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A NEW MANAGEMENT MODEL FOR HIGHER CAPACITY AND IMPROVED ENVIRONMENT IN EMERGENCY SHELTERS

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Abstract

According to a 2012 study in which the Tokyo Metropolitan Government estimated expected damage from an earthquake striking central Tokyo event, the number of evacuees across the 23 wards of Tokyo would exceed 3 million. If 65% of these people are evacuated into shelters, they would number approximately 2 million.

After the Kumamoto Earthquake in 2016, shelter operations were carried out mainly by the local governments. The evacuees' excessive dependence on local government became a serious problem. Ultimately, recovery depends on the autonomy of the affected population, but real autonomy is almost impossible in the immediate aftermath of a major earthquake. The living conditions, environment, and level of resources are initially too challenging: power failures, limited access to water and sanitary facilities, etc.

We think it is essential to establish a new, rational management model for large-scale shelters to prepare the cities of Japan for future earthquakes. Shelter alone cannot restore the lives of disaster victims, but stable shelter is an essential first step toward quicker recovery. Many of these shelters will need the capacity for 1,000 people or more. However, existing Japanese shelters do not have enough facilities or provisions for these emergencies, and there are not good metrics in place to evaluate the quality of life inside shelters.

Our research project aims to establish a new model for large-scale shelters and to apply this model to the construction of a new arena complex in Ibaraki Prefecture. The complex is designed to accommodate as many as 10,000 people displaced by the aftermath of a disaster such as a tsunami.

From interviews and surveys of those who have managed relief shelters in the aftermath of earthquakes – local officials, sports facility operators, and NPOs – we learn to classify management methods by the numbers of evacuees in a shelter. Local government officials and facility managers must cooperate in decision-making. A support network, including NPO members and shelter residents, is necessary to keep facilities running smoothly at an early stage. As the situation in the shelter progresses, its residents' autonomy should be encouraged in a phased manner. In the paper, we describe ways to enable the networking and cooperation of NPOs and shelter residents.

Sufficient seismic safety for buildings is only one part of disaster preparedness. We need measures of living conditions inside shelters. We also need to assess the cooperative network of local officials, facility managers, shelter operators, and NPO personnel. The paper also compares the environmental quality inside Japanese shelter facilities to international standards.

Keywords: Rational production of shelter operation; Large scale shelter; Residents autonomy; Local government; NPO

1. Introduction

In Japan, the imminence of the occurrence of the Tokyo Metropolitan Earthquake and Nankai Trough Earthquake are pointed out. According to a 2012 study in which the Tokyo Metropolitan Government estimated expected damage from an earthquake striking central Tokyo, the number of evacuees across the 23 wards of Tokyo would exceed 3 million [1]. If 65% of these people are evacuated into shelters, they would number beyond approximately 2 million (in case of the Northern Tokyo Bay Earthquake: 18:00 in winter, 8 m/s wind).

In the past, 270,000 people were evacuated to shelters one day after the 1995 Kobe Earthquake [2], 370,000 people in the case of the 2011 Great East Japan Earthquake [2], and 180,000 in case of the 2016 Kumamoto Earthquake [3]. Comparing with these cases, the expected number of people living in evacuation shelters in Tokyo will be overwhelming. Especially, in a large-scale evacuation shelter, it is necessary to respond to evacuees of an unprecedented scale. An evacuation shelter is a home to people who have lost their homes and lives. It plays an important role as a base for distributing information and supplies that support the lives of residents who are forced to live at home.

In the 2011 Great East Japan Earthquake, the government itself was paralyzed by the disaster, and the limits of public assistance when a large-scale wide-area disaster occurred became clear. Even after the 2016 Kumamoto Earthquake, an excessive burden on the affected local government in evacuation center management has been reported as an unsolved issue [4]. A similar situation is expected in the earthquake directly under the Tokyo metropolitan area, and how to make it possible for residents who become refugees to participate is critical for smooth evacuation operations [5].

Therefore, in this study, a new operational model that contributes to the smooth operation of evacuation shelters was constructed to apply it to a large-scale evacuation shelter for 10,000 people currently being constructed by a city, Ibaraki Prefecture.

1.1 Summary of target sports facilities

The target is a public gymnasium/sports facility in Ibaraki Prefecture, which is constructed on a large-scale park site that opened in June 2019. This is a Private Financial Initiative method in which design, construction, and maintenance are ordered collectively. In the event of a disaster, we are planning to prepare for disaster-prevention bases such as evacuation shelters and relief spaces for tsunami evacuation in advance, and the park has disaster prevention functions such as storage warehouses, water tanks, emergency toilets, and emergency benches with a cooking oven.

In the event of a disaster, this evacuation facility is designed to accommodate 10,000 temporary evacuees (1 m^2/person) and 2,000 medium-term to long-term evacuees (2 m^2/person).

The site area is approximately 29,000 m^2 (disaster prevention park is approximately 19 ha), the building area is approximately 13,500 m^2, and the total floor area is 19,000 m^2. The main uses of this complex building are gymnasium (main arena with 3 basket courts, 2,500 seats, sub arena with 1 basket court), indoor swimming pool (25 m × 8 m course), music hall (300 seats for spectators), storage room, training room, and conference room (Fig. 1). There are various rooms such as training rooms, Japanese-style rooms, cafes, exhibition corners, kids' rooms, and nursing rooms.

The facility diversion is planned in the event of a disaster. The edge space, "Lively Deck," that opens widely on the park side can be accessed from inside and outside the facility. "Communication Corridor" and the "Observation Deck" are located on the second floor, as usual. It serves as a temporary evacuation space and a relief center for accepting evacuees at the time of the disaster from a usual place of relaxation for citizens. The main arena, sub-arena, and bleachers serve as the living space for evacuees, and the music hall serves as a venue for explaining disaster response to the refugees. Electricity is provided by an emergency power source that can operate for 72 h, and a drinking water is stationed that can supply 4 L of drinking

water per person for 3 days to 10,000 people. Water required for other daily purposes such as to flush toilets will be obtained by converting water from the pool.

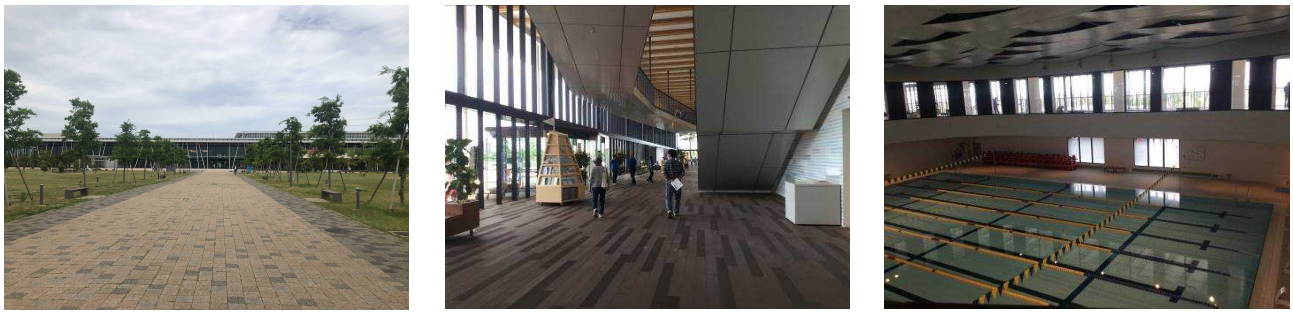

Fig. 1 – Arena

1.2 Methodology

For constructing an operation model for a large-scale shelter facility for 10,000 people, we surveyed and interviewed evacuation shelter operators and management organizations working after the 2016 Kumamoto Earthquake and the 2011 Great East Japan Earthquake and determined the most disruptive opening decision and operation during the initial period after the disaster.

The evacuation centers to be surveyed are the Mifune Town Sports Center, which served in the Kumamoto Earthquake, the Mashiki Town Gymnasium (both are municipal sports facilities), the Kumamoto City Local Government, the Sunatori Elementary School (school facility) in Kumamoto City, and the Big Palette Fukushima, which served in the Great East Japan Earthquake (industrial exhibition hall). In July and November 2017, seven people were interviewed, including facility managers, administrative staff, and residents who were involved in the operation of each shelter (Table 1).

Table 1 –Survey outline

	Survey target		Date	Main survey contents
	Facilities and organizations	Affiliation/Post		
1	Mashiki Town Officials	Urban Construction Division	July 2017	· Facility damage · Assignment and role sharing of evacuation center management · Opening of evacuation centers · Accommodation/reception of refugees/number of people · Life rules · Transmission and sharing of information · Autonomous operation by evacuees · Management of toilets, water, food, and supplies · Health and hygiene management · Consolidation and closure of evacuation centers ·Advance preparation ·Future tasks · Characteristics of evacuation centers and areas · Other
2	Kumamoto City Officials	Office of Crisis Management and Disaster Prevention, Economic and Tourism Bureau		
3	Kumamoto YMCA Mifune Town Sports Center	Chief		
4	Kumamoto YMCA Mashiki Town Gymnasium	Director (at that time)		
5	Kumamoto Disaster Volunteer Group Network (KVOAD)	Representative	July 2017	
6	Sunatori Neighborhood Association, Fire Brigade	Chairman, Secretariat		
7	Big Palette Fukushima	Operation supporter after one month at the request of the prefecture	Nov. 2017	

2. Operational status in the initial period by scale of shelter facilities

Depending on the peak number of people living in the evacuation shelter, the operation types are divided into small (about 250 people), medium (about 1,000 people), and large (about 2,000-3,000 people), (Table 2). Also, the outline of the facilities stated in the table was supplemented by public information.

2.1 Overview of small and medium-scale shelters and operation of shelters

2.1.1 Mifune Town Sports Center

This facility is in charge of designated management by three management enterprises, including the Mifune Town Sports Center, and its representative is Kumamoto YMCA. During the previous earthquake (April 14, 2016, at 21:26), the main arena, was damaged by the ceiling drop and thus was not used as an evacuation center.

However, because the adjacent designated evacuation center was damaged by a dropped ceiling on the 16th main-shock, the refugees were moved, and the shelter operation started of a small size comprising 258 evacuees. As shown in the column “Status of operators and residents' autonomy” in Table 2, the operation was conducted by the designated manager, with the local government making a major judgment and the site manager making the judgment at the site. Furthermore, regarding the situation related to management, support staffs with experience from YMCA have been in operation nationwide, and the management members are aware of the independence of residents from an early stage. By listening to and talking to the evacuees, the operators created an atmosphere where people help each other, before shifting to the autonomy management of residents with the help of experts.

Such a small shelter (for about 250 people) is easy to manage by a designated manager or residents. Furthermore, the transition from management by facility managers or officials to resident autonomy is easy for the management. In particular, whether a smooth operation is plausible depends on the fact that the managers are aware of residents' autonomy. From this point, it is evident that appropriate leadership and operational knowledge of the subjects are crucial.

2.1.2 Sunatori Elementary School in Kumamoto City

Sunatori Elementary School is a government-designated evacuation center in the city. After the earthquake, the gymnasium was damaged, but that did not have an effect on any other part of the building. Hence, the principal of the school came immediately to open the evacuation center and accept the refugees. At the time of the foreshock, approximately 800 townspeople were evacuated to the gymnasium, and at the time of the mainshock, more than 1,000 people had gathered on the sports ground.

Regarding the management, according to a resident survey, the Sunatori Elementary School evacuation shelter was managed by the residents' autonomy, including nine chair members of the nine resident associations, members of the local welfare committees, community activity centers, doctors and nurses, fire brigades, junior high school students, etc. Here, various type leaders emerged from local human resources, and a human network to assign roles functioned. Each living area of nine residents' associations was divided into spaces in the shelter and served as a regional disaster prevention base, and a mutual assistance system was adopted. It can be seen that it was not so dependent on the power of the local government because of the close connection through festivals in the town and school districts.

Table 2 – Overview of evacuation center facilities and operation status in the initial period by evacuation center size

Number of evacuees at peak	Shelter	Facility overview **	Initial refugee accommodation	Opening period	Features of evacuation centers and operators	Status of operators and residents' autonomy	Operational status
About 250 people	**Mifune Town Sports Center**	RC structure 2 stories above ground Total floor area 6,183 m2 --- Arena 1,583 m2 Heated pool 25 m Martial arts field Kendo hall 11 × 11 m Judo hall: 128 tatami mats	* Evacuate in corridors, trance halls, meeting rooms * Approximately 1 tatami per person	16/04/2016-31/10	Not a designated shelter Judgment that the ceiling fell and it could not be used, but it became an evacuation site at the request of the town Facility manager	Although the town decided the big decision, the facility manager took charge of the operation while making decisions on the spot * The atmosphere of helping evacuees has been created through the efforts of the facility manager (such as calling out). * From June, it shifted to independent operation with the support of an external expert (NPO)	* Allocated space at the discretion of the town, adjusted in YMCA and each group * They held evacuation officer meeting * They have experienced staff members who support us from YMCA * In order to grasp the number of people, operators interview about the number of households around one week * After a few days, the management side was aware that the residents would be independent * The management listened to the evacuees * The voice helped to create a mood to help. For example, a staff member used to fill the toilet, but a college student (evacuee) helped. Cooking was done in a way that came to pick it up, not to distribute it * It was prostrate for three days, but we decided to have shoes removed in the lobby by contact from the health center * A footbath was implemented as the Rescue Stockyard proposal * Mental and health care was difficult. Initially a health center, and then a medical team came to watch twice a day * At the evacuation center consolidation in June, with the support of the Rescue Stockyard, the operation side created rules for self-management, group formation of 6 groups, team leaders, cleaning, meals, etc., and held briefing sessions in advance did. operators persuaded the town staff
About 1,000 people	**Sunatori Elementary School**	--- RC structure 3 stories above ground 2016: 17 class 258 children	(14/4) 800 people including car and gym (16/4) 1,000 people or more. Open the corridor with no footsteps. There was no place to make a passage	14/4/2016-6/5	Designated shelter Areas with strong neighbor connections Resident autonomy	* Self-management was successfully carried out by the network in the area centered on the residents * Managed as a group change, such as 9 town chairpersons and local welfare officers	* Residents have a strong local network, and were responsible for cooking volunteers by fire brigades, NPOs and young monks, organizing supplies by junior high school volunteers, watering evacuees, cleaning toilets, transporting meals, etc. * Diverse human resources played various roles, including nine members of the self-government chairman, members of the local welfare committee, people at the Regional Comprehensive Center, hospital doctors and nurses (healthy gymnastics) in the town * Measures have been taken for persons requiring special care, such as providing rooms for pets, parents and children, pregnant women / disabled persons, and people with dementia. In addition, we noticed the distribution of meals to refugees at home, indicating that the evacuation centers had become a disaster prevention base in the area * A mutual assistance system was found in the town and local areas, such as the division of spaces in each town
2,000-3,000	**Mashiki Town General Gymnasium**	--- RC 2 stories above ground Total floor area 8,680m2 Main arena Sub arena Martial arts field Multipurpose room Meeting room 1, 2 Waiting room 1, 2	* They refrained from entering the main arena and sub arena, and put them in the martial arts hall, meeting room and corridor * There was only one tatami room per person (14th) * 15th morning: 250 people 16 days afternoon more than 1,000 End of May 1,700-2,000	16/4/2016-31/10	Facility which is not designated evacuation center, but has resident manager Facility manager	* The facility manager (YMCA) was in charge of the actual operation, but proceeded while checking the decision of the town * There was no sign of residents' autonomy	* It is operated by 10 YMCAs + several government offices, 2 Tokyo YMCAs, and staff, requesting support from YMCAs nationwide, and it can be seen that the operation emphasized external support mainly by facility managers * Requesting 16-17 people to volunteer center exclusively for toilet cleaning * They realize the importance of "supporting power" that connects professionals and people * Operating staff assigned roles and established the operating system, and held two meetings a day with operators, aiming to share information between operators * Evacuees were managed on a family basis, had them fill out a list, and distributed meal tickets on a family basis for fair distribution * There were issues such as tent safety management, toilet, shower room management, etc.
	Big Palette Fukushima	S + SRC + RC 4 floors above ground, 1 floor below ground (International exhibition hall, conference room facilities) --- Multipurpose exhibition hall 5,495 m2 Hall A 1,670 m2; B 1,444 m2; C 2,375 m2 Small meeting room 160 m2; 262 m2; 366 m2 Middle meeting room A 180 m2; B 180 m2 Training room 128 m2 Restaurant 100 seats	* Entered on the 1st, 2nd, and 3rd floors (including passages), the 4th floor was catastrophic and did not include a large hall * (11/4) The evacuees were crowded at about 50 cm in the passage	16/3/2011-31/8	Local governments	[Initial period] * The town was operated by about 150 people, but there was no control tower and it was confusing * The residents were lethargic [1 month later] * Special staff of social education dispatched from the prefecture intervened and restructured the operation system * Self-government was born by creating a mechanism for residents' self-government	[Initial period] * Information could not be shared between operators * Securing a means of communicating information to evacuees by networking with local radio stations [1 month later] * Established a system to share information among operators by reviewing and modifying the organization * To protect lives, laying out the residents, securing evacuation routes, creating a floor map, creating a list of evacuees, isolating infectious disease patients, moving from a place with poor hygiene, and improving the basics * In the next stage, as a mechanism for self-government activities, we created a place for exchange such as a salon and a women-only corner, and also developed a project to encourage male participation as a support for living recovery

** Each facility outline is based on the following public information
Mashiki Town General Gymnasium: Rinkai Nissan Construction and Construction Results (https://www.rncc.co.jp/portfolio/268), Big Palette Fukushima: (http://big-palette.jp/04charge/index2.html), Sunatori Elementary School: School education information site (http://www.gaccom.jp/schools-35028/students.html), Mifune Town Sports Center: Mifune Town Sports Center Management Specifications (http://portal.kumamotonet.ne .jp / town_mifune / life / upload / p1910303_1030_22_g60owkuj.pdf)

Based on the above data, in medium-scale shelters of up to about 1,000 people, the success or failure of shelter management depends on how mature the local community is before the disaster and how many local leaders appear. In areas with strong community strength, it was found that residents' associations' management functioned from the beginning.

2.2 Operation method in large-scale shelters

2.2.1 Mashiki Town General Gymnasium

The Mashiki Town General Gymnasium was a wide-area evacuation site, but the gymnasium itself was not a designated refuge. However, as evacuees gathered from the time of the foreshock, acceptance by the designated manager YMCA began. The evacuation shelters at peak hours are large-scale shelters of about 2,000 people, including overnight stays in the gymnasium and tent villages outside.

As for the operation, the facility manager was in charge of the actual operation while confirming the judgment of the Mashiki Town government. Here again, the designated manager requested support from YMCA nationwide to secure human resources and divided the roles to prepare the management system. Adopting a method to receive support for the operation method at the time of the disaster, the staff was able to take a shift system from the 24-hour operation. In the operation of such a large-scale shelter with more than 1,000 people, it is necessary to support intermediate organizations such as specialized human resources and organizations that can provide advice and practice, like NPOs.

Also, the municipalities also made several efforts to encourage residents to operate autonomously. However, it was not able to move quickly because the president of the residents' association was very aged. As attempts such as assigning roles to residents were made later, residents' autonomy could be built later.

The designated manager discussed the establishment of a shelter with the town officials after the foreshock and the building was lightly and was decided not to use the main arena. Building damage occurred due to the mainshock, and human damage to evacuees was prevented by appropriate risk judgment by the facility manager. Protecting human lives is a major role, especially at evacuation centers in the early days, so it is necessary to have an operating entity that can appropriately control the situation. It is important to complete the end of the shelter closure.

2.2.2 Big Palette Fukushima

This facility became a refuge in Koriyama City during the 2011 Great East Japan Earthquake. It is a complex convention facility with a total floor area similar to that of Mashiki Town General Gymnasium. Although it was not a designated evacuation center, it is located less than 60 km from TEPCO's Fukushima Daiichi Nuclear Power Plant, accepting evacuees from Tomioka Town and Kawauchi Village in the precautionary area, and the largest center in the prefecture that accommodates 2,500 people at one time.

This is an administrative-led evacuation center, which was set up and operated by the local government. However, there was no control tower, the state was confused, the inhabitants were lethargic, and self-government by the inhabitants did not occur spontaneously. A month later, a specialist in social education dispatched from the Fukushima Prefecture rebuilt the operation by revising the management organization and reorganizing the tenant and built the resident autonomy system in stages. At this time, the support decision of the prefecture government that sent experts to the local government and the existence of external experts who were good at building residents' autonomy was the key.

3. Judgment on the establishment of shelters and the basis

Because shelters have the role of protecting the lives of victims, it is necessary to first determine the status of shelters that may cause secondary damage, and then determine whether shelters can be opened and whether

they can be accepted. Therefore, from the three cases of the Kumamoto earthquake and other earthquake, which was able to grasp the situation at the beginning of the establishment, we focused on the decision making at the time of opening the shelter immediately after the most confusing disaster and grasped who went and how (Table 3).

Table 3 –Damage to evacuation facilities, safety confirmation, and evacuation status

Shelter	Facility damage	Status of safety confirmation, establishment of evacuation shelters, and evacuees acceptance
Mifune Town Sports Center	* Ceiling panels fall due to aftershocks * There is no ceiling of the martial arts hall * Power outage is restored immediately * No water	[After foreshock] * Checked the safety of the user and asked him to return * There were no residents evacuating * The ceiling of the arena had fallen due to aftershocks, then the facility manager decided that it could not be used * Facility manager judged that we did not use sports center in town and did not become refuge * Closed due to facility cleanup [After the main shock] * The ceiling of the martial arts hall did not fall * There was a request from the town and operators waited, and the Board of Education also came * There was an instruction to move from the government office to the sports center, and evacuees came in * Facility managers had evacuees evacuate to corridor, entrance hall, meeting room of sports center
Sunatori Elementary School	* The gymnasium was newly built and had no ceiling panels, so there was no fall * Power outage is restored immediately * Water outage recovered in one week	[After foreshock] * The school principal checked the damage to the gymnasium and confirmed that there were no abnormalities. * The principal came immediately, unlocked the gymnasium, and the evacuee entered. [After the main shock] * We decided to open the corridor on the first floor of the school building when there was no footsteps.
Mashiki Town General Gymnasium	[Foreshock] * A part of the ceiling panel of the arena falls [Main shock] * Arena ceiling panel collapsed * Power supply is almost down * Recovery about 3 days later	[After foreshock] * Escape delay, confirmation of injury * Evacuees came in the night * Because evacuees naturally gathered, we started from where we once accepted * Since it is not possible to judge the safety immediately after the disaster (in the town), we said, "Please enter at your own risk." * Because it was cold, people could not afford to spend outside. Some were elderly * I was told that I was evacuated * Administrative people also came to confirm safety and accepted the martial arts grounds * There was a request to put it in the main arena and sub arena, but we refrained from consulting with the facility manager * It was lost in the arena, and the panel on the ceiling had fallen due to the foreshock. Local government officials asked if they wanted to make the arena an evacuation center. However, they thought that it was dangerous because of their intuition as a manager, so they consulted with the director over the phone and said, "You should stop." Policy to stop if you get lost * Entering the room with low ceiling, conference room and corridor * We accepted martial arts hall, lobby, meeting room as evacuation center * There was only enough space for each person

3.1 Status at the time of opening each shelter

3.1.1 Mifune Town Sports Center

This municipal sports facility is not a designated evacuation shelter before. At the time of the previous severe earthquake on April 14, the facility manager confirmed the safety of the users and returned home. He also looked around the facility and determined that it could not be used as an evacuation center because the ceiling of the main facility arena had fallen. At this time, Mifunemachi town decided to use other facilities as shelters and not use this facility. There are no evacuees and it is closed to clean up the facility. However, at the time of the mainshock, there was a request and instruction from the town to accept the evacuees due to the fall of the ceiling of the cultural center, which was the designated evacuation center, and the evacuees moved. Here again, the facility manager accepted the evacuees and placed them in the corridors, entrance halls, and conference rooms where there was no dropped ceiling.

3.1.2 Sunatori Elementary School in Kumamoto City

The elementary school is a designated evacuation center, and the city and the school were supposed to manage the disaster. Since the gymnasium was newly built, there was no ceiling panel, and no fall damage occurred.

The school principal came immediately after the foreshock, confirmed that there was no abnormality in the gymnasium damage, decided to open a shelter, and reported to the Board of Education and the president of the self-government. After that, the neighborhood association was mainly responsible for the operation, but the school principal made the safety checks, the decision to open, and the initial decision to unlock.

Residents were evacuated to the facility according to the disaster prevention training and they were accepted. At the time of the mainshock, there was already no congestion, and the corridor was open.

3.1.3 Mashiki Town General Gymnasium

This facility is an exercise facility operated by the town and not a designated evacuation center. However, there were still users at the time of the foreshock, so the facility manager went out and confirmed the structural safety immediately after the disaster. Evacuees gathered included some aged people who were cold at night. The town officials also rushed to check the safety, but could not judge the structural safety, and were asked to enter the shelter at their own risk. The evacuees requested that they enter the main arenas, but some of the ceiling panels were falling. The local government officials said that the arena should be an evacuation center. However, the facility manager was at a loss and thus consulted with the director over a phone call and decided not to use it owing to the fear of falling ceiling. Lived were prioritized and avoided danger caused by structural or secondary members' damage. They asked people to enter rooms with high ceilings, conference rooms, corridors, and lobby and accepted them to the dojo after confirming safety. During the subsequent mainshock, the arena's ceiling fell, and secondary damage could have been prevented by the appropriate judgment by the facility manager.

It can be seen that the facility manager and the local government have led the establishment of a shelter for the decision to use a building that is directly related to life and death. Mashiki town decided to open as an evacuation center, and the facility manager judged the damage situation of the facility and played the role of ensuring the safety of the users and the evacuation facility.

3.2 Judgment on the establishment of evacuation shelters and acceptance of evacuees and the grounds

The judgments and grounds for establishing shelters and accepting evacuees in the above three shelters are summarized as shown in Fig. 2. It can be seen that the establishment of shelters has been dealt with based on the judgment of using shelters, partially using safe places, not using shelters, or partially using dangerous places. There were multiple grounds for the decision, as shown in the figure, for only three facilities. These can be summarized into four factors, physical conditions, evacuees' conditions, weather / time conditions, and judgments / instructions by town and facility managers.

First, as shown in Fig. 2, the physical conditions correspond to the fact that the main room could not be used due to the fall of the ceiling panel, and that it was necessary to clean up. Even when partially used, it became clear that evacuees were put in a safe place on the grounds of falling ceilings. It can be seen that the structural safety was not confirmed immediately after the disaster.

Next, in the situation of evacuees, even if the facility is not designated as an evacuation center, it cannot be refused due to the fact that the evacuees are evacuating and there are elderly people who need consideration. There was no situation. In particular, facility managers faced situations where they had to

accept evacuees on the scene, and were involved in life and death. In the situation where there is no room for selection of whether to accept or not to use the facility, it was decided to respond.

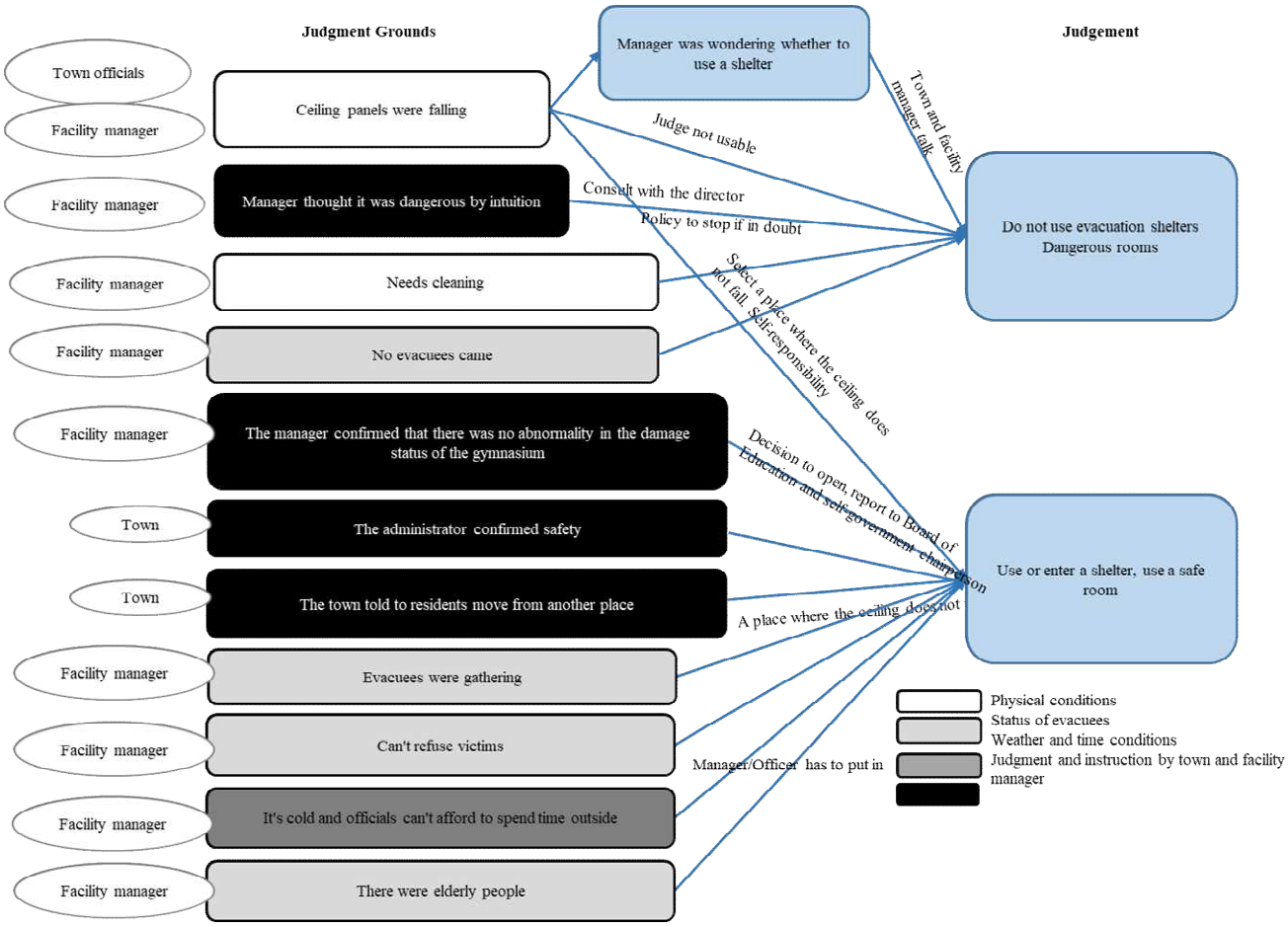

Fig. 2 – Grounds for evacuation shelters and evacuees' acceptance and judgment

In the third weather, time, or bad conditions such as cold at night apply. It was found that the condition of the second evacuee overlapped with this, which led to a situation where it was more urgent to accept the evacuees.

According to the judgment or instruction by the town and facility manager in the fourth, in the case of sports facilities, the town decided or instructed to open a shelter, and in elementary school, the school principal decided to open. In addition, the facility manager perceived the danger by intuition and decided not to use the dangerous place. In particular, since life-related judgments are involved at the time of opening, it is important that the town officials can make the opening judgment correctly after the site has grasped the situation. If the town officials are unable to go to the site, it is difficult to confirm the structural safety of the enclosure immediately after the disaster, and it is necessary to make an appropriate decision while consulting with the site.

3.3 Large-scale shelter management from the scale and time axis

Based on the evacuation center operations that we have seen so far, the relationship between the operator and the supervisor and the residents' self-government needs to be considered both in terms of the size and time axis of evacuee residents (Fig. 3).

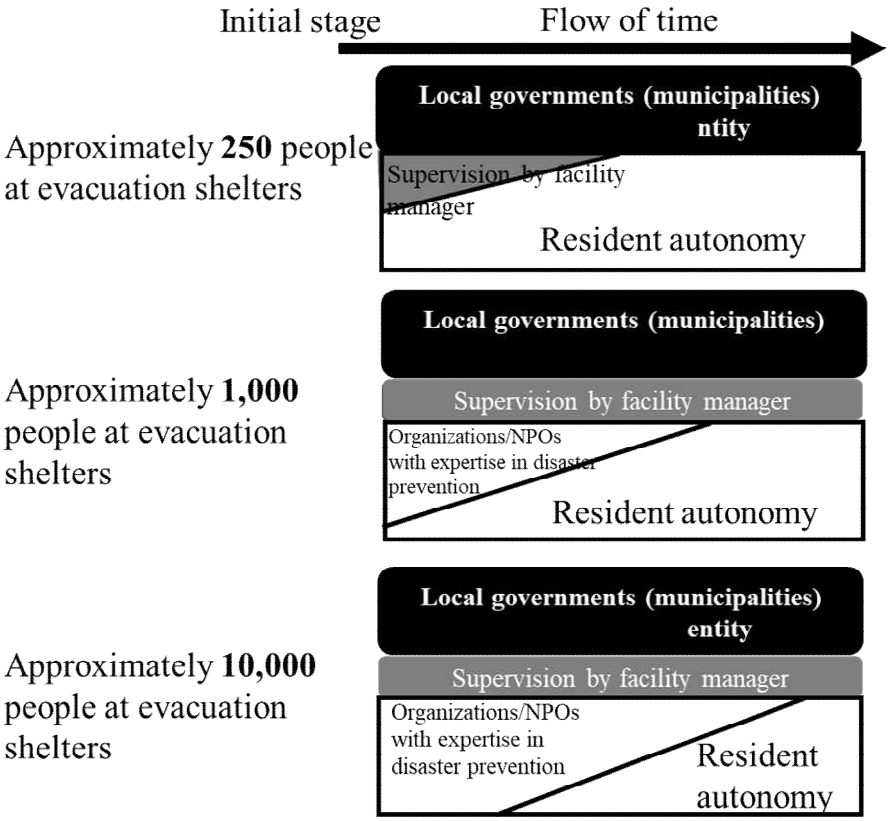

Fig. 3 – Relationships between decision-makers, supervisors, and residents' autonomy by size and time axis

From the viewpoint of residents' autonomy, organizations with experience and know-how must begin to supervise the shelter opening and initial operation in shelters where the number of shelter residents exceeds 1,000. In the case of a large-scale public facility such as a sports facility, a designated manager who has already worked is often used to coordinate the site with the local government.

On the other hand, local governments need to fulfill their responsibilities as decision-making bodies at any size of the shelter. Also, since the designated manager must have a method of judgment and operation in an emergency, it is desirable to operate with the help of supporters, organizations, and NPOs. In large-scale shelters, it became clear that it was difficult to run the operation by residents from the beginning. Step-by-step management is desirable, such as moving to a management system that encourages residents to participate while looking at the timing and builds residents' autonomy.

4. Conclusions

As a basis for practical research that contributes to the smooth operation and design of large-scale shelter facilities, the following findings were obtained from interviews with evacuation site operators.

The situation of the manager of the shelter and the ease of establishing self-government differ depending on the number of shelter residents, indicating that it is necessary to grasp the evacuation shelter management method over time axis and by size. In terms of the number of people, about 1,000 people will be the turning point from the viewpoint of residents' autonomy. If the number becomes more than that, it is necessary to supervise the status of non-residents, such as designated managers, and to organize organizations that assume the support of organizations with specialized knowledge and NPOs. Regardless of the size of the shelters, leaders are indispensable for residents' autonomy. It is difficult for leadership to function suddenly during a disaster, and cooperation between local communities, facilities, and local governments is indispensable from normal times.

Regarding the role of the operator, in the initial period immediately after the disaster, the facility manager is indispensable as the operation supervisor and plays the role of bundling facility users and evacuees, and plays a role in the site that is directly linked to ensuring security and lifesaving.

In many cases, local governments are supposed to open evacuation centers according to regional disaster prevention plans. In this study, local governments played a role in determining the structural safety of evacuation sites. Regardless of the size of the evacuation center, the local government will properly judge the facility manager's on-site judgments related to weather and time, etc., to accurately determine the status of damage to facilities related to the lives of evacuees and decide on opening. That decision-making skill is strongly required.

Also, especially in large-scale evacuation centers, it is difficult to operate by self-government from the beginning. It is desirable to gradually move to self-government promptly. In the early days, it is necessary to connect with people with mobility in the evacuation center from everyday time. It is important to quickly build the necessary human resources networks, such as organizations with disaster prevention expertise and NPOs.

5. Acknowledgments

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