

An extended abstract (1,200-2,000 words)

■ Title

The evaluation reduced the total travel time of emergency transport by reorganization of fire stations in Kyoto Otokuni Area.

■ Study objectives

The population of Japan has been declining since 2004 and the average age of the population is expected to become increasingly older. Consequently, the number of people aged 15 years and younger and the working-age population (aged 15 to 64 years) is expected to decline. Therefore, the formation of sustainable local communities is required in each region, and ensuring the sustainable provision of administrative services to support these communities is an important issue.

In this study, we consider the issue of one of these administrative services—emergency services provided by fire departments. The number of emergency calls in Japan has been increasing every year while the population has been decreasing, and has doubled in the past 20 years. Emergency services must continue to fulfill their responsibility to protect the lives, health, and property of residents by promptly responding to changes in the environment affecting emergency services, such as the diversification and scale of disasters and accidents, the increasing complexity of urban structures, and the diversification of residents' needs.

In this context, the following challenges arise: how to respond to the rapid increase in the number of emergency calls, which has doubled in the past 20 years; how to ensure the level of residents' services, such as emergency transport, considering the limited number of personnel, facilities, equipment, and vehicles, and the severe financial situation; and how to specifically implement the reorganization and integration of fire stations.

■ Contributions of the paper

In order to solve these various challenges, we think that it is very important to first quantify and demonstrate the burden of work undertaken by the fire departments. A qualitative discussion will tend to follow the existing policies, which will increase the possibility that discussions on the reorganization and integration of fire stations will not proceed. Moreover, in the case of multiple fire stations, it is important to think quantitatively about how to balance and distribute the work. This is important from the viewpoint of risk diversification and as well as to maintain the motivation of those who are engaged in the work. In addition, it will provide very meaningful basic data for making policy decisions related to the reorganization and integration of fire stations.

■ Methods and data used

Based on this background, the purpose of this study is to quantitatively discuss the following topics, focusing on the Otokuni Fire Department, which has jurisdiction over the Otokuni area and includes two cities and one town—Muko City, Nagaokakyo City, and Oyamazaki Town—in Kyoto prefecture in Japan.

First, we constructed a system to calculate the travel time from the fire station to an emergency request located on a road network in the Otokuni area. By using this calculation system, we could calculate how the travel time from the fire station would vary if the location of the fire station changed, and calculate which fire station is the closest to an ambulance request in the Otokuni area.

Second, based on the actual data of emergency services provided by the Otokuni Fire Department in 2016, we quantitatively showed the current status of emergency transport operations, such as the number of emergency transports, travel time from the fire station to the location requested by the ambulance, treatment time required on location, and the travel time required to arrive at the hospital. We also examined the personnel allocation and ambulance allocation for the Otokuni Fire Department. Ideally, the closest fire station would respond to all ambulance requests in the Otokuni area. However, it could be the case that there is a request for emergency transport in a large city in the Otokuni district and another emergency team is forced to provide this transport if the nearest emergency team is unable to respond. In this study, we defined this situation as "supporting emergency transport" and the ratio of the number of supporting emergency transports to the total number of emergency transports as the "supporting emergency transport ratio." We calculated the "supporting emergency transport ratio" in the Otokuni Fire Department and analyzed the factors that led to supporting emergency transport being required.

Finally, in the case of the three current fire stations and one sub-station being reorganized into three fire stations, we quantitatively showed how this would affect the "supporting emergency transport ratio," the total travel time for the Otokuni Fire Department, and the total travel time for each emergency team. If the total arrival time is reduced, the burden of each emergency team is reduced. In addition, the rate of lives saved would increase. This social benefit is generally referred to as the benefit of increasing the rate of lives saved. In this paper, we examine how the benefits of improving emergency medical services would be affected by decreasing supporting emergency transport when the fire stations in the Otokuni Fire Department are reallocated or reorganized. Based on the above discussion, we summarized the issues involved in the reorganization and integration of fire stations.

■ Results and conclusions

In the Otokuni Fire Department, the Muko fire station is responsible for 92.8% of emergency transport in the area where the Muko fire station is the closest station to the ambulance requests. On the other hand, other fire stations (Nagaokakyo fire station, East sub-fire station, and Oyamazaki fire station) are responsible for approximately 60% of the emergency transport in each area. The current supporting emergency transport ratio is 29.2%. Therefore, the burden of ambulance requests in the area of the Muko fire station is covered by the supporting ambulance service of three fire stations, other than the Muko fire station. That is to say, by appropriately allocating personnel and vehicles to the Muko fire station, the ratio of support ambulance services and the burden of ambulance requests in the Muko area will be reduced. As a result, the burden of ambulance requests on the entire area will be reduced.

Next, the total travel time of the Otokuni Fire Department is 41,659 minutes/year in the current system of four fire stations. but it increased to 43,896 minutes/year in the integrated system of three fire stations when the ratio of supporting emergency transport was equal to the current system of four fire stations. This means that the current level of ambulance transport is lost unless the ratio of supporting ambulance transport is reduced. Therefore, it is necessary to consider the deployment of personnel and other measures to reduce the number of backup ambulance transports when the number of fire stations is reduced to three. In addition, the total travel time would be 38,515 minutes/year if all emergency transports that occurred at the three fire stations could be carried out in an ideal manner. As a result, in the case of four fire stations, we show that reducing the percentage of emergency medical evacuation support from the current level would lead to a higher level of emergency medical evacuation. Also, in the case of three fire stations, we show that emergency medical evacuation levels could be maintained at the same level as the current situation if the supporting emergency transport ratio in Otokuni Fire Department is 15% or less.

Finally, the total travel time could be reduced by 4,385 minutes when the transport is performed by the four current fire stations, which translates into a reduction of approximately 42 seconds per transport. The annual benefit of this improvement would be 389 million yen per year. Furthermore, the total travel time can be reduced to 3,144 minutes when the transport is performed by the integrated system of three fire stations. The annual benefit of this improvement in emergency medical services is 279 million yen per year. This value is considerably larger than the annual cost reduction of 0.27 billion yen per year at the time of the reorganization, and we quantitatively demonstrate the importance of reducing the ratio of supportive emergency medical services through the appropriate allocation of personnel and vehicles.

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