions that aren't typically influenced by the yearly monsoon. Pakistan's south and center have been particularly hard hit, with Balochistan and Sindh receiving 6.9 and 8.3 times their usual rainfall,

respectively. Both of these provinces were dealing with mild to moderate drought conditions until the arrival of this monsoon a year ago, while mild to moderate drought conditions persisted in southwest Balochistan and south Sindh. The monsoon's worst rainstorms occurred in August, which also happened to be Pakistan's wettest month in more than 60 years, with 3.4 times the usual amount of precipitation. According to Climate Watch and the Global Climate Risk Index 2021, Pakistan is one of the top ten nations in the world affected by catastrophic weather occurrences despite having a very low carbon footprint. According to Pakistan's National Climate Change Policy, which was published last year, the effects of global climate change are already being felt in Pakistan due to the melting and retreating of glaciers, an increase in the frequency of droughts, flooding, and other erratic weather patterns, changes in agricultural practices, a decrease in the availability of fresh water, the loss of biodiversity, and an increase in the formation and outburst of glacial lakes [1].

The Pakistani government has declared 84 districts throughout the country as "calamity affected," mostly in Balochistan (32 districts), Sindh (23 districts), and Khyber Pakhtunkhwa (17 districts) [2].

1.2. Injuries, fatalities, and displacement

The intense rains and flooding have had an impact on around 33 million people, including at least 7.9 million displaced individuals, of whom 598,000 are currently residing in relief camps. More than 40 calamity-notified areas are thought to be housing up to 800,000 refugees, including more than 175,600 women, 194,000 girls, and 206,000 boys. Nearly half of these refugees are housed in Peshawar, in Khyber Pakhtunkhwa, and Quetta, in Balochistan.

Over 1,600 people were killed and over 12,800 people were injured as a result of the heavy rains and floods between 14 June and 28 September, including 333 women and 615 children who perished and 3,452 women and 4,006 children who were injured, according to the National Disaster Management Authority (NDMA). Children make up one-third of all documented deaths and injuries, while Sindh accounts for over half of all fatalities and 66% of all injuries. While Punjab reported 30% of all injuries, Balochistan and Khyber Pakhtunkhwa each reported about 19% of all documented death [3].

2. Materials and Methods

This study utilized delineating climatic causes of floods 2022 in Pakistan. In 2022, Pakistan has experienced climate-related calamities such as severe heatwaves, droughts, and melting glaciers despite producing just 1% of the world's carbon emissions [4]. The recent, extraordinary floods in Pakistan were brought on by a monsoon cycle that was stronger than normal. This is thought to be the result of a spike in the temperature of the ocean as well as prolonged, extreme heatwaves in the country's south in May and June. Glacial flooding was also brought on by the temperature increase in Gilgit-Baltistan (GB).

The floods have killed 1,663 people, including 614 children, according to Pakistan's National Disaster Management Authority (NDMA). They have affected more than 33 million people. 12,865 persons were hurt overall. There are currently 663,869 individuals residing in makeshift camps. Over 2 million homes as well as 410 bridges and 13,074 kilometres of roads were destroyed as part of the infrastructure damage. Additionally, 1.2 million homes suffered partial damage from the floods. Over 1.1 million animals and 2 million acres of crops and orchards are thought to have perished. Over 30 billion dollars have reportedly been lost as a result of floods in Pakistan, according to government estimates. The provinces with the greatest losses in terms of infrastructure and people are Sindh and Balochistan [5].

Following are the focus areas that define the way forward for the country to take.

2.1. Water Storage Capacity

One of the most crucial methods is to control the water flow over the course of a year, a season, and a location. Storage and proper reservoir functioning are the only factors that can guarantee the supply of water for irrigating crops in Rabi and the early Kharif. In particular, water storage on the Indus River is crucial to reducing floods in communities downstream since doing so would enable more water to be drained from the river's tributaries and hill torrents. Storage is also necessary since sedimentation has reduced the reservoir capacity of the Tarbela and Mangla dams. Therefore, it is necessary to increase the country's storage capacity by building big, medium-sized, and small dams wherever feasible.

2.2. Watershed Management

The development of integrated watershed management for enhancing livelihoods in mountainous areas is a key component of the National Food Security Policy for 2018. A prime example of watershed management is the 45-year-long Mangla Dam watershed management initiative. When it was discovered that the yearly silt load into the reservoir had been decreased by almost half, increasing the reservoir's lifespan, its beneficial benefits became obvious. Increasing a reservoir's useful life indirectly aids in reducing flood flows that are directed downstream. Watersheds are the first line of defence against climate change, heat waves, soil erosion, droughts, and floods, as is often believed.

The 2018 National Water Policy emphasizes the significance of (i) enhancing watershed management through extensive soil conservation, catchment area treatment, preservation of forests, and increasing forest cover; (ii) identifying and protecting watershed management zones in upland areas; (iii) promoting re-afforestation, soil conservation, and improvement in land use in the watersheds; and (iv) promoting studies of integrated watershed management for sustainable development.

2.3. Hill Torrent Management

The rain fed and hill torrent regions have been neglected in favour of creating and maintaining the irrigation infrastructure. The recent floods highlighted these places' fragility and promise. Along with reducing the effects of droughts and managing floods, these places might make a big contribution to ensuring food security. What we need is a paradigm change away from creating infrastructure—roads, buildings, etc.—and toward improved development, management, and control of water resources in the Indus Basin and elsewhere. Additionally, while developing hydraulic structures and other associated facilities, hydrologists and engineers need to take the recent, unprecedented high rainfall (both duration and severity) into consideration.

2.4. Creating Eco-friendly Cities

Unplanned city growth, tree-cutting for the construction of roads, buildings, and related infrastructure are turning environmentally pleasant fields into concrete jungles, which eventually reduces groundwater recharge and worsens urban floods. As a result, practically all metropolitan areas are experiencing groundwater depletion in addition to land subsidence. For instance, the groundwater is evaporating at a pace of around one meter per year in Islamabad while receiving about 1400 mm of rain annually; it is evaporating at a rate of about half a meter in Lahore; and at about six meters per year in Quetta valley.

The idea of smart, high-tech cities is increasingly being replaced by the idea of "forest cities," which are mostly made up of trees, lakes, and ponds, as well as climate-sensitive dwellings. Along with the advantages of reducing heatwaves, air and water pollution, droughts, and urban floods, as well as enhancing the physical and emotional wellbeing of its citizens, these cities also have a great deal of aesthetic value. Therefore, rainwater collection and artificial groundwater recharge ought to be a fundamental component of all urban growth, housing societies, and the residential and commercial sectors.

In addition to restoring depleted groundwater aquifers, artificial groundwater recharge also protects water from evaporation and pollution and reduces urban flooding [6].

2.5. Proper Drainage System

Given the lower Indus's relatively flat landscape and high water tables, a proper drainage system is crucial. The soil's ability to absorb water is reduced or nonexistent in areas with high water tables.

The network of the Left Bank Outfall Drain (LBOD), which consists of the Kadhan Pateji Outfall Drain (KPOD) and the Dhoru Puran Outfall Drain, covers four districts on the left bank of the Indus River: Shaheed Benazirabad, Sanghar, Mirpur Khas, and Badin (DPOD). The Tidal Link system, which is connected to these drains, is the only place where rainfall from the left bank of the River Indus may be dumped into the ocean. The LBOD flooded as a result of improper design, siltation, and inadequate maintenance, resulting in extensive flooding in the nearby communities. Additionally, the LBOD was violated in a number of places. As a result, the inadequately maintained drainage system was unable to dispose of rainfall in a timely manner.

5. Limitations

This study has several limitations. First, Pakistan Meteorological Department (PMD) forecasted about 40% above normal rainfalls all over the country during 2022 monsoon season. However, the rainfalls received were around 208% above the normal across the country. Province wise, the rainfalls were 515% above normal for Sindh, 476% for Balochistan, 87% for Punjab, 45% for Khyber Pakhtunkhwa and 129% for GB. The eastern section of Balochistan and the Larkana Division of Sindh saw catastrophic flash floods as a result of receiving the largest amounts of rainfall in the past 70 years about 500 mm and 700 mm, respectively. Due to Sindh's flat landscape and inadequate drainage, the problem was made worse by the region's heavy rains.

Secondly,

6. Conclusions

According to the above analysis of causes and consequences and the discussion of mitigation strategies, effective basin-wise flood control strategies should be taken into consideration from upstream to downstream. On a long-term basis, reactive, singular, isolated, or fragmentary solutions will not be viable.

The fact of climate change has made it a non-traditional security hazard. Droughts, heatwaves, and flooding have taken a toll on the environment and continue to do so. The nation has to reevaluate its tactics and switch from a reactive to a proactive strategy, from catastrophe reaction to disaster preparedness, from response to climate change to adaptation to it, and from smart, high-tech concrete to eco-friendly forest and lake towns.

The federal and provincial governments must reorient their priorities from infrastructure construction to climate funding and adaptation, as well as the management and development of water resources, particularly at the catchment and watershed levels. Additionally, hill torrents that have a significant potential for harvesting must be handled first. To get rid of any extra water, the country's drainage infrastructure, especially in Sindh,

By lowering the sediment and flow velocity, watershed management helps control water flow both inside and beyond the catchment region. It need to be a fundamental part of all hydraulic and hydroelectric structures. Flood control and mitigation would greatly benefit from long-term watershed management projects. Additionally, it is critical to manage grazing in catchment regions to prevent further harm to the watersheds.

Numerous national and regional institutions have used groundwater recharge methods that the Pakistan Council of Research in Water Resources (PCRWR) has developed for rainwater collecting, rooftop rainwater harvesting, and other applications. In the desert of Cholistan, the Council has constructed more than 100 rainwater ponds. It was followed by the development of almost as many ponds in the desert by the Cholistan Development Authority.

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References

1. Revised Pakistan 2022 Floods Response Plan: 01 Sep 2022 - 31 May 2023 (Issued 04 Oct 2022) - Pakistan | ReliefWeb Available online: <https://reliefweb.int/report/pakistan/revised-pakistan-2022-floods-response-plan-01-sep-2022-31-may-2023-issued-04-oct-2022> (accessed on Nov 27, 2022).
2. Sarkar, S. Pakistan floods pose serious health challenges. *BMJ* 2022, 378, o2141, doi:10.1136/BMJ.O2141.
3. Devi, S. Pakistan floods: impact on food security and health systems. *Lancet* (London, England) 2022, 400, 799–800, doi:10.1016/S0140-6736(22)01732-9.
4. Melting glaciers, growing lakes and the threat of outburst floods - Pakistan | ReliefWeb Available online: <https://reliefweb.int/report/pakistan/melting-glaciers-growing-lakes-and-threat-outburst-floods> (accessed on Nov 27, 2022).
5. Pakistan floods: One third of country is under water - minister - BBC News Available online: <https://www.bbc.com/news/world-europe-62712301> (accessed on Nov 27, 2022).
6. Hilal English Available online: <https://www.hilal.gov.pk/index.php/detail/recharging-aquifers-for-sustainable-groundwater-management> (accessed on Nov 27, 2022).

Article

A Study on the Activation of Environmental Education to Overcome the Climate Crisis and Achieve Carbon Neutrality

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Abstract: The pattern of natural disasters caused by the climate crisis is getting worse, and the target year of carbon neutrality, 2050, is approaching. However, steps to overcome the climate crisis are still slow. Floods, strong winds, landslides, heat waves, and cold waves are causing damage all over the world. Some island countries in the South Pacific are on the verge of extinction due to rising sea levels. Despite this serious situation, environmental education for the people, which is the most basic in overcoming the climate crisis, is still lacking in many ways. Educational methods also focus on one-sided simple cramming education rather than field-oriented and participatory education. Therefore, future environmental education should be a practical survival environment education to survive various natural disasters caused by the climate crisis. In addition, the ability of environmental education instructors to teach specific practical behavior and strengthen the environmental education system can draw public attention and promote environmental education. Now every part of our lives must be aligned in a way that puts the environment first. Only then will human life be sustainable.

Keywords: climate crisis; natural disaster; carbon neutrality; environmental education; survival environmental education

1. Introduction

1.1. Background and Purpose of the Study

This is an era of climate crisis in which the world is suffering from climate change. Frequent natural disasters beyond time and space, such as floods, strong winds, typhoon, landslides, heat waves, droughts, and cold waves, threaten humanity, and the situation has become more and more serious in recent years. This phenomenon is caused by rising global temperatures due to excessive greenhouse gases emitted by humans after the Industrial Revolution. The 6th Intergovernmental Panel on Climate Change (IPCC) predicted that the global average temperature will exceed 1.5°C by 2021-2040 and rise to 3.3~5.7°C by 2100 (KEI, 2021: 24). Therefore, in order to slow down the climate crisis and minimize the damage caused by various natural disasters, thorough environmental education that requires the public to reduce greenhouse gas emissions is more urgently needed than ever.

Environmental education began in response to social demands to solve environmental problems (Kang Jin-young, Cheon Hyang-on Nam Mi-ri, Hong Jong-ho, 2021: p1). It was in 1983 that discussions on the necessity of environmental education laws first began in Korea (Lee Jae-young, 2019: 423). After that, in August 1990, environmental education at the national level was implemented as the basis for promoting environmental education was prepared in the Framework Act on Environmental Policy. The Republic of Korea is one of the eight countries (South Korea, the United States, Japan,

Taiwan, the Philippines, Brazil, Colombia, and Armenia) that enacted environmental education laws at the national level. The 「Environmental Education Promotion Act」, enacted as an independent law in March 2008, served as a legal instrument for environmental education (Kim Chan-gook, 2019: 380). Recently, as the importance of environmental education to overcome the climate crisis and achieve carbon neutrality has been highlighted, it has been completely revised and implemented in January 2021 as the Act on the Promotion and Support of 「Environmental Education」 (hereinafter referred to as the Environmental Education Act). Environmental education targets the constantly changing environment, so its role must also constantly change with the times. I would like to examine whether there are any problems in the system of environmental education and the scale of budget support currently being provided to the people. We would also like to find out what direction environmental education should focus on. We are now living in the era of the 4th industrial revolution based on hyper-connectivity, such as Big Data, Artificial Intelligence, Virtual Reality, Augmented Reality, the Internet of Things, and Metaverse. It is also necessary to accelerate the development of high-tech science-oriented environmental education programs that can more actively utilize high-tech technologies to promote environmental education.

In this study, we would like to argue that our environmental education should reflect the concept of "Survival Environmental Education (SEE)" just like survival education that is desperately learned to survive, such as earthquake prevention education in Japan. Also, we would like to examine the current status and deficiencies of environmental education in charge of metropolitan and local governments, and to derive more systematic and sophisticated environmental education to overcome the climate crisis and be carbon neutrality.

1.2. Scope and Method of Research

As '2050 Carbon Neutrality' is drawing attention as a global challenge, the existing 「Environmental Education Promotion Act」 has been completely revised and implemented as 「the Act on the Promotion and Support of Environmental Education」 (hereinafter referred to as the Environmental Education Act) to actively develop and revitalize environmental education to overcome the climate crisis. However, I think our environmental education is not at a satisfactory level yet. This is because the environmental education system is not completely established, and There are many areas that need to be studied in terms of the aspect and quality of environmental education. Especially the government's budget support is insufficient. Therefore, in this study, I would like to find out what environmental education we need in the face of an increasingly serious climate crisis and analyze what needs to be supplemented in the current field of environmental education.

2. Theoretical Discussions on Survival Environmental Education

2.1. Concepts and Types of Environmental Education

Environmental education is defined as "education that allows the public to understand the importance of the environment and practice the preservation and improvement of the environment by having the knowledge, skills, attitudes, values, etc. necessary to preserve and improve the environment" (Article 2, Paragraph 1 of the Environmental Education Act). Environmental education can be largely divided into 'school environmental education' for elementary, middle, and high school students and 'social environmental education' for the general public. Social environmental education and school environmental education differ in the subject and object of education, educational space, textbooks, and financial support. Social environmental education is weaker than

school environmental education in terms of sustainability and systematicity, but it is more free, creative, suitable for dealing with local-centered topics, and has the advantage of implementing issue-oriented environmental education with field and diversity (Oh Hyun-jeong and Hong Sung-doo, 2021: 187). The importance of environmental education is becoming more prominent as the natural disasters caused by the climate crisis are getting worse, and despite the widespread perception that the climate crisis is a global and lifelong problem, environmental education is still not far out of the category of education for children and teenagers (Jang Mi-jeong, Kim Moon-ok, Yoo Young-cho, Lee Da-hyun, Lim Soo-jeong, Jeon Pu-reum, 2021: 453). In addition, in the case of school environmental education, it is only treated as a part of social studies, social environmental education has low public awareness of environmental education, and related support systems and education systems are insufficient (Park Joo-hee, Boo Jae-hee, Park Kyung-shin, 2022:54). Further as non-face-to-face education has become the mainstream due to COVID-19, education focusing on unilateral knowledge transfer rather than participatory and experiential education is being conducted. However, concrete and practical education is now needed to be carbon neutral, and essential and practical education that is useful for public in the climate crisis situation is needed.

2.2. Transition to Survival Environmental Education

While swimming, which we usually enjoy as a sport or hobby, there is Survival Swimming, where one learns how to survive when one falls into the water in case of an emergency. Survival swimming education is water education that improves adaptability to water and develops the ability to protect one's life when one falls into a crisis situation. Already overseas, swimming is recognized as an important survival method in life and is mandatory (Lee Je-seung and Lee Sung-no, 2021: 790). Likewise, when natural disasters due to the climate crisis are increasingly threatening our human lives and property, environmental education should not be an arbitrary environmental education that acquires simple knowledge, but a capacity-oriented "Survival Environmental Education (SEE)" that is essential to survive climate disasters and speed up climate change by reducing greenhouse gas emissions. Now, competency-oriented curriculum is actively being discussed in environmental education, and the concept of environmental competency is being introduced for practical educational purposes rather than general, conceptual, or academic knowledge (Jang Mi-jeong, Kim Moon-ok, Yoo Young-cho, Lee Da-hyun, Lim Soo-jeong, Jeon Pu-reum, 2021: 455).

Article 22-2 (Climate Change Environmental Education) of the Framework Act on Education was newly established (2021.9.24.) and stipulated that "the state and local governments should establish and implement necessary policies to ensure that all citizens receive Ecological Transformation Education to cope with climate change." In this sense, this means that the mandatory requirement for public to receive ecological transformation education is significant in that it is in line with "Survival Environmental Education (SEE). Here, 'Ecological Transformation Education' is education that pursues a holistic transformation of not only individual thoughts and behaviors but also organizational culture and systems for the coexistence of humans and nature and sustainable ecological civilization in response to the climate crisis (Nam Mi-ri, 2021: 1).

3. Climate Crisis and Survival Environment Education

3.1. The Seriousness of the Climate Crisis

The 6th Assessment Report (AR6) 2nd Working Group (WG2) report on climate change impact, adaptation and vulnerability, published at the 55th General Assembly of the "Intergovernmental Panel on Climate Change (IPCC)" (2022.2.14.-2.27.) is mainly

filled with words of negative meaning. For example, 'biodiversity extinction', 'water shortage', 'heavy rain', 'flood damage', 'serious drought', 'food crisis', 'increase in infectious diseases', 'worsening infant health' and 'increasing inequality'.

According to the report's main contents, in Asia, extreme temperatures and increased precipitation volatility are expected to increase food and water security crises, while flooding in coastal cities causes damage to urban infrastructure, while drought damage is also expected to increase by 5 to 20%. In the case of animals and plants, half of the species' habitats move to high altitudes and highlands, two-thirds of the plants grow faster in spring, and eutrophication accelerates due to reduced lake freezing in the northern hemisphere. Meanwhile, the marine life group moved about 59km north per decade, and as plankton decreased globally in the second half of the 21st century, fishery resources also decreased by 5.7 to 15.5%.

Water shortages are also serious. More than 4 billion people, more than half of the total population, are currently suffering from water shortages, but due to large regional variations, heavy rains are expected in some areas, strong droughts are predicted in others. Food problems are even more bleak. The deterioration of food supply stability is expected to increase malnutrition, but environmentally sustainable countermeasures have failed, and more than 10% of crop and livestock areas will be climatically unfit by 2050 and 30% by 2100. It is predicted that even if the current adaptability is fully displayed, it will be difficult to prevent the impact of food reduction. As the population of climate-threatened cities continues to grow, mainly in Asia and Africa, waterborne infections, mediated infections, and infectious diseases are also increasing, and adverse effects of human health are predicted by extreme weather and abnormal weather phenomena. In particular, while adverse effects of human health are also predicted due to extreme weather and abnormal weather phenomena, the possibility of an increase in physical and mental diseases of mothers and infants due to malnutrition was mentioned for the first time. Climate Resilient Development, a process of implementing climate change mitigation and adaptation methods for sustainable development, is feasible when governance is established with central, local government and private part, and social choices over the next decade will determine future climate resilience. In June 2022, floods in Pakistan killed more than 1,700 people, flooded one-third of the country, and damaged about 41 trillion won. Seoul, the capital of South Korea, also suffered heavy rain of 141.5mm per hour in early August, paralyzing urban functions. "The scientific evidence is clear that climate change poses a threat to human well-being and global health," said Hans-Otto Portner, co-chairman of the IPCC's Second Working Group. "The window of opportunity to save a viable future is closing quickly. If we don't act immediately around the world, we'll miss even that opportunity," he said.

3.2. *The Necessity of Survival Environmental Education*

Recently, the topic of environmental education research that is focused on in the U.S. environmental education academia include: ①The impact of environmental education on the community beyond personal interests ②Interest in social justice, health, and emotions based on an understanding of the social-ecological system ③Concerns about the appearance and direction of environmental education in the increasingly urbanized world, etc.(Lee Eun-joo, 2019: 104). Environmental education requires a different approach from mathematics, engineering, and technical education. This is because it is necessary not only to convey environmental knowledge to learners, but also to influence attitudes and behaviors toward the environment (Park Joo-hee, Bu Jae-hee, Park Kyung-shin, 2022:546).

As various natural disasters caused by climate change (flood, strong winds, embankment collapse, urban flooding, landslides, heat waves, cold waves, etc.) occur repeatedly around the world, no one can be free from the climate crisis now, and envi-

ronmental education should be geared toward minimizing the damage caused by these natural disasters. In other words, all efforts should be made to slow down the speed of the 'environmental crisis clock' by responding to and adapting to the climate crisis through carbon neutrality. In addition, practical education is needed for the purpose of cultivating the qualities and abilities to respond quickly and appropriately as actual evacuation training in the event of a natural disaster (Kim Seon-il, 2016: 71-72).

Education and research on abnormal climate phenomena caused by climate change, which is now the biggest threat to us, have adopted the phenomenon, cause, impact, and countermeasures of climate change as educational content. The abnormal climate phenomenon has been composed of contents belonging to the phenomenon and impact of climate change. In this way of constructing, the lives of those affected by abnormal weather are just one example of how serious climate change is (Bang Yoon-young, Lee Da-hye, Moon Hee-soo, Jeong Han-na, and Ahn Sae-rom, 2022:49). In the case of school environmental education, environmental problems are viewed from various perspectives, and education for a holistic approach to them is not well conducted (Kim Ho, Nam Young-sook, 2021:51-52). Therefore, future environmental education to overcome the climate crisis and achieve carbon neutrality should be changed to experiential and participatory education rather than one-sided education so that specific action to reduce greenhouse gas emissions can be guaranteed. At the same time, it is necessary to switch to the Survival Environmental Education (SEE) method of learning how to protect life and property from natural disasters caused by abnormal climate phenomena.

4. Complementary Points in Current Environmental Education

4.1. Mandatory Social and Environmental Education for Public Officials

The establishment of Article 22-2 (Climate Change Environmental Education) clause of 「the Framework Act on Education」, which obliges the state and local governments to prepare policies for public to receive ecological transformation education, is very encouraging. Environmental education is now an essential prerequisite for overcoming the climate crisis and being carbon neutral, and we should all participate in reducing greenhouse gas emissions in homes and workplaces.

「The Environmental Education Promotion Act」, which was enacted as an independent law in March 2008, was completely revised, and 「the Environmental Education Promotion and Support Act」 has been in effect since January 2021. However, in the light of the trend of the times when environmental education should be strengthened, it is difficult to understand that Article 14 (Implementation of Social and Environmental Education) stipulated social and environmental education for public officials as voluntary regulations. In particular, the concept of survival environmental education should be included to make it an essential curriculum, so it should be changed to mandatory regulations through legal revisions as soon as possible.

4.2. Early Establishment and Strengthening Environmental Education System

The Minister of Environment shall designate and operate a national environmental education center to promote environmental education (Article 24 of the Environmental Education Act), and the heads of cities, provinces, counties, and districts shall have a metropolitan environmental education center and a local environmental education center (Article 25 of the same Act). The National Environmental Education Center plays a pivotal role in effectively and systematically supporting various environmental education projects by establishing an environmental education cooperation system by developing and distributing environmental education materials and environmental education programs, research, and developing national plans.

The metropolitan environmental education center, which is in charge of revitalizing environmental education in each city and province, is currently operating in 15 cities and provinces, excluding Seoul and Gwangju. The metropolitan environmental education center is obligated to play the role of a bridge between the national environmental education center and the local environmental education center and to revitalize environmental education at the metropolitan level. In this regard, it is very important that the metropolitan environmental education center plays its function and role because it is difficult to play at the local level and plays a regional role at the national level (Kim Moon-ok, Choi Yoo-jin, Lee Da-hee, 2022:151).

The problem is the Local Environmental Education Center. The Local Environmental Education Center is designated and operated by the head of the city (Si/Gun/Gu) to effectively conduct practical environmental education for residents in the region. However, only 49 local environmental education centers, or 21.7% of the 226 cities nationwide, are designated and operated, and there is no organization dedicated to environmental education in each city and county. Therefore, local grassroots environmental education has not been properly conducted yet.

Environmental education should be different from education in other fields in many ways. Environmental educators in charge of environmental education are asked to strengthen their environmental education capabilities because many of them participated on their own based on voluntary interest and enthusiasm (Kim Chan-guk, 2019: 385). In selecting environmental educators with qualitative levels, not only environmental knowledge but also environmental sensitivity is required. In particular, internalization of attitudes such as basic philosophy, ethics, and communication with others should be prioritized before acquiring environmental education expertise and skills (Kim Moon-ok, 2021: 132). The space where environmental education is conducted should be different from other educational places. Poor conditions with minimal energy use and no disposable use are optimal for environmental education sites, and environmental education should be provided to match education content to minimize greenhouse gas emissions. Otherwise, environmental education has no integrity, is empty, and is difficult to become a sustainable education.

4.3. The Need to Increase the Budget for Environmental Education

The urgency and importance of environmental education are increasing day by day, but budget support for this is far from sufficient. As of 2022, 15 metropolitan environmental education centers are in operation out of 17 metropolitan cities, but only 6 places (Gyeonggi, Chungnam, Gyeongnam, Busan, Incheon, and Ulsan) are funded, and the amount of support is only 150 million won to 300 million won. This is not enough to fulfill its role (Kim Moon-ok, Choi Yoo-jin, Lee Da-hee, 2022: 151). However, next year there will be four more targets for state funding (Chungbuk, Daegu, Daejeon, and Gangwon), providing state funds to a total of 10 places, but it is still not supported to the other five places (Jeonbuk, Jeonnam, Gyeongbuk, Jeju, and Sejong). In the case of Chungcheongbuk-do, a total of 300 million won will be provided to the Chungbuk Environmental Education Center from 2023, including national and local expenses. , However, the Chungcheongbuk-do Office of Education's environmental education budget is about 2.2 billion won, and the conditions for social environmental education are relatively poor compared to school environmental education.

4.4. The Application of Advanced Technology in the Fourth Industrial Revolution

For environmental education, measures should be actively devised to utilize advanced technologies brought by the 4th Industrial Revolution, such as information and

communication technology, big data, artificial intelligence, robots, Virtual Reality, Augmented Reality, the Internet of Things, and metaverse. If education through artificial intelligence or robots is in full swing, it is easy to receive high-quality education services without having to go to school or a specific place (Cho Heon-guk, 2017: 291-292). Realistic education using virtual reality can improve trainees' knowledge understanding through immersion and interaction compared to traditional learning (Park Joo-hee, Boo Jae-hee, Park Kyung-shin, 2022:541).

One of the key roles of the National Environmental Education Center and the Regional Environmental Education Center is the development and distribution of environmental education textbooks and environmental education programs. Therefore, it is expected that the limitations of offline environmental education can be greatly supplemented by creating and distributing various types of environmental education platforms using high-tech technologies. In particular, it is possible to create an extreme situation necessary for survival environment education emphasized in this study, so it has the advantage of maximizing the educational effect.

5. Conclusions

Environmental education is the first step toward overcoming the climate crisis and achieving carbon neutrality. The roles and functions of the National Environmental Education Center, the Metropolitan Environmental Education Center, and the Local Environmental Education Center, which form the basis of environmental education in Korea, have not yet been fully established. Policy and financial support must be provided for the quantitative and qualitative growth of environmental education. However, despite the severe climate crisis, support for environmental education is still very insufficient. Due to the various causes mentioned above, our environmental education has not yet been activated. It is necessary to reconsider the learning strategy of environmental education that has been done so far.

In future environmental education, practical aspects should be emphasized in terms of survival environmental education as well as theoretical aspects. For future generations, climate change is no longer regarded as a vague and uncertain concept. Rather, they seem to be anxious that climate change could pose a threat to their future lives and could be a serious obstacle to improving the quality of life and sustainable growth. Therefore, Improving the ability to adapt to climate change, building resilience, and environmental education are important tasks (Park Ki-ryeong and Shin Dong-hoon, 2020: p24). For now, the most basic and top priority to achieve the global mission of being "2050 carbon neutrality" is quality environmental education. It is necessary to overcome the climate crisis and create a sustainable human life through appropriate and effective environmental education.

References

1. Kang Jin-young, Cheon Hyang-on, Nam Mi-ri, and Hong Jong-ho (2021). Review of the value of environmental education: Metaphraxis perspective. *Educational Philosophy Research* Vol. 43, No. 2, p1-26.
2. Korea Meteorological Administration (KMA) (November 2020). *Climate Change Science Glossary*. Seoul: Climate Change Monitoring Division
3. Korea Meteorological Administration (KMA) (December 2020). *Global Warming 1.5°C Special Report Manual*. Seoul: Climate Change Monitoring Division
4. The Korea Meteorological Administration and the National Institute of Meteorological Sciences (2021). *Report on Climate Change Analysis in Korea 109 (1912-2020)*. Seoul: Climate Change Monitoring Division of the Korea Meteorological Administration, Future-Based Research Department of the National Institute of Meteorological Sciences.
5. Kim Seon-il (2016). *A Comparative Study on School Safety Education in Korea and Japan* a master's thesis at Korea Teachers' University.
6. Kim Moon-ok, Choi Yoo-jin, and Lee Da-hee (2022). Deriving the relative importance between the roles of the Wide Area Environmental Education Center and the roles. *Environmental Education*, Vol. 35, No. 2, p141-153.

7. Kim Jung-in (2021). ESG linkage plan for achieving carbon neutrality Climate Change and Green Growth, Winter 2021 Vol. 22: 16-30.
8. Kim Chan-guk (2019). Exploring the direction of improving the system and policies of environmental education in Korea through international cooperation and mutual learning in environmental education. Environmental Education, Vol. 32, No. 4, p379-391.
9. Kim Chu-ryeong (2021). Tomorrow Earth. Seoul: Red salt.
10. Kim Ha-yeon and Lee Jung-il (2017). The theory of safety management. Seoul: Whasumok
11. Kim Ho and Nam Young-sook (2021). A Study on the Environmental Education Policy Direction Analysis of the Provincial Office of Education in Korea: Focusing on the 2021 Business Promotion Plan of the Provincial Office of Education. Special Session of the 2021 Autumn Conference of the Korean Society for Environmental Policy, p51-52.
12. Nam Mi-ri (2021). Ecological transformation education, a change of thought rather than a change of method! Seoul Education, 2021 Summer Issue (No. 243).
13. Park Ki-ryeong and Shin Dong-hoon (2020). Research on climate change awareness and system improvement tasks for future generations. the Korea Institute of Legislation
14. Park Young-sook and Jerome Glen (2017). World Future Report 2050. Seoul: Business Books.
15. Park Joo-hee, Boo Jae-hee, and Park Kyung-shin (2022). Design and implementation of virtual reality simulation of immersive environmental education. Journal of the Korean Society for Information and Communication Vol. 26, No. 4: 541-547.
16. Park Hoon (2021). The Climate Change Data Book for a Sustainable Future. Seoul: Academy of Social Criticism
17. Bang Yoon-young, Lee Da-hye, Moon Hee-soo, Jeong Han-na, and Ahn Sa-rom (2022). Development of environmental education textbooks based on ecological citizenship. Environmental Education, Vol. 35, No. 1, p37-54.
18. National Emergency Management Agency (2005). A Study on the Countermeasures of Natural Disasters against climate Change.
19. Eric Kleinenberg (2018). A Heat Wave Society. Gyeong-gi: Geul-hangari
20. Oh Hyun-jeong and Hong Sung-doo (2021). Types of perceptions of social and environmental education experts on sustainable development education. Seoul National University of Education Korea Elementary Education Vol. 32, No. 3, p187.
21. Lee Mi-yeon (2020). Analyzing the financial needs of natural disaster damage support considering climate change: Focusing on disaster support funds and storm and flood damage insurance. Budget Policy Study of the National Assembly Budget Office Vol.9, No.1, p28-60.
22. Lee Eun-joo (2019). Current status of environmental education in foreign countries: characteristics and implications of environmental education in the United States. 2019 Korean Society of Environmental Education Presentation Paper, p102-105.
23. Lee Jae-young (2019). The achievements and tasks of the 10 years of institutionalization of environmental education in Korea. Environmental Education, Vol. 32, No. 4, p423-436.
24. Lee Jae-eun (2018). Crisis Management (second edition). Seoul: Daeyoung
25. Lim Hyun-woo and Yoo Ji-sun (2022). Disaster Management Theory (Second Edition). Seoul: Parkyoungsa.
26. Jang Mi Jeong, Kim Moon-ok, Yoo Young-cho, Lee Da-hyun, Lim Soo-jeong, and Jeon Pu-reum (2021). A Study on the Paradigm of the Life Cycle Customized Environmental Education Program. Environmental Education, Vol. 34, No. 4, p452-469.
27. George Marshall (2022). The psychology of climate change. Seoul: Galma.
28. Cho Cheon-ho (2021). 2050 The need for carbon neutrality. Climate Change and Green Growth. 2021 Summer Issue No. 21: 6-13.
29. Cho Heon-guk (2017). Changes in the future society and educational environment following the 4th Industrial Revolution, and tasks of elementary and secondary science education. Environmental Education, Vol. 36, No. 3, p286-301.
30. Choi Jae-cheon (2021). “Ecological transformation for wise earth life”. Gyeong-gi: Kimyoungsa.
31. Paul Hogan (2022). End the climate crisis in a generation. Gyeong-gi: Geal-hangari science
32. KEI Korea Environmental Research Institute (2021). Korea's Carbon Neutral 2050. Seoul: Crayon Book
33. Ministry of Environment (2022). 2050 Carbon Neutrality Education Reference Book. Gwangmun
34. IPCC (1990). Climate Change: The IPCC 1990 and 1992 Assessment. WG1. SPM. 80-81
35. IPCC (1995). IPCC Second Assessment Climate Change 1995. WG1. SPM. 22.
36. IPCC (2001). TAR Climate Change 2001: Synthesis Report. SPM. 20.
37. IPCC (2007). Climate Change 2007: Synthesis Report. SPM. 5.
38. IPCC (2014). AR5 Synthesis Report: Climate Change 2014. SPM. 2-8.
39. IPCC (2021). Climate Change 2021: The Physical Science Basis. WG1. SPM. 5-7.
40. IPCC (2022). Climate Change 2022: Impacts, Adaptation and Vulnerability. WG2. SPM. 3-35.

Article

Climate Change Effects on the Flows of Swat River in Pakistan

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Abstract: Swat River flows, located in Pakistan's Hindu-Kush mountains, were analyzed to determine the impact of changes in precipitation and temperature. From 1965 to 2018, we analyzed long-term trends in river flow, precipitation, and temperature using the Modified Mann-Kendall (MMK) test, and we examined abrupt changes in flow regime using the Sequential Mann-Kendall (SMK) test. We were able to divide the temperature and precipitation records into pre-mutation (1985–2018) and post-mutation (1985–2018) intervals by using the SMK test results. The MMK test results revealed a considerable increase in the basin's precipitation, temperature, and flow. According to the SMK findings, river flows significantly increased after 1984. The post-mutation interval had a greater average yearly flow than the post–mutation interval. We concluded that the growing trend of annual average river flow is primarily attributable to the increased amount of regional precipitation.

Keywords: Trends Analysis; River Flow; Temperature; Precipitation; Pakistan

1. Introduction

Global warming is continually impacting climatic and hydrological systems in different parts of world. Temperature and precipitation both have an impact on river flow, which is a crucial part of the watershed hydrological cycle [1].

River flow fluctuations must be evaluated, and the watershed-level drivers must be identified, in order to properly plan for water supply needs at the local, regional, and global scales. Several previous studies have documented trends in the river flows under the context of climate change. For instance, after studying national discharge trends, Sagarika et al. [2] found that the eastern United States was experiencing increase in average annual river flow while the northwest was experiencing decline.

The objective of this study was to investigate the temporal and spatial variation of precipitation, temperature, and river flow in the Swat River watershed, which is located in the Hindu-Kush Mountain range in Pakistan.

2. Materials and Methods

2.1. Study Area

This evaluation was carried out for the watershed of the Swat River (Figure 1), which has a total area of 14039 km². Located in the Hindu-Kush Mountains, this watershed marks the international border between Pakistan and Afghanistan. The watershed has a very

wide range of elevations, from 376 metres above sea level (masl) to 5917 masl, with a mean elevation of 2177 masl. The Panjkora River is a larger tributary of this river and together they form one of the region's most important waterways. Continually flowing from north to south, this river is a perennial fixture. Records show that, on average, it receives about 730 millimetres precipitation per year and its average temperature ranges from 1 °C in the north to 10 °C in the south.

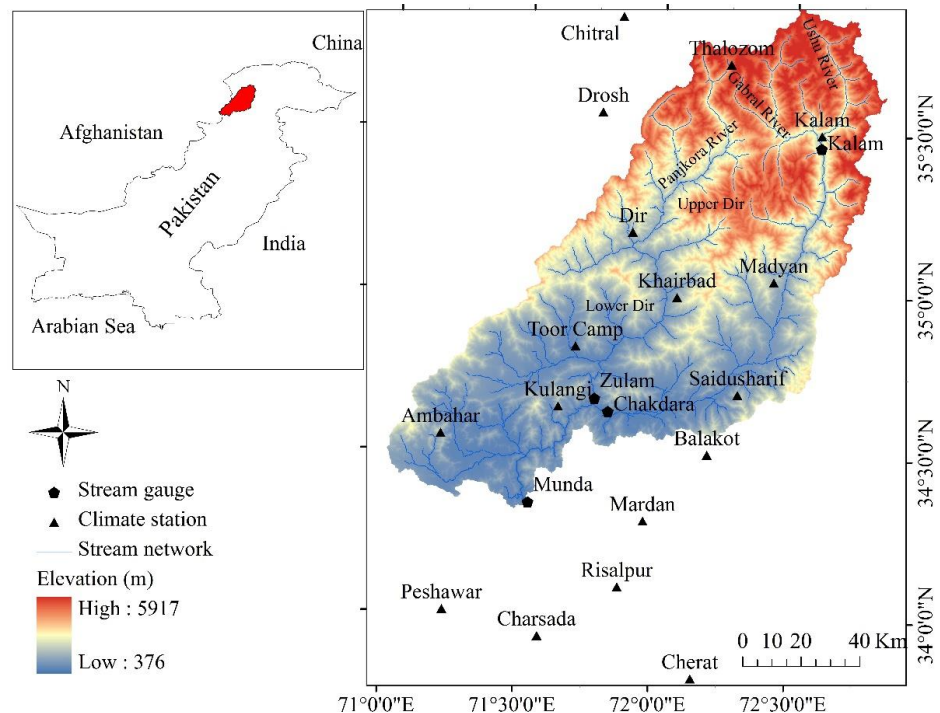


Figure 1. Map showing the location of the Swat watershed, meteorological and hydrological stations.

2.2. Datasets

For this analysis, we used daily precipitation data from 9 meteorological stations, daily temperature data from 8 meteorological stations, and daily discharge data from 4 hydrological stations for a total of 54 years (1965-2018).

2.3. Methods

In this study, total area of the Swat watershed was divided into four sub-watersheds. The positions of hydrological stations were used to determine the sub-catchment outlet points. Since there were four hydrological stations in the watershed, it was split into four separate sub-catchments. River flow, precipitation, and temperature patterns were investigated using the MMK test [3]. Specifically, the amount of slope in the hydro-climatic time series was estimated using the Theil-Sen (TS) method [4,5]. River flow data was analyzed using the Sequential MK test to identify the change point in the time series.

3. Results

According to the preliminary analysis, the Zulam station had the largest annual water supply with a mean annual flow of 110 m³/s. In contrast, Munda station, with average annual flow of 50 m³/s, had the lowest annual flow rates. In addition, the yearly discharge time series recorded at the Chakdara station displayed the greatest amount of temporal

fluctuation, with a coefficient of variation (CV) equal to 38%. Over the course of the investigation, the discharge at the Kalam station exhibited the lowest inter-annual fluctuation, with a CV of only 14%.

Using the MMK test, we see an upward trend in the average yearly discharge data for the last 54 years (1965-2018). Three of the Swat Basin's hydrological stations show a statistically significant upward trend in discharge, whereas the upward trend at the fourth station (Kalam) is not significant at the 5% level. According to the findings of the TS method, the average annual increase in flow (from 1965-2018) at the Munda, Zulam, and Chakdara stations was 5%, 5%, and 8% of their respective long-term average flows, respectively.

The results of the SMK test show that the Zulam station's yearly flow has been increasing since 1986. Mutation was discovered in 1989 at Munda station. Additionally, 1987 was identified as the beginning year of the rising trend in annual discharge at the Chakdara station.

Discharge time-series data at stations showing substantial rising trends were split into pre- and post-mutation intervals using the SMK test results. When comparing the discharge trends of rivers before and after mutation, statistical significance was shown for an upward trend in flow at Munda, Zulam, and Chakdara stations after mutation, although these changes were not noticeable before mutation.

After the mutation, the correlation between river flow and rainfall in every part of the Swat Basin was stronger than it had been before mutation. This demonstrated that precipitation fluctuation in the period after the mutation had an effect on the runoff variations.

4. Conclusions

Following conclusions were made on the basis of findings of this study:

- A significant upward trend in river discharge was found (at a significance level of 5%), and it was seen in three sub-watershed of the Swat watershed. These sections are Chakdara, Zulam, and Munda.
- After the mutation, there was a dramatic rise in river flow. The post-mutation discharge varied the most at the Chakdara station. Planners, managers, and designers of water resources projects must take these differences into account.

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References

1. Wang, H.; Stephenson, S. R.; Qu, S. Quantifying the relationship between streamflow and climate change in a small basin under future scenarios. *Ecological Indicators* **2020**, *113*, 106251.
2. Chu, H.; Wei, J.; Qiu, J.; Li, Q.; Wang, G. Identification of the impact of climate change and human activities on rainfall-runoff relationship variation in the Three-River Headwaters region. *Ecological Indicators* **2019**, *106*, 105516.
3. Hamed, K. H.; Rao, A. R. A modified Mann–Kendall trend test for autocorrelated data. *Journal of Hydrology* **1998**, *204*, 182–196.
4. Theil, H. A rank-invariant method of linear and polynomial regression analysis, Part 3. In Proceedings of the Royal Netherlands Academy of Sciences. Royal Netherlands Academy of Arts and Sciences: Nederland, **1950**, 1397–1412.
5. Sen P K. Estimates of the regression coefficient based on Kendall's tau. *Journal of the American Statistical Association* **1968**, *3* (324), 1379–1389.



Article

A Study on the Local Extinction Discourse and Crisis Management in Rural Areas

- Focusing on the Local Extinction Reaction Fund -

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Abstract: In response to recent discussions on the ‘local extinction discourse’ of Masuda Hiroya in Japan and the ‘local extinction risk index’ in Korea, the government designated a ‘depopulation region’ based on the ‘depopulation index’. In addition, a ‘local extinction reaction fund’ will be established to provide support of KRW 1 trillion to depopulation regions every year. Under these circumstances, the purpose of this study is to confirm the significance of the local extinction reaction fund for crisis management in rural areas and to derive improvement plans for it. The improvement plan for the local extinction reaction fund, which was deduced as an issue of the system, is as follows. First, incentives to prevent adverse selection in response to local extinction must be strengthened. Second, the duplication between local extinction-related projects and financial support should be reduced and the connection strengthened. Third, by strengthening the acceptability of the depopulation index, it is necessary to intensively invest funds in rural areas with a serious risk of extinction, and to respond with a package rather than support focused on one field.

Keywords: local extinction, depopulation, financial support, reaction fund, crisis management

1. Introduction

1.1 Research Background

In May 2014, the so-called Masuda Report, which shocked Japan using the rather radical expression ‘local extinction’, was released. If the current trend continues, half of the Japanese municipalities will disappear by 2040. In Korea, related studies are continuing, such as presenting a “local extinction risk index” by dividing the number of infertile women in the region by the number of people aged 65 or older (Lee, 2016). As a result, Korea also showed a serious level of local extinction. As of March 2022, the number of areas at risk of extinction reached 113, half of 228 si-gun-gu (Lee, 2022).

To respond to local extinction and population decline, the Ministry of Public Administration and Security developed a depopulation index and designated and announced a depopulation region (Ministry of Public Administration and Security, 2021). In addition, in December 2021, the Framework Act on the Management of Local Government Fund was amended to establish a local extinction reaction fund that supports 1 trillion depopulation regions every year. In 2022 and 2023, a minimum of KRW 11.2 billion and a maximum of KRW 21 billion will be distributed to the depopulation region, and a minimum of KRW 2.8 billion and a maximum of KRW 5.3 billion will be allocated to the region of interest (Ministry of Public Administration and Security, 2022a).

1.2. Research Necessity

It is true that there are critical views on 'local extinction discourse' and 'local extinction risk index'. However, it is an undeniable fact that it led to public debate on social agendas that we had neglected, such as low birth rate and unbalanced development, and that various policy discussions began to overcome local extinction. Therefore, it is necessary to organize theoretical discussions on 'local extinction discourse' and 'local extinction risk index'.

The local extinction reaction fund will be allocated to depopulation regions and regions of interest in 2022 (750 billion won) and 2023 (1 trillion won). It is time to review what issues were discussed in the process and what problems are expected in the process of implementing the policy.

1.3. Research Purpose and Research Method

The purpose of this study is to confirm the significance of the local extinction reaction fund for crisis management in rural areas and to discuss improvement plans for it.

To achieve this, various opinions and theories surrounding 'local extinction discourse' and 'local extinction risk index' are analyzed. This is to draw attention to the problem of population decline and regional imbalance. Next, the issues surrounding the local extinction reaction fund will be investigated and improvement plans will be derived through this.

The research method is as follows. Regarding the 'local extinction discourse', based on the Masuda Report, I would like to analyze the literature through previous research on related discussions. Regarding the 'local extinction risk index' presented in Korea, the meaning of the index, the current status of the country, and various discussions surrounding the index will be reviewed through previous studies. Regarding the local extinction reaction fund, the current situation of the policy is reviewed and issues related to it are analyzed to present anticipated problems and improvement plans.

2. Main subject

2.1. Related Theories and Policies

o Masuda Hiroya's local extinction discourse¹

Masuda Hiroya's 'local extinction discourse' starts from a critical mind about the low birth rate and population migration from rural areas to large cities represented by Tokyo. A consistent feature of population migration from rural areas to metropolitan areas is that the movement is centered on the younger generation. This is not just a decrease in the population, but a massive outflow of population reproductive power to the metropolitan area. In addition, although the population of metropolitan areas has increased due to the influx of young people, it cannot be said that metropolitan areas are necessarily ideal environments for marriage and childbirth (Masuda, 2015). In other words, it is argued that Japan's population problem should be understood in connection with the problem of the concentration of the young population in the metropolitan area as well as the low birth rate and aging population. The low birth rate acts as a factor in population decline pressure in both the metropolitan area and the provinces, resulting in population decline and

¹ Japan Policy Conference. 2014. For the ever-growing 21st century: Stop the declining birthrate and regional revitalization strategy.

Hiroya Masuda, ed. 2014. "The disappearance of rural areas: rapid population decline caused by overconcentration in Tokyo", Chuokoron

local extinction. In addition, the concentration of the young population in the metropolitan area increases the risk of local extinction due to the outflow of the local population, and the increase in the burden of housing and education expenses due to the population concentration in the metropolitan area results in a significant decrease in the birth rate in the metropolitan area (Chung, 2019b).

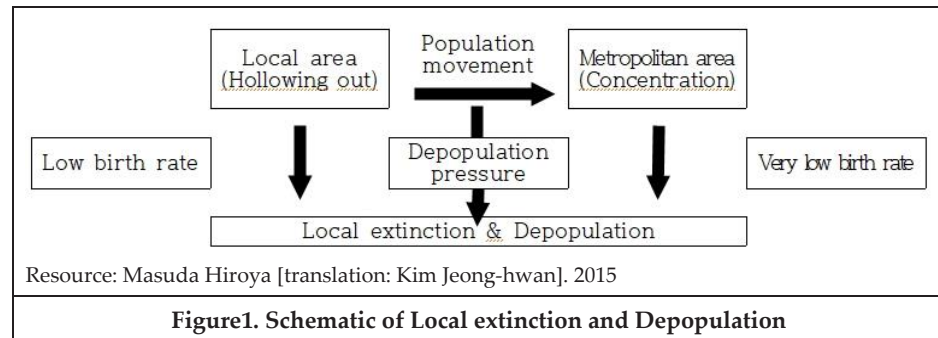


Figure1. Schematic of Local extinction and Depopulation

The Masuda Report argues that in order to increase the birth rate of Japan as a whole and prevent population decline, the huge trend of population concentration in metropolitan areas must be changed (Park, 2017). To materialize this, note that young women between the ages of 20 and 39 have a role in population reproduction. Assuming that population decline estimates from 2010 to 2015 continue, 896 local governments in which the female population aged 20 to 39 decreased by less than 50% between 2010 and 2040 were designated as ‘cities with potential for extinction’. Among them, 523 local governments whose populations fall below 10,000 can be said to be highly likely to disappear if the current situation continues (Masuda, 2015).

o Local Extinction Risk Index

The local extinction risk index is an index proposed by researcher Lee Sang-ho of the Korea Employment Information Service, based on the fact that Masuda Hiroya paid attention to young women and derived the areas at risk of extinction in Japan. Through this, he analyzed the degree of local extinction risk in Korea. The local extinction risk index of a region or community is defined as follows.

Classification		Contents
Local extinction risk index		Number of female population aged 20-39 / Number of elderly population aged 65 and over
low level of extinction risk		Index 1.5 or higher
Moderate level of extinction risk		Index 1.0 to less than 1.5
Attention level of extinction risk		Index 0.5 to less than 1.0
Area of Extinction risk	Extinction risk entry stage	Index 0.2 to less than 0.5
	Area of high extinction risk	Index less than 0.2
Resource: Lee Sangho 2018, revised		
Table1. Classification of local extinction risk index		

Excluding realistic factors and assuming very simplified conditions, if the index value falls below 0.5, it means that the community has entered the demographic risk of decline. If the index value is less than 0.2, it means that the extinction risk is very high. As of March

2022, there were 113 areas at risk of extinction, accounting for half (49.6%) of the 228 Si, Gun, and Gu nationwide. There were only 33 areas at risk of extinction in 2005, but in 2015, 10 years later, the number increased to 80. In 2020, when COVID-19 first occurred, the number of areas at risk of extinction reached 102, a three-digit number, and as of March 2022, just over two years later, the majority exceeded (Lee, 2022).

o Depopulation Region & Region of Interest

The depopulation region is defined in Article 2(9) of the Special Act on Balanced National Development. The term "depopulation region" means an area prescribed by Presidential Decree in consideration of birth rate, population of senior citizens aged 65 or over, population of the youth aged 14 or under, population of working age, etc. among Si (excluding Special Metropolitan City)/Gun/Gu at risk of extinction by depopulation. In addition, based on this, the Minister of Public Administration and Security may designate and announce the depopulation region in the relevant enforcement ordinance.

Based on the Special Act on Balanced National Development and its enforcement decrees, the Ministry of Public Administration and Security announced and designated 89 depopulation regions on October 18, 2021. The depopulation region is a "depopulation index" consisting of eight indicators, including annual average population growth rate, population density, youth net migration rate, weekly population, aging rate, youth rate, birth rate, and financial independence among basic local governments (si/gun/gu). It was selected by applying (Ryoo, 2022a). In addition, the Ministry of Public Administration and Security designated the region of interest using the depopulation index. Region of interest refers to a region included in around 20/100 of the number of depopulation regions in order of highest depopulation index among Si · Gun · Gu excluding depopulation regions.

o Local Extinction Risk Index

To respond to the local extinction problem, on December 7, 2021, the Framework Act on the Management of Local Government Fund was amended to create a legal basis. The local extinction reaction fund is a fund supported to respond to local extinction in 89 depopulation regions and 18 regions of interest (Related ministries joint, 2021). When depopulation regions and regions of interest submit investment plans using funds, the central government evaluates them and allocates funds. In 2022, as the first year of introducing the fund, investment plans for 2022 and 2023 were submitted together. A total of 122 local governments submitted 811 investment plans for 2022 and 880 investment plans for 2023 (Ministry of Public Administration and Security, 2022b).

Classification		Local government			Metropolitan government (15)	Total (122)
		Depopulation region(89)	Region of interest(18)	Subtotal (107)		
Number of project	'22	637	63	700	111	811
	'23	691	66	757	123	880

Table2. Investment plan submission status of depopulation region and region of interest

The Korea Local Finance Association, which was entrusted with fund management and operation affairs under the Framework Act on the Management of Local Government Fund, formed an evaluation team to evaluate the investment plan and determine the dis-

tribution amount for 2022 and 2023. All depopulation regions/regions of interest were allocated without exception, and larger amounts were differentially allocated to regions where excellent fund projects were discovered according to the five evaluation grades derived from the investment plan evaluation (Ministry of Public Administration and Security, 2022a).

2.2. Prior Research

Previous studies related to local extinction discourse and the local extinction index through it were largely divided into three branches. First, interpretive and critical studies on local extinction discourse and local extinction risk index [Park(2017), Ha(2017), Chung (2019b)], Second, domestic status analysis using local extinction discourse and index [Yuk et al.(2017), Chung(2019a), Kim et al.(2017), Han(2018), Kim-Sin(2016)], Third, research that utilizes local extinction discourse and index and presents policy directions corresponding to the results [Kang et al.(2018), Ju(2021), Noh-Kang(2018), Seol et al.(2021), Lee-Choi(2019)].

2.3. Issues

o General grant tax

The general grant tax is calculated based on the difference between the standard financial income and the standard financial demand. The effect of increasing the standard financial income when receiving a local extinction reaction fund, and the effect of increasing the standard financial demand when there are many depopulation regions. In other words, if local governments act passively in securing local extinction reaction funds and maintain a large number of depopulation regions, local governments will secure more general grant tax.

General grant tax = Standard financial demand - Standard financial income
*Standard financial income = Basic income + Corrected income + Self-effort **Corrected income = Objective tax + Non-current tax income + Local tax settlement correction + Municipal tax collection grant + Municipal tax adjustment grant + Real estate sharing tax + Regional Synergy Development Funds distribution
* Standard financial demand = Basic demand + Corrected demand + Self-effort ** Correction demand = Regional balance demand + Regional management demand + Social welfare demand + Policy demand + Other demand *** Depopulation region demand = (Depopulation index/100) ² × [(Local government area × SI or Gun administrative district area average regional management cost standard administrative demand per 1,000m ²)] × 30%
Resource: Ministry of Public Administration and Security. 2022e. Explanation on the calculation of local allocation tax in 2022. pp100-112, pp35-55, revised (Ryoo, 2022a)
Figure2. General grant tax composition details

Funds should be used only for their intended purpose, and their operational performance should also be evaluated. However, since the general grant tax is a general financial resource that can be used autonomously, local governments prefer the general grant tax. In fact, in an in-depth interview with the person in charge in the previous study, there was an opinion that receiving the general grant tax was preferred over receiving the local extinction reaction fund (Ryoo, 2022b).

o Depopulation Index & Depopulation Region

A local extinction reaction fund is a fund for a depopulation region. And the depopulation region selection was derived as the result of the index by applying the “depopulation index” among basic local governments(Si, Gun, Gu). Based on the number of registered residents in 2020, the average population of 89 local governments is 56,000, but the highest is 170,000 and the lowest is 9,000, with a standard deviation of 32,700. depopulation region Most of the depopulation regions are concentrated with an average population of 37,000, but some local governments have populations exceeding 100,000, and even five local governments whose populations have increased in the last 5 years are included (Oh, 2022). It is grouped into a large category called depopulation region, but the reality of each local government is different. Even when submitting investment plans, local governments with relatively large populations and sound finances were able to secure higher allocations by providing higher-quality investment plans by providing specialized services. However, in the case of local governments with a small population and poor finances, problems such as submitting an investment plan that is a patchwork of existing policies may arise.

In addition, the larger the number of Si-Gun-Gu selected as the depopulation region, the larger the subsidy allocated to the metropolitan government. This means that in order to receive more subsidies, Si-Gun-Gu under the metropolitan government continues to be selected as the depopulation region, and the metropolitan government should support as many Si-Gun-gu as possible to be selected as the depopulation region. This can be confirmed through the distribution standard of the wide-area support account. According to the distribution standard of the wide-area support account, the higher the ratio of depopulation regions designated among Si-Gun-Gu within the metropolitan area(a1) and the depopulation region of the relevant metropolitan government among the total depopulated areas(a2), the more funds are allocated. In other words, if the depopulation region (city, county, district) of a metropolitan government decreases, the proportion of α_1 and α_2 decreases, reducing the size of the fund supported.(Park-Joo, 2022).

Si, Do distribution amount =

$$\text{wide-area support account distribution total amount} \times 0.9 \times \frac{A_i \times \alpha_1 \times \alpha_2}{\sum (A_i \times \alpha_1 \times \alpha_2)}$$

* A_i = The average value of the depopulation index of the depopulation region governed by the corresponding Si,Do

* α_1 = Ratio of depopulation region designation among Si, Gun, Gu under the jurisdiction of the relevant Si, Do

* α_2 = Ratio of depopulated areas under the jurisdiction of the relevant Si, Do out of all depopulated areas

Resource: Ministry of Public Administration and Security, 2022c

Figure3. Distribution standard for 90% of the wide-area support account

o A temporary fund that is evaluated annually

The local extinction reaction fund is a temporary fund for 10 years, and the result is evaluated every year and the fund is allocated. Even though local extinction is not a problem that can be solved in a short period of time, there is a concern that annual small-scale

repetitive projects will be carried out. In fact, even in the case of Regional Synergy Development Funds, which were temporary funds for 10 years, policies were implemented focusing on projects that were repeated annually or single-year projects because they were temporary funds. Of the 57 projects supported by the Regional Synergy Development Funds in 2020, 54 (94.7%) were routine and annual repeat projects, such as public works projects, childbirth subsidies, free meal support, and labor cost support for assistant teachers(Lee, 2021).

Classification	Number of Project (Proportion)	Project name(Example)
Annual Repeat Project	54(94.7%)	Public works projects, childbirth subsidy, free meal support, labor cost support for assistant teachers, etc.
Single Year Project	2(3.5%)	Hope Job Project to Overcome COVID-19, Goodbye Corona, Goodbuy Chungbuk
Continue Project	1(1.8%)	Green car parts commercialization and demonstration support project
Table3. Classification of Regional Synergy Development Funds by Project Period		

It was not possible to confirm the composition of the project of the local extinction reaction fund submitted by each local government. However, considering that the fund of 1 trillion won in 2023 was distributed to 880 projects, about 1.1 billion won will be invested in one project per year. The amount invested in each project is a small amount, and it is a concern that the promotion of a single-year project that is repeated annually. Moreover, the fact that management performance is evaluated every year may focus on short-sighted projects rather than mid- to long-term policies.(Son, 2022).

o Connectivity between Projects, Funds, and Regions

In the local extinction reaction fund investment plan evaluation criteria submitted by the Ministry of Public Administration and Security, the connectivity of the plan accounts for 35%, and connectivity with other regions is evaluated even with additional points.

Evaluation items	Details	Considerations	Points
Project excellence (50%)	Feasibility (15%)	- Adequacy of regional condition analysis - Adequacy of strategies and goals - Feasibility of fund project	7-15
	efficiency (25%)	- Effectiveness of fund business - Efficiency of fund business - Sustainability of fund business	13-25
	feasibility (10%)	- Reality of fund business - Implementation of prior procedures	5-10
Evaluation items	Details	Considerations	Points
planned connectivity	fund projects Connectivity (10%)	- Level of connectivity between fund projects - Level of connectivity with other local governments	5-10

(35%)	Other projects/policies Connectivity (25%)	- Level of connectivity between fund projects and other projects and policies -Connectivity effect with other projects and policies	13~25
propulsion system appropriateness (15%)	Organizational structure (8%)	-Appropriateness of organizational system	4~8
	Follow-up management system, etc. (7%)	- Appropriateness of internal performance analysis system - Appropriateness of follow-up management system	3~7
Added Point		-Willingness to promote community -Connectivity with other regions	Add up to 5
Resource: Ministry of Public Administration and Security, Submitted to National Assembly Research Service in 2022			
Table 4. local extinction reaction fund Investment Plan Evaluation Criteria(Ryoo, 2022a)			

In addition, Article 20 of the Special Act on Depopulation Region and Article 29 of the Framework Act on the Management of Local Government Fund contain information on various plans and agreements between the central and local governments. In addition, the local extinction reaction fund investment plan consulting guide cited the central government's project as an example.(Ministry of Public Administration and Security, Korea Institute of Local Administration, 2022). In addition, the local extinction reaction fund is the first fund that directly responds to regional extinction, but similar funds and financial support systems include the Regional Synergy Development Funds, Adequacy which aim to reduce the financial power gap between the metropolitan area and non-metropolitan areas. And there are special accounts for balanced national development. In particular, in the case of Regional Synergy Development Funds and local extinction reaction funds, the actual projects are similar. The current status of each field of Regional Synergy Development Funds in 2019 and the field of local extinction reaction fund in 2022-23 overlap considerably.

Classification		Culture/ Tourism	Industry/ Job	Dwell- ing	Education	Elder/ Medical	Childcare	Traffic	Etc
Number of project	'22	226	190	167	84	47	43	24	30
	'23	232	221	193	85	44	47	24	34
Table 5. Project fields of local extinction reaction fund(Ministry of Public Administration, 2022b)									

Classifi- cation	public admin- istration	educa- tion	Cul- ture/ tour- ism	Social Wel- fare	health	Agricul- ture/ Marine	Indus- try/ Small Busi- ness	Transpor- tation	National Territory/ Regional Develop- ment
Number of project	2	3	2	17	1	7	16	4	1
Table 6. Project fields of regional synergy development funds(2019), Revised(Han et al., 2021)									

Local extinction reaction funds and related laws induce linkages between policies, and similar support systems already exist. It is expected that synergistic effects will be produced when linked, but the method is ambiguous.

o Fast-paced and Bottom-up

The local extinction reaction fund submitted an investment plan in a bottom-up manner to reflect the reality of each local government, and allocated funds based on the evaluation. However, there is an opinion that the situation of each local government could not be properly contained. In fact, in the case of in-depth interviews with the person in charge of each local government, it was not possible to collect the opinions of residents or go through the process of resident participation when establishing an investment plan. The investment plan of the local extinction reaction fund has become a government-led plan rather than a resident-led one (Ryoo, 2022b). In fact, in chronological order, the depopulation region was announced in October 2021, and the Framework Act on the Management of Local Government Fund, the basis for the local extinction reaction fund, was implemented in January 2022. The investment plan for fund distribution was submitted by the end of May 2022, and in August 2022, the local extinction reaction fund distribution amount for 2022 and 23 was decided. It took less than a year to designate depopulation regions and distribute funds. A fund of 1.75 trillion won was distributed in less than a year.

2.4. Improvement

o Prevention of Adverse Selection

In the case of the general grant tax, the autonomy of the local government is highly guaranteed compared to the fund. In fact, in the case of front-line staff, the general grant tax is preferred over the fund project if the same amount of financial support is provided. However, in the current situation, if the local extinction reaction fund is issued, the general grant tax is reduced, and the general grant tax is increased when there are many depopulation regions. In addition, in terms of distribution of local extinction reaction funds, in the case of metropolitan local governments, the more depopulation regions there are, the more funds are received. Of course, the increase in population has the effect of increasing various tax revenues, but the contradiction that failing to respond well to local extinction is helpful in securing financial resources must be corrected.

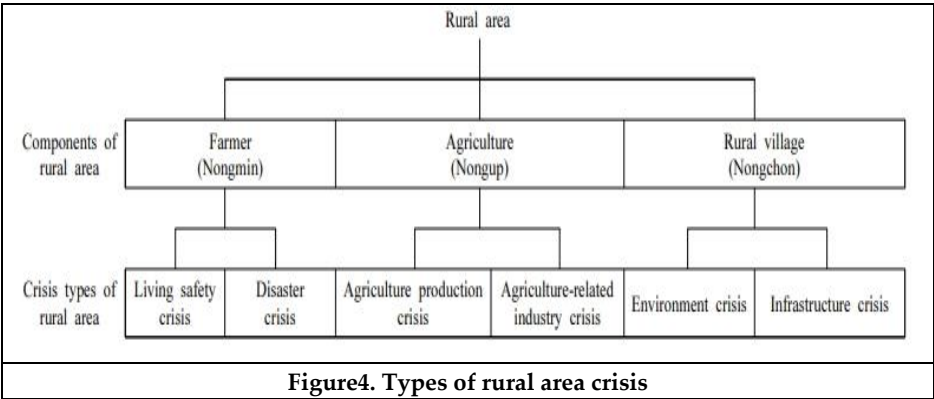
o Stable Support through Strengthening Connectivity with Related Projects and Supporting Finance

Balanced national development, regional disparities, and local extinction all share a critical mind on the same line. Local and rural areas are underpopulated and underdeveloped, and metropolitan areas are overcrowded, causing various problems. However, I think that the response so far has not been systematic and has been a patchwork response by each ministry and local government. Recent discussions surrounding the local extinction reaction fund should be the starting point for a systematic and comprehensive response. To achieve this, similar financial support and scattered response policies must be combined to ensure stable and continuous financial support.

o Reinforcing the acceptance of the depopulation index and establishing a framework for evaluation of plans and results

The local extinction reaction fund is a system that evaluates the bottom-up plan of the depopulation region and supports central financial resources, and it proceeded very quickly. In the process, the local characteristics and the reflection of residents' opinions were insufficient due to an absolute lack of time. In addition, there was a problem that the quality of the investment plan differed due to the difference in relative financial resources and capabilities among the 89 depopulation regions. This part should be improved in the evaluation of already allocated funds and the evaluation of investment plans for fund allocation from 2024.

As an improvement plan, this researcher proposes to strictly calculate the depopulation index and the depopulation region through it, to focus on rural areas, and to establish a framework for fund use plans and evaluation of results. First of all, in the case of the depopulation index, the indicators constituting the index have been disclosed, but the derivation formula has not been disclosed. It seems that it is necessary to disclose this, increase acceptance of depopulation areas, and provide intensive support to actual depopulation regions. Second, it is proposed to divide the evaluation framework for plans and results into demographic, industrial-economic, and environmental characteristics. For local extinction, I think it is necessary to respond to a package that responds in a complex and comprehensive manner without being biased toward any one part. In order to achieve this, I think it is necessary to classify the types of projects rather than listing simple projects and evaluate whether the distribution was successful. In the case of rural areas, one method would be to use the rural area crisis type classified with the 3Nong concept.



The three components of rural areas, ‘Nongmin’ represent demographic characteristics, ‘Nongup’ represent industrial and economic characteristics, and ‘Nongchon’ represent environmental characteristics(Yoo-Lee, 2021).

3. Conclusion

In response to recent discussions on local extinction discourse and local extinction risk index, the government designated depopulation regions and established a local extinction reaction fund. In the process, several issues emerged.

First, in the case of local governments, receiving the local extinction response fund and maintaining the depopulation region had the effect of receiving less general grant tax. Second, in terms of the depopulation index and depopulation region designation, there were problems that the depopulation region had a large variance at the level of local governments and that depopulation region designation could be a means of securing funds for metropolitan local governments. Third, the fact that it is a temporary fund that is evaluated annually has raised concerns that it will focus on projects that can produce results in a short period of time or that are repeated annually. Fourth, although the investment plan evaluation standard table and various supporting laws talk about linking with existing projects and financial resources, there was a problem that the actual method was ambiguous. Fifth, although bottom-up, the process was rushed, so there was a problem that there was not enough process to contain the local situation, such as holding a public hearing for residents.

As an improvement plan, first, incentives should be provided to prevent adverse selection in response to local extinction. Second, it was proposed to link related projects and financial support systems. In particular, it was proposed to prepare a stable support system by reducing duplication with Regional Synergy Development Funds and preparing efficient measures. Third, it was argued that by strengthening the acceptability of the depopulation index, the focus should be on rural areas, and that the framework of the evaluation system should be divided into demographic, industrial, economic, and environmental factors to be systematically and comprehensively analyzed and responded to as a package. At this time, in the case of rural areas, 3 Nong and the concept of crisis in rural areas were presented as one of the alternatives.

References

1. Chung Sungho. 2019a. Population change and risk of regional extinction in Gangwon Province. *Journal of Social Science*. 58(1): 3-22.
2. Chung Sungho. 2019b. A Critical Review of the Local Extinction Discourse. *Korean regional sociology*. Volume 20, No. 3. 5-28
3. Ha DongHyun. 2017. Regional Revitalization Policy and Decentralization of Japan in the Era of Declining Population. *Volume 14, No. 3*. 1-27
4. Han JaeMyung, Lee SangHun, Kim KyungMin, Lee Sheullee. 2021. Improvements of Performance Management of the Fund for Mutual Development of Municipalities in Korea. *JLPF*. Vol.26 No.1 153-196
5. Han Juseong. 2018. Appearance of Marginal Settlements in Depopulated Regions and Local Regeneration: A Case of Uiseong-gun (county) of Gyeongsangbuk-do (province) in Korea. *Journal of the Korean Geographical Society*. 53(3): 327-346.
6. Hiroya Masuda, ed. 2014. "The disappearance of rural areas: rapid population decline caused by overconcentration in Tokyo", Chuokoron
7. Japan Policy Conference. 2014. For the ever-growing 21st century: Stop the declining birthrate and regional revitalization strategy. <http://www.policycouncil.jp/pdf/prop03/prop03.pdf>(Date: 2022.10.6.)
8. Ju Sanghyeon. 2021. Local Government Depopulation Status and Policy Alternatives. *Korean Journal of Local Government & Administration Studies*. Volume 35, No. 3. 297-322
9. Kang Dong-woo, Go Young-woo, Kim Hyun-ji, Nam Su-yeon, Jeon Eun-ha. 2018. A case study of regional employment policy in response to demographic change and local extinction. *Korea Labor Institute Policy Research*. 2018-05.
10. Kim Daesung, Shin Donghoon. 2016. "A Study on Re-Designing Local public Services Considering the Possibility of Local Administrative Units Extinction in Gwangju-Jeonnang Regions." Bank of Korea Gwangju Jeonnang Headquarters.
11. Kim Kyung-Geun, Lee Hyun-Woo. 2017. "Depopulation and Local Extinction Risk Examination and Policy Implications." Bank of Korea, Daejeon Chungnam Headquarters.
12. Lee Sangho. 2016. Seven analyzes of local extinction in Korea. *Regional employment trend brief*. Spring 2016 issue.
13. Lee Sangho. 2018. Korea's local extinction 2018, *Employment Trend Brief*, July 1-21
14. Lee Sangho. 2022. Job polarization, local extinction crisis, and alternative job strategies are needed. *Korea Employment Information Service Local Industry and Employment Policy*. Spring 2022 issue
15. Lee Sanghoon. 2021. Regional Synergy Development Funds performance analysis in 2020. *Korea Local Tax Research Institute*. 60-62
16. Lee Hyunjeong, Choi Kyeongmin. 2019. Regional Disparities of Housing Outcomes in Non-Seoul Metropolitan Areas Facing Depopulation and Deurbanization. *Journal of the Korean Housing Association*. Vol30 No3 87-99
17. Ministry of Public Administration and Security. 2021. Designated 89 'depopulation areas', and started to save local areas in earnest. press release
18. Ministry of Public Administration and Security. 2022a. Local extinction reaction fund to overcome population decline crisis the first allocation. press release
19. Ministry of Public Administration and Security. 2022b. 122 local governments across the country submitted investment plans for local extinction response funds. press release
20. Ministry of Public Administration and Security. 2022c. Concentrate investment in local extinction reaction fund and depopulation region. press release
21. Ministry of Public Administration and Security. 2022d. local extinction reaction fund Application amount by local government. Data submitted by the National Assembly Legislative Research Service
22. Ministry of Public Administration and Security. 2022e. Explanation on the calculation of local allocation tax in 2022. 100-112
23. Ministry of Public Administration and Security, Korea Institute of Local Administration. 2022 local extinction reaction fund investment planning consulting guide. 64p
24. Masuda Hiroya [translation: Kim Jeong-hwan]. 2015. *Local Extinction: Survival Strategies of Cities and Provinces Chain Collapsing Due to Population Decrease*. Wiseberry
25. Noh Se-hee, Kang In-ho. 2018. An Empirical Study on the Functional Changes of Rural Center in the Age of Population Reduction. *Korean Public Management Review*. Volume 32 No. 1 289-310
26. Oh Byunggi. 2022. Directions for improving the local extinction reaction fund for population extinction areas. *Monthly Public Policy*. vol. 202. 28-30
27. Park Gwan-gyu and Joo Yoon-chang. 2022. Critical analysis of the local extinction reaction fund system - Possible problems and solutions. *Korea City and Province Governors Association Decentralization Letter*. vol.91
28. Park Seung Hyun. 2017. Death and Revitalization of Local Cities: Critical Review of "Masuda Report" from the Perspective of "Post 3.11". *Japanese Criticism No. 16*. 158-183
29. Related Ministries Joint. 2021. Local extinction preemptive response plan. press release
30. Ryoo Young Aa. 2022a. Introduction of Local Extinction Reaction Fund and Future Tasks - Mid- to long-term policy and base strategy. *National Assembly Legislative Research Service. NARS Legislation Policy No. 108*
31. Ryoo Young Aa. 2022b. A Study on the Present State of Introduction and Improvement Plan of the Local Extinction Reaction Fund. *Local Tax Review*. Volume 9, No. 2. 1-23

32. Seol Jin-Ju, Cho Gyung-kyung, Lee Hyun-ji, Lee Kwang-soo. 2021. Relationship between Extinction Risk Regions and Amenable Mortality. Health policy and Management. Vol31 No.2. 188-196.
33. Son Heejun. 2022. Local finance in the era of local extinction. National Assembly Legislative Research Service Quarterly Magazine. 2022 Spring No. 52. 40
34. Yoo Woongcheon, Lee Jaeun. 2021. Establishing the Customized Smart Disaster Management System for Rural Areas in Korea. Journal of Safety and Crisis Management. vol11, no.5, 1-10
35. Yuk Donghan, Park Sangheon, Noh Seungman, Kim Injoong. 2017. “Gangwon-do Population Structure and Response (I).” Gangwon Research Institute. Policy Memo No. 617.

Article

Pakistan's water security in transboundary perspective

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Abstract: The security of the water supply directly affects the security of the people. Water security is both a growing problem and a necessity for sustainable development, making it a multifaceted subject with nuanced overtones. This essay will examine the Indus Water Treaty's impact on Pakistan and India's water security issues (IWT). IWT developed a system for an equitable water distribution between Pakistan and India with the help of the World Bank. To gain the power to control the flow of water, India has been constructing a number of dams under the guise of run-of-the-river hydroelectric projects. Unresolved Pakistani grievances may cause India and Pakistan to engage in major conflicts. In order to identify the gaps and weaknesses that must be addressed for more effective transboundary water and benefit sharing, the article then analyses the current legal and institutional framework for handling transboundary water issues in the Indus Basin. The chapter promotes minor steps in hydro-diplomacy to shift from a "water sharing" mindset to a "benefit sharing" one that links all riparian nations to cooperate for a sustainable water future for the Indus as the path ahead for enhanced water security on Pakistan's transboundary front.

Keywords: Water insecurity; Transboundary water resources; Water challenge; Pakistan

1. Introduction

Many people think that future conflicts will be sparked by water insecurity as a result of the world's growing water demand. In reality, the need for fresh water has already elevated to a top global policy concern [1]. The Indus system is largely fed by the snow and glaciers of the HKH ranges. 80% of water for the Upper Indus Rivers comes from Himalayan glaciers. Indus and its tributaries are the most important supplier of water resources for irrigated agriculture. 25 amphibian species and 147 fish species of which 22 are endemic. This article proposes policy proposals that can result in an equitable water-sharing system and reduce the likelihood of future violence in the current tense relationship between Pakistan and India.

Pakistan ranked as the 14th extremely high water stress country. As 92 % of water is for agriculture. 32 % shortfall in water availability for agriculture by 2025. Food shortage of 70 million tons. By 2050, feeding 26 million fewer mouths than now.

1.2. Threat to water security

The 30% reduction in storage capacities due to climate change and siltation
Reduction in river flows coming to Pakistan:

- Indus : 11%
- Jhelum : 32%
- Chenab : 25%
- Ravi : 87%

- Sutlej : 95%
- Overall : 27%



Figure 1. River flows coming to Pakistan

Water insecurity affects a sizable section of the global population today. One-sixth of the world's population, according to a United Nations assessment, lacks appropriate access to clean water, and by 2025, half of all nations will experience water stress or shortages. Water scarcity is made worse by climate change, which also causes glaciers to melt, changes in rainfall patterns, and abrupt temperature fluctuations [2].

Pakistan's watershed connection with India presents the biggest governance challenge in terms of transboundary water. The Indus Waters Treaty (IWT) of 1960 is the sole water-sharing agreement Pakistan has on sharing the Indus. In accordance with this treaty, Pakistan received the three western rivers (Indus, Jhelum, and Chenab), while India received the three eastern rivers (Ravi, Beas, and Sutlej).

Reduced availability to fresh water has far-reaching effects, including lower agricultural production, fewer alternatives for obtaining a living, and higher economic and geopolitical conflicts, particularly in unstable countries like South Asia. In areas with multiple significant international river basins and where there are territorial conflicts between various nations, there are particularly serious issues with water security. The nuclear-armed neighbors Pakistan and India serve as two prime examples of these issues in South Asia. Both nations are experiencing worrisome groundwater depletion, and there are few practical ways to improve supplies. The issue is made worse by bad administration and water management in the context of changing demography [3].

The Inter-Governmental Water Treaty (IWT) between Pakistan and India differs from other problematic water sharing agreements signed between various South Asian nations because it addresses particular water allocation issues and offers special design specifications for dams to ensure the constant flow of water and the production of hydroelectricity.

2. Materials and Methods

2.1. Conflicts - a threat to regional security

One Dispute over Salal dam, controversy on the Wullar Barrage, Baglihar dam created severe conflicts, Kishanganga hydroelectric dams.

Recent Conflicts created around:

- 57-metre high Nimoo-Bazgo dam in Leh (India);
- 42-metre high Chuttak dam on Suru river (India-Kashmir);
- Tulbul Navigation Project in India-Kashmir
- Ratle Hydroelectric Plant (850 MW) (ROR)
- Miyar Hydroelectric Plant (120 MW) (ROR)

- Lower Kalnai Hydroelectric Plant (48 MW) (ROR). Pakal Dul Hydroelectric Plant (initially 1000 MW, ultimate 1500 MW) (Storage).

The World Bank allayed India's worries by making it clear up front that it would not decide the dispute but would merely serve as a mediator to find a workable solution. Although Pakistan disagreed with the World Bank's position, it was forced to accept it since it was bargaining from a position of weakness. The only thing going for Pakistan was that at least the World Bank's involvement in the situation had forced India to sit down and negotiate, something it had previously refused to do.

India has recently planned to divert all flows from east-flowing rivers and build hydropower facilities on western rivers to meet its expanding irrigation and hydropower needs. The Madhupur Beas Link and Beas Sutlej Link Canals, which transfer water from Ravi to Beas and Beas to Sutlej, respectively, were built for this purpose [4].

Over 200 km³ of mean annual flows are thought to exist in the transboundary Indus Basin [5]. The projected 184 km³ influx into Pakistan through the rivers of the Indus Basin is made up of 161 km³ through the three western rivers, 1.9 km³ through the three eastern rivers of the Indus Basin, and 21.6 km³ through the Kabul and other Indus tributaries coming from Afghanistan.

While the UN Watercourses Convention's guiding principles might be a good place to start when developing water sharing regulations for the Basin, Indus riparian nations have not historically backed these international norms. Additionally, each riparian nation's adherence to the fundamentals of international law for transboundary water administration varies.

2.2. Effects of Climate Change on a Basin-Wide Scale

While Pakistan's riparian relationships with India, Afghanistan, and China present particular issues, the issue of climate change and the resulting water variability has severe repercussions for all basin countries. The nine million people in Afghanistan and Pakistan who depend on the Kabul Basin for their livelihoods might suffer devastating effects as a result of climate change. According to recent studies, the Kabul Basin's western regions may see a 50% decrease in precipitation as a result of climate change. The acceleration of snow and glacier melt brought on by the rise in mean annual temperatures as a result of global warming will increase the frequency of flash floods in the basin. The Indus River has several huge hydroelectric projects planned, many of which are in the disputed region of Jammu and Kashmir. Due of the cumulative impact of these dams on the Indus Basin, China's contribution in the development of these dams in Pakistan under CPEC is particularly important.

2.3. Legal and Institutional Framework for Sharing of Transboundary Waters:

The 60-year-old IWT is unable to resolve water sharing disputes in the instance of Pakistan's ties with India. To put it mildly, the institutional and legal framework for transboundary water sharing between Pakistan and its neighbors is insufficient. Despite considerable diplomatic attempts on both sides, there is currently no legal or institutional structure in place for Pakistan's access to water from the Kabul River, which is shared with Afghanistan. The involvement of China in Pakistan's transboundary relationship is arguably the most important and concerning factor. In addition to the obvious gaps in the IWT, the agreement is becoming less willing to accommodate India's and Pakistan's concerns on matters that fall under its purview. There is no agreement on water sharing with Afghanistan on the usage of the Kabul River, although Pakistan's transboundary relationship with India remains unstable despite the presence of a treaty. Previous attempts to negotiate a convention for the Kabul Basin have been hampered by political problems. In order to start drafting a treaty on the use of shared waters, a nine-member technical group led by the Chairman of the Federal Flood Commission of Pakistan visited Kabul in 2003. However, their efforts were apparently thwarted owing to a lack of appropriate river flow data from the Afghan side.

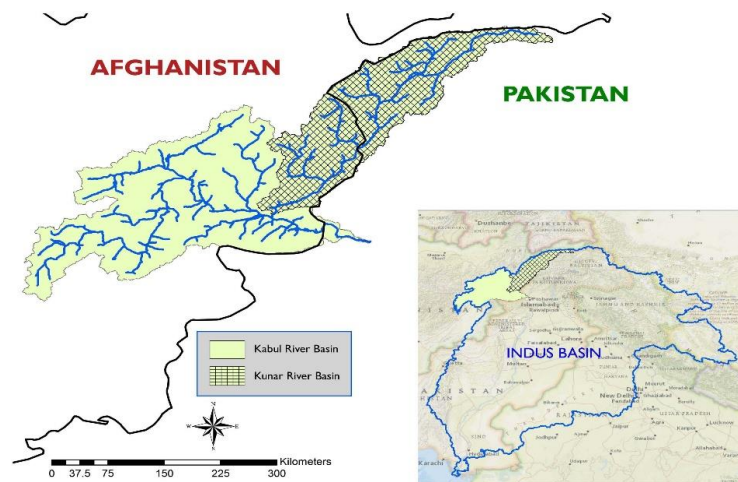


Figure 2. Kabul River Projects by Afghanistan

Both Pakistan and Afghanistan must consider the tenets of prior international conventions, accords, and agreements and, where practicable, sign them. The institutional and legal framework for the conservation of the Tibetan glaciers under Chinese authority is lacking as far as China's position in the Basin is concerned. Although China has made large investments in Pakistani hydropower, much of this has taken place without any institutional or legal framework for the basin that would have protected South Asian nations downstream.

5. Limitations

This study has several limitations. First, The IWT of 1960, the only water-sharing agreement in the basin, is insufficient, as was mentioned in the chapter, and this is the first and most troubling of the difficulties. The necessity to routinely use expensive international arbitration and the increasingly tense hydro politics between India and Pakistan imply the treaty is unable to handle current water sharing difficulties.

Another significant problem is that until now, bilateral initiatives have been the only means of transboundary collaboration on the Indus. Even if the IWT's wording and scope are ultimately enlarged to cover concerns related to water quality, environmental sustainability, and climate change, Afghanistan and China are not parties to the treaty.

6. Conclusions

According to the above analysis For Pakistan's water future, sustainable transboundary water governance will need basin nations to switch from a "water sharing" strategy to a "benefit sharing" approach. The Indus Basin's riparian's have up to now prioritize water sharing, which has resulted in controversial hydro-politics amongst basin countries. Instead, adopting a benefit-sharing strategy can lead to improved ecosystem management (which will benefit the river), increased food and energy production (which will benefit from the river), and increased economic integration between riparian nations (which will result in benefits that go beyond the river).

At farm scale it is needed to introduction of precision agriculture technologies like, Soil zoning & precision planting. Precision irrigation. Variable rate agrochemical. Auto steering technologies. Crop health and water stress monitoring through UAVs and satellites.

An integrated basin-wide and cooperative benefit sharing approach focusing on the water food and energy nexus can yield benefits for basin countries. Regarding this, case studies of worldwide best practices might be beneficial for basin nations. The Indus may

use the Colorado and Murray-Darling Basin's institutional architecture and effectiveness as a model for how to change and strengthen its institutions.

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References

1. Suzanne Goldenberg, "Why Global Water Shortages Pose Threat of Terror and War," Guardian, February 9, 2014, - Google Search Available online: (accessed on Dec 1, 2022).
2. "Asia's Next Challenge: Securing the Region's Water Future," - Google Search Available online: (accessed on Dec 1, 2022).
3. Attitudes to Water in South Asia - Google Search Available online: (accessed on Dec 1, 2022).
4. Bridging The Divide: Transboundary Science & Policy Interaction In The Indus Basin • Stimson Center Available online: <https://www.stimson.org/2015/bridging-divide-transboundary-science-policy-interaction-indus-basin-0/> (accessed on Dec 1, 2022).
5. Understanding water resources conditions in data scarce river basins using intelligent pixel information – case: transboundary Indus Basin. Unpublished PhD Dissertation, Delft University of Technology, Delft, The Netherlands - Google Search Available online: (accessed on Dec 1, 2022).
6. Hilal English Available online: <https://www.hilal.gov.pk/index.php/detail/recharging-aquifers-for-sustainable-groundwater-management> (accessed on Nov 27, 2022).

Does Regional Competence as Resilience Matter for Response to COVID-19?

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Abstract

Although the growing literature on countermeasures against the COVID-19 has been conducted in many countries worldwide, empirical research on regional competence that would effectively combat COVID-19 and longitudinal panel research has been still limited. This research tried to explore the regional competence associated with community resilience in the pandemic that is unanswered. It fills the gap between the regional competence and the effectiveness of the COVID-19. The feasible generalized least square (FGLS) panel analysis was conducted on data collected in 53 countries over 14 months around the vaccination rollout. It outlined which regional competencies of the vaccination, community mobility, universal healthcare, and lockdown severity influence on the effectiveness of fighting against the COVID-19. The preliminary findings indicated that securing vaccination was critical to fight against COVID-19; universal healthcare system relieved the residents to get tested for COVID-19; lockdown severity enhanced the fatality rate; the interaction effect of mobility and healthcare system also indicated to relieve the fatality level. This research practically identifies the effectiveness of the countermeasures to overcome the pandemic and theoretically links community resilience to the pandemic.

Key words: *COVID-19, community resilience, regional competence, vaccination, community mobility, universal healthcare coverage, lockdown severity*

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Article

Directions for Using the 4th Industrial Revolution Technology to Adapt to Changes in the Disaster Environment – Focusing on the Effective Reception and Processing of Deluge Emergency Calls

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Abstract: Functions that should be newly or further advanced in the emergency calls reception/processing system are as follows. ① It should be possible to receive and process emergency calls first by automatically distinguishing emergency calls from non-emergency calls. ② It is necessary to have a support function to preemptively recognize that a catastrophe has occurred or is imminent by integrating calls received individually. ③ Proper response tactics and technical information for each disaster situation must be promptly extracted and provided to situation room workers and on-site responders. ④ It should be possible to automatically recognize (report) the fact that a disaster has occurred or the risk of occurrence. ⑤ Disaster situation information should be automatically recorded and reported and created as statistical data. ⑥ Distributed and processed the overflowing calls to various media or cooperative organizations. ⑦ Callbacks should be performed automatically for calls that are disconnected without being received. ⑧ The situation management support system must be maintained without interruption, and sufficient training programs must be provided to situation management personnel. The 4th Industrial Revolution technology, which gives hope that these tasks can be solved. In terms of technical engineering, there are still limitations and more time may be needed, but conceptually, it is expected to solve the tasks.

Keywords: Emergency call; deluge; 4th industrial revolution; fire; disaster; situation management

1. Introduction

“Climate change” is being replaced by the term “climate crisis” or “climate emergency” and “global warming” by the term “global heating”. This means that climate change is a serious situation. Climate change appears in the form of more frequent or stronger occurrences of large-scale forest fires, desertification, heat waves, storms, and torrential rains (floods). In Korea, in the summer of 2022, We realized it while experiencing torrential rains and typhoons. In particular, the heavy rain that fell in Seoul on August 8 recorded the highest rainfall amount (141.5mm/h) since meteorological observation and caused many casualties. Due to the sudden flooding and isolation of densely populated downtown areas, 119 calls were not successfully received and processed, and there were many cases in which rescue actions were delayed due to a large shortage of fire teams that could be mobilized compared to many rescue requests.

The top 5% of extreme precipitation days in the Korean Peninsula are expected to increase by about 30% (National Institute of Meteorological Sciences. 2020). This means that in the future, torrential rains or floods may occur more frequently, and deluge emergency calls may reappear under such circumstances. In the case of fire, which threatens the life and property of the people as the most representative disaster, human casualties and property damage continue to occur. Although the fire safety system has been continuously supplemented and strengthened, the causes of continued damage must be complex, but the large, high-rise, and deep buildings can be cited as one of the causes.

In addition to sudden floods (inundation) or large-scale fires, emergency call is expected in situations where a large amount of hazardous substances and toxic gases leak and spread, earthquakes, and typhoons occur. It is emerging as a key issue in disaster preparedness for the public to easily report the fact of a disaster to the fire authorities, and for the fire authorities to successfully receive an emergency calls requesting rescue and deploy response resources appropriately.

2. Materials and Methods

Simultaneous disaster accidents and emergency calls deluge do not occur continuously, so it is not possible to maintain personnel in charge of related tasks at all times based on exceptional and extreme deluge situations. However, since such a disaster situation can occur at any time, it is necessary to have a well-prepared system. An information and communication system that can accurately and efficiently receive and process emergency calls not only in normal times but also in sudden deluge situations so that response resources (fire team, rescue unit, ambulance, etc.) can be appropriately distributed to urgent and dangerous disaster accident sites. this should be equipped

On the premise that the 4th Industrial Revolution technology can be effectively applied to the system, newly required functions are presented and the application of technologies that are judged to be helpful in realizing the functions is proposed. The proposal will take a conceptual approach, not an engineering approach, and will refer to related policies promoted by the government.

3. Terms and Concepts

3-1. The Fourth Industrial Revolution

It is the next-generation industrial revolution of the 1st Industrial Revolution (18th century, mechanization based on steam engines), the 2nd Industrial Revolution (19th and early 20th centuries, mass production based on electrical energy), and the 3rd Industrial Revolution (late 20th century, the knowledge information revolution based on computer and Internet). Advanced information and communication technologies such as artificial intelligence, Internet of Things, big data, cloud computing, and mobile are converged with existing industrial technologies such as drones, robots, Internet platforms, autonomous driving, virtual/augmented reality, 3D printing, and nanotechnology. Therefore, innovative changes will occur throughout the economy and society, and hyper-connectivity and super-intelligence will become important features. (Computational Terminology Dictionary Compilation Committee. 2011)

3-2. *EmergencyCall*

It is to report emergency situations such as crimes and disasters so that help (rescue, protective measures, etc.) can be received. In Korea, many organizations have operated separate report numbers, but since 2016, about 20 report numbers have been set to 112 (crime / police), 119 (disaster accidents and emergency patients / fire), and 110 (civil complaints / Corporate Civil Rights Commission → each competent agency) integrated into. All emergency calls are accepted at 911 across the United States.

3-3. *Situation Room*

Receives emergency calls, mobilizes necessary mobilization teams (patrol cars, fire engines, ambulances, etc.) and supports and controls on-site response activities. Information on incidents and accidents is disseminated to related organizations and reported to higher authorities. An advanced information communication system is installed and operated in the situation room to carry out such missions.

4. **Related Cases**

The application of the 4th industrial revolution technology to the information and communication system that receives and processes emergency reports is still insufficient, but it can be evaluated that it is continuously expanding and developing.

4-1. *Application of Artificial Intelligence Technology*

AI speakers that can recognize specific voices such as scream, save me, 119, and 112 to automatically make an emergency call are increasing. As a result, there are an increasing number of cases where AI speakers have escaped the crisis by reporting them. The Korea Information and Communications Policy Research Institute (KISDI) announced in a report on 'Possibility of Popularization of Voice Recognition AI Devices' as a result of a survey last year that 14.7% of all households own voice recognition AI devices in Korea (Electronic Times. <https://www.etnews.com/20221011000211>). A variety of AI speakers (separate products or built-in smartphones) that are connected to the artificial intelligence cloud through a network (smartphone, internet) and perform requirements while talking to people are being released. SK Telecom's NUGU, KT's GiGA Genie, LG U+'s Smart Think Hub 2.0, Kakao's Hey KAKAO, Naver's CLOVA, Amazon Echo, and Google Assistant.

4-2. *Application of IoT technology*

A sensor connected to the network (internet-care center) detects the amount of activity or vital signs (pulse, blood pressure, body temperature, etc.) and automatically reports an emergency in case of emergency. Sensors (detectors) that detect gas leaks or fires are sometimes added to care services. In addition to care services, more and more places are installing fire detection and automatic reporting systems connected to networks for fire safety management of large buildings, factory facilities, and markets, and cases of fire reports are increasing through them.

4-3. Application of Big data Technology

In accordance with the Korean government's big data fostering policy, each institution has secured a person (department) in charge of big data. Through this, information on various attributes (type, time, place, processing result, etc.) of emergency reports is analyzed with big data analysis techniques and attempts are made to reflect them in fire-fighting and disaster management policies. However, it cannot be said that it is achieving useful and meaningful results.

4-4. Utilization of Drones

There is an increasing number of cases where drones equipped with cameras are launched at the site of a disaster accident to acquire situational information and are used by 119 situation rooms and field commanders. There are 326 drones owned and operated by fire authorities nationwide (Fire Agency, 2022). In addition to acquiring disaster site situation information, mission areas are being expanded (attempted) to life search, fire suppression, first aid medicine delivery, and emergency patient transfer.

4-5. Utilization of Robots

Until now, there is no robot that goes deep into the scene of a disaster accident and transmits the situation (video, temperature, sound, etc.) to the control room or commander, or performs evacuation route development and lifesaving. A firefighting robot was piloted to discharge water by dragging a nozzle to a point where there was a risk of explosion, strong radiant heat, or spread of toxic gas, but it was not introduced in earnest due to its ineffectiveness. The low use of robots in the field of disaster response is because disaster accident sites have various variables, high uncertainty, and many infringing factors such as high temperatures and falls. It is judged that the best and last field of robot utilization will be the disaster accident response field.

4-6. Utilization of Virtual reality Technology

As disasters become larger and more complex, the fire commander's responsibility and role are becoming more important. However, in the process of growing into a fire commander-level, it is difficult for everyone to gain sufficient experience in disaster response. The need for command training that can replace actual experience is growing, but it is practically impossible to realistically implement a disaster situation. In order to solve these problems, a training program using virtual reality technology has been developed to train fire commanders. Incident Command Training Centers have been installed and operated in 3 fire academies, and installation is in progress at all 9 fire academies nationwide.

5. 119 Call Deluge and Problems

On August 8-9, 2022, a maximum of 515.5mm of rain fell in Seoul for two days, with a maximum precipitation of 141.5 mm per hour. This is the highest level since Korea's meteorological observation (Korea Meteorological Administration, 2022). At this time, 119

calls to the 119 situation room in Seoul were deluge. 119 calls per hour are 236 cases per year on average, but at the time, the highest was 3,206 cases, and ARS standby recorded the highest 465 cases (Fire Agency, 2022). The problem is that there have been several times of call deluge before, and it is expected to increase further in the future.

5-1. Unable to Connect

The number of 119 call included in statistics is the number of cases accessed to the 119 situation room regardless of whether they were received or processed. However, there will be many calls (back busy) that are not even connected to the 119 situation room, and the number of such unconnected cases is unknown. In 18 119 situation rooms across the country, 6,185 lines dedicated to 119 calls are being operated (June 2022 / National Fire Agency, 2022). Calling 119 by the public is free, but each fire department pays for the use of a dedicated line to the telecommunications company. Even if the dedicated lines are drastically increased so that there are no reports that cannot be connected to the 119 situation room, it is useless if the number of cases that the workers in the situation room can receive and process is exceeded. That is, a dedicated line should be operated in proportion to the maximum reception and processing capacity.

5-2. Increase in ARS Standby Calls

Even if the call is not busy because there is an empty dedicated line and the 119 situation room reception system is connected, if the situation room workers cannot receive due to other tasks (receiving calls, dispatch orders, control, reporting, etc.), ARS continues to guide them to wait. No matter how urgent a case like this is, you have to wait or hang up and call again. In other words, reports that go to ARS are virtually impossible to receive and process.

5-3. Difficulty Distinguishing between Emergency and Non-emergency Cases Separately

The current 119 situation management system and operational procedures are designed to sequentially receive and process 119 calls. Sequential processing is the principle, but in situations where there is no congestion, it is possible to seek understanding for non-emergency cases after the reception and to handle emergency cases first (dispatch of fire team, rescue unit, ambulance, etc.). However, when there is a congestion, a lot of time is spent receiving calls, so there is no room to handle emergency cases first.

In addition to being physically difficult to prioritize receiving and handling emergency cases by distinguishing between emergency and non-emergency cases, it can also be a matter of legal dispute. Cases classified as non-emergency may actually be urgent. It is unclear whether civil complaints regarding non-emergency classification and service delays (or non-action) can be recognized as legitimate administrative actions. These legal problems will have to be solved through legislation, not technology (Dae Hoon Kang, 2022).

6. Required Functions and Technology for Effective Handling of Emergency Calls

Responding agencies must be able to promptly recognize the occurrence of disaster accidents (damage) or the risk of occurrence without omission and respond effectively to prevent or minimize damage. Emergency response agencies must be able to recognize disaster accidents (damages) that have little sign of occurrence or risk of occurrence or

that occur outside human cognitive ability. It should be possible to receive and process all calls even in the case of a deluge of calls. Necessary information such as disaster situation information and technical information necessary for response measures must be efficiently collected, analyzed, provided, and reported. Future information and communication systems that support situation management must ensure such efficiency and stability to perform target functions without interruption.

6-1. Determination of Emergency and Non-emergency Cases

In the event of a disaster that causes widespread damage, such as a storm, torrential rain (flood), or earthquake, emergency calls overflow. However, not all calls are calls of significant disaster damage (imminent risk to life). At the same time, there are many disaster-damaged sites, so emergency response resources that can be utilized in disaster-stricken areas are absolutely insufficient. Support can be provided in areas where disaster damage has not occurred, but after a considerable period of time, support resources arrive at the disaster damage site sequentially.

In such a disaster situation, it is necessary to classify and receive emergency cases among many calls. It is also necessary to prioritize dispatching limited resources to the scene in need of an emergency response. However, it is very difficult to sort and process calls as the number of recipients is limited, and it is difficult to explain the subordinated treatment to the reporters of cases classified as non-emergency.

The artificial intelligence chatbot first receives the call, analyzes the call voice (key phrase/word, context, tone, background noise, etc.) and connects it to the worker if it is determined to be urgent. If it is determined to be a non-emergency, the chatbot will continue to receive reports or guide waiting. If this function is implemented, it will be of great help in handling many calls without omission and selectively injecting limited response resources into emergency situations (Fire Agency, 2022). Technology to process call reception and processing data (voice recordings, reports of previous actual calls, action results, voice recordings, etc.) into big data, and artificial intelligence algorithms that evolve by learning from big data are used to implement the function may be applied

6-2. Comprehensive Judgment of Critical Situation

A function that supports preemptively recognizing that a serious disaster has occurred or is imminent is needed. It is difficult to comprehensively judge the disaster situation when several recipients receive calls individually. An example that clearly shows this problem is the disaster that occurred in Itaewon-dong, Seoul on October 29, 2022 (158 dead and 196 injured, as of November 18, Central Disaster and Safety Countermeasures Headquarters). It was 22:15 when the 119 situation room recognized that there were many casualties and began to respond. Prior to that, 11 reports containing the content “I am likely to be crushed” were received in the 112 (police) situation room from 4 hours ago (The Dong-A Ilbo, <https://www.donga.com/news/article/all/20221101/116265858/1>). At 22:12, a call was received in the 119 situation room saying that it was “difficult to breathe”, but the call was disconnected without specifying the specific situation and location, so it was terminated without an ambulance dispatch. (JoongAng Ilbo, <https://www.joongang.co.kr/article/25115308>).

If it were possible to comprehensively judge the many similar calls, the characteristics of the calls, and the reporter's sense of crisis, the disaster could have been prevented or the number of victims reduced. However, at present, calls from the 119 and 112 situation rooms are not integrated and analyzed, and it is difficult for managers to continuously monitor, concentrate, and judge individually received and processed calls.

A function that comprehensively analyzes and judges individual calls, on-site CCTV images, and keywords related to disaster accidents that are increasing on the Internet must be implemented. Networking technology, voice recognition and text conversion technology, technology for recognizing abnormal patterns in CCTV images, and artificial intelligence for comprehensive judgment can be used to implement the function.

6-3. Extraction of Tactical and Technical Information Suitable for Each Case

There is a qualification system for information searchers in various fields such as intellectual property information, Internet information, and technical information. Considering the reality that social sensitivity to disasters is increasing and the attributes of climate crisis and "risk society" (Ulrich Beck, 1986) are being strengthened, information searchers in the field of disaster risk are also needed. If search engine technology used by Internet portal sites such as Google and Naver is combined with artificial intelligence, it will be possible to technically implement a function that efficiently searches, organizes, and analyzes various information necessary for disaster prevention, preparation, response, and recovery.

6-4. Automatic Recognition of the Occurrence or Risk of a Disaster Accident

Damage can be prevented or minimized if the risk is controlled before a disaster occurs or if countermeasures are taken at an early stage. If you use sensor technology and analysis technology that precisely detect CCTV images, sound, vibration, pressure, temperature, movement, and indicator substances such as carbon monoxide and tar in residential facilities or major dangerous places, you can prevent or prevent disaster accidents in advance. At the same time as it occurs, the responding agency will be able to recognize it. When artificial intelligence technology that collectively judges individual information is combined, more accurate alarms can be made, minimizing side effects (turning off detectors and alarms, not evacuating when an alarm sounds, responders acting lukewarmly, etc.) caused by repeated false reports. If various sensors evolve into the Internet of Things (IoT), their effectiveness and efficiency will increase.

6-5. Automatic Recording and Reporting of Disaster Situation Information and Creation of Statistical Data

In times of urgency and lack of manpower, it is one of the difficult tasks to organize and record (document preparation) the disaster situation and deliver it to the reporting target. If a function that automatically creates a report by integrating and arranging various information such as the contents of the report call, the location information of the reporter, the location information, the contents of the on-site radio communication, the contents of the dispatch order, and the dictation and input text of the control room worker

is implemented, it will greatly contribute to successful situation management. Automatic generation of reports can lead to automatic generation of statistical data.

Among the generated reports, important reports may be guided or automatically transmitted to related organizations and higher organizations. Furthermore, through Internet platforms, Internet search portals, TV broadcasting, radio broadcasting, IPTV, cable TV, etc., it will be possible to disseminate it to residents exposed to or potentially exposed to disaster risk. In order to implement these functions, not only artificial intelligence but also voice recognition technology and automatic document creation technology can be used.

6-6. Automatic Distribution of Report Calls

Police and fire agencies receive emergency calls or civil complaints through various media (message, homepage, app, e-mail, SNS) in addition to phone calls. In the event of a flood of phone calls, if calls (especially non-emergency) can be automatically distributed to other media, paralysis of the reporting system can be prevented. In addition to media distribution, a method of distributing to other local or central government situation rooms or mutually distributing between 112 and 119 will be possible. Artificial intelligence judgment technology and networking technology can be used to implement these functions.

6-7. Automatic Callback

Callbacks should be implemented as quickly as possible for calls that have not been received by either the receptionist or the ‘primary reception AI chatbot’ and have been disconnected. This is because there may be emergency calls among disconnected calls, and non-emergency cases must also be received and processed in a subordinated manner. ‘Automatic callback’ will be able to be performed by AI chatbots, which are developing remarkably recently.

6-8. Virtual Reality-based Situation Management Training

Reception and processing of emergency calls must continue without interruption 24 hours a day, 365 days a year. Failure to manage the situation leads to damage to people's lives and property, so it must be supported by an advanced information and communication system. Sufficient training programs should be provided so that situation management personnel can use advanced information and communication systems smoothly and successfully complete their missions. If you use virtual reality (VR) technology, you will be able to create and operate effective training programs.

7. Conclusion

In August 2022, 19 people died, 1 person went missing, and 26 people were injured due to heavy rain in Korea (Search and Rescue Situation Report by National Fire Agency). On September 26th, 7 people died and 1 person was seriously injured in a Hyundai Premium Outlet fire in Daejeon-city, and firefighting activities were carried out for about 13 hours. It is estimated that fire facilities were blocked and 119 calls were delayed, resulting in increased damage (Fire Situation Report by the National Fire Agency). On October 29, a disaster occurred in Itaewon-dong, Seoul, in which 354 people were killed or injured

(Central Disaster and Safety Countermeasures Headquarters). A series of large-scale disasters like these presented many challenges to Korean society. Among them, it is also included that the situation management system needs to be further advanced. Support must be provided to receive and process calls stably even in extreme situations where calls are flooded due to simultaneous large-scale damage. They must also have the ability to quickly and accurately collect and judge information on disaster accidents. The 4th industrial revolution technology will inevitably be used in this next-generation situation management system. In terms of technical engineering, there are still limitations and more time and research may be needed, but conceptually, it is expected to solve many tasks in the field of situation management.

If we can use the information and communication system to which the 4th industrial revolution technology has been successfully applied, most of the problems in situation management can be solved. However, 'digital dementia' (decreased cognitive ability due to excessive dependence on digital devices) may appear in situation management personnel. Since all systems have the possibility of a down, analog situation management training to prepare for a system down should be repeated.

References

1. Kim Do-hyun, Kim Yeon-hee, Kim Jin-wook, Kim Tae-jun, Moon Hye-jin, Byun Young-hwa, Byun Jae-young. 2020. Weather Change Prospect Report on the Korean Peninsula. Jeju: National Institute of Meteorological Sciences
2. National Fire Agency. 2022. Measures to strengthen response capacity for heavy rain
3. NAVER. <https://www.naver.com>
4. Ministry of Science and ICT. 2022. Korea Digital Strategy. <https://www.nfa.go.kr>
5. Computational Terminology Dictionary Compilation Committee. 2011. Dictionary of Computer Internet IT Terms. <https://terms.naver.com>
6. Daehun Kang. 2022. Review of Situation Management Related Laws as a Key Means of Emergency Management: Crisisonomy: pending publication



Article

A study on the social risks of 3D printing and the harmfulness of filament materials

Ran Hee Jeong

Abstract: The purpose of this study is to find out about institutional issues, ethical issues, and safety in related industries, such as the fact that firearms made with 3D printers have already exceeded the level of danger and that Korea is not a safe zone, and that a teacher who frequently used 3D printers died of sarcoma cancer. Due to the lack of problems, a study was conducted on the social safety of 3D printing and the harmfulness of filament materials. Through this study, I would like to make some suggestions for the continuous development of safe materials for 3D printers and improvement of the system to ensure safety. As a research method, previous research, academic journals, institutional research reports, media reports, and knowledge information platforms were used to investigate and study related cases.

Keywords: 3D printer; filament material; hazardous chemicals; system and safety; carcinogens, ABS; PLA

1. Introduction

Modern society is the era of the 4th industrial revolution, which is a next-generation industrial revolution that is achieved through the convergence of information and communication such as artificial intelligence (AI), drones, robot technology, virtual reality (VR), self-driving cars, and 3D printing. We live in an age of convergence. Its functions and performance are developing rapidly, and it will be a driving force to renew the world order, Dunn Klaus Schwab said at the 2016 Davos Forum

The World Economic Forum predicts that by 2025, robot pharmacists will appear, cars will be produced with 3D printers, self-driving cars will exceed 10% in the United States, and 30% of companies will be audited by AI. However, it is necessary to think about what the rapidly developing 4th industrial revolution will bring to humans. A world in which robots will do what humans used to do by creating machines that surpass or resemble human intelligence beyond human physical limitations will unfold.

It is a self-evident fact that these changes will come as irreversible big changes in human life. 3D printers have already entered the mass production system due to changes in the industrial structure of the manufacturing industry, and robot services are gradually becoming commonplace. In restaurants, you can see robots serving or serving coffee in many places. In the course of this development, preparations for various situations such as legal system maintenance and moral and ethical awareness must be prepared, but the situation is not keeping up with the pace.

As an area to lead the 4th industrial revolution, the World Economic Forum (WEF) announced the 10 future technologies in 2012, and 3D printers were announced as the second most important ranking. It is a technology that is attracting attention as a technology that will lead democratization. As the industry based on 3D printing technology develops, it is emerging as a key manufacturing technology that will change the form of the existing manufacturing industry by enabling products with complex shapes to be produced more easily and providing time and economic advantages. (Eunyoung Oh, Jinwoo Lee, Jonghwan Seo)

However, the rapid development of civilization also brings many trials and errors and various crises. Incidents of replicating firearms made with 3D printing technology have already occurred in many places. As a representative example, it was revealed that the shooting death of former Japanese Prime Minister Abe in 2022 was a gun accident made with a 3D printer. In addition, in July 2020, it was reported in the media that two teachers who frequently used 3D printing at school to teach classes were diagnosed with sarcoma, a rare cancer, and one died. (Chungcheong Times). Since then, the bereaved family is demanding an investigation into the correlation with the 3D printer.

As a result of the 2018 Occupational Safety and Health Research Institute's study on exposure to ultrafine particles for 3D printer users, it was confirmed that they could be exposed to organic compounds and metals.

This study focused on 3D printing, briefly reviewing the overview, application areas, and legal system, and studying problems caused by 3D printing technology. Factors were analyzed and the influence of materials on users was investigated and analyzed based on previous research data and media reports.

2. Main subject

2.1. 3D Printing Overview

In the 1980s, a company called 3D Systems in the US developed a printer that hardened plastic liquid to create three-dimensional objects. However, due to high production cost and intellectual property rights, it was used on a limited basis for making prototypes in the aerospace and automobile industries. As of 2014, about 90 patents owned by 3D Systems and Stratasys expired, resulting in a sharp drop in cost and full-fledged development and distribution. It is becoming.

The method of printing on paper that has been used so far is a traditional printer method, and if it is a two-dimensional method, a 3D printer is a device that prints in a three-dimensional space. While general printers use document data composed of text or images, 3D printers use drawing data to create three-dimensional objects.

In general, 3D printing refers to an additive manufacturing technology in which a specific material is printed layer by layer based on three-dimensional design data or modeling data to form a three-dimensional shape. This is different from the traditional production method of printing 2D data on paper, which is close to the cutting process made by printing 3D data layer by layer with various materials and cutting or shaving (Yeo Hee-gyo).

2.2. Types and methods of 3D printers

2.2.1. type

2.2.1.1. Lamination type : This is a method of stacking very thin two-dimensional planes layer by layer, so there is no loss of material, so most of the recently popular printers are stacking type.

2.2.1.2. Cutting type : As a method of making prints by shaving a large lump as if carving, material loss occurs because unnecessary parts of the material are cut away.

2.2.2. method

2.2.2.1. Photo Curing Process

The model is completed by hardening the raw material with light to make a three-dimensional model, applying a liquid photocurable resin, hardening it with a laser, and building the next layer on the hardened surface.

SLA method : It is made by drawing lines with a laser and hardening the resin.

DLP method : It is similar to the SLA method, or it is a method of curing the entire layer at once using an ultraviolet lamp and a light control device.

2.2.2.2. Polyjet method

It is similar to the photocuring lamination method in that a photocurable material is used. Just as conventional inkjet printers that print characters on paper spray liquid ink through nozzles, Polyjet 3D printers spray plastic resin through nozzles. The biggest advantage of Polyjet 3D printers is that they can create precise models by spraying material very thinly by laminating using special plastic resin that changes from liquid to solid in response to UV lamps, but the types of materials are very limited. This is considered a limitation of the Polyjet method. (Oh Won-seok)

2.2.2.3. Laser Sintering Process

It refers to a technology that applies a powder-type material to a bed and then irradiates a laser to harden only the desired part. It is the principle that only the part exposed to the laser hardens to form a shape. This is also called ‘selective laser sintering (SLS)’. The selective laser sintering method refers to SLS-type 3D printers. (Oh Won-seok)

2.2.2.4. extrusion method

FDM (Fused Deposition Modeling) refers to a method of extracting raw materials by applying heat or pressure to a nozzle. It is the cheapest technology among 3D printers. Due to its low price, it is the most widely used method for small businesses and households. It is a method of making a three-dimensional model by melting plastic filaments, etc., with the heat of the nozzle, and then stacking them layer by layer to make a three-dimensional model. It is an urgent situation. (Oh Won-seok)

2.3. Materials for 3D printers

The main material for 3D printing filament is plastic, and various other materials such as rubber, metal, and ceramic are used. Examples of using food ingredients such as chocolate are also introduced. Models produced by 3D printing are used in various fields. In particular, medical models must be inserted into the human body or come into contact with human skin. Therefore, the Korea Medical Device Industry Association is making every effort to prevent medical accidents that may occur by preparing strict guidelines for the use of 3D printed models. The Korea Medical Device Industry Association requires the submission of biosafety data when 3D printing medical devices are licensed, and follows safety guidelines according to the Common Criteria for Biological Safety of Medical Devices and international standards (ISO, etc.) announced by the Ministry of Food and Drug Safety. are demanding Recently, the diversity of materials is increasing, such as the emergence of materials for making medical models using titanium. (Won-Seok Oh)

3D printing materials are used in three forms: powder, filament and liquid, and the liquid form is used on a large scale. Polymers (plastics), metals, and ceramics are some of the 3D printing materials currently in use. Among them, polymers are the most commonly used printing materials and are expected to continue to meet major material demand over the forecast period. Across the industry, significant efforts are being made to commercialize new materials to meet the specifications of high-end applications. The demand for polymers in the 3D printing materials market is growing significantly due to the rapid increase in demand for desktop printing, while the demand for metals is increasing day by day due to the increasing penetration of high-end applications such as structural parts in the automotive and aerospace industries. In addition, it is necessary to prepare standards for the safety of materials in a situation where problems with the effect on the human body are occurring during the manufacturing process.

Various types of 3D printing materials sold on the Internet

소재	특성	적용사례
나일론 (폴리 아미드)	<ul style="list-style-type: none"> • 흰색이라고도 하며 강하고 유연한 / 내구성 있는 플라스틱 / 흰색 플라스틱 • 강력하고 유연한 플라스틱 • 최소 벽 두께 1 mm • 자연적으로 흰색이지만 색상을 얻을 수 있음 • 1 mm 당 약 10 개의 층 • 분말로 만든 • Alumide = 폴리 아미드 + 알루미늄 • 연동 가능, 움직이는 부분 가능 (체인) 	 
ABS (가정용 프린터)	<ul style="list-style-type: none"> • 레고처럼 강한 플라스틱 • 필라멘트 같은 스파게티로 만든 • 다양한 색상 옵션 • 1 mm 당 약 3 개의 층 • 최소 벽 두께 1 mm 	 
수지 (여러 옵션)	<ul style="list-style-type: none"> • 화이트, 블랙, 투명한 디테일 / 화이트 디테일 레진 / 하이 디테일 -, 투명 -, 페인트 가능 수지 • 엄밀하고 조금 섬세한 • 자외선으로 경화 된 액체 포토 폴리머 • 백색, 까만 & 투명한 가장 전형적인 색깔 • 1 mm 당 약 10 개의 층 • 최소 벽 두께 1 mm 	 
스테인레스 강	<ul style="list-style-type: none"> • 아주 강한 재료 • 여러 단계 또는 분말로 직접 제조 • 금 및 청동 도금과 같은 착색 옵션 • 1 mm 당 약 6 개의 층 • 최소 벽 두께 3 mm 	

[출처: <https://blog.tinkercad.com/materialsguide/>]

소재	특성	적용사례
금은	<ul style="list-style-type: none"> 강력한 재료 확스로 만든 후 주조 1mm 당 약 10 개의 층 최소 벽 두께 0.5mm 	 
티타늄	<ul style="list-style-type: none"> 가장 강한 소재 직접 금속 레이저 소결 1 mm 당 약 30 개의 층 최소 벽 두께 0.2 mm 	 
세라믹	<ul style="list-style-type: none"> 엄밀하고 섬세한 첫번째 세라믹이 인쇄된 후 표면이 유리 세라믹 백색, 유약은 전형적으로 백색 1 mm 당 약 6 개의 층 최소 벽 두께 3 mm 	 
석고	<ul style="list-style-type: none"> 사암 / 레인보우 도자기 / 다색 엄밀하고 섬세한 분말로 만든 제품 자연적으로 흰색, 색상으로 얻을 수 있음 1 mm 당 약 10 개의 층 최소 벽 두께 2 mm 	 

[출처: <https://blog.tinkercad.com/materialsguide/>]

2.4. Industries utilizing 3D printers

The reason why 3D printing technology was selected as the second most important industry in many fields leading the 4th industrial revolution is probably because it is an innovative future cutting-edge technology that can be expected to bring innovative results that can be used in various fields. There are doubts as to whether 3D printing technology is a technology that will bring about great changes in our lives, such as automobiles, aerospace, medical care, education, food, clothing and shelter, bio, and IT. It is expected that a lot of remarkable research and development will be made in the application field.

The medical sector has already achieved remarkable growth, and can use a variety of shapes and materials, such as metal, leather, and plastic, that are almost similar to the patient's body shape, such as hearing aids, implants, artificial bones, and medical aids, and can express various designs to suit individual tastes. It also has the advantage of being able to save.

In the automobile sector, there is already a case in which the weight of the car door frame has been reduced by 90% by changing the material of the car door frame from aluminum to a carbon rod made by 3D printing. In the aerospace field, high value-added parts are being developed with 3D printing technology, and many aerospace parts are

being manufactured. Classes that help visually impaired people shape and touch historical relics to develop their cognitive abilities are also being used in actual educational settings. In addition, after printing and making the world's smallest lithium-ion battery, it succeeded in operating a medical robot and is being used in the energy and nano fields.

As such, the industrial applications of 3D printing technology range from industrial consumer goods requiring rapid prototyping (RP) to education, marketing. It can be applied to a wide variety of industries, including the field of art. (Eunyoung Oh, Jinwoo Lee, Jonghwan Seo) 3D printers are expected to play an important role in manufacturing as companies that can provide this technology as social manufacturing or places that service SNS network-based products evolve.

3D printers won't stop there. The evolution of printers is now ahead of the development of smart materials with 4-dimensional printers, design technology that can predict the change process, and high-function printers. It is expected that the focus will be on the development of technologies that use biomaterials, biomaterials, or cells themselves, which have self-degradation characteristics and are self-degrading in the body.

3D printing technology is being discussed as a key technology that will create innovation and new markets in the manufacturing industry of the 4th Industrial Revolution by directly producing products thanks to groundbreaking technological advances such as the development of the Internet, collaboration and open source community culture, software and computing power.

2.5. Legal system for 3D printers

As mentioned earlier, the technology development of the 4th industrial revolution is accelerating. However, the system or the legal system to respond to the resulting problems has not yet been properly established or has not been able to keep up with the speed. It is also necessary to consider the aspect of research ethics in the development process. As can be seen in the case of successful cloning by culturing cells, research should be conducted with an ethical mindset that does not harm humanity.

The United States and European countries are in a situation where they are thinking and discussing to prepare legal and policy alternatives and systems. In the case of Korea, regulation or management of simulated firearms or home-made firearms produced by printing is not properly carried out. It is very worrisome that this is rarely done. In addition, with rapid technological development, it is necessary to recognize as soon as possible that the probability that materials and products in the form of forms not included in dangerous substances or weapons in the traditional concept can be used as means of terrorism or criminal use is increasing, and countermeasures must be prepared.

2.6. Consideration of social problems of 3D printers and harmfulness of materials

2.6.1. Incident (manufacturing firearms)

3D printing, one of the new technologies, is revolutionizing the industrial structure and production method. These changes are also bringing about major changes in the field of violence, including general crime and terrorism.

In 2013, Cody Wilson, who insisted on the freedom to use firearms, manufactured a homemade firearm named 'Liberator' using a 3D printer, and made the 3D printer firearm production drawings that can be reproduced freely downloadable through open source data. In the United States and Europe, the risk of crime using 3D printed homemade firearms called 'ghost guns' is rapidly increasing.

Cases such as the death of two people in a 3D-printed simulated shooting at a synagogue by a far-right extremist terrorist in Germany, and the illegal distribution of 3D-printed guns in the UK and the US, make this threat a reality. As it is revealed that some of the guns used by the suspect in the shooting of former Japanese Prime Minister Shinzo Abe on July 8, 2022 are handmade products made using 3D printers, attention is focused on the issue of making home-made firearms using 3D printers in Korea. have.

Choi Ki-il, a professor at the Department of Military Science at Sangji University, emphasized that "3D printer technology is currently capable of plastic injection as well as processing of steel products," and emphasized that "currently, it can also produce bullets used as rifle bullets." do. In the case of science and technology, legislation is slow compared to the speed of development, so countermeasures are insufficient, and in fact, cases where cyberbullying and criminal acts taking place online are not punished are rapidly increasing due to lack of legal regulations. (Financial News)

From early 2020 to March of the following year, he was accused of purchasing various gun parts from overseas online sites dozens of times, smuggling them in, and then trying to manufacture a firearm. Mr. A made 12 firearms, including 7 pistols and 5 rifles, with parts smuggled in several times. As a result of the analysis of the performance by the National Institute of Scientific Investigation, these homemade firearms are known to have similar performance to general firearms in Korea. It is also considered to be not a safe zone. (Asia Economy)

2.6.2. Problems with Toxicity of 3D Printer Materials

In this study, the harmfulness of materials used in 3D printing was investigated in the most in-depth way and based on previous studies.

In 2020, as an accident was reported in which a teacher who used printers to teach education using printers in schools died of sarcoma cancer, interest in the harmfulness of 3D printing filament materials was raised, and the National Assembly also questioned the state of supply of 3D printers. there was.

According to the Korea Institute for Occupational Safety and Health in 2018, acrylonitrile butadiene styrene, one of the types of plastics made of fillers, was melted at high temperatures to produce ABS materials, and harmful substances were detected in two types of materials through an experiment on the generation of harmful substances. It has been analyzed that long-term exposure to harmful substances spread in the air can adversely affect health.

However, there is also a research result that the 3D printer material caused sarcoma cancer and the material reagent is toxic, but the announcement of the confirmation as the cause of death is being delayed.

In 2018, a research team at the Korea Occupational Safety and Health Agency (Jeong Eun-gyo, Kim Seong-ho) conducted an evaluation of 3D printing workplaces and confirmed that they could be exposed to organic compounds and metals, although not at a high level. However, MSDS (Material Safety Data Sheet) of 3D printing materials is not possessed, and even if it is possessed, the name of the chemical substance is not specifically specified on the MSDS, so it is difficult to identify the causative substance due to 3D printing work. Therefore, based on the major 3D printing materials, a study was conducted to identify possible exposure factors by analyzing the chemical components of the material.

The Occupational Safety and Health Act (hereinafter Sanan Act) categorizes chemical substances into seven categories (substances for which exposure standards are set, substances for which acceptance standards are set, harmful substances subject to management, permitted substances, prohibited substances, work environment measurement substances, and special health diagnosis substances). are sharing Among them, 'hazardous substances subject to management' are specially managed substances according to the effects of health problems. "Raw materials and gases that require health measures to prevent health problems in accordance with Article 24 of the Act because they are likely to cause significant health problems to workers. 'Steam-dust-fume-mist' refers to organic compounds, metals, acids-alkali, and gaseous substances specified in Annex 12." This means that the actual management of chemicals as hazardous substances must be carried out.

Most small 3D printers using plastic materials do not have ventilation or airtight structures installed on desktops used in homes and public places. However, users do not

use appropriate personal protective equipment (respirators). However, industrial 3D printers are mostly closed structures or ventilation devices are installed. For this reason, in previous studies, the exposure level is low in industrial use. Therefore, when adopting this technology in a non-industrial environment, it is important to characterize the physical and chemical nature of hazardous material emissions from 3D printing operations in order to reduce the potential for and risk of exposure as early as possible.

ABS, a filament material, is a 3D printer material, and is used more often than other materials in terms of high heat resistance and heat resistance, and low price. In addition, in the case of PLA material, 5 to 7 types of substances subject to management and 20 to 25 types of polymer substances were detected. In the case of ABS material, 5 to 6 types of substances subject to management and 15 to 23 types of polymer substances were detected. In other materials, 2 to 8 types were detected as substances subject to management, and 15 to 30 types were detected as polymer substances. And in the case of metal materials, 3 types of substances subject to management were detected. (Eungyo Jeong, Seongho Kim)

2.6.3. Material Analysis and Releasing Hazardous Substances

Most desktop 3D printers currently use either acrylonitrile butadiene styrene or polylactic acid as a thermoplastic material (Ragan, 2013). The main differences between ABS- and PLA-based printers are raw material origin and nozzle and baseplates temperatures during operation.

PLA is a biodegradable corn-based plastic that prints at a nozzle temperature of about 180°C and a bottom plate temperature near room temperature. ABS is a stronger thermoplastic that prints at nozzle temperatures around 220 °C and baseplate temperatures around 80 °C on most commercially available equipment (Weinhoffer, 2012).

ABS is a material that is used in many parts of our daily life and has good impact resistance, chemical resistance, and good processability. From a chemical structural point of view, acrylonitrile contributes to chemical resistance and thermal stability. And butadiene enhances the impact strength. Finally, styrene helps with structural rigidity and machinability. Due to these properties, ABS plastic is used in various fields. The disadvantage is that it is not suitable for use in food containers. In particular, acrylonitrile is a highly toxic compound widely used in the manufacture of plastic adhesives and synthetic rubber. It is a colorless liquid with a characteristic odor. It has a molecular weight of 53.07, a melting point of -83°C and a boiling point of 77.3°C (760 mmHg). Because it is highly toxic, it is dangerous if it is contained in the air at 20 ppm or more. It is used as a raw material for organic synthesis, as a solvent, and as an insecticide.

2.6.4. How Chemicals Affect the Human Body

Occupational asthma, among occupational lung diseases caused by chemicals in the workplace or work process, has clinical symptoms such as shortness of breath, chest tightness, and coughing symptoms. Manifestations can cause negative psychological effects. Pulmonary function tests, continuous peak expiratory flow measurements, and bronchoconstriction induction tests are used to diagnose occupational asthma. Although early diagnosis is difficult and it is difficult to objectively prove the disease, due to the nature of the disease, rapid diagnosis is required to aggravate symptoms. can be prevented (Cho Eun-sang et al. 2020).

In the research data of Jo Eun-sang and Cha Hyo-geun, who studied the AOP of allergic respiratory diseases caused by chemicals in the workplace, the Adverse Outcome Pathway (AOP) ranges from molecular-level changes induced by specific chemicals to environmental and human health effects. It is a conceptual method that presents a series of biological processes from exposure to the body of a chemical substance to the final effect on an individual (or group) by connecting pathways and sequentially exploring toxicological effects that occur at each stage. It was used in research in a year-by-year manner.

Eun-Kyo Jung and Seong-Ho Kim's research team confirmed the possibility of exposure to carcinogens in the thermoplastic processing and finishing industry. However, it has been observed that there is a lack of published data on exposure levels of fumes from the firing process to be addressed. As a result of analyzing national mortality data by occupational group in the 1980s, it was found that during this period, the excess risk of death from bladder cancer in men in plastic product manufacturers and the number of lung cancer registrations in women among plastics handling workers were excessive. If not properly controlled and process parameters such as temperature and residence time are exceeded, polymer degradation can occur and release air pollutants that can irritate the eyes, nose and lungs (HSE, 2002).

In addition, we tested how much ultrafine dust is emitted in the 3D printing operation of the desktop FDM method (Brent Stephens et al., 2013). While operating the FDM printer in a general office, the number of particles in the air was measured at 1-minute intervals. As a result, up to 190 billion pieces of ultrafine dust were detected per minute. This is similar to the concentration of ultrafine dust emitted when cooking on a gas stove, burning a scented candle, operating a laser printer, or burning a cigarette. As a result of analyzing the components of dust and gas coming out of the FDM printer, carcinogens such as benzene, toluene, formaldehyde, and phthalate and endocrine disruptors (environmental hormones) were detected (Yoon et al., 2015). This is because when melted with heat over 200°C, "thermal decomposition products" that are harmful to the body are released. Exposure experiments on rats and mice of acrylonitrile, styrene, and 1,3-butadiene, which are decomposition products in the ABS heat treatment process, have been shown to have toxic effects (Zitting and Savolainen, 1980; Schaper et al., 1994). It was shown that exposure to fumes due to plastic thermal decomposition of PTFE (Polytetrafluoroethylene) causes acute toxicity to mammals (Oberdörster et al., 2005), and it was confirmed that ultra-fine particles generated during 3D printing work are more toxic than gas. (Johnston et al., 2000).

Examining previous research data, it was found that each researcher suggested hazardous substances and emissions through measurements and experiments in various fields and conditions. However, there is a slight difference between harmful substances and emissions. When considered as a whole, gaseous substances include formaldehyde (HCHO), acetaldehyde (C₂H₄O), styrene (C₈H₈), caprolactam (C₆H₁₁NO), and diethylene glycol monobutyl ether (2,2-butoxyethoxy ethanol (C₈H₁₈O₃), methyl methacrylate (C₅H₈O₂), trichloroethylene (C₂HCl₃), toluene (C₇H₈), ethyl benzene (C₈H₁₀), caprolactam, lactide, cyclohexane Paddy, methyl methacrylate, normal butanol, types of materials used in 3D printers and characteristics of hazardous substances studied Total volatile organic compounds (TVOCs), 1,3-butadiene, vinyl chloride monomer monomer), naphthalene, polycyclic aromatic hydrocarbons (PAHs) and particulate matter are fine or ultrafine particle, and heavy metals are chromium (Cr), arsenic (As), cadmium, Cd), copper (Cu), antimony (Sb), etc. are identified as harmful substances that can be exposed through the use of 3D printers. (Eungyo Jeong, Seongho Kim)

3. Conclusion

Chemical substances are continuously increasing in quantity and number along with the development of industry. According to CAS, a chemical information index in the United States, as of 2017, the number of substances with unique numbers assigned to chemicals exceeded 130 million, and about 15,000 new chemicals are registered every day (except Choong-Sik Yoon).

The number of chemicals distributed or used at least once in Korea is about 45,000, and it is estimated that about 16,000 are currently in circulation, and about 300-400 new chemicals are introduced every year (Chungsik Yun, etc., 2014; Lee Kwon-seop et al., 2015; Park Ji-hoon et al., 2015)

Although the 3D printing technology of polymer composites has made rapid progress, complex research and improvement in terms of materials and performance are required to overcome the limitations of this technology. Only thermoplastic polymers, powder molded materials and a few photopolymers with low glass transition temperatures and suitable melt viscosities can be used for 3D printing. However, since these limited materials cannot satisfy the wide range of requirements for industrial applications, the variety of materials will need to increase. (Eunyoung Oh, Jinwoo Lee, Jonghwan Seo)

In the meantime, although the materials of filaments used in 3D printing may be exposed to harmful substances, the Occupational Safety and Health Act has not clearly provided grounds for this, or substances that have been found to be harmful in the workplace to protect the health of 3D printer users have been banned. There was no clear suggestion on how to manage it, and it is limited to recommending frequent ventilation during use.

Therefore, there is a need to propose a plan for overall management of chemicals known to be harmful (except for Yun Choong-sik). There are many cases where harmful substances are not managed, so it can be said that health problems are not prevented. Therefore, it is inevitable that the government should expand the scope of management. In addition, more specific studies are needed on the reasons for preparing the criteria for selecting hazardous substances subject to comprehensive management and the effects and validity of such regulations. Estimating the burden of disease from multiple risk factors is a useful public health tool for assessing premature mortality and morbidity. Measuring various burdens, such as disease rates, deaths, and incidence and prevalence of disease, provides decision makers with important data to help prioritize risk reduction strategies.

Although many studies to date have focused on lifestyle causes of the disease, various environmental and occupational risks are increasingly being included. Diseases that can be attributed to all hazardous substances account for about 4.4% (982,317 deaths from diseases caused by hazardous substances/22,332,976 total deaths from related diseases (12,611,343(M)+9,721,633(F)), among which chronic obstructive pulmonary disease, asthma, etc. Disease deaths (48%, 475,589/982,317) and occupational cancer deaths (42.3%, 415,622/982,317) accounted for 90.3% of occupational disease deaths.

However, how much of a specific exposure contributes to the attributable risk for workers or employers exposed to hazardous chemicals. If the incubation period is included in order to be recognized as occupational cancer, it is difficult to prove it as an occupational disease because most workers who handle chemicals develop the disease after retirement. It is possible to calculate the correlation to some extent by measuring the population attributable risk (expanding the contribution of diseases caused by carcinogens to the entire population), but there is still a DB establishment for it in Korea or the difference between malignant tumor codes and international standard disease classification codes. It is judged that the calculation basis is insufficient. Therefore, it is important to acknowledge and improve continuous supplementation and change regarding the scale of occupational cancer.

Based on the investigation through this preceding study, I would like to make some suggestions on various hazardous chemicals as well as the materials of 3D printers.

1. Reinforcing the legal system of various industries in the era of the 4th industrial revolution and strengthening the system for establishing an accurate database.

2. Establishment of continuous database of hazardous chemicals and chemical MSDS, preparation of legal grounds for hazardous substances subject to management, and strengthening of distribution and evaluation management at each business site.

- Companies that manufacture or distribute materials provide more accurate MSDS information, and employers secure accurate and reliable MSDS for handling chemicals,

provide safety and health information to workers who use them, and provide training on them.

3. Improving a safe workplace environment from harmful factors such as labor safety and health and user safety and health.

4. Conducting education to spread national safety and health culture awareness on hazardous chemicals.

5. Research investment for diversification of 3D printing filament materials and development of eco-friendly materials.

6. Reinforcing work environment management at 3D printer locations.

① Engineering measures: substitution, isolation, ventilation

■ Substitution - Substitute with a resin that emits less harmful substances through research and development.

■ Isolation - A method of minimizing exposure through isolation between the source of hazardous substances and workers, such as sealing, shielding walls, and storage in separate locations.

■ Ventilation - There are local ventilation and total ventilation, and a method to engineerly discharge harmful gases, steam, and fine dust generated by installing a local exhaust system at the source of harmful substances to the outside of the workplace.

② Administrative measures: wearing protective gear, training, etc.

■ Education on the hazards of exposed chemicals, training on work methods, wearing and maintenance of personal protective equipment, etc.

Referenc

1. Jaecheol Koh, (2020). Characteristics of hazardous substances according to 3D printer materials. Occupational Safety and Health Research Institute-524 Industrial Accident Prevention Research Brief
2. Jung Eun-gyo, Kim Seong-ho.(2019). Research on the types of materials used in 3D printers and the characteristics of hazardous substances
3. Hyunchang Kim. (2015). A study on the impact of 3D printing on society and economy. Digital Convergence Research, 13(7), 23-31.
4. Yeo Hee-gyo. (2018). A study on the current status and development of 3D printing technology. Journal of the Korean Printing Society, 33(1), 25-37.
5. Kyungah Kim, Seongryeol Han. (2021). Evaluation of mechanical properties according to process parameters of ABS specimens for 3D printing utilization. Journal of the Korean Society of Mechanical Engineers, 23(2), 300-305.
6. Lee Sang-hee, Lee Jong-suk. (2021). Development of 3D printing fashion eyewear using eco-friendly filaments. Journal of the Korean Society of Fashion Design, 21(2), 1-16
7. Yun Choong-sik and 10 others. (2019). A study on the impact analysis of the chemical substance system according to the improvement (proposal) of the system for hazardous substances subject to management. Safety and Health Corporation.
8. Bone Systems. (2021). Plastic CNC machining method by material: <https://bon-systems.com/newsletter&num=13>
9. news pim. (2022). 3D printing safety measures 'Post-hospital visits'... Impossible to block distribution of hazardous materials:<https://www.newspim.com/news/view/20220308000355>
10. JoongAng Ilbo. (2022). 10 neighborhoods where immortal substances that cause cancer and infertility were first detected in Korea. <https://www.joongang.co.kr/article/25098676> -> Sacheon-dong, Cheongju 2022.09. 01.
11. Eunyoung Oh, Jinwoo Lee, Jonghwan Seo (2018). Research trends in composite materials for 3D printers. 31(5), 192–201. <https://doi.org/10.7234/COMPOSRES.2018.31.5.192>
12. Naver Encyclopedia: What is 3D Printing Technology?<https://terms.naver.com/entry.naver?docId=3546214&cid=42171&categoryId=58497>
13. Oh Won-seok. (2016. 5. 30.) Basics of 3D printing technology, Naver Knowledge Encyclopedia.
14. Oh Won-seok. (2016. 5. 30.) Technical Improvements of 3D Printers, Naver Knowledge Encyclopedia.
15. Eunyoung Kim, Minwoo Yoon. (2021). The dangers of 3D printed firearms and the need for regulation. Public Security Administration in Korea, 18(4), 21-35.

16. Swoogeun Kim, Yangho Choi. (1994). A case of toxic hepatitis caused by exposure to dimethylacetamide at work. Korea Occupational Health Association Occupational Health Research Institute.
17. Swoogeun Kim and Imjoong Yun (1991). occupational asthma. Korea Occupational Health Association Occupational Health Research Institute. Occupational Health 8-15
18. Kim Soo-geun. (1994). Plastic injection molding processing and hazards. Korea Occupational Health Association Occupational Health Research Institute. Occupational Health 8-16
19. National Science Museum: IoT Science Museum 3D Printer
20. Edugene. (2021) Core technology of the 4th industrial revolution! Internet of Things & 3D Printing <http://www.edujin.co.kr/news/articleView.html?idxno=36013>
21. Myeongwoon. next encyclopedia. 3D Printing: How far can a 3D printer go? <https://100.daum.net/encyclopedia/view/124XX73300008>
22. Information and Communication Technology Promotion Center. (2015). 3D printing strategic technology roadmap
23. Financial News. (2022). 'Abe's sniper' 3D printer gun production, Korea is also on fire...“From home to bullet” <https://www.fnnews.com/news/202207111109556637>
24. Asian economy. (2022). ‘Ghost guns attack’ [Lim Joo-hyung’s Tech Talk] ; <https://n.news.naver.com/article/277/0005075194>
25. Plastic : 3D Ways.co.kr

Article

A study on how to improve environmental problems in the Chungcheongbuk-do region using big data

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Abstract: Currently, interest in the fourth industrial revolution technologies such as big data, the Internet of Things, and artificial intelligence is increasing. Recently, the public sector, such as the government and local governments, is making efforts to utilize the 4th industrial revolution technology. In particular, big data can be useful in many sectors other than the public sector because it can promote policies based on data. Therefore, the purpose of this study is to try to empathize with the use of big data and the natural environment of Chungcheongbuk-do in Cheongpung Myeongwol. In addition, it is necessary to approach big data in more detail by considering its goals and characteristics so that big data can be used as a means of policy process through big data use cases in each stage of environmental crisis management.

Keywords: 4th Industrial Revolution, Chungbuk region, environment, big data, big data utilization policy

1. Introduction

The Industrial Revolution overcomes the stagnation of growth through technological innovation and represents innovative changes in the economy and society. The first industrial revolution was a machine revolution in which the production system centered on domestic handicrafts was converted into a factory production system, the second industrial revolution built a mass production system using oil and electric energy, and the third industrial revolution created the foundation for the knowledge service industry by realizing automation and replacing some of mental labor with machines. The Fourth Industrial Revolution is an era of new technological innovation due to the disappearance of academic and technological boundaries and the fusion of various powdered technologies. In other words, through the Fourth Industrial Revolution, everything will be transformed into an interconnected and intelligent society." (Kim Jin-ha, 2016:47)

The pace and ripple effect of change are rapidly evolving with the fusion of digital devices, humans, and physical environments. In addition, boundaries such as digital, biology, and physics are disappearing and the field of convergence studies is spreading. The 4th Industrial Revolution has the characteristics of hyper-connectedness, hyper-convergence, and super-intelligence. As a result, the Internet of Things, big data, artificial intelligence, robotics, and 3D printing are emerging as key drivers of the 4th industrial revolution. (In addition to Bok Kyung-soo, 2017:29)

As the importance of the Fourth Industrial Revolution is recognized, big data technology that generates meaningful information and knowledge through data collection, processing, and analysis stands out. (Kim Doo-hyun et al., 2014:25)

The vast amount of data generated through the Internet of Things is stored as a cloud in virtual space, analyzed by big data and artificial intelligence technologies, and predicts situations in physical space. Decision-making made through this process creates

a cyclical ecosystem while affecting the actual physical space again (Jeon Jong-kyu et al., 2016.)

Starting with smartphones, “smart” is already common around our lives, including smart watches, smart TVs, smart refrigerators, and smart vacuum cleaners. While we were not aware of it, words such as smart and IoT (Internet of Things) permeated throughout our daily lives. This is an era where you can operate home appliances or locks even when you go out with a smartphone. In addition, the recent virtual reality (VR) devices, augmented reality (AR) devices, the popularity of games using them, and the emergence of self-driving cars are heralding a change to a new era. This change, called the Fourth Industrial Revolution, is no exception in the environmental field. (Ko Young-gu, 2017:32)

Natural environment refers to a state that encompasses all living and nonliving things on Earth. It refers to land landscapes that function as an ecosystem, including topography that humans have not touched, natural resources or air purification, water circulation, climate, and natural features that are closely related to humans. (Meteorological Agency, Biodiversity Crisis Due to Climate Change)

In general, when it is referred to as the environment, it means the natural environment, and they maintain harmony and balance by forming a constant material cycle with each other in terms of function, which is called the natural ecosystem. (Chungcheongbuk-do Environmental White Paper, 2021:73) The natural ecosystem is composed of inorganic environments such as atmosphere, water, and soil, and creatures such as animals and plants, and they are constantly circulating materials with each other. The climate is controlled by the complex connection of the ecosystem, pollutants are absorbed, decomposed, and assimilated, and materials and spaces necessary for human food, clothing, and shelter are secured. In addition to the functions of the public interest, nature plays a hidden role in purifying human emotions that are prone to roughness in complex social structures. (Ministry of Environment, Cyber Environment Class)

Chungcheongbuk-do is an inland island located in the center of Korea, and is the home of Cheongpung Myeongwol, where mountains and rivers harmonize. (Ban Young-woon et al. 2017:19) It is bordered by Gyeongsangbuk-do, Daejeon Metropolitan City, Gyeonggi-do, Chungcheongnam-do, and Sejong Special Self-Governing City, and consists of three cities and eight counties. The area is large in the order of Chungju-si, Cheongju-si, and Jecheon-si, and Jeungpyeong-gun is the smallest. The natural environment is represented by the Hangang River water system and the Geumgang water system, which are divided into the national park area centered on Baekdudaegan Mountain Range and the Hannam Geumbukjeongmaek (a mountain range from Cheonwangbong Peak of Songnisan Mountain to Chilseongsan Mountain in Anseong). The climate shows a typical continental climate, but it is mild as a pointy climate in the north and south. Summer is hot and humid, and winter is cold and dry, with clear seasonal changes and various agricultural products. (30 years of Chungcheongbuk-do, 2020:34)

The world is facing a new environmental crisis due to various crises such as global warming and climate change, and infectious diseases such as the COVID-19 pandemic. (Kim Sang-bae, 2020:55) Experts point out that common infectious diseases, which do not know when they will end, are caused by human activities and continue to penetrate our lives. (Science Times 2020)

In this crisis situation, this study aims to study ways to improve major environmental problems in Chungcheongbuk-do, such as fine dust, based on various public cases and actual successes using big data.

2. The Role of Big Data in the Fourth Industrial Revolution

2.1. Big Data Concept

WEF Chairman Klaus Schwab defined the 4th Industrial Revolution as a technological revolution in which the convergence of digital and digital, bio-industry, and physics based on the 3rd Industrial Revolution rapidly changes the economic system and social structure. The 4th Industrial Revolution is characterized by hyper-connected and hyper-intelligent, and it means that humans, humans, objects, and objects are interconnected through information and communication technologies such as the Internet of Things (IoT) and cloud, and humans and objects are transformed into more intelligent societies with big data and artificial intelligence. Klaus Schwab specifically presents 10 leading technologies leading the 4th Industrial Revolution. Physics technologies include unmanned transportation, 3D printing, advanced robotics, and new materials, digital technologies include the Internet of Things, blockchain, and sharing economy, and biology technologies include genetic engineering, synthetic biology, and bioprinting.⁴) Based on these technologies, industries such as cloud computing, smart terminals, big data, deep learning, drones, and autonomous vehicles are expected to develop. (Young-gu Ko et al., 2017: 34)

Thanks to the rapid development of information and communication technology in recent years, we have faced a rapid change in life that we have not experienced before. In particular, with the development of information storage technology, smart devices are widely distributed, and all information in daily life is accumulating as data. As data generation increases exponentially, big data concepts that are distinct from existing data have emerged, and the government and companies are making great efforts to extract and analyze only the necessary information from the vast amount of data. (Lee Mi-sook et al., 2014:5)

Big data refers to a vast amount of data that does not exist but is generally difficult to process with existing technologies in a narrow sense, and broadly refers to the ability, technology, and tools to analyze and manage them (Ham Yoo-geun, Chae Seung-byeong, 2012). Gartner (2012) defined big data as "a large, rapidly increasing and diverse information asset that requires an innovative, cost-effective information processing process for advanced insight and decision-making." Accordingly, the characteristics of big data, which are generally distinguished from existing data, are defined as 3Vs, which means volume, velocity, and diversity, and may be expanded to 4Vs+1C, which additionally emphasizes complexity and value depending on the researcher. (Lee Mi-sook et al., 2014:5)

2.2. Big Data Features

The characteristics of big data usually presented size, speed, and diversity, but as the utilization of big data increases, it includes characteristics such as complexity, integrity, and value (Jeong Ji-sun, 2011:). Complexity means that in modern society, it is difficult to process and manage data because various types of data are produced and collected. In addition, there is a study that additionally presents authenticity and value to the attributes of big data (An Jong-wook et al. 2013).

Authenticity means that goals and decisions should be considered to derive potential value by processing and analyzing vast amounts of data, and values mean that the value of data should be improved based on objective and trusted data. (Kang Jeong-mook. 2015:182)

The Ministry of SMEs and Startups (2020) is promoting a big data analysis system construction project by dividing the big data technology fields into distribution and logistics, marketing, healthcare, and non-identification of personal information. First, distribution and logistics are aimed at optimizing delivery efficiency, optimizing logistics processing, and analyzing relevance. Second, marketing is setting up emotional analysis and data standardization. Third, health care consists of the development of risk indexes by health level, bio-information and indicator development, modeling, and the development of private information stabilization devices. Fourth, de-identification of personal

information aims to develop automatic identification technology for personal information through artificial intelligence technology and voice data de-identification technology through dual voice conversion technology (Song In-bang et al., 2020). In other words, based on big data technology, the scope of big data use in the public sector will be expanded as it can be applied to various fields such as economy, welfare, and transportation. (Kang Jung-mook. 2015:182)

3. Status of Natural Environment in Chungcheongbuk-do

3.1. General status of Chungcheongbuk-do

Chungcheongbuk-do, the only inland island that has not encountered the sea, has a beautiful natural environment enough to be nicknamed "the hometown of Cheongpung Myeongwol." The east is bordered by Sangju-si, Mungyeong-si, and Yeongju-si, Gyeongsangbuk-do, the west is Cheonan-si, Daejeon-si, and Sejong Special Self-Governing City, the south is Muju-gun, Gyeongsangbuk-do, Icheon-si, Gangwon-do, and Yeongwol-gun, and is located in the middle and upper reaches of the Han River and Geumgang River. (Ministry of Environment, National Geographic Information System)

It has an area of 7,407.67 km² (7.5% of the land), a population of 1,600,837 (3.1% of the people), and consists of three cities and eight counties. The large mountain range of Baekdudaegan Mountain Range, which contains three national parks, Songnisan Mountain, Woraksan Mountain, and Sobaeksan Mountain, forms a Dogye with Gyeongsangbuk-do. Hannam Geumbukjeongmaek, which extends from Cheonwangbong Peak of Songnisan Mountain, crosses Chungbuk, forming a watershed between the Han River and the Geumgang River. (The Ministry of Land, Infrastructure and Transport, released statistics on the status of urban development areas nationwide as of the end of 2019) The Han River flows southward and merges with Dalcheon Stream. From the south, the Geumgang River moves northward, merges with Mihocheon Stream, and curves into the West Sea. The beautiful natural environment is the result of the water streams of the Han River and the Geumgang River colliding with the mountain streams of Baekdudaegan and Hannam Geumbuk veins. Villages and cities were located in it. The total area of Chungcheongbuk-do is 7,406.2 km², which is the second smallest province after Jeju Special Self-Governing Province. (30 years of Chungcheongbuk-do, 2020:34)

3.2. Environmental status of Chungcheongbuk-do

3.2.1. Waste

The total amount of waste generated in Korea in 2019 was 497,238 tons/day, an increase of about 11.5% compared to 446,012 tons/day in 2018. The composition ratio of each type of waste was 44.5 percent for construction waste, 40.7 percent for business sites, 11.7 percent for household waste, and 3.1 percent for designated waste. (Ministry of Environment, National Waste Generation and Disposal Status)

Total waste generation by region was the highest in the order of Gyeonggi, Chungnam, and Jeonnam, and these three cities and provinces accounted for 41.5% of the total. The amount of household waste generated was 57,961 tons/day, and 27,516 tons/day (47.5%) was generated in densely populated areas such as Gyeonggi, Seoul, and Gyeongnam. The amount of waste generated by the workplace discharge facility is 202,619 tons/day, and 109,083 tons/day (53.8%) were generated in Chungnam, Jeonnam, and Gyeonggi. Construction waste generation is 221,102 tons/day, 103,419 tons/day in Gyeonggi, Seoul, and Gyeongbuk, 15,556 tons/day in designated waste generation, and 7,290 tons/day (46.9%) in Gyeonggi, Gyeongbuk, and Chungnam. In 2019, Chungbuk discharged 2,274 tons of household waste, 8,287 tons of workplace discharge facility waste, 8,438 tons of construction waste, and 1,082 tons of designated waste. (Ministry of Environment, National Waste Generation and Disposal Status)

Meanwhile, for about 10 years from 2011 to 2020, the total amount of waste generated in Chungbuk increased by about 26.6% to 15,059 tons/day in 2011, 19,072 tons/day in

2020, and an average of 16,779 tons/day per year. As of 2020, it ranked 12th out of 17 metropolitan cities and provinces and 7th out of 9 cities and provinces, accounting for 3.6% of the total waste generation nationwide.(Chungcheongbuk-do 2nd Resource Circulation Implementation Plan Establishment Service, 2022:8)

As of 2020, 12.1% (2,304 tons/day) of household waste and 87.9% (16,768 tons/day) of workplace waste are found, and Chungbuk has a high proportion of household and designated waste compared to the national average.(Chungcheongbuk-do 2nd Resource Circulation Implementation Plan Establishment Service, 2022:8)

Most of the waste disposal has been reclaimed, but since the implementation of the standard waste fee system in January 1995, recyclable waste has increased rapidly, reducing waste disposal by landfill and incineration to 17.3%, 46.9% and 35.8% in 2019.(Environmental White Paper, 2021:101)

3.2.2. *fine dust*

Fine dust is a first-class carcinogen designated by the World Health Organization (WHO), which not only poses a fatal risk to health, but also directly affects work productivity, academic and work efficiency, negatively affecting people's lives and economic activities. Fine dust in the air is composed of various particle diameters ranging from 0.005 to 500 μm , and a size with a particle diameter of 10 μm or less is called respiratory fine dust.(Park Sung-joon, 2015:216)

In 2021, the National Disaster and Safety Research Institute of the Ministry of Public Administration and Security selected disaster types with high risk in the near future and announced the results. As a result, the top five disaster types were selected as the top five among natural disasters, including storm and flood, heat waves, infectious diseases and fine dust among social disasters, and industrial accidents among safety accidents. (E-Daily, 2021)

The rapid development of the industry over the past few decades has caused serious air pollution problems. In particular, high-concentration ultrafine dust (PM_{2.5}) with a particle size of less than 2.5 μm has been paying special attention because it adversely affects people's health and environmental problems (Son Dae-sung et al., 2017:23) and thus the importance of predicting ultrafine dust is being highlighted. The National Institute of Environmental Research of the Ministry of Environment has implemented an air quality forecast system since 2013 through the operation of the Air Quality Integrated Forecast Center, and is making efforts to increase prediction accuracy by predicting ultrafine dust by grade and region.(Other than Kang Sung-won, 2020) If exposed to fine dust for a long time, respiratory and cardiovascular diseases may occur, and in severe cases, death may occur (Other than Son Dae-sung, 2017:23)

North Chungcheong Province generates 3-4 percent of its own fine dust nationwide, but the concentration of fine dust has remained the worst in the country since the beginning of 2000. Recently, the maximum concentration of fine dust was more than 200 $\mu\text{g}/\text{m}^3$ on January 16 (237 $\mu\text{g}/\text{m}^3$) and January 20 (225 $\mu\text{g}/\text{m}^3$) in January-March 2018, but in 2019, it increased to January 14 (204 $\mu\text{g}/\text{m}^3$), February 28 (223 $\mu\text{g}/\text{m}^3$), March 1 (212 $\mu\text{g}/\text{m}^3$), and March 5 (239 $\mu\text{g}/\text{m}^3$). In particular, Cheongju is one of the worst fine dust concentration areas in the country, and on March 5, the ultrafine dust concentration in Sacheon-dong, Cheongju-si, surpassed 239 $\mu\text{g}/\text{m}^3$, per cubic meter, Seoul 178 and Jeonbuk 237 $\mu\text{g}/\text{m}^3$, showing the worst confrontation in the country all day. According to Air Korea, 44 days were recorded as "bad" (36 $\mu\text{g}/\text{m}^3$ more than or "bad" (81 $\mu\text{g}/\text{m}^3$ more than or more) in Chungbuk until 19.35, the longest period among 17 metropolitan cities and provinces nationwide. According to the current status of ultrafine dust warnings and warnings, only one warning was issued in 2015 (period 12 days), but it surged to 15 in 2016, 26 in 2018, and 51 in 2019.(Bae Myung-soon et al., 2020:97)

In 2020, the average concentration of ultrafine dust (PM-2.5) in the Chungcheongbuk-do region significantly decreased from 46 $\mu\text{g}/\text{m}^3$ to 29 $\mu\text{g}/\text{m}^3$ compared to the same period last year (January-March). As air quality improves, the number of emergency

reduction measures to reduce fine dust and protect the health of residents during high concentrations of fine dust ($50\mu\text{g}/\text{m}^3$) has also decreased significantly from 12 last year to two. (Bae Myung-soon et al., 2020:97)

The reason for this is that fine dust emissions have decreased by about 39% (-2503 tons) due to restrictions on the operation of thermal power plants, the inflow of fine dust from China is also expected to be reduced due to the COVID-19 response, and measures to reduce air quality. In addition, the reliability of fine dust concentration and regional representation are also improving by expanding the air pollution measurement network (18 places → 29 places). (Bae Myung-soon et al., 2020:97)

However, despite the high level of fine dust, companies' insensitivity to safety is not improving. There are also various reasons, such as installing unauthorized air cabbage facilities, not reporting changes to air discharge facilities, exceeding the air discharge acceptance criteria, or not operating air pollution prevention facilities or self-measuring them. In some cases, it was not possible to check whether the facility was operated properly because the operation log of the air pollutant emission facility was not prepared. Meanwhile, studies showing higher concentrations of fine dust than other regions have continued, but critics say that they have not improved. In order to actively respond to these fine dust issues, Chungbuk-do has expanded its air quality improvement project by implementing the total air pollution system, strengthening business emission standards, and imposing nitrogen oxide emission charges from 2020. (Bae Myung-soon and others, 2020: 98)

In addition, in order to enhance the responsibility and role of local governments in regional air quality management by expanding the air pollution measurement network, it is divided into a national measurement network and a local government measurement network, and the measurement results are jointly utilized and DB is established to improve data utilization. (Chungcheongbuk-do Environmental White Paper, 2021:149)

In addition to the air quality improvement project, effective improvement projects are being promoted to curb the generation of air pollutants, early abolition support to reduce old diesel cars, supply of smoke reduction devices, and purchase of new LPG cargo vehicles, and efforts are being made to create a pleasant environment. (Bae Myung-soon and others, 2020: 98)

3.2.3. Responding to climate change

In 2018, Korea's total greenhouse gas emissions were 727.63 million tons of CO_2eq , ranking 11th in the world and the proportion of emissions is about 1.51%, and cumulative emissions, a measure of historical responsibility, are steadily increasing due to continued economic growth and non-industrial structure. (Greenhouse Gas Information Center, 2020)

The Paris Agreement, adopted at the United Nations Climate Change Conference in Paris, France in December 2015, set a goal to reduce global temperatures to below 2°C compared to before industrialization and to within 1.5°C . Later, at the 48th Intergovernmental Panel on Climate Change (IPCC) held in Songdo, Incheon in 2018, it approved the Global Warming 1.5°C Special Report, suggesting that carbon neutrality should be achieved in 2050 to provide a scientific basis for the 1.5°C target agreed upon when adopting the Paris Agreement. (Chungcheongbuk-do Environmental White Paper, 2021:123)

Chungcheongbuk-do's total greenhouse gas emissions in 2018 were 26.64 million tons of CO_2eq , ranking 10th among 17 metropolitan cities and provinces, and its share of emissions was about 3.7%, and its emissions decreased slightly due to the full-scale implementation of the greenhouse gas and energy target management system in 2011, but it is on the rise again. (Chungcheongbuk-do Environmental White Paper, 2021:124)

Looking at the current status of emissions by sector in 2018, the energy sector increased by 1,574,000 tons (12.4%) compared to 2010, the agricultural sector decreased by 62,000 tons ($\Delta 2.6\%$) compared to 2010, 1,185,000 tons of waste, and 16,000 tons ($\Delta 1.3\%$)

compared to the national average (5.7%). Indirect emissions increased by 2,286,000 tons (23%) to 12,058,000 tons.(Chungcheongbuk-do Environmental White Paper, 2021:124)

3.2.4. Current status of water resources (living, supply, agriculture)

Of the total 132.3 billion m³/year of Korea's water resources, including the amount of inflow from North Korea (2.3 billion m³), the average annual available water resources is 76 billion m³, which is the remaining 57%. Of these, 37.2 billion m³ (28%) is used in total, and 35.1 billion m³ household water (76 m³/year), industrial water (23 billion m³/year), agricultural water (15.2 billion m³/year), and 12.1 billion m³ or 32.5% of the remaining 32.5% are river maintenance water.(In addition to Bae Myung-soon, 2020:90)

In Chungbuk, the number of industrial complexes that start construction every year has increased significantly in the past 10 years since 2010, and 20% of industrial complexes have been constructed in the past 5 years since 2015, resulting in rapid economic development such as industrial complex development and population growth.(Bae Myung-soon and others, 2020:91)

However, as of 2018, 36.6% of the water supplied by Chungju Dam was distributed outside Chungbuk, and the supply of industrial water in Eumseong-gun and Jincheon-gun exceeded the regional distribution, so it is estimated that 356,691 tons/day (347,831 tons/day as of 2025) of industrial complexes are needed.(Bae Myung-soon and others, 2020:91)

3.2.5. Flood Damage and Causes in Chungbuk

From 2004 to 2012, there were a total of seven major storm and flood accidents (concentrated downpours, typhoons) in the Chungbuk region (Chungcheongbuk-do Feng Shui Sea Reduction Comprehensive Plan), and two major flood damage occurred recently. The first was torrential rains of more than 300 years in the central region from July 15 to 16, 2017, and the second was the longest 54 days in the central region in 2020, recording more than 700mm of rainfall at major weather points.(Bae Myung-soon and others, 2020:93)

In 2017, Cheongju-si broke the record for the maximum daily rainfall of 290.2mm (July 16), causing a large amount of heavy rain in a short period of time, and rainfall in Cheongju and Boeun areas flowed into Goesan Dam, flooding many villages in the upper and lower reaches. The 2020 torrential rain continued during the rainy season due to the strong force of the cold air due to the unusual Siberian high temperature phenomenon, and local heavy rains with large rainfall variations between Jecheon-si and Boeun-gun occurred at dawn. Many bridges installed in streams flowing through the city center, narrow span fields between piers, obstacles and sediments between piers, and impermeable layers in urban areas increased, and bottlenecks caused by reduced river width in some bridges were cited.(Bae Myung-soon and others, 2020:92)

Due to torrential rains in 2020, 11 people died, 2 missing, and 1235 people (632 households) were killed and 42 railway operations were suspended, 241 roads and bridges were restricted (101 ha) due to landslides and flooding, villages of residents in Yongdam Dam, 4 reservoirs, and 10 cultural properties were destroyed. (Expected: KRW 2.6 billion)

The main causes are landslides in the ground weakened by the rainy season, difficulty in responding quickly due to torrential rains in the early morning hours, and mainly in disaster-prone areas.(Bae Myung-soon and others, 2020:93)

4. Big Data Use Cases

4.1. Examples of use in the political field

In the 2008 U.S. presidential election, U.S. Presidential candidate Barack Obama secured various types of voter databases and developed a customized election strategy that analyzed and utilized them. At that time, the Obama camp collected voter infor-

mation by phone, individual visits, or social media, from past voting, subscription magazines, and drinking beverages to basic personal information such as race, religion, age, household type, and consumption level. The collected data was sent to the Obama camp headquarters to analyze voter propensity, screen undecided voters, and predict voters with the help of the Boatbuilder (VoteBuilder.com) system, which integrates and manages voter databases online. Based on this, the Obama camp was able to hold cost-effective elections, such as drawing up voter maps and developing voter-tailored election strategies[Cha Jae-pil, 2012]

Since the 19th general election, the National Election Commission of the Republic of Korea has always allowed election campaigns on the Internet, such as social networks. As a result, election-related data were amplified on social media, and political parties that confirmed the importance of SNS in the 5th local elections in Korea and by-elections in 2011 also paid attention to the use of social networks (Yonhap News, 2012). Among them, pollsters conducted an analysis of social media opinion using big data technology to compensate for the big difference between the poll results of the 5th local election in 2010 and the 2011 by-elections predicted by the existing poll method. However, since the majority of SNS users are concentrated in their 20s and 30s in the Seoul metropolitan area (Kyungyang Newspaper, 2012) 2012, SNS analysis of the 19th general election in Korea using big data was limited to the Seoul metropolitan area, revealing consistent limitations.(Kim Dong-wan, 2013:43)

4.2. Examples of social use

The Seoul Metropolitan Government used big data to determine the route of late-night buses. First, in cooperation with KT, the information of people using the phone at night was analyzed. After finding a way to move late at night by connecting the sender's location (origin) and the number holder's address (destination), the Seoul Metropolitan Government decided on a new route based on this data[Seoul News 1, 2013]

Boston City used a system that automatically detects road damage using GPS and sensors through smartphone applications to reduce manpower and budget required to check and collect information directly. A mobile app called Street Bump, developed by an American venture company, was provided free of charge to citizens to serve as a human sensor for drivers to directly collect and transmit data from the surrounding environment. When a car passes through a damaged road, it detects vibration using a smartphone's GPS and sensors, and when it detects vibration, it transmits it to the Road Management Bureau's Road Information Collection Server, and the collected information is recorded on the city hall's interactive map. Big data analysis based on huge amount of road surface information collected in real time reduced road maintenance and manpower and budget[World Urban Trends, 2012]

To analyze data to implement a new urban environment, the city of Zaneiro introduced a system that monitors natural disasters, traffic, and power supply 24 hours a day by integrating information and processes from more than 30 institutions in the city into a single system. Since then, the new alarm system has immediately notified automatic email notifications and text messages, unlike previous systems that manually delivered notifications in the event of an emergency. Through this system, the response time to emergencies was improved by about 30% (Yoon Mi-young, 2013:32)

4.3. Examples of utilization in the economic and management fields

Amazon Dotcom records all customers' purchases in a database and analyzes these records to identify consumers' consumption tastes and interests.(Jang Young-jae, 201:99). Through the use of such big data, Amazon displays recommended products (recommendations) for each customer. It is to find each customer's hobby or reading tendency and automatically present products that are considered to match them to each customer on the e-mail and website. Google and Facebook are also increasing the use of big data by immediately processing users' search conditions and the use of unstructured data such as

photos and videos to provide customized advertisements to users in the same way as Amazon's recommended products display. (Kim Dong-wan. 2013:46)

4.4. Utilization of big data in the environmental field

Social media is also more useful in responding to international environmental problems such as forest protection and climate change in that it breaks down the physical barriers of the real world and enables interaction regardless of place and time. For example, the World Resource Institute (WRI), an international private research institute that studies various environmental problems, established an online monitoring system in February 2014 that can determine the loss and afforestation status of global forest resources in real time. The system, called Global Forest Watch (GFW), actively utilizes social media data from the general public along with satellite data from NASA and Google. Through the crowdsourcing method, anyone using Twitter can upload forest-related information, photos, and videos in real time, which are importantly used to monitor forest conditions around the world along with geographic information data and government data. This information collection method allows you to check small changes in forests in real time, which were difficult to grasp before, so that you can respond quickly to forest issues. (Lee Mi-sook et al., 2014)

Another example of using social big data technology in the environmental field is the climate change monitoring system. Modu University of Austria established the Media Watch on Climate Change in 2011. The system monitors climate change problems in real time by analyzing structured and unstructured data from various sources, from scientific papers to social media such as news, Twitter, and YouTube. When users enter keywords related to climate change, they can check the latest data and geographical information related to them, and various analyses are possible by providing services such as related word analysis and emotional analysis. Language other than English is not yet included in the data, so there are limitations, but it is expected that it will be useful for identifying trends related to climate change and establishing policies as it can see trends of global interest at a glance. (Lee Mi-sook et al., 2014)

If general goods are efficiently distributed through a resource allocation mechanism called 'market', 'environment', a public good, requires government intervention for efficient production and consumption, which is embodied through environmental policies of various means. Through environmental policies, the government reduces environmental pollution or damage, induces environmental improvement, and eventually ensures that sufficient "environmental services" are provided and consumed by the people. (Lee Mi-sook et al., 2014)

The "product" that mediates supply and demand in the private sector is "environmental policy" in the public sector, and the product demand and preference analysis methodology, which is the core of big data analysis in the private sector, can be used directly to analyze demand and preference for "environmental policy" in the public sector. (Lee Mi-sook et al., 2014)

The government has been trying to identify people's demand through various channels and establish environmental policies, but it has not escaped from the one-sided form of top-down due to the limitations of how to identify people's demand. Therefore, social big data analysis in the public sector, especially in the environment sector, is expected to be used to understand the public's policy demand for environmental services, providing the information necessary for effective environmental policy establishment (Lee Mi-sook et al., 2014)

V. Conclusion

Interest in the Fourth Industrial Revolution is increasing around the world, and a lot of investment is being made to develop the technology of the Fourth Industrial Revolution. It is possible to derive achievements such as productivity and efficiency by utilizing the 4th industrial revolution technologies such as big data and artificial intelligence in

various fields such as finance, welfare, and transportation. Usually, it is actively used by large companies or IT companies with expertise in the 4th industrial revolution. Recently, the government and local governments have been providing various support to apply and utilize the 4th industrial revolution technology to the public sector. In particular, it is preparing for the future by providing financial support related to the 4th Industrial Revolution, securing professional manpower, and training for human resources.(Kang Jung-mook. 2021:179)

With the rapid spread of smartphones and the emergence of various information channels such as Facebook, Twitter, and Kakao Talk, various and numerous unstructured data are being created around us. The so-called big data era has entered the era of various sizes and forms and rapid growth. This large amount of uncertain data is generated by analysis as valuable information and is used as a technology to predict active responses and changes based on it. (Kim Dong-wan. 2013:42)

In order for big data analysis in the environmental field to lead to more three-dimensional and multi-layered implications, it is judged that it is essential to analyze the connection with structured external data. In particular, social big data can derive various results depending on what subject and what external data is linked to.(Lee Mi-sook et al., 2014)

If the topic to be analyzed is clearly set through social big data and technical support is secured for it, new perspectives and information needed to establish environmental policies can be provided. In particular, social media can be used as a channel for communication to provide and share environmental-related information and to hear the voices of the people on environmental policies.(Lee Mi-sook et al., 2014)

Developed countries around the world are selecting and promoting big data as national policies and actively supporting to create infrastructure to utilize big data. Korea is also trying to derive potential value by applying and utilizing big data in various fields, but the level of big data utilization is lower than that of developed countries. In addition, as the introduction of big data was slower than that of developed countries, it was necessary to specifically review cases of big data use in major countries. Therefore, this study attempted to empathize with the use of big data and the natural environment of Chungcheongbuk-do in Cheongpung Myeongwol. In subsequent studies, it is necessary to approach big data in more detail by considering its goals and characteristics so that big data can be used as a means of policy process through big data use cases in each stage of environmental crisis prevention, preparation, response, and recovery.

References

1. Kim Jin-ha, "The Age of the Fourth Business Revolution, Seeking Strategic Response to Future Social Change", KISTEP InI, No. 15, 2016, pp.45-58
2. Bok Kyung-soo, Yoo Jae-soo, "Big Data in the Fourth Industrial Revolution," Journal of Information Science, 2017. pp.29-39
3. Kim Doo-hyun, Heo Sung-jin, "The Status and Development Prospect of Hadoop, Big Data Processing Platform", IITPCP Issue Report, pp.25-38, 2014.
4. Jeon Jong-kyu, Byun Jeong-rok, "Smart China, 4th Industrial Revolution in China", Global Market Strategy, 2016
5. Ko Young-gu, this game. "A Study on the Countermeasures of Agriculture and Rural Areas in the Era of the Fourth Industrial Revolution: Focusing on Chungbuk Region" Korea Regional Economic Research, 15(3), 2017. pp.31-57.
6. Korea Meteorological Administration blog, https://blog.naver.com/kma_131
7. 2021 Environmental White Paper, Chungcheongbuk-do
8. Ministry of Environment, Cyber Environment Class, <https://www.me.go.kr/gg/web/index.do?menuId=2271>
9. Semi-un, Ko In-cheol, & Baek Jong-in. . Comparative analysis of public officials and provincial residents' perceptions of climate change adaptation: Focusing on Chungcheongbuk-do. Regional Studies, 33(4), 2017. pp.19-28.
10. 30 years of Chungcheongbuk-do autonomy, 2020 in Chungcheongbuk-do.
11. Kim Sang-bae. "Covid-19 and Emerging Security Complex Geopolitics: The Rise of Pandemic and Transformation of World Politics." Journal of the Korean Political Society 54.4 2020. pp. 53-81.

12. Science Times (2020), "Why is the number of common infectious diseases increasing?", <https://www.sciencetimes.co.kr/news/%EC%9D%B8%EC%88%98%EA%B3%B5%ED%86%B5%EA%B0%90%EC%97%BC%EB%B3%91%EC%9D%B4-%EC%A6%9D%EA%B0%80%ED%95%98%EB%8A%94-%EC%9D%B4%EC%9C%A0%EB%8A%94>
13. Analysis of policy demand in the environment sector using Lee Mi-sook, Lee Chang-hoon, Kim Ji-yeon, and big data. 2014.
14. The Stop Line. "New Value Creation Engine, New Possibilities and Response Strategies for Big Data," [Korea Information Society Agency IT & Future Strategy], 2011 pp. 1-30.
15. Ahn Jongwook; Lee Misook; Shin Dongbin. "A Study on the Concept and System of Spatial Big Data" Journal of the Korean Society of Spatial Information, 2013, 21.5: pp.43-51.
16. Kang Jung-mook. "A Study on the Use of Big Data in the Public Sector in the Fourth Industrial Revolution Era" Academic Conference of the Seoul Administrative Society, 2015, Issue 4, 2021. pp. 177-19
17. Ministry of Environment, National Geographic Information System
18. Ministry of Land, Infrastructure and Transport announces statistics on the current status of urban development zones nationwide as of the end of 2019
19. Environment Ministry, National waste generation and disposal status
20. Chungcheongbuk-do, 2023-2027 Chungcheongbuk-do 2nd Resource Circulation Implementation Plan, 2022
21. Park Sung-joon, Kim Ji-hye, Cho Gu-sang, Yeo Myung-seok, & Kim Kwang-woo. Analysis of indoor and outdoor sources of fine dust in childcare facilities by particle size. Paper Collection of Korean Architecture Society - Planning, 31(12), 2015 pp. 215-222.
22. E-Daily, 2021-12-27: [https://www.edaily.co.kr/news/WorldHealthOrganization\(WHO\)in2013](https://www.edaily.co.kr/news/WorldHealthOrganization(WHO)in2013)
23. Embrace Bae Myung-soon, Bae Min-ki, Kim Mi-kyung, Yeom Woo, Park Hyun-soo, Blue Life, Chungbuk. Chungbuk Research Institute, 2020.
24. Son Dae-sung, Yoon Young-sun, Park Yong-deok, and Kim Sung-hyun. "A study on how to respond to fine dust using the foundation of big data" Journal of the Korean Society of Intelligent Information Systems, 2017 pp.23-24.
25. Kang Sung-won. Environmental big data analysis and service development (i). 2020.
26. Greenhouse Gas Comprehensive Information Center, 2020 National Greenhouse Gas Inventory Report
27. Cha Jae-pil. "National Sympathy Election Strategy in the Age of Big Data - Focusing on the U.S. presidential election case." Korea Information Society Agency. 2012.
28. Yonhap News (2012), "Saenuri Party SNS Capability Index delivered to the nomination committee during the week," <http://www.yonhapnews.co.kr/bulletin/2012/02/21/0200000000AKR20120221198700001.HTML?sns>
29. Kyunghyang Shinmun (2012), "Social public opinion's failure to predict the general election is due to the concentration of users in the Seoul metropolitan area," http://news.khan.co.kr/kh_news/khan_art_view.html?artid=201204242003055&code=210100.
30. Kim Dong-wan. "Examples of the use of big data by field." Management discussion total 34, 2013. pp.39-52
31. Seoul News 1 (2013), "Building a Late Night Bus Route with Big Data in Seoul," <http://news1.kr/articles/1219217>.
32. World Urban Trends "Operation of an Automatic Recognition System for Road Pavement Damage Using Smartphone App and Support for Technology Development of New Packaging Materials" by Seoul Research Institute. 2012.
33. Yoon Mi-young, "Data Analysis for a Better Future", Korea Information Society Agency, 2013. pp.32
34. Jang Young-jae, "Amazon Dotcom, the man of modern bookstores," Business Books, 2012. pp.99.
35. Kang Jung-mook, "Case of Establishing and Using Big Data Concepts" Journal of the Seoul Administrative Association, 2021 pp.177-196.

Article

Suggestions for Mitigating Fire Damage in Electric Vehicles

–Focusing on the risk of fire in the underground parking lot

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Abstract: Self-driving cars, which will be the future technology of the automobile industry, are based on electric vehicles. In addition, the spread of electric vehicles continues to increase due to carbon-neutral policies in the time of the climate crisis. However, the lithium-ion battery, which is the power source of an electric vehicle, is more difficult to cope with a fire than fossil fuels. As there are no proper fire extinguishing measures yet, it is most important to reduce the risk of battery fire as a countermeasure to reduce fire damage. To this end, while regulating charging facilities, I would like to suggest ways to respond more efficiently in the event of a fire.

Keywords: an electric car fire; Lithium-ion batteries; a fire in an underground parking lot

1. Introduction

Recently, carbon-neutral policies related to the climate crisis are also the biggest concern in the automobile industry, and automobile manufacturers are investing heavily for electricity (Park Oh-young, 2022:6). As a result, the supply of eco-friendly cars in Korea is rapidly increasing, and as of the end of 2021, the number of domestic cars registered was 24.91 million, up 2.2% (+55 million units) from the previous year, of which 231,443 were electric cars, up 71% from the previous year (the Ministry of Land, Infrastructure and Transport website). Along with the rapidly increasing number of electric vehicles, charging facilities for charging electric vehicles are increasing, with 76,715 charging facilities nationwide, including private charging operators (60,690) and public charging operators (16,025) as of the end of September 2021.

However, along with the increasing number of electric vehicles, electric vehicle fires are also increasing, and according to data from the National Fire Agency, a total of 69 electric vehicle fires occurred over the five years from 2017 to 2021, 58% of which were caused by electrical factors. Compared to the internal combustion vehicle fire statistics, it seems insignificant, but there is a problem that there is no clear way to extinguish the electric vehicle fire yet. As can be seen in Table 1 below, many media have pointed out the problem of the risk of electric vehicle fire. Therefore, we would like to investigate the mechanism of electric vehicle fire and the countermeasures and limitations of electric vehicle fire suppression accordingly. And finally, I would like to suggest a plan to minimize damage in the event of an electric vehicle fire.

(Table 1) Current status of reports related to electric vehicle fires over the past six months

Num ber	Title	the date of the re- port	a news agency
1	"If there's a fire, there's nothing I can do..." Consideration for countermeasures against electric vehicle fire	10.17	KBS
2	"Fire hazard electric vehicle charging stations, 90% of them in the basement of apartments and shopping malls	11.05	biz.heraldc orp.com
3	"Rep. Kim Kyung-hoon" has a high risk of fire at an underground charging station for electric vehicles...Seoul Metropolitan Government Urgent to Establish Regulations	11.9	www.oneyes. tv
4	"Electric vehicle fires are soaring...Only 3 out of 17 cities and provinces nationwide will introduce 'a portable water tank'	8.18	www.donga. com
5	"A series of electric vehicle fires and deaths..." What are the causes and countermeasure?	6.14	YTN

2. A theoretical discussion

2.1. Fourth Industrial Revolution and self-driving cars

The 4th Industrial Revolution, represented by 'super-connected', 'super-intelligence', and 'super-convergence', means that advanced information and communication technologies such as artificial intelligence, the Internet of Things, big data, virtual reality, and self-driving cars are fused throughout society and the economy (Kim Young-wook, 2017: 28). Among them, self-driving cars are being developed based on electric vehicles, and electric vehicles use secondary batteries as a power source. There are many promising industries related to the 4th Industrial Revolution, but the secondary battery industry is a key driver of the 4th Industrial Revolution related to drones, autonomous vehicles, and electric vehicles (Kim Young-wook, 2017:31).

Self-driving cars and electric vehicles can be strictly distinguished by different concepts, but in the 2017 Rethinking Transportation 2020-2030 report, there are six reasons why self-driving cars should be electric vehicles, and first, control is easy. Second, fault diagnosis is easy. Third, it is suitable for vehicle sharing. Fourth, vehicle design becomes easier. Fifth, indoor usability is good. Sixth, wireless charging provides convenient usability (Jeon Gu-min, 2018: 28).

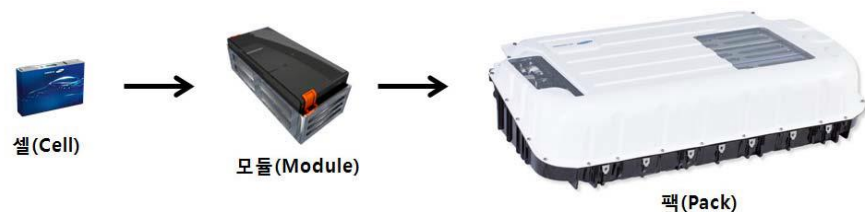
Therefore, autonomous vehicles are being developed based on electric vehicles, and the capacity of secondary batteries mounted on autonomous vehicles is required to be several times larger than that of simple electric vehicles. A secondary battery is divided into nickel battery, ion battery, lithium-ion battery, polymer battery, lithium polymer battery, lithium-sulfur battery, etc., depending on charging materials, and among them, the most widely used battery is lithium ion (Kim Young-wook, 2017: 31). Therefore, this study focuses on lithium-ion batteries.

2.2. Fire Generation Mechanism of Lithium-ion Secondary Battery and Electric Vehicle

A lithium-ion battery uses the principle of oxidation-reduction of lithium ions (Li^+). It has the advantage of being a better power source than any type of battery developed so far, but it uses highly reactive lithium, so it has relatively low stability, so a protection

circuit for overcharge prevention, overdischarge prevention, etc. is essential in a cell and is in the form of a battery pack (Changsoo Kim, et al., 2020: 21).

A lithium-ion battery mounted on an electric vehicle is composed of a battery cell as a minimum unit and a module as a collection of dozens of cells, and a battery management system (BMS) and a cooling system are inserted into a housing to protect this configuration from immersion and impact and mounted on the lower part of the vehicle in a pack form (Lee Kwang-woo, 2021: 40).



Electric vehicle battery pack configuration *Source: Samsung SDI, BMW I3



Electric vehicle battery pack location *Source: Volkswagen

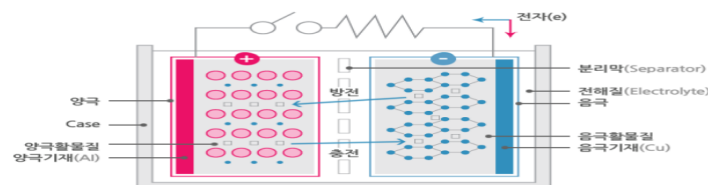


Fig. 1 The principle of the battery.

한국화재감식학회지 제11권 제3호 (2020년 9월)

As shown in the figure above, a cell, which is a basic unit of an electric vehicle battery, is separated into a cathode and an anode based on a separator, and contains an electrolyte that serves as a buffer for a rapid chemical reaction.

In this structure, if a separator is damaged due to any cause¹, the cathode and anode are in contact with each other, it is fired and burned along with a chemical reaction, and a fire is spread throughout the pack as the neighboring cell is heated directly. If the flame spreads outside, it will lead to a fire in the entire car, burning nearby cars or combustibles, and the fire will expand.

2.3. Countermeasures and Limitations for Combating Electric Vehicle Fire

¹ Causes are classified into physical and thermal factors. An example of a physical cause is an external impact, and thus a separator is damaged so that a cathode and an anode material contact each other and an explosion occurs through a fast reaction. Next, thermal factors include overcharging, over current, and overload, and when the temperature inside these battery cells rises, the risk of thermal runaway increases. (Park So0-kyung, 2020: 6)

As previously discussed, when a separator is damaged due to overcharging, overdischarging, overheating, and impact, the cathode and anode directly contact each other to generate heat, and when a fire breaks out in all cells in the module and pack, thermal runaway occurs (Park Yong-sung, 2020:44). There is no way to effectively extinguish a fire in this stage of progress. A fire in the body, chassis, and interior material of an electric vehicle could be extinguished by general water maintenance, but it is limited in suppression because, if a fire of the lithium-ion battery in the battery pack is not suppressed fundamentally, it would recur.

The most common methods of extinguishing electric vehicle battery fires developed so far are to delay the spread of fires by using suffocation extinguishers and to cool down electric vehicles by flooding them in simple tanks. In the case of a suffocation fire extinguisher, it cannot be said to be a fundamental fire extinguishing method other than delaying the spread of fire, and in the case of a simple tank, it takes 40 minutes to assemble and fill water (5m*3m*0.5m). The fire suppression method of an electric vehicle battery is to remove thermal runaway by lowering the battery temperature below the ignition point, and the electric vehicle battery pack is finished with a waterproof housing to prevent external impact and flooding. Hyundai-Kia's battery pack can be maintained 24 hours a day. It also takes a considerable amount of time to soak in the water tank.

<An example of a fire suppression method for an electric vehicle in an underground parking lot>

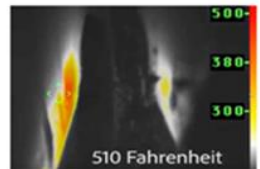


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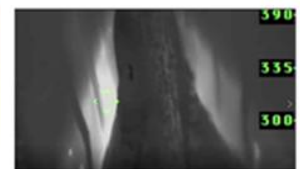
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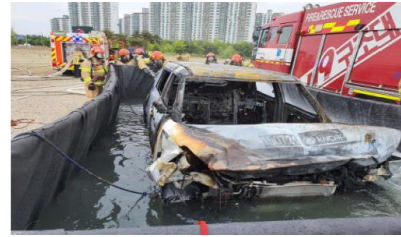


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Source: Fire Protection Measures for Fire Response Technology of Electric Vehicles

< the German case >

< the case of Korea >



* Source: Fire Protection Measures for Fire Response Technology of Electric Vehicles

2.4. Underground Electric Vehicle Fire Risk

With the increase in the supply of electric vehicles, the government has enacted the Act on the Development and Dissemination of Environmentally Friendly Vehicles (hereinafter referred to as the Eco-Friendly Automobiles Act) to require charging facilities for environmentally friendly vehicles in public buildings, public housing, parking lots, and other facilities. The problem is that most of these parking lots are underground.

The reasons why charging facilities located underground are relatively more dangerous than charging facilities for electric vehicles on the ground are as follows. First, most of the underground parking lots are 2.3m high, so fire trucks cannot enter. Therefore, the use of fire equipment such as fire trucks is limited, making it difficult for firefighters to operate smoothly. Second, there is a risk of combustion expansion. If initial fire extinguishing fails, combustion can rapidly expand to nearby vehicles and move to piping insulation near the ceiling of the parking lot, which could spread the fire to the entire basement floor. Third, it is an obstacle to the evacuation of people inside the building. If toxic smoke and heat spread rapidly to the upper floor through vertical spaces such as stairwells, elevators, and shafts of pipes or wires, it can make evacuation more difficult and cause many casualties.

3. Suggestions for Mitigating Fire Damage in Electric Vehicles

3.1. Revision of the Environment-friendly Automobile Act – Establishment of institutional safety standards

The government and local governments are required to install charging facilities under the Eco-friendly Automobile Act, but safety-related standards are insufficient. As discussed earlier, it should be noted that most electric vehicle fires occur during charging.

Electric vehicle charging facilities are stipulated in Article 18-7 (type and quantity of charging facilities, etc.) of the Enforcement Decree of the same Act. 1. It is divided into fast charging facilities and 2. Slow charging facilities. By revising these regulations, charging facilities installed inside or underground of buildings need to be regulated to install only slow charging facilities, and second, battery charging rates need to be limited in consideration of safety. Fast charging facilities already installed should be sufficiently lowered in consideration of safety. The lower the battery charging rate considering safety, the better,

but battery efficiency cannot be ignored, so it would be desirable to decide through policy discussions or public discussions with stakeholders, including experts.

Third, it is necessary to restrict the installation of charging facilities below the second basement floor, but if inevitable, it is necessary to install them near the ramp so that they can be taken out immediately in the event of a fire. Here, if the parking lot management entity takes measures for fire safety of charging facilities, install fire-resistant sections such as fire shutters on three sides of charging stations, installation of fire detector-linked smoke facilities using parking lot ventilation facilities, etc

In the case of doing so, exceptions to the above measures may be recognized.

3.2. *Parking Lot Management main agent – assign Fire blanket*

If a fire occurs during charging, the primary measure is to prevent the spread of the fire. Until the fire brigade arrives, the risk of spreading to large fires can be reduced if the parking lot management entity covers the vehicle where the fire broke out and uses indoor fire hydrants to collect it. Therefore, it is necessary to obligate the parking lot management entity to have asphyxiation fire blanket in proportion to the total number of parking lots.

3.3. *Electric vehicle battery pack external overpressure outlet installation - battery manufacturer*

The electric vehicle battery has a mechanism in which the separator of cathode and anode is damaged for some cause and electric conduction occurs, and a sealed battery pack explodes due to thermal runaway and combustion expands to the surrounding area. In addition, fire extinguishing of a battery is a mechanism that prevents and cools thermal runaway by injecting water into the battery pack where thermal runaway occurs.

Digestive tanks say that many European data require more than 10,000 liters, and some studies say that more than 100,000 liters are needed.

Since it requires water and time, it has practical limitations. An electric vehicle battery fire is extinguished only when thermal runaway inside the battery pack stops, so if there is a hole for injecting water inside the pack, it will be able to extinguish the battery fire with the most effective amount of water. These overpressure outlets play two roles: first, they release internal gas before explosion in case of thermal runaway; second, at least two overpressure outlets are installed in areas that can be easily found by firefighters, such as sides or lower parts. It is responsible for injecting digestive water into the hall.

4. Conclusions

In the era of the 4th Industrial Revolution, new digital innovation will develop in a direction that makes human life more convenient. However, the crisis that occurs in the process of innovation is neglected. In the past, Korea achieved rapid industrial development and was preoccupied with performance, so risks that could not be considered at the time have eventually emerged as social crises in recent years. Therefore, new innovations in the era of the Fourth Industrial Revolution will have to manage the risks of end cancer from now on. Although electric vehicles are an important industry in the era of carbon neutrality as the basis of self-driving vehicle technology, they contain many risk factors. Before it is too late, we should pay attention to the safety of electric vehicles right now.

The increase in the supply of electric vehicles has a significant impact on the needs of buyers and the marketing of manufacturers as well as the government's policy recommendations. Therefore, the government needs to strengthen its policy on electric vehicle safety.

I do not think that the contents suggested in this study are fundamental solutions to electric vehicle safety management. However, I would like to emphasize that it is time for our society to pay attention to the safety management of electric vehicles, and if we overlook this, electric vehicles could become a threat to safety in various parts of society in the near future. The fire risk of an electric vehicle battery will increase in proportion as the number of batteries used increases. Therefore, it is proposed to strive for the fundamental value of crisis management that protects human dignity and life through safety management of electric vehicles from now on.

References

1. Kang Sung-wook.; Lee Kyu-min.; Kwon Min-jae.; Choi Joung-Yoon. “Examination and proposal for Standard Operating Procedure (SOP) to respond to Battery Electric Vehicle (BEV) fire Incidents”. 『 Fire science and Engineering』, 2021, p 63-63.
2. Jeon Chang-ho.; Kim Dong-kyu. “Analysis of Electric Vehicle Fire Characteristics in Underground Space”. 『 International Journal of Automotive Technology』, 2021, pp986-987.
3. Park Yong-sung. “How We Should Manage Electric Vehicle Battery Safety”. 『 Journal of the Korea Society of Automotive Engineers』, Vol.42 No.12 [2020],pp 42-47.
4. Lim Ohk-Kun.; Kang Sung-wook.; Kwon Min-jae.; Choi Joung-Yoon. “Full-scale fire suppression tests to analyze the effectiveness of existing lithium-ion battery fire response procedures for electric vehicle fires”. 『 Fire Science and Engineering』, Vol.35 No.6 [2021], pp21-29.
5. Jung Gu-Min, “Why Self-Driving Cars Need Electric Vehicles in the Future”. 『 The proceedings of KIEE』, Vol.67 No.1 [2018], pp26-29
6. Kim William W, “The Fourth Industrial Revolution and Future Promising Industries”. 『 Korea Contents Association』, 2017. v.15 no.4 .
7. Lee Kwang-woo, “A Study on the Fire Protection Plan of ESS(Energy Storage System) Vehicles”. MA.Thesis, mokwon university, 2021.
8. Lee Jong-in, “A study on the fire risk of small energy storage device through empirical experiments”. Ph.D.Dissertation, gachon university, 2022.
9. Park Oh-Young, “Current Status and Prospects of the Eco-Friendly Automobile Industry”. MA.Thesis, dongguk university, 2022.
10. Rethink X, “Rethinking Transportation 2020-2030”, 2017.
11. Korea national fire agency. “Measures to Combat Fire Response Technology in Electric Vehicles”. 2021.

Article

Projection of Future Floods in Swat Pakistan

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Abstract: Climate change may significantly influence flash floods due to the accelerated frequency of extreme precipitation events. In this study, the Rainfall-runoff model (HEC-HMS), is constructed for a Swat River watershed that was examined in the context of potential future climate change scenarios. The calibration and Validation of the HEC-HMS model for Swat watershed have been done by using the observed data of precipitation, which was obtained from the Pakistan Metrological Department (PMD), whereas the observed data of discharge were obtained from the Irrigation Department, Lahore Punjab. Digital Elevation Model (DEMS), land cover (LC) and soil data were acquired using satellite images. In addition by using the soil, land use and land cover, the estimation of hydrological parameters Time of Concentration (Tc), Storage-Coefficient (R), Basin Lag (tp), Muskingum (K), Curve Number (CN), Initial Abstraction (Ia), and Recession Constant (RC) are identified by calibrating the HECHMS model. The model was calibrated and validated between 1999 and 2006 by using both Clark's and Snyder's unit hydrograph to find the suitable direct runoff method that is able to simulate the hydrologic response reliably over the study area for the selection of the most appropriate climate change scenarios. After calibration, and validation of the model sensitivity analysis of the hydrologic parameters is done. Sensitivity analysis performed on the basis of three statistical evaluation criteria Nash–Sutcliffe efficiency (NSE), Normalized Objective Function (NOF) and Percentage error in peak (PEP) showed that the HEC-HMS hydrologic model is more sensitive to the CN value over the study area. During the calibration process it is noted that Clark unit hydrograph is better able to simulate the flows with lesser value of objective function than the Snyder unit hydrograph method. At the end, future flash flood predictions for the Swat River watershed were generated using the HEC-HMS model, the model was calibrated and validated. After that statistical analysis (NSE, NOF) were applied using coupled global climate models (GCMs) from CMIP 6 (Coupled Model Intercomparison Project Phase 6) for future Projection.

Keywords: Climate change; projection; runoff; remote sensing; HEC-HMS; SSPs; Pakistan

1. Introduction

Flash floods are the most dangerous natural disasters on the planet, resulting in thousands of deaths and billions of dollars in damage each year. Pakistan has seen seventeen major floods, the most damaging natural hazard there, costing the nation 12 billion USD in economic losses since independence [1]. The 2010 flood in Pakistan was the worst in recorded history and caused very much destruction [2]. More than 1900 individuals lost their lives in the 2010 flood, which also devastated 17 million acres area of agricultural land, 1.5 million homes, and 20 million other people [3]. Since June 2022, Pakistan has experienced an unprecedented climate-induced disaster that has killed numerous people, killed cattle, damaged and destroyed governmental and private infrastructure, and caused widespread destruction. This disaster was brought on by heavy rains and a combination of riverine, urban, and flash floods. Local ecosystems have been impacted by landslides and floods brought on by rain that have also destroyed forests and agricultural land [4].

In the 2010 flood the River of Swat and Kabul had a record flow of 400,000 cusecs, breaking the already existing record of 250,000 cusecs set in 1929. During the 2010 flood, the exceptionally high flow devastated Charsadda, Peshawar, and other villages [5]. The monsoon's worst rainstorms occurred in August, which also happened to be Pakistan's wettest month in more than 60 years, with 3.4 times the usual amount of precipitation. The majority of the "calamity-impacted" districts in Pakistan are located in Balochistan (32 districts), Sindh (23 districts), and Khyber Pakhtunkhwa (17 districts) [6].

The flow regime is essentially a description of the flow structure. In Pakistan, climate change will be expected to cause significant glacier melt and deicing of mountain peaks as well as excessive monsoon rainfall an increase in the frequency and magnitude of floods in the Swat River Pakistan. In 2003, Sindh province was badly affected by extreme precipitation. Extreme monsoons in 2007, badly affect Baluchistan, Sindh, and KPK. In 2010, a Flood event is noted in the Swat River that was experienced due to an extreme monsoon precipitation event (Anjum et al. 2016), almost 20 million people were affected by the flood disaster, and 2000 people died. September from 2011 to 2014, thousands of homes have been destroyed, as well as thousands of acres of fertile land, and thousands of people died due to flash floods. In 2020 only Karachi had 484 mm (19 inches) of rain, the highest rainfall recorded in the previous 90 years. In Swat River, all regimes are active and occur at the junction of monsoon and westerly's. Cloudburst also often occurs at this junction point. Now the westerlies have more influence than easterlies, because of climate change. To fill this gap, this study was conducted to investigate the projection of flash flood behavior for 20 years of flood trends in the Swat River. In this study, we only focused on climate change while Land cover changes were constant, due to climate change their regimes were at a point, so the purpose of the research was that for how long this condition will remain the same. Extreme flood events have been occurring in recent decades so to prevent flash floods, the situation demands efficient and long-term flood management. In this study will project the behavior of flash floods for the next 30 years in the Swat River based on historical precipitation and discharge time-series data during the last 30 years (1990–2020), by using the GCMs Model.

2. Materials and Methods

2.1 Study area

The River Swat basin catchment area is located between latitudes 34°00' North and 35°56' North, and longitudes 70°59' East and 72°47' East. The river's catchment basin is mostly hilly from south to north, with elevations varying from 360 meters to 4,500 meters. There is flora between 1,800 and 3,400 meters, and glaciers may be observed above 4000 meters.

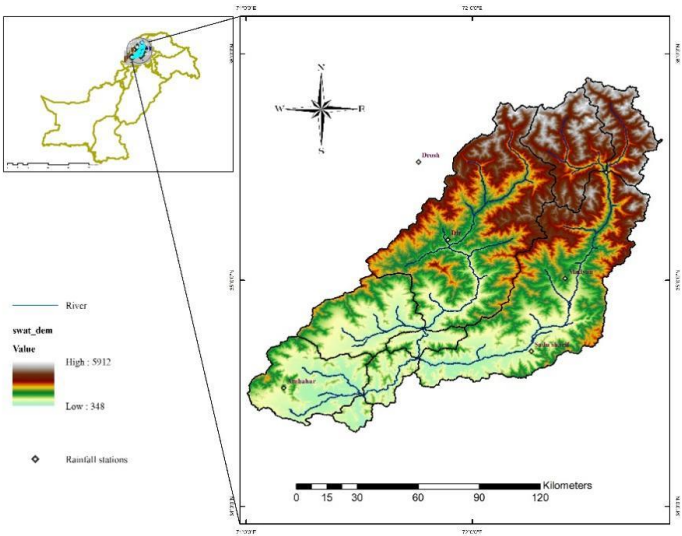


Figure 1. Study Flowchart

In this study, the daily calibration and validation of the physically based semi-distributed continuous hydrological model HEC-HMS at Swat River Mohmand Dam.

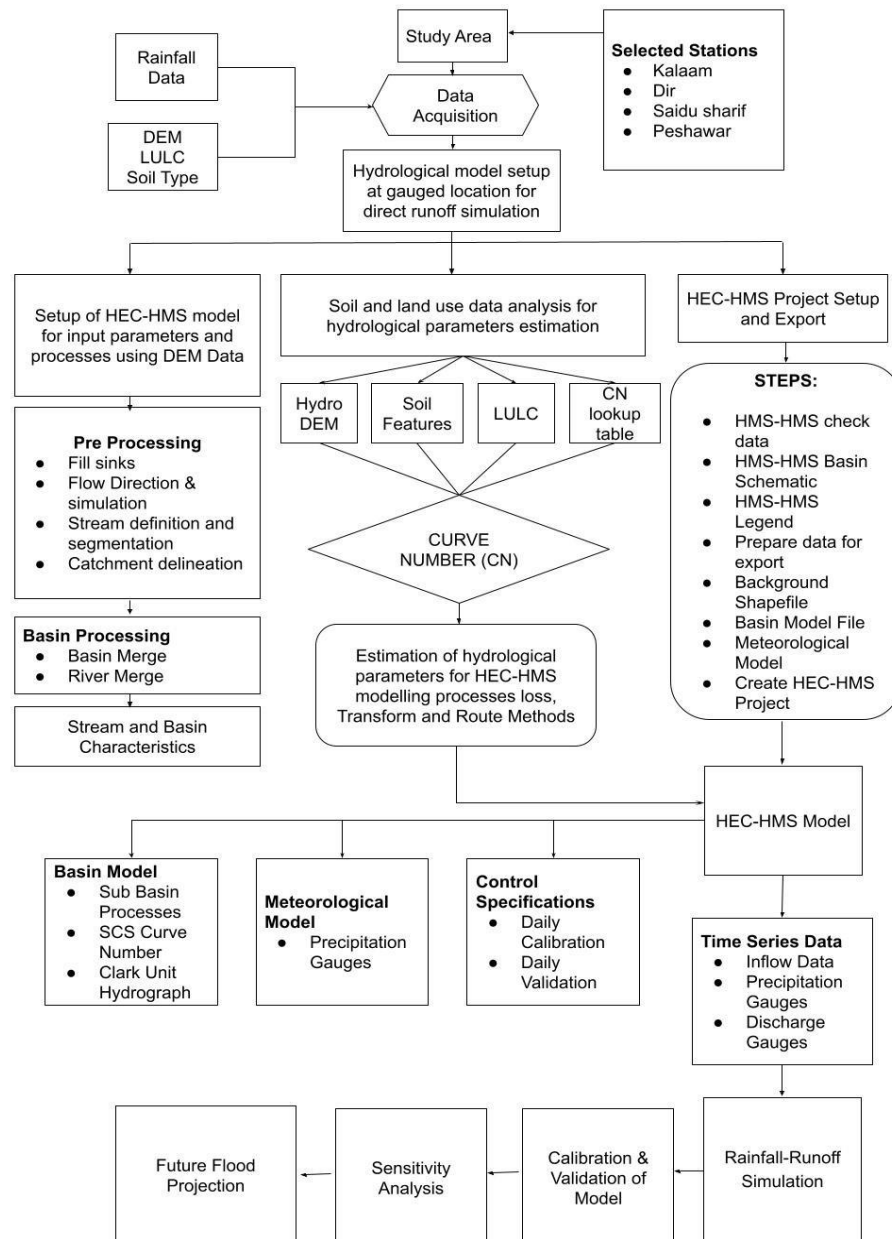


Figure 2. Study flowchart for hydrological system

2.2 Determination of parameters

Information detailing the physical features of the watershed is needed for the construction of the HEC-HMS model. The basic parameters needed for calibrating the HEC-HMS model include Time of Concentration (T_c), Storage-Coefficient (R), Basin Lag (t_p), Muskingum (K), Curve Number (CN), Initial Abstraction (I_a), and Recession Constant (RC). The majority of the initial parameters were determined using mathematical techniques drawn from hydrology textbooks. To begin an optimization process, the initial values of the parameters that are amenable to automated calibration are needed. Time of

Concentration (Tc), Storage-Coefficient (R), Basin Lag (tp), Muskingum (K), Curve Number (CN), Basic Abstraction (Ia), and Recession Constant are the fundamental parameters required to calibrate the HEC-HMS model (RC).

3. Results

Prior to the model's calibration, sensitivity analysis was carried out to improve the prediction accuracy of the hydrologic parameters that would later be utilised to calculate runoff. In order to select the best direct runoff technique between the Clark and SCS unit hydrograph, sensitivity analysis is very helpful. Both NOF and NSE displayed the least value of the objective function with a 90% decrease in parameters. Sensitivity study based on two statistical assessment criteria revealed that the following values can be utilised for future model calibration: CN=87.36, Tc=3.62, K=4.73, S=1.46, tp (h)=2.17, and Ia=0.29. Fig. 3 provides the final calibrated parameters for each sub-basin.

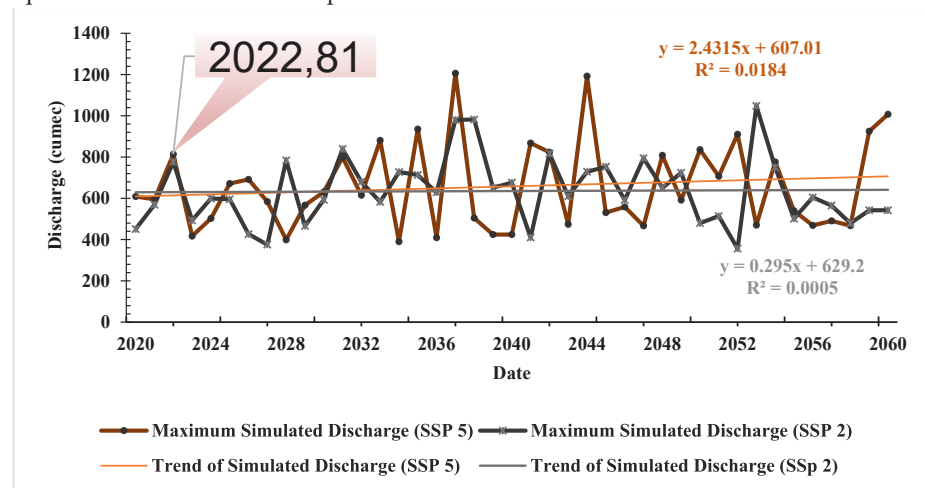


Figure 3. Maximum yearly discharge of Rainfall-Runoff simulation obtained by using SSP 2 and SSP5 scenario precipitation in HEC-HMS model for swat river catchment.

For calibration and validation purposes, data on significant rainfall occurrences from 1990 to 2020 were gathered using PMD as a base. The hydrologic parameters are subjected to sensitivity analysis prior to calibration and validation of the model. Sensitivity research revealed that the HEC-HMS hydrologic model is more sensitive to the CN value over the study region based on three statistical assessment criteria: Nash-NSE, NOF, and PEP are examples of Sutcliffe efficiency. It is discovered throughout the calibration process that the Clark unit hydrograph approach outperforms the Snyder unit hydrograph method in simulating flows with a lower value of goal function.

For the years 2020 through 2060, we utilized the annual precipitation simulation produced by the CMIP6 GCMs. An updated set of scenarios are included in CMIP6 for the goal of simulating the climate. In this study, SSPs 2 and SSPs 5 are seen to be trends that are beneficial for human progress. From the above trend line in figure 3, the increase in yearly discharge shows that climate is considerably changing in these 40 years (2020-2060).

4. Limitations

This study has several limitations. First, of Increase Storage and Improve Water Governance, construct small and large dams where possible. Improve the surface water governance with proper pricing and legislate and restrict indiscriminate groundwater abstraction also control increase in population. Secondly, improve water productivity by

improving conveyance and application efficiencies like, canal and watercourse improvement/maintenance, improving farm layout and levelling of fields. High efficiency irrigation systems are also used to improve water productivity like, bed and furrow methods of irrigation or sprinkler/drip irrigation system. Changing the existing cropping patterns i.e. by adopting low delta crops is also a technique for improving water productivity by adopting proper irrigation scheduling. Using saline groundwater, in conjunction with canal water, or independently with salt tolerant crops and use of improved agronomic practices for improving water productivity.

Re-model and up-grade irrigation infrastructures to the projected range of expected extreme weather events. Introduce water harvesting and conservation schemes in rural and urban areas. Improve irrigation technology and promote compost organic fertilizers to reduce water requirements in agriculture. Construct small and medium-sized reservoir dams to capture water from flash floods. Promote forestation and reforestation programs to increase water catchments. Establish systems to monitor ground and surface water resources.

5. Conclusions

To determine the lead time and runoff/stage threshold value in flood alarm applications, the semi-distributed HEC-HMS rainfall-runoff model is a crucial tool. Due to this, the study also concentrated on stabilizing the hydrologic parameter sensitivity analysis technique employed in the HEC-HMS model calibration.

The Swat watershed's topography, soil, and categorized land cover data were combined with a GIS tool to calculate the model's input parameters. Clark's and SCS unit hydrographs were applied to calibrate and evaluate the model in order to determine the best direct runoff technique for accurately simulating the hydrologic behavior over the research region.

Based on three statistical assessment criteria, a sensitivity analysis revealed that the HEC-HMS hydrologic model is more sensitive to the CN value over the research region. During the calibration procedure, it was discovered that the Clark unit hydrograph approach is more effective at simulating flows with lower values of the goal function.

Future flood maps may be produced based on the model as can estimates of the peak flood level based on future precipitation projections. On projected flood inundation maps, this analysis was conducted.

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References

1. Shah, A.A.; Ye, J.; Abid, M.; Ullah, R. Determinants of flood risk mitigation strategies at household level: a case of Khyber Pakhtunkhwa (KP) province, Pakistan. *Nat. Hazards* 2017, 88, 415–430, doi:10.1007/s11069-017-2872-9.
2. Atta-ur-Rahman; Khan, A.N. Analysis of 2010-flood causes, nature and magnitude in the Khyber Pakhtunkhwa, Pakistan. *Nat. Hazards* 2013, 66, 887–904, doi:10.1007/s11069-012-0528-3.
3. Sajjad, S.H.; Waheed, S.A.; Khan, T.; Qadri, S.M.T.; Gilani, N. Natural Hazards and Related Contents in Curriculum of Geography in Pakistan. *Asian J. Nat. Appl. Sci.* 2014, 3, 40–48.
4. Revised Pakistan 2022 Floods Response Plan: 01 Sep 2022 - 31 May 2023 (Issued 04 Oct 2022) - Pakistan | ReliefWeb Available online: <https://reliefweb.int/report/pakistan/revised-pakistan-2022-floods-response-plan-01-sep-2022-31-may-2023-issued-04-oct-2022> (accessed on Nov 27, 2022).
5. Alam, N.; Ali, Z.; Haq, M.; Ghouri, B.M. Flood Hazard Zonation and Damage Assessment Using Geospatial Techniques. *Glob. J. Multidiscip. Stud.* 2015, 4.
6. Sarkar, S. Pakistan floods pose serious health challenges. *BMJ* 2022, 378, o2141, doi:10.1136/BMJ.O2141.

Article

How to Improve the Crisis Management System by Harmonizing between Objective and Subjective Risk Perception

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Abstract: In 2022, natural disasters such as forest fires, heat waves, floods, and social disasters such as train accidents and crushing disasters are still continuing in Korea and around the world. The first step to predicting and responding to such a disaster crisis in advance would be awareness of the risk. The accuracy and promptness of risk perception can prevent a crisis situation from occurring or minimize its size. However, the perception of risk differs depending on the stakeholders. Data indicating risk perception in Korea include the regional safety index and the degree of safety sensitivity. Regional safety index represents objective risk perception, and safety sensitivity represents subjective risk perception data. Analysis of these two risk perception data revealed that there was little correlation. The severe difference between objective risk perception and subjective risk perception causes many problems in risk management policy or risk management in reality. It is a very important goal to create a desirable crisis management policy environment by identifying these problems and suggesting measures to resolve the gap between risk perception.

Keywords: risk perception, objective risk perception, subjective risk perception, safety sensitivity, regional safety index

1. Preface

The turbulent momentum of danger is spreading all over the world, and in the end, it makes a risk society. The appearance of accidents and disasters reigns over the people every day, and always neutralizes the power of government authorities and safety managers who resist them. Even the major disasters that occurred in 2022 continue to occur all over the world, the same as in the past in scale and frequency.

In the case of Korea in 2022, wildfires occurred intensively in the east coast. On February 15, in Yeongdeok, about 400ha of forest was lost. On March 4, a forest fire occurred in Uljin-gun, and the fire was extinguished in 9 days (the longest history of 213 hours and 43 minutes). 643 places in Samcheok City were destroyed, 6,500 people evacuated and 340 people displaced, and the affected areas were 18,463ha in Uljin and 2,460ha in Samcheok. On March 4 and 5, forest fires also occurred in Donghae City and in Gangneung City, respectively. A total of 4,000 hectares of forest fire damage occurred, covering 2,100 hectares in Donghae City and 1,900 hectares in Gangneung. On May 28, even after the spring fire warning period(2.1.-5.15) had passed, another forest fire occurred in Uljin, evacuating 460 people and burning 145 ha of forest. Starting on August 8, 2022, most of the rivers and roads were flooded in the areas south of the Han River in Seoul and southern Gyeonggi Province, causing a lot of damage, such as missing citizens and issuing landslide forecasts. The daily precipitation was 381.5 mm, exceeding the previous official maximum of 354.7 mm (August 2, 1920) in Seoul for the first time in 102 years. As a result of this heavy rain, 14 people were killed, 2 people were missing, and a lot of property damage occurred. Hinnamno, the 11th typhoon in 2022, occurred on August 28 and disappeared on September 6. It is the first super typhoon that occurred in the sea north of the 25th

parallel in the history of climate observation, not in the subtropical ocean. The typhoon caused considerable damage. In an apartment in Pohang, nine of the residents who went down to get their cars out before the underground parking lot was flooded due to flooding of Naeng river were either isolated or drowned in the sudden influx of water.

On January 5, 2022, a KTX train carrying 300 people derailed at Yeongdong Tunnel and 7 people were injured. On July 1st, an SRT train carrying 380 passengers on the Daejeon railroad yard suffered a derailment accident, believed to have been twisted as the track expanded in the scorching heat of over 30 degrees Celsius, injuring 11 people. On September 26, a fire occurred on the first basement floor of Daejeon Hyundai Premium Outlet, which killed 7 people.

In 2022, heat waves and heavy rains were rampant around the world, including Korea. This appears to be a sign that extreme weather events are in full swing due to the rise in global temperature due to global warming. From March to May, fatal heat of close to 50 degrees Celsius was recorded in India and Pakistan. These extreme heat waves are a global phenomenon. In Pakistan, due to the heat wave from March to May, heavy rains and floods have occurred since June 14, displacing 30 million people and causing astronomical damage to crops and livestock. In the United States, Hurricane Ian scraped through Florida on September 28-29, and heavy rains continued to blow the river through October 1, increasing damage. It is estimated that more than 100 people were injured and the damage alone could reach 82 trillion won. Meanwhile, on January 15, early this year, an eruption occurred at a submarine volcano near Hungatonga Island in Tonga, killing at least 7 people and damaging facilities.

As mentioned above, climate disasters are in full scale. A long-term heatwave caused by high temperature causes damage from drought, and after a certain period of time, the glacier melts, the river overflows and the atmosphere filled with water vapor creates a chain of continuous damage due to heavy rain and flooding, and also expands the area of occurrence of typhoons. Its size and strength are rapidly increasing, causing enormous loss of life and property. These climate disasters are not limited to just natural disasters, but can lead to a series of damage to facilities. If damage is caused to nuclear power plants and chemical plants, which are the most dangerous to mankind, the risk of ripple effect is unpredictable. As in the case of the large-scale earthquake (magnitude 9.0) that passed through the northeastern part of Japan on March 11, 2011, if a complex disaster occurs in which natural and social disasters are linked, including earthquakes, tsunamis, and nuclear accidents, the damage is enormous.

The major domestic and international disasters for the year 2022 are listed, and these disasters are constantly occurring. In preparation for the occurrence of such disasters, the government authorities are trying to reduce the damage as much as possible by preventing disasters and preparing for and appropriate responses to imminent disasters. The first key to preventing disasters and minimizing losses due to disasters depends on how well an approaching disaster is recognized and prepared for in advance. In order not to face a crisis situation, one must be aware of the risk that is a precursor to the crisis. This is because the failure to recognize risk leads to crisis. In the future, it is necessary to recognize the importance of risk perception in managing disaster and crisis, and to make efforts to reflect risk cognition in the crisis management system.

2. Crisis and Risk Perception

2. 1. Crisis

A crisis refers to a sudden change in a situation that has a negative impact on a certain stable state, or a decisive and significant moment (Jae Eun Lee 2006: 162). The etymology of crisis comes from the Greek word 'krinein', which means 'to separate'. Crisis is a dangerous turning point or period that becomes a crossroads (Yong Gyun Kim, 2018). Another etymology is also derived from the Greek word 'krisis', which means a certain judgment, decision, and choice. It is a stage in which policy makers need to make a decision to respond under severe

hostility and time constraints (Jae Eun Lee 2006; 162). A crisis is a dangerous situation, but it also provides an opportunity for change that is not normally attempted (Young Wook Kim 2008: 219). In a similar sense, a crisis is a situation in which a decision is made whether to proceed, modify, or end an event or action as a point in time when a significant change is required (Jong Yeol Lee et al., 2004). On the other hand, Young Wook Kim (2002: 66) sees crisis as an organizational phenomenon and refers to "all events that disrupt the day-to-day operations of an organization, threaten future activities of the organization, and negatively affect relationships with the major public". Lerbinger (1997) said, "A crisis is an event that is negative for the survival of an organization." 'A crisis is embodied in the subject to which the risk is concerned', which means that the risk is always in people's perception, but the crisis manifests itself in the person concerned (Young Wook Kim 2008: 219). Attributes implied in the concept of crisis include surprise, threat, and short reaction time (Hermann, 1963), non-predictability, unusualness, uncertainty, and threat to purpose (Ulmer et al, 2007). In general, a crisis can be viewed as having a large negative impact on the organization in a sudden, short period of time without being prepared by its nature. Therefore, it is important to recognize a crisis in advance or to determine and respond to a crisis as quickly as possible, and to prepare personnel and systems to detect it.

2.2. Risk Perception

Like the attributes of crisis mentioned above, Levinger (1997) cites suddenness, uncertainty, and time constraint. Here, if the organization does not catch the signs of a crisis in advance, it becomes difficult to respond appropriately due to uncertainty and time constraint and faces a major national crisis. At the time of importation of beef from the United States, the government judged the risk of mad cow disease to be very low based on scientific probabilistic grounds, and ignored public concerns. For this reason, it faced great opposition while viewing the public unrest as insignificant. In the case of the Sewol ferry, the top government official did not show an active response to the situation in which the accident occurred for the first time and was in great danger. It faced a national crisis that even provides a starting point for regime change.

If so, what is the method to prevent the occurrence of risk from becoming the beginning of a crisis? It should be noted that the occurrence of risk is the very sign of a crisis. A crisis sends out signals and signs before it occurs, and when these prior signals are ignored, it develops into a crisis situation (Young Wook Kim, 2008: 243). When a risk, which is a symptom of a crisis, occurs, prompt and accurate recognition of this risk is made, and timely and appropriate preparation and response are made, the state of the organization and the public is positioned in the realm of safety and the crisis situation is resolved. However, even in a dangerous situation, if a proper response is not made in a timely manner by not being properly aware of this risk, or by underestimating or ignoring this risk, it will turn into a crisis situation. Risk perception can change into the realm of safety and crisis depending on the success or failure of risk recognition.

Risk is defined in the dictionary as "the possibility of something bad happening". Risk can be defined as the likelihood that an event or activity will lead to an undesirable negative outcome (Rowe, 1997). Risk is an uncertain situation in which undesirable outcomes can occur, and the risk increases as the complexity of the modern social system increases (Bax, Steijn, & De Witte, 1998: 177). Danger has always existed at any time. However, as we enter the modern era, the number of risk factors increases, the size of the risk increases, and it is felt that the risk also increases in perception. The reason for the increasing awareness of risk is the increase in knowledge and the increase in unwanted risk (Leiss & Chociolko, 1994). With the increase of knowledge, he learned that a disease that was previously recognized as a simple fever was an infectious disease caused by bacterial infection and its spread, and that what was considered a disease of unknown cause in the past was group poisoning due to water pollution caused by

heavy metals. The risks are increasing due to complex environmental threats such as the emergence of super-large industries and high-tech industries, the complexity of transportation systems and transportation methods, drought due to global warming, local flooding, desertification, and increase in sea level. In modern times, the awareness of risk will continue to increase as the knowledge of the cause of risk increases and people actively respond to risks caused by external factors (Young Wook Kim, 2008). Ulrich Beck said that in Risk Society (1986), the development of technology and science in a new modern society also produces risks, so modern society is defined as a risk society. Risk is a precursor to a crisis. When something unsafe is seen in an uncertain situation, it is recognized as a risk and an appropriate response is required. When awareness of risks is not properly recognized and necessary measures are not taken properly, risks can be transformed into various crises, such as accidents, disasters, and catastrophes, which can lead to fatal losses in our lives. Knowing when a risk has occurred or is about to occur and reacting in our cognitive system can be said to be risk perception.

2.3. *Discussing Risk Perception*

There are several theories about risk perception, which are broadly divided into objective risk perception and subjective social risk perception theories. Objective risk perception is the view that risk can be calculated from the probability of occurrence and severity of consequences as a scientific and statistical point of view. Risk is objectively real to everyone, and the risk can be known based on expert knowledge. The general public's perception of risk is assumed to be a fact-acceptor of the simple level of risk that can be known by receiving the expert's calculated risk size. However, in reality, when a risk problem occurs, the level of risk perceived by experts about objective risk is not accepted as it is, but a completely different risk perception behavior is shown. In particular, in the case of a nuclear accident, experts claim that it is relatively safe, but the general public has a great fear and threatens when an accident occurs, and they flee from the area or, in the end, exercise extreme opposition to the abolition of the nuclear power plant and a new construction plan. The explanation of this phenomenon in terms of risk is the concept of subjective risk perception. Contrary to what the concept of objective risk perception claims, risk is not real, but rather depends on the subjective judgment of each individual. It can be said that the theory of subjective risk is to seek out what the main factors influencing such subjective judgment are. There are heuristic approaches, psychometric paradigms, and cultural approaches regarding what the decision mechanism for risk perception.

First of all, a heuristic risk perception is that humans prefer an intuitive way without using a lot of brain rather than accurately grasping a problem while mobilizing a serious, systematic and statistical method in thinking. This leads to a bias in thinking that does not accurately recognize reality (Kahnemann & Tversky, 1979). The intuitive cognitive method is (1) availability, which uses what comes to mind more easily as a criterion for judging the degree of risk. (2) Representativeness, judging on the basis of similar cases that well represent the essence of the matter. (3) Taking early impressive information (anchoring) as a basis for risk recognition, adjusting it and judging it is to use it as a 'shortcut' to make risk recognition easier. In addition, (4) people tend to miss objective judgments by overconfidence in their own judgments. The risk perception method based on each of these individuals leads to an error in judging the risk accurately. This is the cause of a large gap with a scientific and technological risk perception.

Next, as a psychometric paradigm, the focus is not on the tendency of the person who is the subject of information processing, but on the specific properties of the hazard that is the object of cognition (Slovic, 1987). In particular, in a situation where the safety of nuclear-related new technologies, such as nuclear power plants, which appeared after the 1960s was questionable, the conditions for accepting them began to be studied. In this study, the method of the public's awareness of the risk factors was investigated and the relationship between the per-

ception of the properties, etc. and the individual's perception of risk was investigated. For example, as a result of measuring respondents' perceptions of whether the characteristics of various hazard factors are chronic, spontaneous, immediately effective, or new, and analyzing the relationship between them and their risk perception, dreadfulness and newness was found to account for differences in inter-individual risk for the same hazard.

Another is to deal with risk perception based on cultural relativism from an anthropological perspective. As risk is defined by the culture and values of each society rather than objective measurement or subjective psychological judgment, it is the view that risk perception is also affected by cultural values and belief systems, social power and order, etc. possessed by each society (Douglas & Wildavsky, 1982). The main researcher, Douglas (1985), in the grid-group theory, is the social division within the group that regulates individual behavior and the group, which indicates the strength of setting boundaries with the outside of the social group. Four types of social groups are distinguished, each selecting a different cognitive style and a different mode of coping in exchanges with potential risks according to the combination situation. (1) In a hierarchical culture, it is characterized by high value in both the group and grid dimensions, i.e., the difference externally and the high intensity of integration internally. It recognizes risk as fundamentally controllable and prefers regulatory-oriented crisis management. (2) Individualistic market culture (individualism) is of low value in both the group and grid dimensions, and classifies risk according to the scope of the individual's ability to freely exercise, and accepts the calculable risk. (3) Equalitarian culture (sectarian culture, equalitarianism) has the characteristics of low grid value and high collective value, and usually fosters a high aversion to risk and reacts very sensitively to the possibility of threats. (4) Fatalism has the characteristics of high grid value and low collective value, and it reacts passively with resignation to risk as forced from outside or other transcendental beings.

In addition to what has been described so far, there are many other discussions about risk perception, but I have mainly described it as objective risk based on scientific and technological grounds and subjective risk based on cognitive psychology and socio-cultural situation. By estimating the probability and severity of risk, it was found that there can be a gap between objective and subjective risk due to distortion of risk perception due to individual cognitive bias, difference in perception according to characteristics of risk, or difference in perception according to cultural background.

3. Local safety index and safety sensitivity

As a policy in Korea, various safety investigations are conducted for each government department or local government in order to use basic data for policy establishment to strengthen safety levels in various fields such as industrial safety, crime safety, food safety, gas safety, and fire safety. Efforts are made to reduce the level of risk in the relevant field. In an effort to identify and measure risks to ensure such safety, the regional safety index and the sense of safety are the surveys that can grasp the basic contents of a risk perception related to a physical risk related to a disaster in particular.

3.1. Local safety index

The regional safety index is defined in Article 66-10 (publication of safety index) of the Framework Act on Disaster and Safety Management, "Minister of the Interior and Safety has developed and can investigate and publish the results." Based on the regulations, the safety level for each region was announced. According to the National Disaster and Safety Research Institute, the regional safety index uses various statistics on safety to indicate the safety capability of each local government on a rank scale of 1 to 5, and a grade of 1 means that it is relatively safe within the unit of the same administrative district (National Disaster Safety Research Institute, 2022). The local safety index for the year is calculated from the previous year's

statistics, and has been announced every year since 2015 with the goal of reducing the number of fatal accidents by strengthening the responsibility of local governments for safety management. Minister of the Interior and Safety measures and publishes the regional safety indices of 17 cities, provinces, 226 cities, counties and districts based on safety statistics in accordance with Article 66-10 of the Framework Act on Disaster and Safety (Society for National Crisis Management, 2021: 236). The regional safety index consists of hazard indicators (results) such as death and accident statistics, vulnerability indicators (causes) that aggravate harm, and mitigation indicators (prevention) that reduce harm, and the specific formula is as follows.

Safety Index = 100 - (hazard indicators + vulnerability indicators - mitigation indicators)

The safety index calculates and announces the safety index for each of six fields, including traffic accidents, fires, crimes, suicides, infectious diseases, and life safety. After deriving the result values for each field calculated by the above formula for each region, consider the characteristics of cities and rural areas, and group them by city/province, city/gun/gu to rank 1-5 (The higher the grade, the safer, the distribution ratio by grade is 10%:25%:30%:25%:10%).

This safety index can be interpreted as depending on objective risk perception in terms of risk perception. However, the formula for calculating objective risk is ‘risk = probability of occurrence × fatality’, which can be seen as indirectly indicating the degree of risk by measuring the degree of safety. For example, in the case of a traffic accident, the number of traffic accident fatalities (.500) is entered into the hazard index used in the formula for the safety index, and ① the number of vulnerable victims per 10,000 population (.105), and ② the number of medical covered workplaces per 10,000 population (.011), ③ the number of vehicle registrations per 10,000 population (.084), etc. were included to calculate the degree of risk. In the mitigation index, ① the number of traffic enforcement CCTVs per road area (.095), ② the budget for the traffic safety environment improvement project per road area (.084), ③ the rate of wearing a seat belt while driving (.121). were used in the overall index calculation, including the formula to increase the safety level. Since safety and risk are the same as both sides of the coin, it is not too much to use this as a basis for objective risk perception that is currently measured in Korea.

The ranking of regional safety index for 2021 calculated and announced in this way is shown below.

1. Sejong, 2. Gwangju, 3. Seoul, 4. Ulsan, 5. Gyeonggi, 6. Daejeon, 7. Busan, 8. Incheon, 9. Daegu, 10. Gyeongnam, 11. Jeonbuk, 12. Chungbuk, 13. Gyeongbuk, 14. Chungnam, 15. Gangwon, 16. Jeonnam, 17. Jeju

The ranking shown above is calculated by applying the basic data according to the formula at the National Institute of Disaster and Safety Research. The absolute value of each field cannot be grasped in the program and is presented only as ranking data. The safety level is expressed by summing and averaging six fields and using the value as a simple ranking data. Although there is a critical limit to the assumption that the total value represents the overall safety level, it is meaningful that intuitive views for comparison are reflected. As shown in the table above, Sejong and Gwangju rank 1st and 2nd, and can be evaluated as the safest among all 17 local governments in special metropolitan areas. On the other hand, Jeonnam and Jeju rank the lowest. Looking at the general trend, it seems that special cities and metropolitan cities are safer, and only Gyeonggi-do is safe in the provinces. In the case of the province, it is shown that the risk is relatively higher than that of the city. In general, it can be interpreted that the higher the rate of urbanization, the higher the level of safety.

3.2. Safety Sensitivity

The public's perception of safety is a survey conducted to regularly assess the public's perception of disasters and accidents. Unlike the safety index, this sense of safety is a calculation of the regional safety level through regional summation based on the data that individual citizens feel for their own safety, and can be interpreted as basic data for subjective risk perception. Ministry of the Interior and Safety prepared in January 2021 the results of the safety sensitivity survey conducted for one year in 2020. The contents of the survey design are as follows. For the survey target, a total of 24,000 samples were selected from the general population residing across the country in March, April, June, August, October, and December, for a total of 4,000 people over the age of 16 each time. The analysis here mainly analyzes the sense of safety in the area, but the actual survey also investigates and publishes the sense of safety by field. It includes 13 types of accidents, including accidents, sexual violence, environmental pollution, infectious diseases, and cyber threats. For sampling, the square root proportional quota sampling method was used by region, gender, and age. The survey method was conducted by computer assisted telephone interviewing (CATI) based on wired/wireless random digit dialing (RDD).

The main contents of the public safety sensitivity are 1) individual safety sensitivity, 2) safety sensitivity of residential areas, 3) safety sensitivity of our society, 4) disasters or accidents that our society thinks are unsafe, and 5) Safety sensitivity of disaster and accidents in each field. The ranking of safety perception in residential areas of the survey based on the survey design as described above are shown below.

1. Sejong, 2. Jeonbuk, 3. Jeonnam, 4. Gwangju, 5. Jeju. 6. Daejeon, 7. Gangwon, 8. Gyeongnam, 9. Chungbuk, 10. Gyeonggi, 11. Seoul, 12. Chungnam, 13. Busan, 14. Incheon, 15. Ulsan, 16. Daegu, 17. Gyeongbuk

In the case of safety sensitivity, the result is completely different from the local safety index, where a difference in safety level occurs depending on the degree of urbanization. It shows the same conclusion as the result of risk perception theory that there is a difference between so-called objective risk and subjective risk. However, only in the case of Sejong, the safety evaluation of the local safety index and the safety sensitivity showed the characteristic that it ranked first. The rankings are consistent between objective risk and subjective risk.

3.3. Correlation analysis between regional safety index and regional safety sensitivity

It compares the regional safety index and the sense of safety below.

<The ranking of regional safety index>

1. Sejong, 2. Gwangju, 3. Seoul, 4. Ulsan, 5. Gyeonggi, 6. Daejeon, 7. Busan, 8. Incheon, 9. Daegu, 10. Gyeongnam, 11. Jeonbuk, 12. Chungbuk, 13. Gyeongbuk, 14. Chungnam, 15. Gangwon, 16. Jeonnam, 17. Jeju

< The ranking of safety sensitivity in residential areas >

1. Sejong, 2. Jeonbuk, 3. Jeonnam, 4. Gwangju, 5. Jeju. 6. Daejeon, 7. Gangwon, 8. Gyeongnam, 9. Chungbuk, 10. Gyeonggi, 11. Seoul, 12. Chungnam, 13. Busan, 14. Incheon, 15. Ulsan, 16. Daegu, 17. Gyeongbuk

Sejong ranked first in both while Seoul ranked third in the safety index and 11th in the sense of safety, showing a difference of eight rankings. As for the place where the difference in ranking between the safety index and the sense of safety is small, Daejeon has the same ranking, and Gwangju, Gyeongnam, and Chungnam have the same or similar ranking in the two survey

fields with two ranking differences, and the rest of the local governments have significant differences in rankings.

To find out how much correlation exists between the local safety index and perceived safety, which is an index that substitutes for objective risk and subjective risk, a hypothesis is established and whether the hypothesis is adopted is as follows. The hypothesis for the correlation between the two sets and verifies, "There is no difference between the regional safety index and the safety feeling." If the hypothesis is correct, there is no difference between the local safety index and the perceived safety, so there is a similarity between objective risk and subjective risk. If there is no correlation, there is a difference between an objective risk perception and a subjective risk perception, and the scientific, technical and statistical method of risk recognition differs from the risk perceived by individual citizens. The safety policy is not expected to bring the effect that people feel on the skin. There will be a gap between policy and policy evaluation. The hypothesis testing procedure is as follows. The null hypothesis states that 'there is no difference between the safety index and the perceived safety ranking (there is a correlation)', and the confrontational hypothesis sets that 'there is a difference between the safety index and the safety feeling ranking (no correlation).'

Null hypothesis $q = 0$ vs. Alternative hypothesis $q \neq 0$

For the correlation analysis of this data, rather than simply analyzing the correlation between the data values of two variables, it is more meaningful to understand the correlation by determining whether the rankings are consistent by region, so the Spearman correlation coefficient indicating the ranking correlation was calculated.

The rank correlation coefficient between the two variables was 0.245. The significance probability was 0.343 on both sides, which was greater than the 90% confidence interval of 0.05. This can be interpreted as having little correlation between the two variables, so that the null hypothesis can be rejected and the alternative hypothesis can be adopted. However, as a limitation of the analysis, professional institutions directly calculate the regional risk level, and individuals do not use the index indicating the risk level in the area, but convert the safety index and sense of safety into numerical values indicating whether the risk is perceived. In addition, simply summing up the grades by field of the regional safety index and calculating the ranking as the regional safety index has a limit in fully expressing the degree of risk perception.–

4. Measures to overcome the difference in risk perception when operating the risk management system

4.1. The problem of risk perception inconsistency

Through the analysis of the correlation between safety index and safety sensitivity, it was found that there was little correlation between so-called objective risk perception and subjective risk perception in most regions. Looking at the coincidence of the rankings of the two variables in Sejong and Daejeon alone, it may be interpreted that the two regions are the most accurately aware of the risk of the region, but it may be a coincidence as they are not correlated in the other 15 regions. Serious discrepancies between the two data have several problems.

First, it is difficult for the government's policies for crisis management, such as disaster management and safety policies, to be properly implemented as expected by the general public. By sector, there are six regional safety indexes and 13 safety sensitivity surveys, and the common survey indexes are four areas: fire, crime, traffic accidents, and infectious diseases. The central or local governments develop and use policy measures to reduce risk indicators or vulnerable indicators included in the formula and increase mitigation indicators according to the results of the regional safety index. However, for example, if the government determines that

the fire-related index is insufficient, but the residents are not sensitive and are perceived as safe enough, the policy effect will not affect the residents' risk perception. Rather, in other areas that the government has judged to be safe, residents feel that they are at risk, and the sense of safety continues to remain low.

Second, if the difference in risk perception is not overcome, mistrust will build up between the government and the public, or between experts and the general public. Objective risk recognition is based on the probabilistic size calculated based on the basic scientific and technological data of experts or governments. In the case of the general public, who are complex and do not fully understand the contents, and judge based on intuitive understanding, the government and experts claiming that they are safe based on calculations based on scientific facts do not fit in reality, resulting in distrust and non-cooperation. The view that risk is objectively calculable is often untested. In fact, in the case of a radiation or chemical leak accident, the risk probability is not verified and in many cases it is the opinion of factory or equipment manufacturers and experts. If you unilaterally ask the general public to follow the opinions of these government officials and experts, the gap of distrust will deepen.

Third, mismatch in risk perception acts as a political unrest factor. In the case of Korea's mad cow disease, the government dismissed concerns about the occurrence of mad cow disease by stating that the incidence of mad cow disease is negligible. According to the social diffusion theory of risk (Kasperson et al., 1988), when a risky event occurs, description and interpretation are made in the process of delivering it, and then it is transmitted to various subjects such as individuals and groups through the media. It triggers collective action and then spreads again like a ripple effect. In the case of the Sewol ferry, the seriousness of the danger was not properly grasped at the beginning, and the government-wide response was not prompt, resulting in many people expressing their dissatisfaction with the government and eventually causing political danger.

Fourth, as a problem that is constantly raised, it is an insensitive phenomenon to the risk expressed as safety insensitivity. In the case of risk perception for various accidents or accidents at industrial sites, it is suggested how likely the objective statistics can be generated through the actual number. In this regard, policy authorities constantly suggest hazardous factors to safety and emphasize safety activities through publicity activities. However, in the case of companies, the desire to enjoy the maximum profit at the minimum cost as much as possible, and in the case of ordinary citizens, there are many neglects in complying with the set regulations due to overconfidence in their own safety behavior.

4.2. Resolving the risk perception gap

4.2.1. Accurate risk information collection and delivery system establishment

Prompt delivery of accurate information in the event of a disaster is the key to crisis management. In the case of the Sewol ferry, it was not possible to obtain accurate information about the dangerous situation until a considerable amount of time had passed since the accident. The accident occurred at 8:48 a.m. and the initial rescue report was filed at the Mokpo Coast Guard Situation Room at 8:54 a.m., almost an hour after 123 ships arrived at the accident site and reported the initial site situation at 9:43.. Then, at 10:31, the Sewol was completely capsized. Rescue work could not be done properly and it became a catastrophe that occurred in an instant. The problem was that accurate reporting of such a situation did not work smoothly in the delivery line connecting the Coast Guard Situation Room, the Central Disaster and Safety Countermeasures Headquarters, and the Blue House. Meanwhile, the situation based on incorrect information was reported through the media, and eventually, the Central Disaster and Safety Countermeasures Headquarters presented the wrong number of rescuers at a press briefing at 2 p.m. When the information obtained by the government was later turned

out to be erroneous, public outrage grew out of control. It was an event that showed how important it is to establish a system for prompt delivery of accurate information. To this end, it is necessary to establish a management system for the collection and delivery of risk information, and to prepare a system that enables accurate information on decision to be delivered quickly by using informatization devices from field workers such as fires and maritime accidents. Since then, a disaster safety communication network has been established and operated in Korea, and based on this, more effective information exchange and communication can take place. In addition to this, construction of a database of crisis-related information, preparation of drawings for facilities, construction of an early warning system, construction of a smart information system in the general situation room, and construction of an information sharing system among related organizations (Lee Jae-eun, 2012; 396-399).

4.2.2. *Improvement of the survey method for local safety index and safety sensitivity*

For the safety index, the National Disaster and Safety Research Institute develops a basic measurement model, collects the opinions of disaster-related experts and public officials, establishes a formula, examines the basic data for each region, and then substitutes it into the formula to calculate the safety index. This index is calculated by inserting the figures surveyed based on objective data into the formula, and there is a limit in reflecting the opinions of the local residents, so it seems that there is a considerable distance from the safety sensitivity. To supplement this, a plan to include the safety awareness of the local residents has been prepared (National Disaster and Safety Research Institute, 2021), and it is being applied as a trial to the calculation of the regional safety index in 2022. The formula including the awareness index is: Local safety index = $100 - (\text{risk index} \times 50\%) - (\text{vulnerability index} \times 10\%) + (\text{reduction index} \times 20\%) \pm (\text{conscious index} \times 20\%)$. This awareness index is an indicator of residents' efforts to prevent and respond to harm, and includes seat belt wearing, drunk driving (behavior), number of people participating in education (cognition), and autonomous crime prevention crew (participation).

In the sense of safety, there is a need for a device to supplement the appropriateness of the survey method and response. In evaluating the safety of the region, when a major accident occurs throughout the country, the division between region and the whole is not accurate, and it should be judged based on the events that occurred during the period. Since distorted evaluation values may appear, it is necessary to continuously supplement the survey technique so that the respondent does not have a cognitive bias through a clear understanding of the questionnaire.

4.2.3. *Risk Communication*

There is a difference between the general public and various stakeholders such as disaster managers, experts, and the media in risk perception. In recent years, there have been extreme differences in risk content, crisis situation, disaster response plan, and damage recovery and support depending on political orientation in the perception of risk. The formation of trust between subjects surrounding risk can correct misunderstandings and facilitate understanding of content through information transmission (Song Hae-ryong and Kim Won-jae, 2014: 261). Scientists and experts need to understand that ordinary citizens perceive risks ‘differently’ rather than misunderstanding them through biased errors or misinformation. In this way, it can be said that risk communication enables harmonious perception of risk. Risk communication is referred to as “a mutually beneficial communication process that operates between organizations, individuals, and groups based in the community with a diverse understanding of the nature, causes, and solutions of risks” (Palenchar, 2005). Since risk is a matter of how one perceives it, it is an issue that can only be solved through communication for consensus (Young Wook Kim, 2008).

4.2.4. Risk Governance

It is problematic to limit disaster management in the complex and uncertain situation of the modern risk society within the government-centered management system based on the traditional bureaucracy (Jung Ji-bum, 2015 a:3). In a situation where differences in knowledge and experience of risk and errors due to cognitive bias are intricately intertwined, risk management must be carried out within the governance system comprising the central government, local governments, the private sector, and various expert networks. In the case of the United States, after experiencing severe disasters such as the 9/11 terrorist attacks and Hurricane Katrina, the roles of private companies and NGOs are specified in the National Response Framework, one of the national disaster management systems of the United States (Oh Yoon-Kyung, Jung Ji-bum). Bum, 2016). The UK Civil Contingencies Act 2004 requires local governments, businesses and disaster management agencies to do their own risk assessment, risk inventory, and emergency preparedness plans to maintain business continuity. Establishing risk governance means that the government and the private sector together participate in the decision-making and execution process within the crisis management system, thereby reducing the gap in risk perception through mutual information and opinion exchange. I believe that the establishment of risk governance can be achieved through the core system. A core system is a system that constitutes the central function of a system built with organic interconnection and interdependence. As the input elements of the crisis management system improve and develop, it is necessary to establish a core system so that they can properly implement their outcomes (Lee Jae-eun, 2015:4, Yeong Seok Jo· Jea Eun Lee, 2021). Harmony between objective risk perception and subjective risk perception will be realized when risk perception is systematically operated under a risk management governance system properly equipped with values, institutions, leadership, dedication/followership, and expertise (competence) that make up the core system.

5. Conclusion

The starting point of risk management is risk awareness. It is to prevent a risk from turning into a crisis by predicting the occurrence of a risk, sensitively sensing the risk, and quickly preparing and implementing countermeasures to eliminate the risk. It would be said that risk-aware competency is just as important. Regarding risk perception, we found that if there is a difference between objective risk recognition based on science and statistics and subjective recognition based on individual cognitive characteristics, risk target attributes, and cultural background, various problems occur. In order to quickly and accurately recognize risks for effective crisis management, the difference in risk perception among risk management related stakeholders is minimized, or sometimes, consensus on the content and method of risk perception of the other party is achieved, and crisis management authorities must fully understand the general public. There may be cases where it is necessary to understand or persuade the risk perception content so that it is understandable and further seeks active cooperation. For more accurate risk recognition, it is necessary to have a certain level of cognitive capacity. Cognitive competence refers to the mental ability that enables cognitive activities such as perception, thinking ability, knowledge, and judgment about dangerous objects or situations. These are competences in language, econometrics, logic, and spatial perception (Ha, 2015:171). It is difficult to see that the general public is properly equipped with this level of cognitive competency. The risk management policy based on the risk perception of the policy authorities based on the judgment of experts and experts inevitably differs greatly from the understanding of the general public.

Through the results of the regional safety index and safety perception survey, statistically no correlation was found between the two risk perception methods.. This fact was verified through statistical analysis that there is a difference between the objective survey results of experts (government) and the subjective risk of the general public. It is impossible to determine

which is more accurate, objective risk or subjective risk. In fact, when a specific event occurs in a specific area, when there is a difference between the objective risk perception method and the subjective perception level, the objective method is predicted by a general statistical method, and if the probability is low, it is not so much about the accident. They're not going to do a thorough preparation. However, subjective risk perception would be more accurate if there was a request to prepare for a risk by subjectively feeling a sign of an accident in the vicinity. There is a difference between subjective risk perception, which is influenced by various factors such as closeness to the site of danger, experience, media reports, and intuition, and objective risk perception based on so-called scientific level data collection and analysis, and professional knowledge.

The larger the gap, the more problems arise. Various problems such as a decrease in satisfaction with policy effects, distrust, political risks, and insensitivity to safety arise. In order to overcome this and achieve harmony between the two, measures such as the establishment of an information system that can quickly and accurately grasp risk information, improvement of the local safety index and safety sensitivity survey method, risk communication, and risk governance were proposed.

Risks include the risk of experiencing damage without being aware of the risk over time, the risk of being able to resolve or evacuate after recognizing the risk, and the risk that is predicted to occur in the distant future. Depending on how sensitive you are to predicting each risk, you can prepare for it and prevent it from spreading into a crisis. Looking back on the Itaewon stampede that occurred in the middle of the night on October 29, 2022, safety measures against risks were not sufficiently discussed at the preliminary meeting of related organizations in preparation for crowds. The local government responsible for the safety of the area lacked safety measures for the situation of large crowds, and the police failed to respond sensitively to calls to report the danger of stampede to the situation room 11 times before the accident. And similar to the past, the government and the people will consider who is more responsible for the accident.

Risk perception is the cognitive ability to prevent a crisis from occurring by knowing in advance a situation in which a risk is expected to occur. Policy authorities are responsible for resolving what the general public feels dangerous in managing dangerous situations. In addition, safety governance will work properly if policy authorities activate risk communication through activities that communicate with the public about perceived risks and request them to follow safer measures.

※ I would like to inform you that this thesis is an excerpt, summary, and summary of a part of Yoonhan Jung's doctoral dissertation in the process of writing.

Reference

1. Young Wook Kim. (2008). Risk, contracts and communications: breaches and responses to risks, crisis and conflict disputes in the modern world. Ewha Womans University Press.
2. Yong Kyun Kim. (2018). Disaster Rights and Disaster Management in Korea. blue road.
3. Jae Eun Lee. (2006). Disaster management theory. Daeyoung Munwhasa .
4. Jae Eun Lee. (2018). Crisisonomy. Daemyoung Munwhasa.
5. Jong Yeol Lee, Gwang Guk Park Gyeong Ho, Cho, and Ok Il Kim. (2004). “A Study on Establishing an Integrated System for National Crisis Management”, 『Korean Society and Public Administration Research』15(2).
6. Amos Tversky, Daniel Kahneman. (1973). Availability: A heuristic for judging frequency and probability. Cognitive Psychology, 5(2): 207-232
7. Bax, Eric H. Bram J. Steijn, & Marco C. De Witte. (1998). Risk Management at the Shopfloor: The Perception of Formal Rules in High-Risk Work Situations. Journal of Contingencies and Crisis Management, 6(4): 177-188.

8. Beck, U. (1986). *Resikogesellschaft: Auf dem Weg in eine andere Moderne*, Frankfurt am Main, Suhrkamp Verlag.
9. Douglas, M., & Wildavsky, A. (1982). *Risk and Culture: An essay on the selection of technological and environmental dangers*. Berkeley: University of California Press.
10. Douglas, M. (1982). *The active voice*. London, UK: Routledge and Kegan Paul.
11. Hermann, C. F. (1963). Some consequences of crisis which limit the viability of organizations. *Administrative Science Quarterly*, 8, 61-82.
12. William Leiss, Christina Chociolko. (1994). *Risk and Responsibility*. McGill-Queen's University Press.
13. Lerbinger, O. (1997). *The crisis manager: Facing risk and responsibility*. Mahwan, NJ: Lawrence Erlbaum Associates.
14. Ulmer, R. R., Sellnow, T. L., & Seeger, M. W. (2007). *Effective crisis communication; Moving from crisis to opportunity*. Thousand Oaks, CA; Sage.
15. Rowe, W. D. (1997). *An Anatomy of Risk*. New York: John Wiley and Sons.



Article

A Study on the Advancement of the Disaster Management Resource Logistics System in the Age of the Fourth Industrial Revolution

- Focusing on the Case of Private Logistics Companies -

HyunmHun Kim

Abstract: Logistics in disaster management is a lifeline for disaster relief activities. This is because disaster management logistics means delivering the minimum daily necessities necessary for survival to victims in the response and recovery stage. In particular, the pattern of disaster is changing, and there have been many changes in terms of the end of daily necessities and demand due to changes in lifestyle. In this context, the policy of today's disaster management resources is naturally focused on upgrading the logistics system, such as deviating from the provision of uniform net items. Therefore, this study aims to find ways to upgrade the disaster management resource logistics system based on understanding the disaster management resource management policy.

The technology and environment of the Fourth Industrial Revolution are driving the digital transformation and opening the door to the digital era. The private logistics industry seeks a rapid transition to a smart logistics system suitable for the digital environment because the increase in logistics costs due to urbanization and concentration leads to weakening competitiveness of companies as well as national industries. It can be confirmed that the problem of restrictions on the speed of delivery and accessibility of delivery vehicles experienced by private logistics companies is no different from the problem of rapid and accurate delivery of disaster management supplies needed by victims and survivors in the event of a disaster. In the event of a disaster in which the market stopped working, governance centered on the government would replace the function that the market was in charge of in peacetime.

Therefore, the disaster management resource logistics system in the new digital environment proposed a model that allows government local governments and private logistics companies to work together to mobilize and deliver customized disaster management resources.

Keywords: Disaster Management Resource Logistics, Smart Logistics System, Digital Transformation, Advancement of Logistics Industry

Article

Healthcare Crisis: Explainable Artificial Intelligence based Framework for Non-Communicable Diseases Prediction

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Abstract: In this talk, we will explain an eXplainable Artificial Intelligence as well as non-communicable diseases, first, and then discuss why this non-communicable disease is healthcare crisis. Also we not only propose the framework for explainable artificial intelligence for non-communicable disease, but also show the experimental results for the proposed framework. The rapid rise of non-communicable diseases (NCDs) becomes one of the serious health issues and the leading cause of death worldwide. In recent years, artificial intelligence-based systems have been developed to assist clinicians in decision-making to reduce morbidity and mortality. However, a common drawback of these modern studies is related to explanations of their output. In other words, understanding the inner logic behind the predictions is hidden to the end-user. Thus, clinicians struggle to interpret these models because of their black-box nature, and hence they are not acceptable in the medical practice. To address this problem, we have proposed a Deep SHapley Additive Explanations (DeepSHAP) based deep neural network framework equipped with a feature selection technique for NCDs prediction and explanation among the population in the United States. Our proposed framework comprises three components: First, representative features are done based on the elastic net-based embedded feature selection technique; second a deep neural network classifier is tuned with the hyper-parameters and used to train the model with the selected feature subset; third, two kinds of model explanation are provided by the DeepSHAP approach. Herein, (I) explaining the risk factors that affected the model's prediction from the population-based perspective; (II) aiming to explain a single instance from the human-centered perspective. The experimental results indicated that the proposed model outperforms various state-of-the-art models. In addition, the proposed model can improve the medical understanding of NCDs diagnosis by providing general insights into the changes in disease risk at the global and local levels. Consequently, DeepSHAP based explainable deep learning framework contributes not only to the medical decision support systems but also can provide to real-world needs in other domains.

INDEX TERMS Healthcare Crisis, Epigenetics, Non-Communicable Diseases, Explainable Artificial Intelligence, Deep Neural Network, Prediction

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Article

Study on Community Earthquake Preparedness in Urban Areas of Mongolia

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Abstract: Mongolia is in a highly active seismic zone in Central Asia. Historically, earthquakes with a magnitude of $M > 8$ have occurred four times and $M > 7$ more than 20 times in the 20th century. The frequency of earthquakes with $M > 3.5$ is constantly increasing. In 2021, the number of earthquakes in Mongolian territory reached 254, which was six times more than the average number of the last decade. Simultaneously, Mongolia is experiencing rapid urbanization. 6.1 percent of the total Mongolian population resided in the cities in 1933 while commencing the transfer of nomadic husbandry lifestyles to settlement. The percentage of the urban population dramatically gained to 69.4 in 2021. Urbanization increases the disaster exposure of the communities in cities at high risk of earthquakes.

Community earthquake preparedness, mainly urban community preparedness, is vital to prevent consequences caused by possible earthquake occurrences. Thus, we aimed to assess community earthquake preparedness in urban areas through an online survey based on voluntary participation. The study covers the contents of disaster risk reduction knowledge, awareness, and practical skills; disaster preparedness behavior and attitude; and readiness for earthquake early warning signals for community disaster preparedness. The results state that the responses “Very Good” and ‘Good’ occupy only 23.5 percent of all responders. Community disaster preparedness in cities is not adequate in Mongolia.

Keywords: earthquake; urban; community; preparedness

Approaches of Urban Vulnerable Targeting in Municipalities of Nepal: Practices and Pitfalls

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Abstract

A high level of poverty and inequality, lack of tenure security, informal settlements, inadequate access to infrastructure, the existing unplanned and haphazard urban development in Nepal increase threats to urban population to potential environmental, geological-hydrometeorological hazards, urban floods, inundation, air pollution and fires. Here, we developed a vulnerability targeting guidelines to reach urban vulnerable populations to reduce vulnerability and build resilience using a mixed-method approach of data collection and analysis. It comprises need assessment, selection of appropriate targeting methods, defining eligibility criteria, beneficiary selection and monitoring and evaluation of the targeting process and outcomes. To prevent the biased decisions, a system to report concerns, complaints and grievances, as well as an independent monitoring and evaluation should be developed at municipal and sub municipal levels together with awareness and capacity building regularly at different levels (schools, community, clubs, mother groups, and cooperatives). Additionally, Nature-based adaptation approach needs to be applied for the green, resilient and inclusive development (GRID) of for long-term sustainability.

Keywords: *Disaster, Vulnerability targeting, GRID*



Article

Risk Sensitive Land Use Planning for Lamkichuha Municipality, Far Western Province, Nepal

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Abstract: This study focuses formulation of risk sensitive land use planning for Lamkichuha Municipality, Kailali district, Far Western Nepal. The municipal's major hazards include flood, fire, thunderstorm, river erosion and windstorm including earthquake. The multi-hazard risk assessments were carried out and modeled them in geo-spatial system. Contextual analysis of settlement pattern and spatial growth trend, socio-economic condition and regional connectivity including population projection were carried out. For the balanced development, conservation of natural resources and agriculture land a concept of 'development node' was applied by identifying the low-risk land. Thirteen different land use were planned within three types of development nodes for 2030 and 2050: one 'primary node' (central business district), two 'secondary nodes' (institution and education) and thirteen 'tertiary nodes' (residential, culture and tourist, sport, etc.). Two more zoning namely natural conservation protection zone and agriculture promotion zone were also proposed by calculating each node.

Keywords: Risk sensitive land use planning, RSLUP, Multi-hazard risk assessment, Lamkichuha Municipality, Development Nodes



Article

Why the Stampedes Repeated Again and Again? — — Accident Causes and Emergency Governance Ability Evaluation by QCA Case Study

Yinghua, CHEN (Jiangsu University, China)

Abstract: Stampedes are very easy to occur in the religious gathering events, holiday celebration events, and some sports venues, which would bring casualties and property losses. In order to systematically analyze the causes of stampedes and the government's emergency management ability when stampedes occur, this paper selects some major stampedes that have occurred around the world in the past one century as medium-scale samples, uses QCA qualitative comparative analysis method to find the configuration explanation that can explain the why stampedes occur, and evaluates the government's emergency management ability when the stampede occurs. It will provide reference for the future prevention of stampedes in public places.

Keywords: Stampede Accidents; cause Analysis; Emergency Governance Ability Evaluation; QCA Case Study

Does Regional Competence as Resilience Matter for Response to COVID-19?

Ki Woong Cho¹

Minsun Song²

Abstract

Although the growing literature on countermeasures against the COVID-19 has been conducted in many countries worldwide, empirical research on regional competence that would effectively combat COVID-19 and longitudinal panel research has been still limited. This research tried to explore the regional competence associated with community resilience in the pandemic that is unanswered. It fills the gap between the regional competence and the effectiveness of the COVID-19. The feasible generalized least square (FGLS) panel analysis was conducted on data collected in 53 countries over 14 months around the vaccination rollout. It outlined which regional competencies of the vaccination, community mobility, universal healthcare, and lockdown severity influence on the effectiveness of fighting against the COVID-19. The preliminary findings indicated that securing vaccination was critical to fight against COVID-19; universal healthcare system relieved the residents to get tested for COVID-19; lockdown severity enhanced the fatality rate; the interaction effect of mobility and healthcare system also indicated to relieve the fatality level. This research practically identifies the effectiveness of the countermeasures to overcome the pandemic and theoretically links community resilience to the pandemic.

Key words: *COVID-19, community resilience, regional competence, vaccination, community mobility, universal healthcare coverage, lockdown severity*

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