

Review Paper:

Hazmat emergency management: Case of Korea

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Abstract

The threat of hazmat has always been situated around Korea, considering that each stakeholder has carried out isolated activity in the field. This study aimed at studying how Korea must enhance its absence of a national framework for the ultimate goal of emergency management. A major methodology was qualitative content analysis by studying the topic of either without a national framework or with a national framework via Governments, industries, NGOs and local residents.

The key theme was that Korea would need to fundamentally set up a national framework for hazmat emergency management while timely implementing the issues of all hazards, equity, best practices, competency, education and training. The major contribution of this study was that it studied the topic of Korean hazmat emergency management more comprehensively than previous studies.

Keywords: Hazardous materials, chemical materials, human health, a national framework, training.

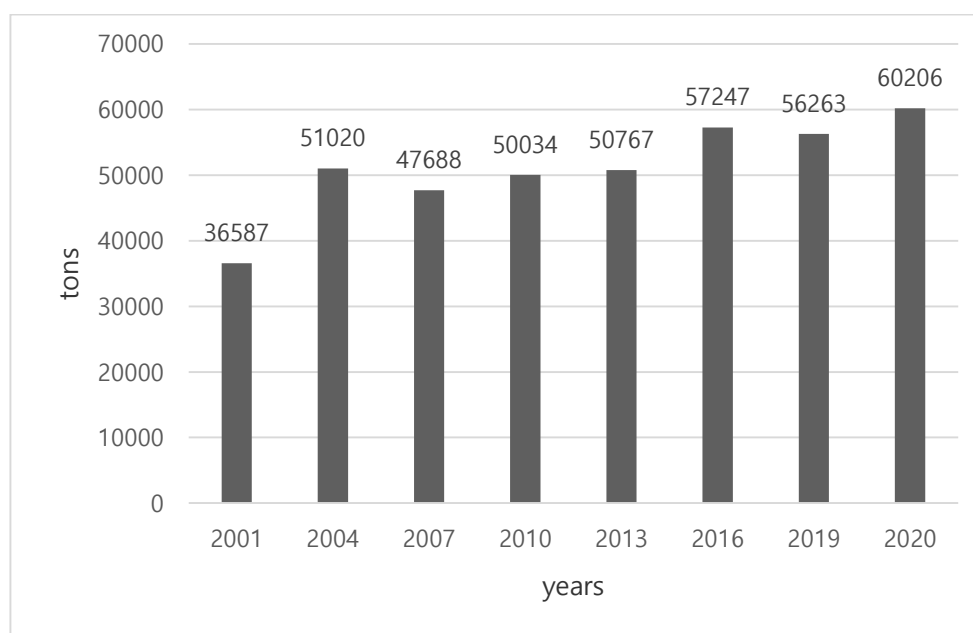
Introduction

Emergency information literacy is the capacity of collecting, analyzing and then utilizing emergency information on the way to making concrete judgment.^{30,38} Emergency information literacy includes various steps such as

organization information, legal standards, resource management and others. Among them, a whole framework on a specific emergency management is an inevitable factor for related emergency information literacy. Without recognizing a whole framework, many people would be at a loss when faced with any emergency.

A series of hazardous material(s) (hereinafter hazmat) emergencies have sufficiently induced stakeholders to learn and further take appropriate action.¹⁰ Particularly, when the field repeatedly fails to manage a hazmat emergency, the related emergency motivates stakeholders to draw lesson(s). A lesson learned will play a minimal role in managing diverse hazmat emergencies unless substantially connected with behavioral change or policy implementation. Thus, the field needs to turn a lesson learned on a whole framework into a reality.

South Korea (hereinafter Korea) has not set up its national framework for hazmat emergency management yet despite the fact that the nation has continued to release a huge amount of chemicals as shown in fig. 1. Although, Government officials have frequently maintained that they are doing their best to deal with hazmat accidents, many stakeholders have carried out isolated activities in particular without utilizing a national framework. The nation established its national emergency management system in 2004 by launching the National Emergency Management Agency but its hazmat emergency management is yet to start.



Source: (Statistics Korea, 2023)

Fig. 1: The amount of chemical material release in Korea

With the above in mind, the Korean case is unique enough to study particularly by raising the importance of a national framework for other nations. In the international community, multiple nations have not fully set up or implemented a national framework for hazmat emergency management. Korea might set up an adaptive system for hazmat emergency management and thus draw appropriate lesson(s) for others. Therefore, a research question is to ask how the absence of a national framework for hazmat emergency management in Korea can be overcome.

The objective is to investigate how Korea has to improve its hazmat emergency management for the ultimate goal of reducing both the physical and social impacts of emergency. Whether this will be done without a national framework or with a national framework, will be discussed with respect to the same four variables of governments, industries, non-Governmental organizations (NGOs) and local residents. The most significant finding is that Korea needs to newly set up a national framework for hazmat emergency management while addressing all kinds of hazard, best practices, risk and competency, education and training and others in a timely manner.

Review of Literature

Generally, hazmat is considered any material or substance which poses unreasonable threat to humans and the environment. Hazmat includes chemical nature, biological nature and physical nature and thus it is classified as explosive material, flammable material, toxic material and radioactive material⁹. That is why the scope of hazmat is very wide. This study mainly includes chemical hazmat materials as the focus of research. Briefly, hazmat here refers to a chemical substance which poses risk to life or environment.

Human beings are exposed to hazmat via various routes of entry such as inhalation, ingestion, absorption and injection. Hazmat is located in or is utilized as the decorum of commercial places, manufacturing establishments, experimental labs, medical facilities, transportation processes, or even households.²⁵ Hazmat has been known as a silent killer because hazmat emergency victims do not realize if they have been affected until several years later.

Many practitioners have seriously discussed how to deal with hazmat during transportation in their areas⁸. However, it does not mean that hazmat should be considered only during transportation. Hazmat has been frequently present around human life or within the field of emergency management such as during production, storage, use and disposal as well as during transportation. Appropriate emergency management is required for each phase of the hazmat life cycle.

Hazmat emergency has been considered a part of a complexity or complex system. A number of hazmat emergencies share many features in certain aspects but no

two emergencies are identical.¹³ Many factors between/among hazmat emergencies are unique in their nature or systematic settings. Such factors include not only physical elements of hazmat emergency but also related social elements. Therefore, the nature of a hazmat emergency has by far been more complicated than many have expected.

Hazmat emergency has been primarily classified into the category of technological hazards which include hazmat incidents, household chemical emergencies and nuclear power plant failures.¹¹ The number of technological hazards has been increasing because the number of human errors or the number of chemical substances is on the rise. In general, almost no warning has ever preceded the occurrence of technological hazards.

Nonetheless, hazmat emergency is not only a kind of manmade emergency, but it has also been initiated by natural disasters such as earthquakes, typhoons, floods, wildfires and others. In summary, hazmat emergency (or technological hazard) has been induced by both manmade emergencies and natural disasters.⁴¹ Furthermore, hazmat emergency induced by natural disaster has been referred to as natural-technologic events in certain cases.

The field of hazmat emergency management has recently realized the significance of comprehensive emergency management for the upmost goal of reducing related emergency impacts. However, these efforts are still lagging behind³. Particularly, these efforts have not completely included diverse factors such as the high extent of safety, societal aspects, transparency, the entire life cycle, quick decision-making process, sustainability and others.

In another aspect, the structured collaboration among all stakeholders has been basically and frequently vindicated in the field. Collaboration addresses not only coordination but also cooperation among various stakeholders.¹⁴ Therefore, collaboration plays a role in improving hazmat awareness, utilizing all hazmat knowledge and sharing related responsibilities. In short, structured collaboration facilitates diverse stakeholders to pursue the goal of hazmat emergency management while allocating appropriate roles and responsibilities for them.

Similarly, many stakeholders have joined appropriate hazmat networks for comprehensive emergency management. No single agency has dominated these networks unlike traditional relations. At any rate, not all but some networks which possess the capacity of adequately utilizing personnel, resources and others, have been successful in fulfilling their hazmat emergency management.⁴⁰ Considering that each individual and region has their own culture, successful networks have cultivated realistic relations among stakeholders under their respective cultures. Some developed nations have practically set up a comprehensive framework for hazmat emergency. For

instance, the United Kingdom has implemented its Government Decontamination Service (GDS) to deal with the recovery of hazmat release.¹⁶ In doing so, the GDS has carried out many responsibilities such as expert advice on decontamination, waste options, the extension of science and technology, framework maintenance, cooperation with the public and private sectors and others.

The United States has improved the National Prevention Framework (NPF), the National Response Framework (NRF) and others under the name of National Planning Frameworks. While the NPF is to prevent hazmat terrorism, the NRF is related to the nation's emergency response to hazmat emergency. For the NRF, the United States has fully utilized two Emergency Support Functions (ESFs) such as the ESF #7—terrorism incident law enforcement and investigation annex—and the EST #10—Oils and hazardous materials response.¹²

During hazmat emergency, there are always crowds.⁴ Crowds include a number of people who stay or gather around the spot of the hazmat emergency in a disorganized way. The majority of these crowds are usually irrational during the short period of hazmat emergency response and thus cause public disorder or mass panic. In this context, multiple individuals or institutions have to play their own roles in the timely management of such crowds.

For hazmat emergency management, not only one criterion but various criteria have been frequently supported.¹ To elaborate, various concepts or methods are available in the field. Difficult challenges have made it difficult for decision makers to choose reasonably practicable solutions. Moreover, the field is always surrounded by changes or uncertainty. It has been necessary for the field to apply measuring preferences for emergency management and thus come to rely on multiple criteria.

Besides, hazmat emergency management has at least partially been politics-oriented, in particular, considering that politics has directly or indirectly influenced the direction of hazmat emergency management.³⁶ Several issues and events regarding hazmat emergency have considered politics as an integral factor of related management. Hazmat emergency affects people who manifest political behavior, its management on how these people have been affected?

The international field of emergency management has extended its research relevance to hazmat these days. Hazmat logistics, as an example, has been suggested as a new research topic in the field. However, this does not mean that the research level on hazmat emergency or its management has been satisfactory. Rather, many sub-topics lack relevant researches to include the application of hazmat emergency management for developing nations, training human resources for hazmat emergency and others.³³ Therefore, the international field still seeks appropriate researches. In Korea, a few researchers have studied the

subject of various hazmat. Moreover, not only chemical scientists but chemical engineers have also discussed the nature of multiple hazmat via their own experiments, new developments, risk assessment etc.³² However, they have not similarly examined the subject of hazmat in terms of emergency management. Although some researchers have partially mentioned the danger of hazmat emergency in the field, almost no rigorous research has ever been attempted to study the issue of hazmat emergency management.

This study has its own contributions. To elaborate, this study attempts to more comprehensively examine the aspect of Korean hazmat emergency than previous studies. In doing so, various factors have been discussed to include individuals, institutions, resources, strategies and others. Simultaneously, the viewpoint of emergency management has been much reflected to the subject of Korean hazmat or its emergency. Many significant principles of international emergency management as well as Korean typical hazmat information and situation have been utilized.

The issue of without or with a national framework in Korea will be primarily discussed. A national framework is neither the central government's plan nor a national plan. Instead, it is essentially a framework which is a fundamental supporting structure of hazmat emergency management at the national level. In doing so, a national framework assigns appropriate roles and responsibilities to each hazmat stakeholder before, during and after the occurrence of hazmat emergency. Indeed, a national framework is a legally binding skeleton. Additionally, a national framework is constantly in effect while each element is implemented anytime.

Development of Analytical Framework

The issue of hazmat emergency management includes not only the historical aspect of human behavior but also the subjective aspect of human experience. It is necessary for appropriate researchers to incorporate various human behaviors and experiences into the category of interpretive inquiry under the methodology of qualitative content analysis²⁸. Therefore, this study associates the empathic interpretation of many texts and contexts with the issue of hazmat emergency management.

For qualitative texts and contexts, this study has relied upon several search engines such as Google.com, Yahoo.com, ScienceDirect, EBSCO, Oxford University Press, American Chemical Society and Web of Science among many. Among them, Google.com included many Government documents regarding the main subject. ScienceDirect has uploaded multiple academic texts and data. Typed keywords include "hazmat emergency", "hazardous material policy", "hazmat emergency management theories", "hazmat emergency in Korea" and others. A major criterion of including or excluding a specific text has been whether it is much related to hazmat emergency, the Korean case, national emergency framework, or international implications.

As shown in fig. 2, this study will support the importance of establishing a national framework for Korea. In doing so, the issue of both without a national framework (without connecting lines in the picture) or with a national framework (with connecting lines in the picture) will be thoroughly compared. Four comparative variables (or units of analysis) have been chosen; Governments, industries, NGOs and local residents. Each (or analytical category) of the four without a national framework (or performing isolated activity without coordination) has been depicted in a different diagram whereas each counterpart with a national framework (or with coordinating efforts) has been included within the same diagram.

Each variable has its own reason to be selected here based on the extensive literature survey. In general, the three major stakeholders in the field of hazmat emergency management are Governments, industries and NGOs. Similarly, Governments are a primary stakeholder in the field because hazmat emergency management is a public matter. Industries play a significant role in producing various hazmat in the field and the role of NGOs is rapidly rising in the field. Living with numerous hazmat in households, local residents are sometimes victimized by hazmat accidents in the region.

Hazmat Emergency Management without a National Framework

Governments: Multiple laws, regulations and standards have been enacted on the matter of hazmat emergency in

Korea. However, each one has been isolated in terms of scope or legal effect and thus they have not been well connected to one another.²⁶ At the central Government's level, the National Institute of Chemical Safety (NICS) was recently established under the rule of the Ministry of Environment (ME) and further attempted to work for the issue of chemical safety. However, even NICS has not fully coordinated the issue of hazmat emergency management in Korea yet. Similarly, despite many local institutions, local Governments have not flexibly dealt with local hazmat emergencies in the region.

To elaborate, each institution at the central Government's level has carried out its own activity on hazmat emergency management such as the Ministry of Science and ICT (MIST), the Ministry of Employment and Labor (MOEL), the Ministry of Health and Welfare (MOHW), the National Fire Agency (NFA) under the Ministry of Interior and Safety (MOIS) and NICS as well. Additionally, local governments consisted of not only 6 Local Chemical Hazard Prevention Centers (LCHPCs) but also about 170 local fire stations.^{20,24} These two institutions have not been seriously associated with each other on the issue of hazmat emergency either.

Industries: Certain hazmat corporations are huge in terms of size or finance such as LG Chem, Lotte Chemical, SK Innovation, Isu Chemical, Kumho Petrochemical, Hanwha General Chemical Co. and others. They are widely known as Chaebol.⁵

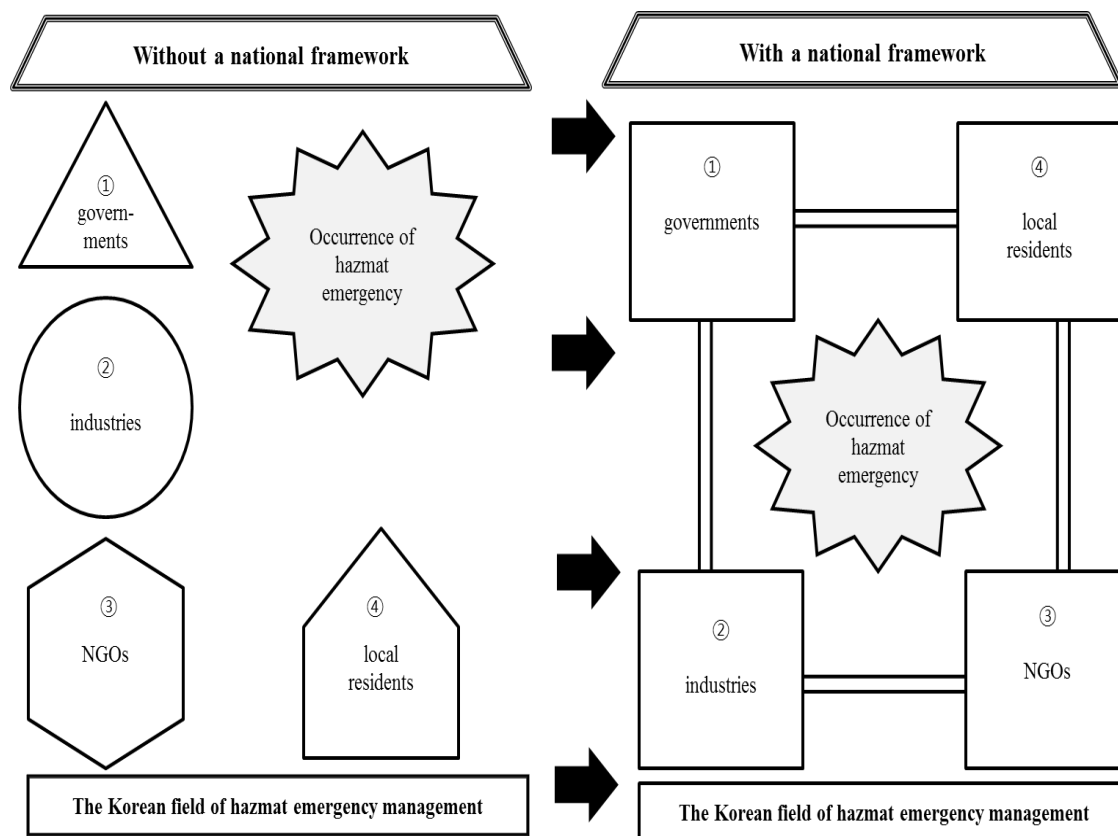


Fig. 2: Analytical framework

However, many hazmat corporations are small and medium-sized. Because of frequent hazmat accidents, they have been recently forced to improve safety conditions.

Nevertheless, their facilities are generally old and thus surrounded by potential hazmat emergency risks. Some regions in Korea have been specialized in accommodating hazmat industries. For example, Ulsan city, Yeosu city and Daesan-Up have accommodated various petrochemical corporations such as Hyundai Oilbank, S-Oil and others. In doing so, these regions have tried to embody their own safety levels.²² However, other small and medium-sized corporations are located near or within residential areas. Therefore, these hazmat corporations might cause critical hazmat emergencies for the residents around them.

NGOs: Since the end of the 1980s, the number of NGOs in the nation has increased. In the 21st century, related NGOs have tried to reflect their interests in Governments' hazmat policies. Many of them have driven for a few issues such as waste management and radiological leakage, addressing that these topics have been frequently argued upon in the society. Besides, these NGOs have not been oriented toward the goal of managing a specific hazmat emergency but the goal of managing general activities (e.g. town festivals, meetings among peers etc.).

Regarding chemical materials, many business corporations participated in forming their own NGOs (i.e. the Korea Chemicals Management Association) and then continued to supplement for the lack of Government efforts. This does not imply that NGOs have succeeded in reflecting the civilians' will for government policy. Rather, some civilians only set up their own NGOs (e.g. the Chemicals Monitoring Networks and the People for their Health and Life) in 2018 which resulted from the leakage of hydrofluoric acid in Gumi in 2012 and the adverse health effects of humidifier disinfectants in 2016.²¹

Local residents: Local residents in some communities have developed a high extent of hazmat awareness such as those in Gumi city, Suwon city and Hwaseong city, mainly because some industries such as Hube Global Co. Ltd., Samsung Semiconductor and Samsung Electronics leaked chemical hazmat and caused emergency in those areas. However, the level of hazmat awareness, in particular compared to that of frequent disasters such as fires, typhoons and floods, has not been generally high in many communities.

Some public or private organizations have begun to implement hazmat training and exercise for their local communities. However, this does not mean that all local residents have been included in the scope of training.²³ Even though some cases have included local residents, many cases have been executed only with emergency responders or public employees. Even when local residents have been allowed to participate in training, the related process has not been so practical such as too much emphasis on table top

exercise.

Hazmat Emergency Management with a National Framework

Governments: Without legal obligation, many individuals or institutions would hardly be willing to join a national framework and fulfill their assigned roles and responsibilities.¹⁹ Therefore, Korea needs to revise the Chemicals Control Act (CC Act) particularly because the CC Act is considered a basic law regarding hazmat emergency management. While newly stipulating the principle of a national framework, the CC Act must address various relationships among multiple laws, regulations and standards.

Under the auspices of the revised CC Act, the central Government should more clearly declare which institutions are coordinating agencies (e.g. NICS, ME etc.) toward hazmat emergency management and which are cooperative agencies. The status of NFA also needs to be further specified in order to comprehensively manage all manmade emergencies in Korea. Similarly, local governments should specify the enhanced role of LCHPCs when analyzing that the majority of fire stations do not have professionals for toxic hazmat.

Industries: Huge hazmat corporations are to directly comply with hazmat production, transportation, labeling, packaging, storage and others. However, they are not complete in these regards. In particular, a few corporations hid the occurrence of hazmat emergency in their facilities such as the case of Hanwha Total Petrochemical Co. Ltd. Many have contributed to increasing the extent of pollution in the region. Accordingly, they must publicize information and data regarding the health effects of their hazmat, hazmat quantities and others when officially asked.

Small and medium-sized corporations must consider moving their business facilities to hazmat specialized areas not to threaten residents in the same community. However, it might not be a panacea due to the related costs. Alternatively, they need to further integrate their hazmat emergency plans into their business operations.⁷ Namely, these corporations should treat their hazmat emergency plans as their operating culture or corporate culture and thus always prepare for how they are doing with their hazmat under the relationship with neighbors.

NGOs: Although the number of chemical NGOs is very small, they do support the right to know about chemical hazmat. They believe that without the appropriate information, hazmat emergency would not be systematically managed. In doing so, each NGO needs to focus on dealing with a specific chemical emergency. When insisting on working for general activities, each NGO might face low productivity like the previous NGOs.

As Governments or private enterprises have not fully

realized the concept of a national framework for hazmat emergency yet, it is possible for new NGOs to initiate related efforts as pioneers.³¹ Although NGOs' initiatives are limited in nature because of the lack of money or resources, they might initiate to speak loudly regarding the significance of a national framework for hazmat emergency. Moreover, NGOs can map out their initiatives in the region by utilizing internet-based networks such as Naver Band, Kakaotalk, Facebook and others.

Local residents: To raise the extent of hazmat awareness among local residents, the importance of communication must be addressed.² To elaborate, local residents must be frequently informed regarding how hazmat emergencies have been operationally or environmentally managed or will be managed with respect to the relationship with human health, safety, or other environments. This information can be distributed among local residents via various communication channels such as town hall meetings, information bulletin, internet, mobile phones and others.

When any hazmat emergency occurs, the period of initial emergency response is very crucial to ensure the success of continuous management.³⁹ Even when emergency services are provided within time, initial emergency response still dictates the outcome of emergency management. Hence, training and exercise might address hands-on particularly without any risks by fully preparing for all emergencies. Thus, all local residents must practically participate in appropriate training and exercise under a larger framework.

Major Implications

In some senses, many countries have had no choice but to initiate to deal with frequent emergencies earlier than infrequent emergencies because such emergencies continue to hit many local communities such as the Japanese case of earthquakes or typhoon. As in the case of the mercury incidents, many nations did not start seriously dealing with these incidents until some emergency responders were killed on the emergency spots.¹⁵

Korea started seriously dealing with two frequent emergencies such as fires and typhoons accompanied by floods. The occurrence of these two has been annual in Korea. However, this does not mean that the nation might disregard the threat of comparatively infrequent hazmat emergencies. Rather, Korea must tackle down various risks of hazmat emergencies under the concept of equity because they will come to impartially haunt the whole nation similar to the impacts of frequent emergencies.

Besides, all nations need to address the issue of a national framework for hazmat emergency management, incorporating other hazards into the issue. Hazmat emergency does not always occur alone but it has been frequently initiated by other emergencies such as flood, typhoon, earthquakes, or other manmade emergencies. Hence, the field has to include other kinds of hazards into

the issue of the national framework for hazmat emergency management. This shows the significance of inclusive emergency management. Under a national framework, all four stakeholders, that is, Governments, industries, NGOs and local residents need to fulfill their own roles and responsibilities early, frequently and continually.³⁵ In other words, all stakeholders must initiate to share related vision and specific alternatives as soon as possible. Afterwards, they need to track down and revise appropriate processes on a regular basis. Furthermore, they should not utilize this mechanism as a temporary tool but as a continuous engagement.

The field must refer to the concept of best practices. After spending time, space and other resources, the establishment of a national framework has been outlined in terms of theoretical applications. When doing so, the transition must be substantially practiced. Without best practices, the theory on yes or no of a national framework would be useless. In particular, in the field of hazmat emergency management which is related to human loss, best practices are equally important like the function of theories.

The field must not utilize traditional tactical-oriented approach but risk-oriented emergency management.²⁷ The former relies on predetermined factors for hazmat emergency management whereas the latter includes flexible factors. Risk-oriented emergency management refers to the identification and analysis of a specific hazmat hazard and evaluation of expected consequences. At this time, risk-oriented emergency management dynamically utilizes sciences, facts and appropriate circumstances altogether.

Competency means the quality or capacity of being qualified. Transition to a national framework keeps the same pace as competency-oriented emergency management.²⁹ In the field, many factors operate such as individual characteristics, bureaucracy, political power, regional culture and others and contribute to making a final decision. Therefore, the field has to depend on competency-based approach and thus minimize various emergency impacts.

The matter of time should be considered during the establishment of a national framework for hazmat emergency management.⁶ The issue of time has often emerged considering various aspects such as road closure policy, alternatives for transportation risk, government intervention and others. Namely, time does clearly matter around the transition. Thus, it is necessary for the field to enhance the matter of time-dependent national framework in a timely manner. No single way is applicable to maximize the effect of hazmat emergency education considering that each individual learns differently from related education.¹⁸ In other words, many ways must be combined to improve hazmat education. Therefore, educational materials should be attractive, interactive and engaging to students. For instance, appropriate education might effectively utilize diverse materials such as campaigns, videos, audios,

websites, formal discussion, real experiences, informal education and others over time.

Not only discussion-oriented training but operation-oriented training also needs to be implemented in the field.^{17,34} Although many individuals recognize the importance of personal protective equipment in a classroom, they cannot successfully wear it on the spot without related training. Thus, they need appropriate training and exercise to include not only seminar, workshop, tabletop exercise etc. but also drill, functional exercise and full-scale exercise, in particular, considering that they will do as they are trained or exercised.

Conclusion

The research has attempted to study how the absence of a national framework for hazmat emergency management in Korea can be improved. In doing so, the study has addressed the issue of hazmat emergency management without a national framework, the issue of hazmat emergency management with a national framework and related implications. In particular, considering that the study has substantially provided the concept, significance and other rationales of a national framework for hazmat emergency management, the goal of this study has been quite achieved.

The key tenet of study is that Korea must flexibly change its current situation without a national framework to the alternative, that is, with a national framework for its hazmat emergency management. Unless Korea newly sets up a national framework, various stakeholders would not be able to not share hazmat emergency information with one another and continue to pursue isolated activities, repeated overlapping activities and thus fail to deal with any new hazmat emergency.

To implement the establishment of a national framework, four stakeholders in Korea must carry out their assigned roles and responsibilities such as legal obligation, the integration of hazmat emergency management into business operations, a right to know hazmat information, the issue of communication and others. Similarly, neighboring nations might address the issues of equity, inclusive emergency management, best practices, risk and competency, education and training and exercise in a timely manner particularly for their own purposes.

As the biggest advantage, this study has approached the topic of Korean hazmat emergency management more comprehensively than previous studies. Although many chemical scientists or peers have discussed the issue of Korean hazmat, almost no rigorous research has ever been attempted to study the topic of Korean hazmat emergency management. In doing so, multiple subjects have been included in the scope of this study such as institutions, resources, strategies, culture, politics and others.

Korean researchers should further study the subject of

hazmat emergency management for the nation. For example, both chemical scientists and chemical engineers might expand the principles of emergency management to their chemical research areas. In addition, this study will encourage other national researchers to examine how their national frameworks will be enhanced for the goal of hazmat emergency management. All these efforts will be a shortcut to the spirit of international emergency management.

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