

Design of Disaster Response Facilities to Improve the Efficiency of Relief Services in Catastrophe

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ABSTRACT

This study proposes to explore the design direction of disaster response facilities and functions of disaster response facilities on the premise of securing disaster response bases and introducing disaster management systems. For the purpose of this study, this study first reconsidered the major issues of introducing a disaster prevention base in Korea and an integrated disaster management resources management center based on previous studies. The results show that is the possibility of integration of each of these facilities can be considered more highly. So, the roles to be considered while newly designing disaster response base facilities are proposed as follows. First, response base facilities should be headquarters for the activities of metropolitan local governments for the purpose of large-scale disasters. Second, facilities prepared for large-scale disasters should include complex functions that can be used both before and after disasters. Third, disaster response base facilities should be the starting point for collecting and supplying not only human resources, but also resources in a wide sense for disaster response, such as institutions and equipment.

Key words: disaster response; disaster management resources; base facilities; logistics; catastrophe

1. Introduction

Recently, Korea has been discussing the importance of disaster management resources. The issue of disaster management resources has been discussed as an important issue in advance stockpiling and management of resources required during a disaster by disaster type.

However, disaster management resources are expanding into discussions on the rapid mobilization of resources in the event of a disaster, as well as stockpiling space, along with securing the quantity by resource of traditional disasters. In particular, from this point of view, the discussion of disaster management resources is linked with the problem of disaster logistics (Kim, *et al.*, 2018; Kim, Kim, *et al.*, 2019; Lee, *et al.*, 2019; Kim & Chenung, 2019; Kim, *et al.*, 2020; Lee, 2022: 51-52). After the Gyeongju earthquake and the Pohang earthquake in 2017, research on the provision of disaster prevention bases and evacuation spaces centered on the supply of stable disaster management resources for large-scale disasters has emerged in Korea (BDI, 2017; Yun, *et al.*, 2017; Park & Jang, 2018; Park, 2019; Ju, *et al.*, 2021). Since then, the Ministry of the Interior and Safety has announced a plan to pro-

mote the disaster management resource management system innovation project in 2020, and is pushing to establish an integrated disaster management resource management information system. At the same time, the Ministry of the Interior and Safety is promoting the establishment of integrated disaster management resource management centers in 17 metropolitan cities. This is fundamentally due to the increase in large-scale disasters and the high urban density in Korea in the event of urban disasters, the importance of disaster management resources necessary for disaster-stricken areas is highly recognized (Lee, 2022).

Nevertheless, the role and function of the integrated disaster management resource management center for each metropolitan city are relatively insufficient to discuss specific operations and measures to secure effectiveness despite the expectation of integrated disaster management resource control and coordination at the metropolitan government level. In particular, the Disaster Management Resource Integrated Management Center has not even discussed the installation standards, facilities, space composition, and functional design outside of the area, and related laws that directly define them are pending in the National Assembly.

Therefore, this study proposes to explore the design direction of disaster response facilities and functions of disaster response facilities on the premise of securing disaster response bases and introducing disaster management systems. For the purpose of this study, this study first reconsidered the major issues of introducing a disaster prevention base in Korea and an integrated disaster management resource management center based on previous studies. In addition, the proposals included in the issues of these studies were comprehensively analyzed. Finally, based on this, this study aims to present the types of disaster response base facilities and the inclusion and direction of facility components accordingly. If necessary, it is intended to specify policy considerations by discussing the characteristics of disaster prevention parks as a disaster prevention base in Japan.

2. Theory Background

2.1. Disaster Resources and Logistics Hub Areas

Emergency resources required at disaster sites are highly uncertain about supply and demand, so it is important to overcome the limitation of stockpiling by controlling the resources needed in disaster areas and managing them at the supply chain network level (Selminaz, 2019: 212; Lee, 2022: 52). In particular, due to uncertainty in demand for resources required in the event of a disaster, the logistics of disaster management resources, i.e., efficient mobilization and use, are very important to support decision-making by disaster responders (Garrido & Ivan, 2020: 2369; Lee, 2022: 52). 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 is to connect necessary resources, equipment, and manpower to disaster-stricken areas in a balanced and prompt manner at the time of need. In other words, from the perspective of efficient distribution of disaster resources, disaster logistics has the meaning of a bridge between resources and affected areas, and conversely, disaster logistics guarantees efficient flow to disaster areas (Köseoğlu & Hatice, 2015: 377; Lee, 2022: 55). So, discussions on logistics hub areas are needed to ensure the efficient movement of these disaster resources. This is not limited to efficient stockpiling and management of disaster management resources before a disaster occurs. A more fundamental problem reflects that the problem of aggregating, distributing, and supplying resources through pre-designed locations or places after a disaster is one of the more important issues with regard to disaster management resources.

2.2. Necessity of Disaster Response Facility

Disaster logistics focuses on minimizing disaster damage from the perspective of maximizing the distribution of goods, manpower, information, etc. among a series of actions to respond to disaster situations before, during, and after a disaster. In other words, the flow to quickly and safely provide resources such as relief goods to those affected by a disaster situation can be defined as a series of processes of planning, management, implementation, and control (Caunhye, 2011: 4-13). In general, the key issues of disaster logistics compared to business logistics are as follows (Balcika & Beamon, 2008; Lee, et al., 2015:3; Lee, 2022: 54-55);

First, demand for additional uncertainty (unavailable routes, safety issues, changes in facility capacity, uncertainty in demand),

Second, complex communication and cooperation (damage of communication facilities, involvement of government, private and businesses, difficult access to real-time demand information),

Third, limited resource utilization due to disaster.

In addition, despite its geographical size, Korea has various regional characteristics such as natural disaster damage, industry, economy, and urban structure, and it is difficult to predict the development of disaster situations, so it is required to link and operate disaster management resources. Therefore, not only local governments but also government organizations consider the location of facilities to connect logistics hub points for efficient use of resources and to deliver resources to disaster sites. For this reason, Japan designates disaster prevention bases in stages 1 to 3, and in particular, it stores disaster management resources at ordinary times through disaster prevention parks, and uses them as a place to effectively respond to disasters by mobilizing disaster management resources from various institutions (Lee, 2022: 60-61).

However, Korea has to stockpile and manage various disaster management resources in preparation for various disasters, but most local governments stockpile and manage necessary resources on their own, and there are problems due to insufficient resources, such as excessive stockpiling, etc.

Therefore, it is necessary to discuss the installation of disaster response facilities in the region as a way to efficiently operate and manage disaster management resources from the stockpile and management of disaster management resources to the mobilization and overall use of resources. However, using facilities only in the event of a disaster can lead to a problem of inefficiency from the standpoint of the government dealing with limited resources. Therefore, before a disaster, citizens should use it as a useful disaster safety facility, and after a disaster, institutions for disaster response should conduct operations and use it as a key facility for controlling, coordinating, and supporting resources.

From this point of view, this study aims to analyze major policy proposals and backgrounds by analyzing major studies in Korea on disaster prevention bases, disaster management resources integrated management centers, disaster prevention parks, and disaster prevention facilities. Through this, the implications for the function and design plan of the disaster response base facility are to be derived.

3. Analysis of Previous Studies

Research is being conducted focusing on discussions on the establishment of disaster prevention bases and the introduction of an integrated disaster management resources management center conducted by major metropolitan governments and research institutes in Korea. In particular, research on the establishment of disaster prevention bases after the Gyeongju earthquake in 2017 has been discussed in connection with the disaster management resources issue with the announcement of the plan by the Ministry of the Interior and Safety in 2020.

3.1. Disaster Prevention Base

Discussions on the establishment of disaster prevention bases have been conducted focusing on the design of disaster prevention bases on existing facilities such as urban parks, schools, and large gymnasiums or new urban planning.

BDI (2017) proposed the introduction of a wide-area disaster prevention hub as a task in the field of urban management among studies on resilience in the Busan area. The reason why this study paid attention to the necessity of a wide-area disaster prevention base is to prepare for large-scale disasters and secure control tower space. At the same time, the introduction of a wide-area disaster prevention base is aimed at stockpiling relief supplies and storing disaster management resources for evacuation of disaster victims and temporary residence due to large-scale disasters. In addition, the disaster prevention base introduced was intended to consider the characteristics of the Japanese wide-area disaster prevention base that is used as an educational training and civic learning facility as well as a civic rest area.

One of the characteristics of this study was to secure two or more wide-area disaster prevention bases on the premise of functional efficiency rather than installing them in one concentrated space. To this end, one facility was dualized into a facility in the city center including a control tower function and the other as a logistics-oriented transportation base using a port function.

Park & Jang (2018) conducted a study on the introduction of disaster prevention functions in urban parks in Jeju. This study focuses on the advantages of sufficient space and safe open space for evacuation for disaster relief purposes. In particular, the

necessity of securing disaster prevention functions in urban parks was analyzed in the event of flooding damage caused by floods or typhoons. To this end, this study focused on the types of disaster prevention parks that are already becoming common in Japan, safety improvement, information collection and delivery, quarantine and cleaning activities, restoration activities, and transportation support included in the disaster prevention park guide in Japan. In particular, the actual case of Japanese disaster prevention parks was analyzed how the arrangement, size, shape, and structure of disaster prevention facilities included in the disaster prevention park are being implemented. Through this, the use of disaster prevention bases using open spaces such as disaster prevention parks is presented as follows.

First, children's parks and neighborhood parks are constructed so that they can be used as evacuation sites; Second, designation of disaster prevention bases for relief and restoration activities such as Japan among parks throughout Jeju; Third, it was proposed to introduce a fire prevention function in urban parks in areas vulnerable to fire.

Hwang & Hwang (2018) studied the direction of strengthening disaster prevention plans in urban planning in order to secure the safety of port space. In particular, in the case of Busan, urban regeneration and redevelopment are underway around port spaces and coastal areas, increasing the risk of disaster damage in the event of a disaster. Accordingly, the issues of disaster prevention plans reflected in urban plans in the United States and Japan were analyzed, and priority tasks for domestic application were derived based on FGI analysis. In this process, the second-priority alternatives suggested were the establishment of disaster prevention bases and disaster prevention axis (33% of respondents). Accordingly, it was proposed that the disaster prevention base and disaster prevention axis setting should be applied to the new development spaces.

Ju, et al. (2021) studied the design of resilience base facilities for Incheon. The characteristics of this study suggested that resilience base facilities should be approached from a completely different perspective from logistics centers or disaster relief centers used in Korea. In addition, resilience base facilities were approached as facilities that prepared for large-scale disasters secured at the level of metropolitan governments and included the following functions. First, in addition to relief and restoration support, control and management of the situation, second, temporary evacuation of victims, third, storage of disaster management resources, and fourth, support of manpower.

On the premise of this, three alternatives to improving the function of existing facilities and expanding or renovating existing facilities were explored. This study analyzed Japan's wide-area disaster prevention base to present policy measures.

Through this, resource storage, situation management, manpower gathering, shelter, support space, and educational place were presented as functions to be included in resilience base facility. Other facility requirements included independent power generation facilities, communication facilities, and outdoor green spaces for daily use. And the location of the resilience base facility was presented as important factors such as safety, traffic accessibility, facility safety, and area. Based on this, the final facility reviewed was Incheon's Munhak Stadium, and alternatives were proposed in consideration of the purpose of use and movement in the facility, considering the function of the base facility as a function improvement, new facilities around the stadium, and expansion and reconstruction tasks.

3.2. Disaster Management Resources Center

KRIHS (2021) conducted a study on improving the logistics distribution of emergency public goods in preparation for disasters in the wake of the problem of mask supply and demand in Korea in the early stages of COVID-19. This study reviewed the necessity of revising the Road Act to build a stockpile warehouse in idle land around the highway. At the same time, it was proposed to diversify the logistics of quarantine goods while diversifying relief goods under the current Disaster Relief Act.

The main issues of this study were the establishment of the quantity of relief goods, lack of design standards for stockpiling warehouses, and diversity of demand for disaster victims, focusing on the number of disaster victims, as important reasons for securing logistics bases. On the premise of this, the requirement for selecting a logistics base was considered for accessibility and geo-coverage. At the same time, the logistics warehouse evaluated the available land area around the highway, the height of the logistics warehouse by floor, the volume of goods, and the stockpile per area as important factors in the introduction of the logistics warehouse.

GRI (2021) studied ways to improve the disaster management resource integrated management center in Gyeonggi-do, which had already operated the regional hub center before the plan of the disaster management resource integrated management center by the Ministry of the Interior and Safety (2020). This study reviewed the method of renting existing facilities and the method of newly constructing the center. On the other hand, the operation method compared the consignment method and the direct operation method. The former was considered as the biggest advantage of economics and the latter as expertise.

The main characteristic of this study emphasizes the importance of disaster relief materials as much as disaster management resources for disaster response based on the experience of Gyeonggi-do. In

addition, it is evaluated that changes in the future disaster environment should be considered rather than securing quantities based on the number of disaster victims. The criteria for resource stockpiling were emphasized to consider new disaster types and to link the types of goods to the disaster types.

It is also suggested that the regional integrated management center stockpiles resources by distributing them with disaster prevention warehouses of local governments, and that the facilities operation of metropolitan and local governments are unified separately from the choice of operation.

SIT (2021) conducted an alternative review on the introduction of new facilities while the construction of an disaster management resource integrated management center in Seoul was pending. Currently, disaster management resources in Seoul ask fundamental questions about whether it is efficient to integrate and store resources, with quarantine supplies, preventive drugs, disaster relief supplies, and unused items managed by each department.

This study considered that the Ministry of the Interior and Safety does not present clear standards and management standards for facilities in relation to the establishment of the center. Accordingly, a new integrated management center was proposed as a long-term alternative. At the same time, the center's advanced facility technology was introduced and a plan to construct a warehouse space was presented. The facility technology is characterized by the introduction of automation trails and fixed pallets at the same time, and the proposal to include picking robots. shipping resources, washing and drying facilities and spaces in consideration of restocking. The storage location of resources included classifying spaces according to the frequency of use of resources and designing space facilities in consideration of storage methods according to the characteristics of resources.

4. Policy Implications

Looking at the results of literature analysis on disaster prevention bases and disaster management resources in Korea, each issue is mutually independent and contains very similar implementation tasks. In addition, it is confirmed that each issue needs to have a different structural function design according to several location selection and roles and functions to be played before or in the event of a disaster.

Another thing is that disaster prevention base facilities and disaster management resource integrated management centers can be designed as one integrated facility depending on how they set their functions and roles.

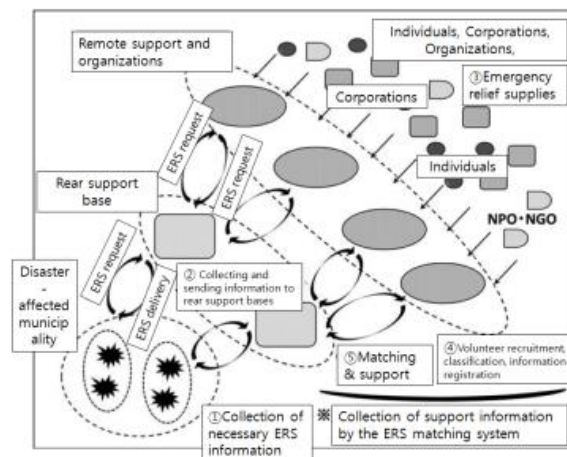
In particular, the study of disaster prevention bases in Korea attempted to reflect its characteristics by focusing on the case of wide-area disaster prevention parks in Japan.



Resource: tokyorinkai-koen.jp/en/(2022.07.01)

<Figure 2> Tokyo Rinkai Disaster Prevention Park

On the other hand, the integrated management center study considers the operation method of a wide-area base for resource logistics in Japan.



Resource: Oak, et al.(2017: 672)

<Figure 2> Disaster Resources Support Flow Chart

Therefore, the possibility of integration of each of these facilities can be considered more highly.

The roles to be considered while newly designing disaster response base facilities are proposed as follows.

First, response base facilities should be headquarters for the activities of metropolitan local governments for the purpose of large-scale disasters. Already in Korea, warehouse facilities that store disaster management resources are located in various branches of local governments. In addition, parks and schools are designated as shelters in the event of a disaster, and disaster relief supplies that require basic local governments in the event of a disaster are delivered mainly to shelters. Therefore, the current situation does not mean that local governments are demanding new facilities to respond to disasters. The introduction of facilities focusing on large-scale disasters that are difficult for local governments to directly manage disaster situations or to solve damage on their own should be considered.

Second, facilities prepared for large-scale disasters should include complex functions that can be used both before and after disasters. At the same time as several local governments, disasters that suffer great disaster damage at the same time are not frequent. Therefore, it is administratively inefficient to plan facilities only for the purpose of responding to disasters.

Third, disaster response base facilities should be the starting point for collecting and supplying not only human resources, but also resources in a wide sense for disaster response, such as institutions and equipment. At the same time, shelters should be included where disaster victims from various local governments can safely evacuate from unstable areas. This requires not only an evacuation space, but also a spare space for additional warehousing and management of various resources such as daily necessities, food, relief kits, and medicines. Furthermore, medical functions that can support emergency medical care such as disaster victims and on-site response personnel should be included. At the same time, disaster response base facilities must have independent infrastructure as a control tower headquarters where various resources, manpower, and institutions gather.

In addition, it is also necessary to consider functions that can help citizens understand by utilizing not only civic parks that use open space but also operations headquarters and warehouses as learning spaces.

5. Conclusions

This study presented issues of future research on the design direction of the facility through the analysis of the previously discussed disaster prevention base and disaster management resource integrated management center on the premise of the necessity of introducing disaster response base facilities.

Future research requires a process of exploring more specific alternatives through case studies and empirical analysis of core functions and facility composition.

In particular, in the case of Korea, the types of metropolitan and provincial governments are diverse, so it is necessary to consider further subdividing the functions of response base facilities according to the types of local governments.

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Profile

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