LOGISTICS OPERATION SIMULATION IN BEIJING OLYMPIC GAMES STADIUM

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Abstract: In 2008, the 29th Olympic Games was held successfully in Beijing. It was the largest scale games in the history, and achieved amazing results. The experience of the Olympic Games is worth to summary. Statics and analyse of logistics operation volumes in an Olympic Games stadium are made in this paper. A simulation model about stadium logistics system based on discrete event is developed by using Anylogic software. With the simulation model, the logistics resource dispatching is discussed. We find logistics coefficient that 3.2 order sheets for a fork truck and 1.6 orders sheets for a worker are proper burden. These coefficient could help us to plan logistics resources readily. The paper is useful for us to improve logistics system in a stadium.

1 INTRODUCTION

In 2008, the 29th Olympic Games were held in Beijing. High level logistics service of the Olympic Games was required. The sports equipments, grocery and other things for competition were delivered by logistics system. The well done logistics system ensured the sports games carried on smoothly. It proves that the logistics system of Beijing Olympic Games could run smoothly.

As the uncertainty of the transportation in Beijing, it was difficult for logistics system to be run accurately, effectively and quickly. It is very useful to study logistics system operation in Beijing. In this paper, the simulation model is developed to investigate the logistics operation in a stadium. It can help us to understand how to make logistics run better in sports games.

2 REVIEW ON OLYMPIC GAMES LOGISTICS SYSTEM STUDYING

The issues of communication and information system on Olympic Games were discussed in many theses. But fewer people have studied Olympic Games logistics thoroughly. Some papers have reviewed logistics of Atlanta Olympic Games and Sydney Olympic Games logistics.

John Mascaritolo (1996) introduced the function of logistics department of Atlanta Organizing Committee for the Olympic Games. The challenge and problems occurred in Atlanta Olympic Games were illustrated in his paper as well.

Trunick (2004) summarized the Olympic Games logistics organization of Sydney. In his report the various logistics problems, such as the problems of international logistics, the information technology application, and the cargo transportation during the Olympic Games held were put forward.

Ioannis (2006) wrote a paper focused on the design of the organization, processes, and systems of Olympic logistics. In his paper, a systematic methodology has been developed to design the strategy and tactics of logistics operations for the Athens 2004 Olympic Games. It is the first time that a systematic view of Olympic logistics is dealt with, as opposed to experiential knowledge with local applicability that has been used in the past to plan similar operations.

In China, the studying on Olympic logistics became hotter after Beijing was elected host city for the 2008 Olympic Games. Most researching concentrated on such aspects: the logistics market development, the company's strategy around

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Olympic, the operation of Olympic logistics and the Olympic logistics system planning.

Xianliang Shi, Keming Zhang (2003) forecasted the quantities of delivery, the transportation, the storage, and the distribution for the Beijing Olympic Games logistics.

Olympic logistics system will be studied on the actual operation data in this paper.

3 THE LOGISTICS OPERATION ANALYSIS OF A BEIJING OLYMPIC GAMES STADIUM

We have studied the logistics operation in an Olympic Games stadium. This stadium is divided into five regions: goods unload area, VOC (Venue Operation Centre), FOP (Field Of Player), TC (Temporary Construction), media area, shown as in Fig.1. The logistics department responded for service in these regions, and also provided fork trucks lending for other departments as well. We have taken statistical analysis of the logistics operation and have used it in model.

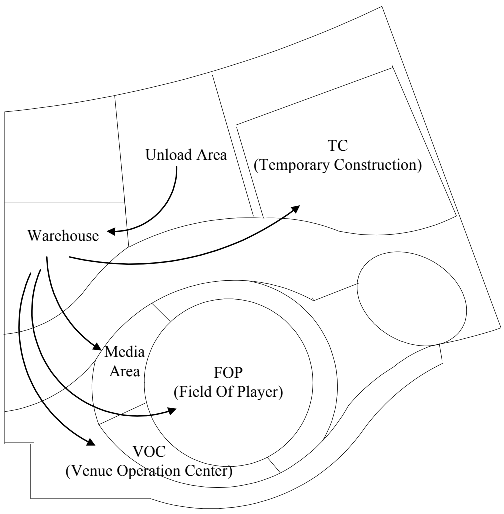

Figure 1: Regions of a Beijing Olympic Games Stadium.

3.1 Operation Volume of Goods Unload

During the Olympic Games in August 2008, the goods arriving schedule was changing from time to time due to the influence of traffic.

According to the operational standards of the United Parcel Service (UPS), which provided Olympic Games logistics sevice, we got handling volumes statistics in each area. It is shown in Fig.2. It is found that the burden in each region normally is no more than 10 pieces.

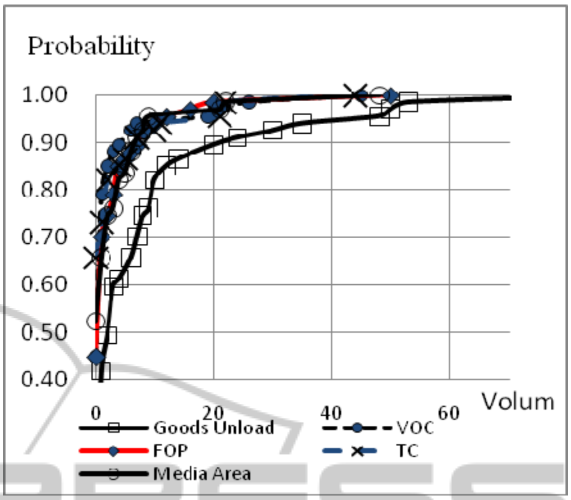

Figure 2: the Probability of the Operating Volume in Each Region.

3.2 Logistics Operation Time

By analyzing this stadium, we got the operation time of manual fork trucks, and found that the average operation time for a fork truck is half an hour. The variance is about 0.16 hour, meaning operation time is 0.5 ± 0.16 hour.

In this stadium, the logistics service is mainly provided to BOCOG (Beijing Organizing Committee for the Games of the 29th Olympiad) and sponsors for materials handling. But other department's workers often borrowed tools from logistics department. According to the stipulated process, other department's workers should put forward an application in 24 hours in advance. The tools borrowed were non-power devices, such as trolleys, manual fork trucks, etc. When tools were occupied by other departments, it might cause urgent task postpone. So it is important to study tools lending time and frequency. Because fork trucks are key devices, so we studied fork trucks lending regular.

The fork trucks lending time is shown in Fig. 3. We found that the lending time is about 4.6 hours, and its standard deviation is 13.4.

We analyzed the frequency of the forklift lending. It is shown in Fig. 4.

By using the software SPSS, We carried One-Sample Kolmogorov-Smirnov Test. The frequency of the forklifts lending obey the Poisson distribution (mean λ =5.023), and asymptotic significant (2-tailed) is 0.784

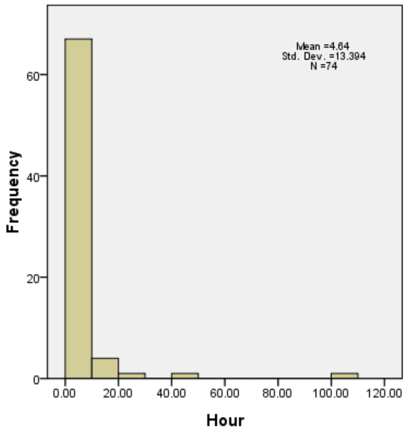

Figure 3: the Lending Time of Forklifts.

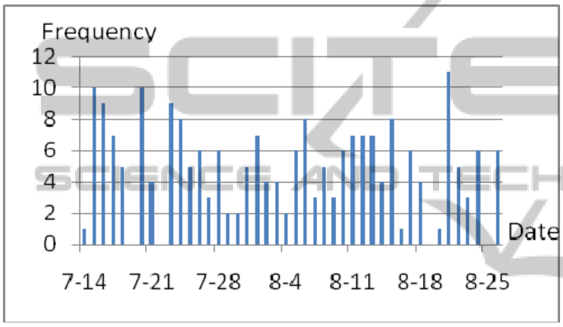

Figure 4: the Frequency of Forklifts Lending.

4 THE SIMULATION MODEL OF LOGISTICS OPERATION

4.1 The Simulation Model

In this paper, we take Anylogic (a simulation software of XJ technology Company) to establish the simulation model of logistics operation in the stadium. The model includes two parts of module: the resources network module and the logistics operation module.

In the resources network module, the application of resources is defined. The process of logistics service is simulated in the logistics operation module.

Network objects in Anylogic mainly are used for maintaining the topological structure and resources management. There are three kinds resources are defined in the paper: workers, fork trucks, and the location. The resources network structure of the model is shown in Fig. 5.

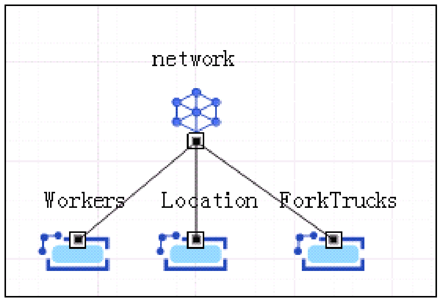

Figure 5: The Model of Resources Network.

The logistics operation in the stadium is simulated in this module. The operation process includes 2 sections: materials receiving and distribution, the forklifts lending .This model is shown in Fig. 6.

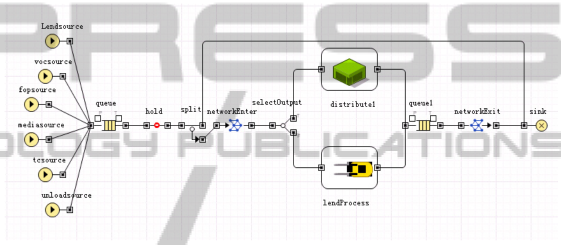

Figure 6: the Module of Logistics Operation.

(1)The Module of Material Receiving and Distribution

In this venue, a work group (fork truck and worker) could start material handle working when they got a working-sheet from logistics department. In our model, the network resources are used to simulate the materials receiving and distribution. The module is shown in Fig. 7.

In this model, the waiting tasks in 5 regions and application of forklifts lending are presented by queues. But the tasks in 5 regions priority are higher than the task of forklifts lending.

(2)The Module of Fork Trucks Lending

The amount of fork trucks in this venue is 6. But these trucks couldn't be all lend out. If a fork truck was ideal, the other departments could borrow it. But if all fork trucks were busy, the other departments must fill an application form and wait till a fork truck was ideal.

The fork trucks lending must be treated specially. So we build a sub-model to deal with the fork trucks lending. This model is shown in Fig. 8.

When a lending application appears, firstly it waits in queue to size the resources (shown as the object of 'Network Seize1' in Fig.8). The action is that a fork truck can be lent only if staffs register it.

So the lending process can be carried when there is a fork truck is ideal.

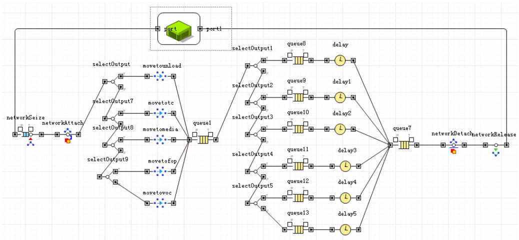

Figure 7: the Module of Material Receiving and Distribution.

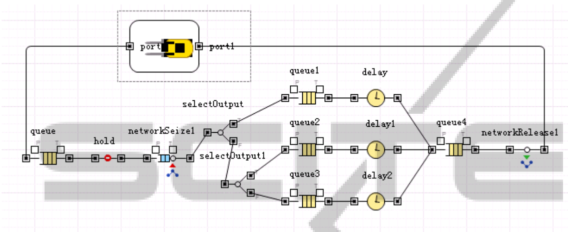

Figure 8: the Module of Fork Trucks Lending.

4.2 The Model Parameters

With the consideration of the actual situation in the stadium, the model parameters are set as follow:

(1) The working-sheets priority. According to the actual logistics operation in the stadium, the working-sheets of materials delivered in should be given the highest priority. The working-sheets of materials distribution were given a normal priority. The working-sheets of lending forklifts were given the lowest priority. When the staffs were busy in working with receiving goods or distributing goods, the forklifts must be provided for them and forklifts couldn't be lent out.

(2) The resources occupancy. In accordance with the logistics service standards, when a forklift was in operating state, an operation occupies three workers and a truck.

(3) The simulation length. In this model, the simulation time is set as minute. A working day is 8 hours. The simulation length is set as 120 working days.

(4) The number of workers. In this stadium, 11 workers were working for logistics department and the number of forklifts was 6.

5 SIMULATION RESULT ANALYSIS

In this paper, the model has been simulated for ten times. The forklift lending, material receiving and distribution results has been analyzed. It is shown in table 1. The simulation result shows data in the range of 95% confidence.

Table 1: the Simulation Result.

Exp.	Forklifts Lending	Material Receiving and Distribution		Resource Utilization	
No.	Waiting Time (hour)	Over-time Freq.	Operation (hour)	Workers' Load Rt.	Forklifts' Util.
1	0.49	11.7%	3.5	35.3%	30.9%
2	0.46	11.6%	3.0	35.0%	30.3%
3	0.45	11.9%	3.1	32.8%	30.7%
4	0.55	11.4%	3.4	33.6%	31.9%
5	0.52	11.2%	3.2	32.4%	29.7%
6	0.46	11.8%	3.3	33.6%	32.8%
7	0.48	11.8%	3.3	34.1%	29.5%
8	0.54	11.1%	3.8	34.5%	30.6%
9	0.51	11.1%	3.3	31.1%	29.8%
10	0.47	11.4%	3.6	33.3%	30.3%
Mean	0.51	11.5%	3.3	33.0%	30.2%
Variance	0.04	0.3%	0.2	1.3%	1.0%
95% Conf.	0.03	0.2%	0.2	0.9%	0.7%
Upper Bound	0.54	11.7%	3.5	33.9%	30.9%
Lower Bound	0.48	11.3%	3.2	32.1%	29.5%

5.1 Submodel Simulation Results

(1) The model of material receiving and distribution simulation result.In the case of 11 workers, the simulation result shows that the time spending on material receiving and distribution is 3.3 hours. It means that to carry the material handling usually needs a half working day. The probability of over-time work is 11.3%~11.7%(the mean is 11.5%).It indicates that, when the quantity of material handling work is quite large, there will be 11.5% tasks beyond the normal working hours.

By the simulation result, we find that it can meet the need of work with 11 workers. Actually, due to the large amount of unexpected tasks before the

Olympic Games helding, the staffs of logistics department often has to work overtime.

(2) Forklifts lending simulation result. Under the circumstances of 6 forklifts, the simulation result shows that average waiting probability of trucks lending is 3.2%. The waiting time of forklifts lending is about 0.51 hours. It indicates that the process of trucks lending is relatively smooth. Other departments can borrow forklifts nearly without waiting. It can meet the needs of other departments very well.

5.2 Resources Utilization Optimization

From the simulation results, it is found that there is room for improvement in the logistics resources planning in this stadium. There is lot of work to do on optimizing resources so as to improve resource utilization rates.

From the simulation result, we find that the load rate of workers and forklifts utilization are lower. The load rate of workers is only 33%, their work rate could be improved.

The number of forklifts is 6. In this situation, it may be considered to streamlining appropriately. But the utilization of fork trucks is only about 30.2%. We set the number of fork trucks from 6 to 5. In this solution, the utilization could be improved to 78%.

The optimization work on forklifts' utilization has been made. When the number of forklifts is 4,the simulation result shows that the utilization of forklifts is 92%. When the number of forklifts is 3, the utilization is 98%. The result is shown as Fig.9.

So we think that 5 forklifts are better for this stadium. The forklifts could be working in a good state.

We have got received order quantity of this stadium, which is shown as Fig.10. To this stadium, order quantity median value is 4 sheets a day. Its mean value is 6 sheets and stand deviation is 8. Considering 90% probability, this stadium received order quantity is under 16 sheets .

So we can get coefficient to determine numbers of fork trucks and workers in a stadium.

Fork truck coefficient is:

$$\frac{16}{5}=3.2$$

Worker coefficent is:

$$\frac{16}{10}=1.6$$

So we think that in this stadium, 3.2 order sheets for a fork truck and 1.6 sheets for a worker are proper durden. By using these logistics cofficent, we can get numbers of fork trucks and workers in a stadium easily.

6 CONCLUSIONS

The logistics system of this stadium, there is certain of balance between fork trucks lending services and material handling. The logistics department's main task is to receive and delivery material, in order to maintain the high efficiency of this service, it is bound to occupy quite a lot of material resources.

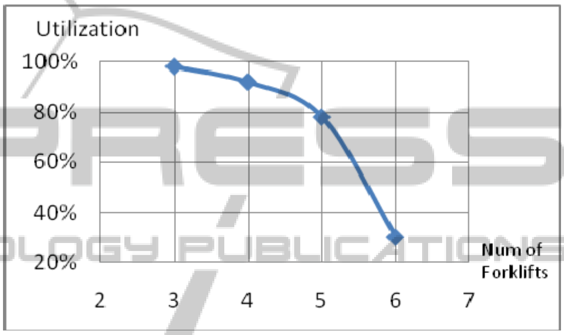

Figure 9: Forklifts' Utilization Optimization.

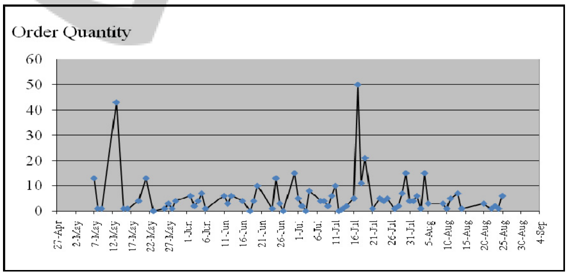

Figure 10: Received Order Quantity of this Stadium.

Based on the analysis above, this paper considers that the proportion of workers and fork trucks could be adjusted. The number of workers can be cut down to 10 and the fork trucks can be cut down to 5. In the Olympic stadiums, the configuration ratio of actual workers and logistics tools is fixed, which is due to operational efficiency and safety. If we can flexibility adjusts the amount of forklifts and workers based on actual situation, the overall flexibility of the system can be enhanced, which makes the system efficiency improve. By studying simulation results, we think that 3.2 order sheets for a fork truck and 1.6 orders sheets for a worker are proper burden coefficient. These coefficient could help us to plan logistics resources readily.

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