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The Reasonable Location Selection Model for Optimal Location installation of the Disaster Prevention Base Facilities

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A B S T R A C T

This thesis is to redefine the concept of the disaster prevention base facility, which is currently focused on the function of a simple logistics warehouse, in line with the purpose of the integrated management system for disaster management resources. This is because, through the policy of introducing disaster prevention base facilities, it becomes the basis for proposing an optimal location for a wide area disaster prevention base facility that can realize the two main goals of joint distribution of disaster management resources and maximization of disaster prevention capabilities.

To this end, first, the concept of a wide area disaster prevention base facility is defined and the core functions to be equipped based on the role that the facility will play are presented. Based on this, we exemplified the functions that a wide area disaster prevention base facility should have in consideration of the characteristics of disasters and potential capabilities of each region. This will be the basis for preparing criteria and indicators for site selection evaluation suitable for pursuing the core goals of each regional disaster prevention base facility as well as fairness in the site selection process by identifying the policy goals for the installation of regional disaster prevention base facilities.

Key words: Disaster prevention base facility; function of wide area disaster prevention base; location theory; location model; integrated management system for disaster management resources

1. Introduction

In the last 10 years (2011-2020), the amount of damage caused by disasters was about 6.1 trillion won, and the damage caused by natural disasters was 72.1%, or about 4.4 trillion won (2020 Disaster Yearbook: 23), whereas the damage caused by social disasters was 27.9% In the case of Korea, the damage from typhoons and heavy rains during the same period amounted to 4.1 trillion won (typhoon damage 1.95 trillion won, heavy rain damage 2.1 trillion won). It accounts for 66.9% of the disaster damage, and in particular, heavy rain damage tends to increase.

In the case of natural disasters, typhoons were considered the biggest cause of damage in the past, but recently, the damage caused by heavy rains tends to increase. In the case of social disasters, the amount of damage is rapidly increasing centering on fires (wildfires, building fires), and the number of occurrences increases every year as well as many casualties due to heat waves. A total of 107 people are affected by heatwaves annually (annual average of 35.67 people).

The global problem of climate crisis and the problem of shortage and waste of disaster management resources found in the response and recovery stage due to the complexity and enlargement of disasters have undermined the resilience of individuals and communities. Accordingly, as the demand for innovation of the national disaster response system increases, the Korean government is promoting projects for the establishment of disaster prevention base facilities and the maintenance of the disaster management resource management system as an alternative.

In the background of the innovation demand, there is a problem of role sharing through the participation and utilization of the private sector as the large-scale and complex disasters expose a clear limit to the supply and demand problem of disaster management materials that the public sector has been in charge of. In addition, when disasters occur across multiple cities and provinces, efficient distribution

or delivery cannot proceed smoothly if disaster management materials are supported by local governments or administrative jurisdictions. Finally, there is the problem of management inefficiency of disaster management resources. It is a problem in that it is not possible to properly manage the quality level and condition of the disaster management materials and resources that are being secured as well as the maintenance and management of the amount of inventory required to maintain an appropriate level of stockpile. As a result, there were often cases of wastage in which the stockpiled goods were not used due to excessive stockpiling, and cases of not being able to supply them in a timely manner due to shortages. As an alternative to solving such a problem, an integrated management center for local disaster management resources was established.

If you look at overseas examples, Japan's wide-area disaster prevention base facilities go beyond the concept of simply stockpiling and storing disaster management materials and disaster management logistics facilities. It is widely used as disaster-related education and training facilities. In this case, the disaster prevention base facility is more than just a disaster preparedness facility, it is a resident-friendly facility that also performs a public function as a leisure facility and a welfare facility.

In Korea, in order to strengthen the role of cities and provinces in the disaster management resource management system and establish an integrated management system, for the first time in 2020, integrated management centers were established in three regional organizations including Gangwon-do and Ulsan-si, Gyeonggi-do, and are currently in operation. In 2021, 7 regional organizations has been promoted and will be built sequentially thereafter. The point to note here is that digital technologies such as AI and big data are actively introduced to the disaster management logistics system for efficient storage, management, distribution and delivery of disaster management resources. In particular, it is establishing a governance system with a private logistics company to link the supply chain management of the private logistics system with the logistics system.

Against this background, this thesis is to redefine the concept of the disaster prevention base facility, which is currently focused on the function of a simple logistics warehouse, in line with the purpose of the integrated disaster management resource system. This is because, through the policy of introducing disaster prevention base facilities, it becomes the basis for proposing an optimal location for a wide area disaster prevention base facility that can realize the two main goals of joint distribution of disaster management resources and maximization of disaster prevention capabilities. To this end, first of all, we will present the core functions to be equipped based on the definition of the concept of a disaster prevention base facility in a wide area and the role that the facility will play. This will serve as the basis for preparing indicators and criteria for site selection evaluation suitable for achieving the core goals of each regional disaster prevention base facility as well as fairness in the site selection process by identifying the policy goals for the installation of regional disaster prevention base facilities.

2. Theoretical Discussion

2.1. The concept of disaster prevention base facilities

From the point of view of the advancement of the overall national disaster management function, it is reasonable to view the disaster prevention base facility as a large-scale disaster prevention base facility as a large-scale disaster prevention infrastructure, beyond the level of mobilizing disaster prevention resources and in charge of emergency transportation. This is because it is the basis for the establishment and operation of the disaster management resource logistics system that quickly supplies urgently needed resources in case of large-scale disasters such as storms, floods or infectious diseases.

Therefore, a disaster prevention base facility is a facility that performs the functions of situation management, education and training, material management, and support personnel base camp for a wide area such as a metropolitan city. (Ju, et. al., 2020: 230). The concept of a disaster prevention base facility includes various types of sub-concepts that consider the district unit of a disaster prevention base, a large-scale storage warehouse, a collection site for logistics, medical care, administration, and response resources for disaster response, and a temporary shelter. In disaster prevention base facilities, financial waste occurs in the process of stockpiling and managing disaster management materials in preparation for disasters, and delays and shortages in the supply and delivery of disaster materials cause secondary damage and weakening of resilience. Therefore, the problem of integration and advancement of the disaster management resource management system will come to the fore.

After the Great East Japan Earthquake, Japan introduced the “Urban Regeneration Safety Plan” to ensure the safety of residents in case a large-scale disaster occurs in the city center, and focuses on maintaining functional continuity through the operation of small-scale disaster prevention base facilities. Disaster prevention base in Japan does not define a branch, region, or facility as a specific object, but it means performing a base function that supports the overall recovery and reconstruction of the disaster-affected area from various viewpoints in the event of a disaster (Lee, 2022: 57). Therefore, as seen in the case of the Tokyo Rinkai Disaster

Prevention Park, it is common in Japan that the disaster prevention base is operated as a disaster prevention park that is used as an urban park and converted into a disaster prevention base when a disaster occurs (Jang, et. al., 2019). : 79-80).

On the other hand, the reason for the emphasis on regional disaster prevention base facilities is to improve the inefficiency and cost burden caused by stockpiling and managing disaster management resources by region, despite the differences in the types and development characteristics of disasters by region and the types and amounts of resources required. In preparation for disasters, the focus is on disaster recovery and relief services at the regional level, but in a situation where uncertainty due to disasters increases, it is to secure the continuity of the functions of resource operation and recovery support and relief services.

2.2. Functions of disaster prevention base facilities

The reason why a re-base facility is necessary is that it can play a role in minimizing damage caused by disasters and strengthening resilience through prompt support and recovery activities. In the case of large-scale disasters, the extent of damage can occur irrespective of the administrative unit, and in order to maximize response capacity to disasters that appear according to regional characteristics, an organic and integrated response must be made centered on disaster prevention bases. It is important to timely and efficiently supply and demand disaster management resources required in the response and recovery process. To this end, it is necessary to establish an integrated distribution system for disaster management resources that enables mutual cooperation centered on disaster prevention base facilities and to manage them from storage to delivery.

In this context, the function of a wide-area disaster prevention base required today can be inferred from the case of Japan. It can be broadly divided into normal functions and disasters. In the event of a disaster, there is an emergency disaster control tower, distribution and procurement of stockpiles, a relief goods relay base, a gathering place for support personnel, and a temporary evacuation space. The function is given so that it can be used (Ju, et. al., 2020: 230).

On the other hand, the main functions that Korea's disaster prevention base facilities should have when designing disaster prevention base facilities in the Busan area are presented as follows (Hwang, et. al. 2017: 167).

①A place where people who have suffered damage such as damage to their residence or flooding due to a large-scale disaster temporarily evacuate

②Storage of minimum food and daily necessities needed by evacuees after a disaster

③Storage of disaster prevention equipment necessary for rescue activities

④Collection and provision of disaster information, evacuation information, damage information, etc.

⑤Publicity base, such as posting and delivering news from the government and local governments

⑥Storage and distribution of relief materials such as food and daily necessities arriving from all over the country

⑦Medical support for injured and rescued persons

⑧Used as a temporary gathering point and base camp for relief goods relay bases and support units (civil service groups and military bases, etc.)

⑨Use as a space for disaster prevention-related seminars, education, and various experiences and training

⑩Usual facilities are opened to the public and used as a space for relaxation and various leisure.

2.3. Operational Status and Problems

Currently, there are three types of disaster prevention base facilities in Korea: a disaster prevention base center type, a distribution center type, and a stockpile storage type.

The disaster prevention base center type is an integrated management center for disaster management resources, which is a facility that plays the role of a regional disaster prevention base facility. It is operated in three places: Gyeonggi-do, Gangwon-do, and Ulsan. In the case of the Gyeonggi-do disaster prevention base center, it is a single warehouse facility capable of loading and unloading.

As for the disaster relief logistics center type, there are two disaster relief logistics centers (Paju, Hamyang) of the National Disaster Relief Association, which focus on the storage function of relief goods. This disaster relief logistics center goes beyond a simple warehouse function, and operates as a logistic center function such as operating earthquake and flood disaster experience programs in normal times, providing recovery equipment in case of disaster, or providing emergency relief kits, clothing, and residential facilities to the victims. carry out

The stockpile warehouse type is a stockpile warehouse operated by local governments across the country, and 66 locations have been installed and operated.

The weakness of these disaster prevention base facilities is that they lack continuity of facility, continuity of function, and continuity of resource operation. Therefore, not only financial waste and inefficiency in the process of storage and management of stockpiles, but also lack of mutual cooperation between disaster prevention base facilities and information on stockpiled materials are not shared at the stage of disaster occurrence, so supplies and delivery to disaster sites are not carried out in a timely

manner. shortage will occur. Therefore, it is necessary to rescue the disaster management resource integrated management system, and for the expanded function beyond the simple stockpiling and logistics function, the problem of rational selection of a location for a wide area disaster prevention base facility as a basis is emerging.

3. Location Selection Conditions and Techniques

3.1. Location Selection Conditions

Disaster prevention base facilities have the function of storing disaster management materials, distribution and recruitment of resources in the event of a disaster, dormitory and base camp functions for relief and recovery personnel, and control and management functions. Disaster prevention base deployment conditions are as follows (Lee, 2021: 58).

First, bases are placed in each side of the base where it is advantageous to secure the substitutability of transportation and transportation to access the disaster area.

Second, if a disaster occurs in the downtown area, the base should be placed in the periphery where the dense urban areas are connected so that confusion can be minimized and evacuation can be carried out quickly.

Third, in order to secure accessibility from other regional disaster prevention bases, the main deployment base is near the node of land transportation or where sea and air transport are possible.

Meanwhile, since disaster prevention base facilities must withstand disasters, the conditions that base facilities must have are as follows. First, in terms of convenience, not only recruitment of disaster management resources, but also access to transportation and information and communication infrastructure should be well equipped. Next, it is necessary to have safety management and protection capabilities to withstand the threat of disasters such as typhoons, favors, and earthquakes. Lastly, in order to minimize uncertainty in disaster situations, it is possible to secure alternative functions for transportation and transportation and to supply energy or water on its own.

3.2. Location Theory and Method

Location theory refers to the theory that explains the rational position of the design structure for the achievement of the desired purpose of corporations and public organizations (Yoon, et. al., 2008: 8). These theories are largely summarized in the theory of public goods, product differentiation theory, central place theory, and location decision analysis. In the theory of public goods, it is the view that public facilities should be located at the point that maximizes the user's convenience. The product differentiation theory is to ensure that the characteristics of public services, i.e., the number and scope of service areas according to differences in user preferences and income, and the monopoly of public services, are reflected in determining the location of public facilities. Central place theory is the view that since the center of the market becomes the maximum point of demand, the optimal location of facilities is the location of public services where the spatial distribution of users is concentrated just as companies are concentrated there. Location decision analysis emphasizes transportation and labor costs, which act as costs in any region, and considers the agglomeration economy as a location factor.

In conclusion, these theories select the location that minimizes the production cost as the optimal location. Based on this theory, it can be said that the location of public facilities is optimal at a point that minimizes travel distance and travel cost. However, in the case of an anti-hazardous base facility, considering the preconditions of disasters and disaster areas, it is impossible to simply travel distance and cost, and it must be a point that can guarantee accessibility and safety. It must be taken into account whether there is sufficient infrastructure for detours or alternative transportation and means of transportation to a specific point.

The site selection method includes a quantitative selection method and a qualitative selection method. First, the quantitative selection method, the GIS-based site selection method, derives an objective candidate site using empirical geographic information data. et. al., 2001). There is a comprehensive scoring technique that analyzes by assigning weights to location determining factors, and a location distribution model that draws more sophisticated analysis results using vector-type data. These models used for location selection of distribution centers are focused on the flow of logistics, efficiency, and economic cost reduction, so there are clear limitations in applying them to the location evaluation of disaster prevention base facilities that are absolutely subject to uncertainty such as publicity and disaster. .

It is a qualitative selection method that defines disaster prevention base facilities, sets types and achievement goals, derives location conditions and location factors, and selects the optimal location through the process of analyzing and evaluating their interrelationships. In this process, differentiated and different site selection procedures and methods can be designed, from regional disaster prevention base facilities to regional base facilities, taking into account the characteristics of disasters and regional infrastructure and capabilities.

On the other hand, from simple distribution warehouse-type facilities to disaster prevention park-type facilities, residents' acceptance attitudes will

vary greatly depending on the type and degree of use of disaster prevention base facilities. On the other hand, at the local government level, it will be approached in connection with the establishment of urban planning.

4. Conclusions

As we experienced a new level of natural disaster and the social disaster caused by the COVID-19 pandemic, we confirmed the limitations of the existing national disaster response system and realized the need for innovation. When a complex and large-scale disaster occurs, it is impossible for the government alone to provide prompt and efficient support for emergency response and emergency recovery activities. The government, acting as a control tower in a disaster situation, came to experience the importance of mobilizing all capabilities, including the private sector, and establishing a management system to quickly supply the necessary resources.

Against this background, this study aims to establish a disaster prevention base facility as an integrated management system for disaster management resources applying information and communication technologies such as AI and big data that are rapidly developing in preparation for a new type of complex disaster that we will face. This was to explore alternatives for selecting the optimal location for the city. In the case of regional disaster prevention base facilities, it is not limited to the function of disaster management resources as a logistics center, but it is intended to maximize economic reduction and disaster response capabilities through management efficiency and maintenance of supply and demand systems. It also means using it as a park to support leisure and sports activities in the surrounding area during peacetime and as a disaster preparedness education and training facility.

In this context, it is reasonable to view disaster prevention park-type disaster prevention base facilities as preferred facilities like welfare and cultural facilities that can provide welfare services with park functions, rather than disgusting facilities such as distribution centers or landfills. In this case, various location determination methods can be proposed, but a location determination method that can select a location that is safe from typhoons, heavy rains, or earthquakes, which are recurrent disasters in Korea, and has a detour road necessary for delivery of goods, would be preferable.

Therefore, it is inappropriate to select a location for a regional disaster prevention base facility simply by evaluating the spatial adequacy by means of a quantitative technique. The use of selection techniques including.

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Profile

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