Simulation and Optimization of Emergency Evacuation in Gold Museum Based on AnyLogic

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Abstract. This article combines the characteristics of the gold museum building structure, facilities distribution and personnel distribution characteristics, uses AnyLogic to complete the museum's environmental modeling and visitor behavior modeling, simulates the completed tourist evacuation model, analyzes the evacuation process of personnel, and responds to potential safety hazards. The evacuation process was simulated and optimized, and an improvement plan was proposed. Finally, reference suggestions were made for the tourist evacuation plan of the Gold Museum. It provides a way of thinking and method for safe evacuation in scenic spots, and has certain practical application value.

1. Related theories

1.1. Research Background
In recent years, the tourism industry has developed rapidly, and tourism has become one of the most popular consumption methods of the general public, and the safety of tourist attractions that has followed has become the most worrying issue for consumers. The tourist scenic area is a place of high-density crowds. Tourists are vulnerable as vulnerable groups in the face of fires and other emergencies. The life and safety of tourists is an important task in the work of tourist attractions. The research object of this article: the Gold Museum, surrounded by mountains on three sides, the peak tourist season in spring and autumn, the number of tourists increased sharply, and the lack of emergency facilities and lack of emergency management of personnel in the Gold Museum, in case of fire, equipment failure, power leakage, etc. The consequences of the stampede were unthinkable. To this end, this article uses AnyLogic simulation software to establish a simulation model for the emergency evacuation of the Golden Museum, and develops an emergency evacuation plan for tourists in the scenic area.

1.2. AnyLogic software introduction
AnyLogic is a powerful general modeling and simulation tool developed by XJ Technologies. It is based on the latest complex system design methodology and uses the latest system design method. Introducing UML language into the field of model simulation is the only software that supports multiple modeling
methods and is highly developed. This article will use AnyLogic software to complete the environment modeling and pedestrian behavior modeling of the Golden Museum Scenic Area.

1.3. Model basic parameter setting
A unified standard is set for evacuation tourists in the model to avoid errors caused by personnel factors in different evacuation models. The settings are combined with the actual conditions of tourists in the scenic area to make the simulation results of the model reflect the actual state to the maximum.

2. Construction of Simulation Model for Tourist Evacuation in Gold Museum

2.1. Gold Museum Environmental Model
Draw AutoCAD floor plans according to the floor plan of the Golden Museum and import them into the newly created AnyLogic model. Set the scale and add rectangular area components to build the model. The three-dimensional model is constructed in synchronization with the two-dimensional model. This model defines the areas where visitors are prohibited from walking in the simulation environment. The two-dimensional model construction of the Gold Museum is shown in Figure 1, and the three-dimensional model construction of the Gold Museum is shown in Figure 2.

2.2. Model of Visitor Behavior in the Gold Museum
Based on the construction of the environmental model, a tourist behavior model is constructed, and the initial state values of tourists are set to decentralize the tour inside the venue, that is, enter the venue from the museum gate, the left venue is set to the area stop tour mode, and the right venue is set to Queue path visit mode. The probability shunt mode will be used to enter the queue on the right side of the pavilion with a 40% probability, and the visitors will enter the venue on the left for a mode of regional stay. The logical meaning is that after the visitor visits, he will walk to the exit target line and leave the hall by himself. After leaving the hall building, the visitor will disappear automatically. This model no longer considers the follow-up actions of the visitor. The completed logic diagram of the Golden Museum tourist tour is shown in Figure 3, and the Golden Museum tourist behavior model is shown in Figure 4.

2.3. Model of evacuation of tourists at the Gold Museum
Add a pedestrian movement module to the simulation model. The logical meaning is that when an emergency occurs, tourists in each tourist area immediately automatically search for the nearest exit for emergency evacuation. After evacuating to a safe exit, the tourist disappears in the model for the evacuation and the follow-up actions of the tourists are not considered. The completed logic diagram of the evacuation of tourists at the Gold Museum is shown in Figure 5, and the two-dimensional simulation model of the emergency evacuation of tourists at the Gold Museum is shown in Figure 6.
2.4. Analysis of simulation results

Construct an overall evacuation model for tourists, draw up evacuation conditions, construct a visual data window, and count the relevant data of the tourist evacuation simulation model based on the data window. According to the model simulation data, the evacuation time of all visitors in the venue is 248.744s, the fastest evacuation time of tourists is 12.873s, the slowest evacuation time is 248.744s, and the average value is 128.681s. From the evacuation simulation results, it can be known that the current evacuation time of the venues is 248.744s, which does not meet the safety evacuation time standard of 120s in the Code for Fire Protection of Building Design.

3. Simulation optimization

3.1. Gold Museum evacuation plan

3.1.1. Increase evacuation exits. Open the emergency exit, build a multi-exit evacuation simulation model, and get three simulation results, as shown in Table 1.

| Number of exports | Max (s)   | Minimum (s) | Mean (s)  | deviation |
|-------------------|-----------|-------------|-----------|-----------|
| 1                 | 248.744   | 12.873      | 128.681   | 64.031    |
| 2                 | 207.574   | 12.396      | 101.379   | 50.718    |
| 3                 | 202.420   | 12.096      | 98.615    | 49.274    |
According to the analysis of the model simulation time, during the emergency evacuation process, the evacuation time of opening the two exits of the lobby was 41.17s less than that of opening one exit. The evacuation time was reduced by only 5.1s when the three exits were opened. Three exits are opened in the lobby to meet the evacuation requirements in this state.

3.1.2. *Widen the entrance of the exhibition hall.* Simulate different doorway widths and analyze the appropriate width of the fire safety door. The simulation results of the doorway are shown in Table 2.

### Table 2. Simulation results of doorways with different widths.

| Left exit width (m) | Right exit width (m) | Max (s) | Minimum (s) | Difference (s) |
|---------------------|----------------------|---------|-------------|----------------|
| 2                   | 2                    | 158.336 | 17.240      | 0              |
| 2.5                 | 2.5                  | 142.866 | 15.740      | 15.470         |
| 3                   | 3                    | 136.870 | 15.440      | 5.966          |
| 3.5                 | 3.5                  | 122.571 | 15.140      | 14.299         |
| 4                   | 4                    | 118.024 | 14.956      | 4.547          |
| 4.5                 | 4.5                  | 116.569 | 14.739      | 1.455          |
| 5                   | 5                    | 115.870 | 14.692      | 0.699          |
| 5.5                 | 5.5                  | 114.143 | 14.540      | 1.727          |

Throughout the entire simulation process, when the width of the safety fire door in the exhibition hall is set to 4m, the evacuation time of the personnel is 118.024s and the safety evacuation requirements have been met, and the width of the doorway continues to increase, and the evacuation time reduction is only about 2s. This data shows that the location of the safety gate of the exhibition hall was no longer crowded with tourists, and the evacuation requirements were met when the width of the doorway was set to 4m.

3.1.3. *Optimize the layout.* Cancel the central exit of the lobby and divide the width of the central exit equally to the left and right exit widths. Thereby simulating the evacuation status of the exit in the actual evacuation situation. After modifying the model, a line chart of tourist evacuation density is constructed, as shown in Figure 7.

![Figure 7. Exit Optimized Tourist Density.](image_url)

Analyzing Figure 7, in the model, the exit logic of the lobby is optimized and the actual width is not changed. The density of visitors at the exit of the lobby is stable below 0.4 people / m², and the overall evacuation time is 115s, which meets the evacuation requirements.
3.2. Recommendations for safe evacuation

(1) Move the showcase in the left hall to the side closer to the wall by 1m to widen the central visitor passage by 2m, and remove the showcase near the fire safety door;

(2) Emergency passages shall be provided at the junction between the partition wall in the right hall and the outer wall of the hall;

(3) Widen the safety fire doors of the left and right pavilions to 4m;

(4) At the exit of the hall, all three entrances and exits will be opened as emergency evacuation exits during evacuation.

4. Conclusion

This article takes the Gold Museum as the research object, and constructs a simulation model for the evacuation of tourists in the Gold Museum. The simulation results show that the evacuation time of all tourists in the Gold Museum is 248.744s, and there are hidden safety risks in the evacuation. Through AnyLogic simulation optimization, the Gold Museum optimized the passage in the museum, widened the fire safety doors of the exhibition hall, all emergency exits were opened, and the evacuation time was optimized to 115s, so that visitors can be evacuated safely. This article uses AnyLogic to simulate and evacuate tourists in scenic spots, which provides a way of thinking and methods for safe evacuation in scenic spots, and has certain practical application value.

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