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Team Control Number

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Problem Chosen

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2019

MCM/ICM

Summary Sheet.

In case of the terrorist attacks in France, the Louvre needed emergency evacuation plans to avoid danger. This paper first establishes the goal programming model with the minimum total evacuation time to make sure that people in building can be evacuated safely and quickly. The model divides the evacuation time into the moving phase of the room channel, the up and down building phase, the entry and exit phase, and the accident occurrence phase. By optimizing each of these stages, the goal of minimum total time is achieved. In order to achieve optimal path, we improve the Dijkstra algorithm and find the most efficient route from each room to the exit. In addition, we propose a dynamic scheduling algorithm between the same floor and a dynamic scheduling algorithm between different floors to solve the congestion problem according to the goal planning. Furthermore, we have designed targeted response strategies for different characteristics of vulnerable groups to reduce accidents.

In our model, we have obtained the optimal evacuate path of the Louvre and the weak bottleneck location. The emergency evacuation completion time of the Louvre is 527s, and the congestion time is 37.5%. Compared with the random method, we reduced the time by 39.3%, reduced the congestion by 24% and reduced the injury of 60.69%.

Secondly, this paper incorporates the disaster factors into the model, which further improves the adaptability of the model to different disasters and also considers the arrangement of emergency personnel entering the building. The maximum number of emergency personnel that can be entered at each intersection can be obtained without affecting the maximum evacuation time.

Based on the model, we calculated the maximum number of 410 emergency personnel and 370s of the optimal route through the Lions Gate exit, while through the Richelieu is about 229s but the maximum number was 240.

In addition, the model proposed in paper also explores other large-scale multi-storey public buildings and gives model improvement plans. Finally, in response to the conclusions of the model, this paper proposes to Louvre managers the plan to speed up evacuation, arrange emergency personnel, increase exits, and target vulnerable groups.

