

Congestion Monitoring System for Infection Control Measure

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This article describes the congestion monitoring system provided to the Olympic and Paralympic Games Tokyo 2020, focusing on two distinctive points: first, the service was provided in a short period, and second, the project progress and system operation was under an exceptional environment, during the infection spread period of the coronavirus disease 2019.

Keywords : Social distancing measures, Congestion monitoring, Behavior change

1. Background of the Introduction of the Congestion Monitoring System

The Olympic and Paralympic Games Tokyo 2020 (hereinafter referred to as “Tokyo 2020 Games”) scheduled for 2020 were postponed by one year to summer 2021 due to the spread of the coronavirus disease 2019 (COVID-19) infection. In addition to the original plan, it was necessary to prepare for the Games keeping COVID-19 in mind. And an additional budget was created as a measure in the December 2020 supplementary budget. The congestion monitoring system shown in Figure 1 was introduced as a social distancing measure.

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1.1 Short-term Implementation after the Decision to Introduce the System

The adoption of the congestion monitoring system was officially decided at the end of March 2021. This project had to build and deploy the system locally in about 3 months.

1.2 Globally Recognized Measures against Infectious Diseases

Avoidance based on “SANMITSU” has been proposed as a measure against infectious diseases in Japan⁽¹⁾. “SANMITSU” means “avoiding gatherings in crowded places, close-contact settings, and enclosed spaces”. WHO also called for the “3Cs” in July 2020, which are the same as the “SANMITSU in Japan⁽²⁾”.

2. Congestion Monitoring System and Project Management

This section provides an overview of the congestion monitoring system, tasks and solutions, and how the project is progressing.

2.1 System Implementation

It was decided that the congestion monitoring system

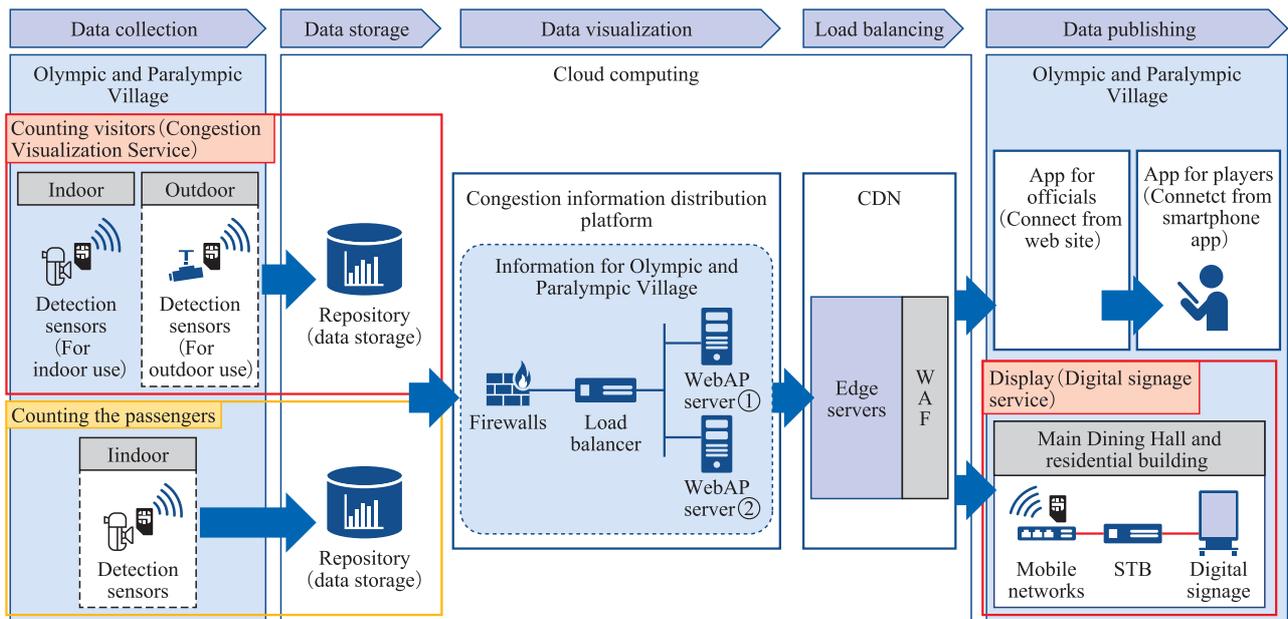


Figure 1 Overview of Congestion Monitoring System

planned initially would be built for the Games. However, there were challenges in terms of delivery time and cost. The system utilized an existing cloud service to overcome these issues. This led to the introduction of a congestion monitoring system that could be implemented in a short period and solve the installation issues.

2.1.1 Installation Issues

Initially, a plan to use network cameras was considered for the congestion monitoring system. Most of the facilities prepared for 2020 had already been constructed at the time of the study. There were problems in constructing additional networks and other infrastructure facilities regarding cost, physical coordination (e.g., securing conduits), and construction period.

2.1.2 Solutions

To address this issue, the existing “Congestion Visualization Service” using mobile networks was adopted to solve the network installation issue, and construction work was kept to a minimum for power supply and sensor installation. In addition to the “Congestion Visualization Service”, Digital Signage Service” and “Passer-by Counting Service” were used for short-term implementation. The lack of functionality was addressed by minimizing customization and designing a system to meet the operational needs of the Games. As a result, the services solved the issues of short-term implementation and achieved low-cost implementation.

2.2 Project Progress

This project was not only a large-scale event but also faced different constraints and risks than usual under the circumstances of a global pandemic.

2.2.1 Requirements for This Project

- Construction in a short period of about 3 months, until June 2021.
- Low-cost implementation
- Security and content design must comply with PJ standard
- To be understood worldwide as a measure for infectious diseases.

2.2.2 Approach to the Requirements

To manage the progress of multiple teams, a “Work Breakdown Structure (WBS)” was used to visualize the tasks and team status of the entire project. In addition, agile development was used to adjust to the requirements, and Daily Scrums were conducted to ensure that the schedule was maintained while the situation changed day by day. We have assigned quality control experts to ensure the quality of the project.

2.2.3 Progress of the Project during the Pandemic

The first state of emergency was declared during the project period on April 7, 2020.

Project members were restricted in their activities; therefore, they had to communicate more closely to keep

the project moving forward. Measures were necessary to prevent infection among project members during processes that required on-site response, such as preliminary inspections to determine sensor installation locations, installation work, and subsequent testing.

2.2.4 Measures during Site Work

A detailed work plan was made for the site and preliminary inspections, considering routes between target areas, and rehearsals were conducted. In addition, the number of people was narrowed down by subdividing an area into smaller areas for sensor detection testing. The members who worked on the site reported daily their temperatures and physical condition during the work period to avoid the risk of the project shut down due to infection and the risk of being placed in quarantine at home in the event of heavy contact.

2.2.5 Other Measures

To prevent congestion by workers on-site, we ensured that no more than four people were present in a group during meetings, dismissal, and waiting at the site. In addition, heat stroke measures were also prioritized by increasing the number and duration of breaks because the site tests were conducted under high temperature and humidity conditions.

2.3 Information Provision Mechanism

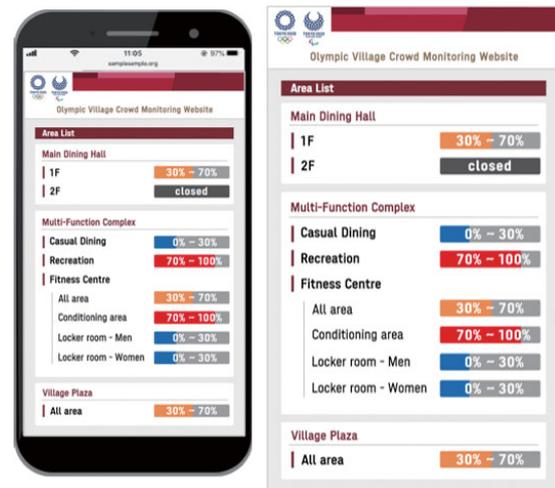
For conveying the detected congestion information in real-time to the athletes and other people involved, consideration was given to the diversity and ease of understanding of the information.

2.3.1 Diversity of Communication

Digital signage was installed in the lobbies, main dining hall, casual dining room, and fitness centre of the athletes' residential building in the Olympic and Paralympic Village. For example, when athletes leave the residential building for a meal, they can check the digital signage in the lobby to find out the availability of facilities. The same information was provided to the smartphones used by athletes and related personnel to access the information from anywhere. By using various methods to provide information, the system was able to guide users to avoid congestion.

2.3.2 Understandability of the Content

The information shown in Figure 2 is displayed in Japanese and English, but the content is mainly visual



(a) For Smartphone



(b) For Digital Signage

Figure 2 Information Display (©2021-International Olympic Committee-All Rights Reserved)

that does not rely on the language for non-verbal communication. Congestion information was displayed in three levels (below 30%, 30-70%, above 70%). Staff could switch the display on the second floor of the main dining hall to a "Closed" sign. An original content design was created following the guidelines of the Games look design. Due to the short turnaround time, design proposals were exchanged closely with the Tokyo 2020 Organising Committee. Still, it took longer than expected to finalize the design because approval had to be obtained from several departments.

2.4 Overview of the Congestion Monitoring System

Informing athletes and other related personnel of congestion conditions in real-time made it possible for them to take action to avoid crowded places and times of

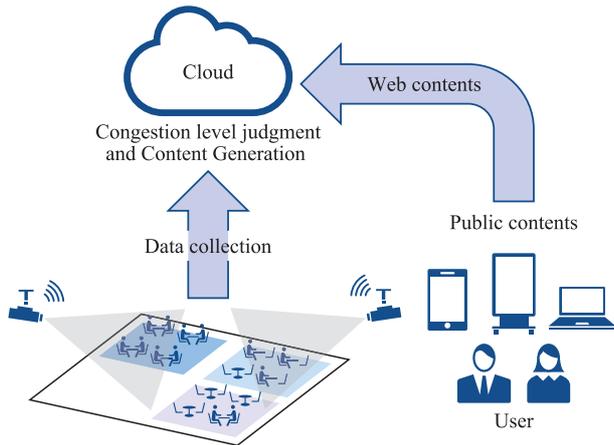
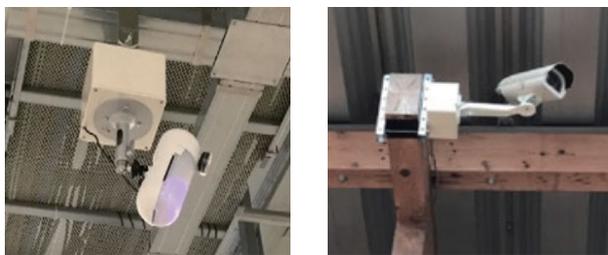


Figure 3 Congestion Visualization Service



(a) For indoor use (b) For outdoor use

Figure 4 Detection Sensors (©2021-International Olympic Committee-All Rights Reserved)

congestion. The following is an overview and configuration of the system (Figure 3).

2.4.1 Location of the Congestion Monitoring System

The congestion visualization system was installed in the main dining hall, casual dining room, recreation area, fitness centre, and village plaza of the Olympic and Paralympic Village.

2.4.2 Congestion Monitoring Mechanism

The congestion monitoring mechanism uses a detection sensor (Figure 4) to capture images of the target area, detect human shapes, and count the number of people (Figure 5). The detection sensor consists of a computer, a camera and a SIM, and counts the number of people (Figure 6). The images captured are immediately deleted after processing in the detection sensor, and the appropriate area that can be covered by a single detection sensor is 10 m × 10 m (Figure 7). The congestion level content was generated based on the threshold values specified in advance in the cloud (Figure 8).

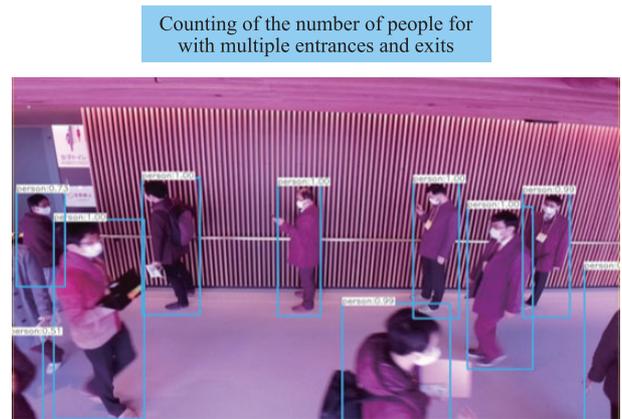


Figure 5 Image of Counting the Number of People Detection sensors count the number of people, image data is discarded, and only the numerical data is sent to the cloud. (©2021-International Olympic Committee-All Rights Reserved)

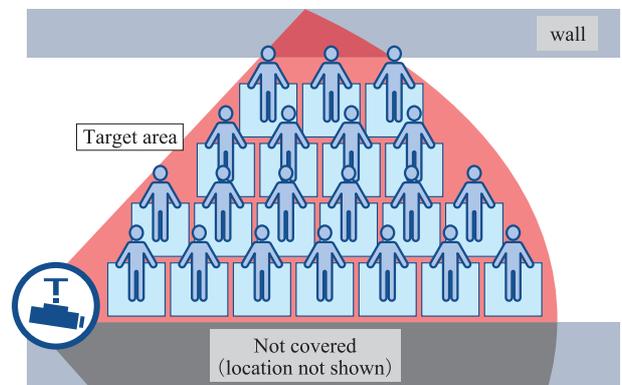


Figure 6 Appropriate Number of People in the Target Area Example : Capacity : 20 people, the number of people is calculated considering the appropriate interval for the target area.

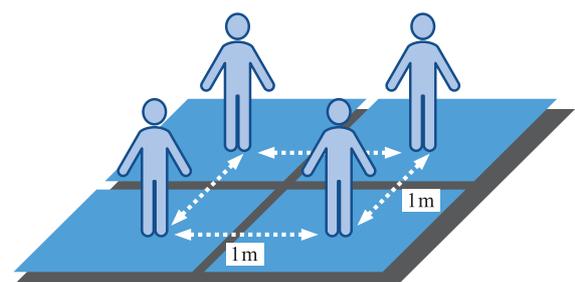


Figure 7 Appropriate Interval Considered as Social Distance According to the "New Lifestyle" announced by the Ministry of Health, Labor and Welfare, the recommended distance is 2 m, and the minimum is 1 m.

2.4.3 Digital Signage Service

The digital signage was a cloud-based system (Figure 9). The subscription-type service, which includes hardware, made it possible to deploy the service at the Olympic and Paralympic Villages in a short period. By

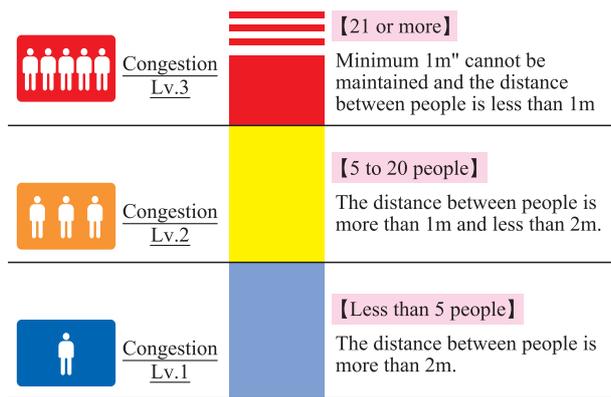


Figure 8 Criteria for Judging Crowding In the case of 20 people, 1 person/1 m² was used as the maximum capacity.

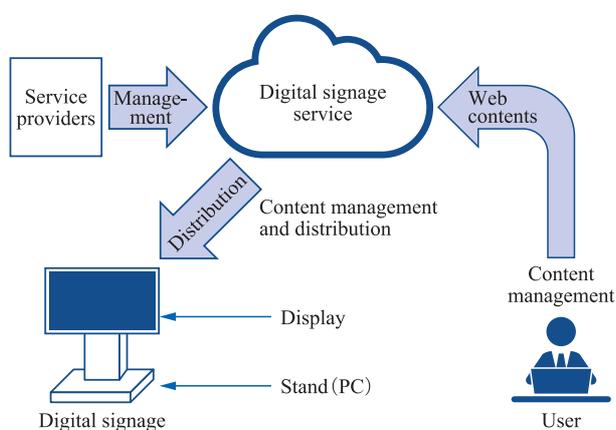


Figure 9 Digital Signage Service

preparing a unified support desk as a congestion detection service, inquiries after the start of operation could be handled promptly, and operations could be continued until the end of the Games without trouble.

2.4.4 Web Construction

The Web server was built on an IaaS service and complied with the security requirements described by the Tokyo 2020 Organising Committee. The load balancing was performed using a CDN: Content Delivery Network service provided by Tokyo 2020 Organising Committee, and dual security measures were implemented by the Tokyo 2020 Organising Committee and the vendor. As in past Games, there were many cyber-attacks at this Games, but none of them affected our services.

3. Service Operation and Lessons Learned during the Games

Standard services alone cannot cover all the requirements. The policy of this project was to respond to the characteristics of a short-term event. The gap with the request was addressed by human operation.

3.1 Utilization of Existing Services

Generally, the operation of the service aims at automation. However, in this project, the service was designed with the highest priority to date of delivery and cost. The operation design was studied according to the Tokyo 2020 Games. A one-stop service was provided as a system, including operation and maintenance, such as establishing a local response system and designing escalation rules for the Games period.

3.2 Issues during the Games

There were discrepancies between the congestion level considered by the site staff and the congestion level displayed by the system. If the level felt by the site staff and the level of the system are different, the on-site staff will be given priority. Therefore, this problem was solved by adjusting the threshold settings again since on-site operations are given priority.

3.3 Operational Changes during the Games

During the Games, there were no major system failures. It is due to the success of repeated on-site operational tests. During the transition period from the Olympic to Paralympic Games, the thresholds were modified to reflect the change in the maximum number of people in each area. We took into account the change in the number of athletes and the number of wheelchair users during the duration of the Tokyo 2020 Paralympic Games.

3.4 Behavioral Changes during the Period

According to the final report compiled by the Tokyo 2020 Organising Committee, approximately 14,000 people stayed in the Olympic and Paralympic Villages during the peak of the Games. The facility was used by 3,636 people, of which 500 people, or 14%, viewed the Web. The number of viewers of the digital signage was not counted.

3.4.1 Effects of Introducing the System

At the time of the Tokyo 2020 Games, the capacity of

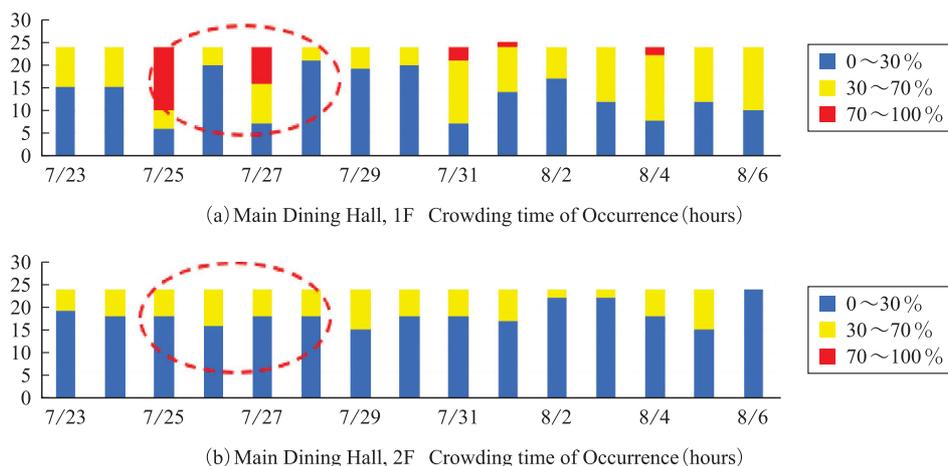


Figure 10 Crowding Time of Occurrence (hours) on 1F/2F Analyzing the data of July 25 (Sun.), a dispersion induction time zone was set up on the second floor. In addition, the threshold value for the first floor on July 26 was lowered, and an early warning was issued. As a result, the congestion time zone on the first floor has decreased.

the main dining hall was 618 seats on the first floor and 2,100 seats on the second floor. The entrance to the facility is located on the first floor, and the first floor is quickly crowded, but effective dispersal guidance and alerts were provided through quantitative monitoring, thereby leveling the congestion, as shown in Figure 10.

3.4.2 Effects of the System on the Operation Staff

The system was well received by the facility's users as a "good initiative". It was also highly evaluated by those involved in managing the Olympic and Paralympic Villages. The management staff was able to make decisions on the operation of the facilities based on the data of the crowded information. In addition, the data also helped to improve the overall efficiency of the Olympic and Paralympic Villages, as the staff was able to grasp the status of not only the facilities they were in charge of but also the entire Olympic and Paralympic Village. Furthermore, we analyzed the congestion period in each area and captured the behavior patterns of the athletes. The behavior patterns provided useful data for the future provision of meals.

4. Conclusion

This project provided a system that could be used to deal with infectious diseases in a short period and at a low cost by utilizing a standard service. In addition, the project was able to make up for requirements outside of the service with a minimum of customization and operation. The key point of the congestion monitoring

system for the Tokyo 2020 Games was a flexible operational design. We proved that standard services could be used for future large-scale events such as the Tokyo 2020 Games by designing operations according to requirements.

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