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Simulation Research on Jingdong Orders System Based on Flexsim

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Abstract

Order processing system is the beginning and core part of distribution center operations, and efficient order processing operations can not only improve customer satisfaction but also reduce costs. Therefore, the trade-off analysis between order processing difficulty and quick response time, improving the handling capacity and efficiency while reducing order processing costs are regarded as two big challenges for e-commercial enterprise. Based on queuing model as well as some data collected from Jingdong, a Chinese E-commerce giant, this paper constructed a 3D simulation model by using Flexsim, aiming at solving the bottleneck of the whole system of E-commerce order processing. According to the simulation, the author gives two order processing optimization solution, service stations optimization and queuing optimization to solve the two challenges.

Keywords*: Orders system; Flexsim; Simulation model; Cost; Efficiency*

1. Introduction

Taobao monitoring data shows that the number of the parcels increases rapidly with a speed on 1 million pieces per hour, during the peak night of November 11, many orders cannot be processed in time so that warehouse exploded seriously. As a result, products ordered that day can only reach to customer after one week, or even have been served for more than ten days. To avoid this kind of problem, orders processing need to be optimized. How to improve the efficiency without increasing the cost becomes an urgent problem. On the basis of the analysis and optimization of the order processing system, there was the concept model of order processing system based on queuing theory, and the simulation research was carried out with the Anylogic, which mainly focuses on optimization of queuing rules [1-2]. Then, based on the same idea, the M/M/n queuing model of order processing system based on queuing theory, using M/M/n to simulate and analyze the Matlab model of order processing system was established. The performance parameters vary with the number of orders processed [3-4].

The Jingdong order processing system is optimized with Flexsim, and the bottlenecks are found to be further optimized. Through the change of the number of service desks, the queuing rules makes the improvement of operation efficiency realize. This paper will discuss this issue from the perspective of logistics simulation based on a case study of Jingdong .

2. Model

Jingdong logistics is composed of suppliers, electricity supplier companies, websites, consumers, distribution systems, payment systems, information systems, and order system, *etc.* As shown in Figure 1.

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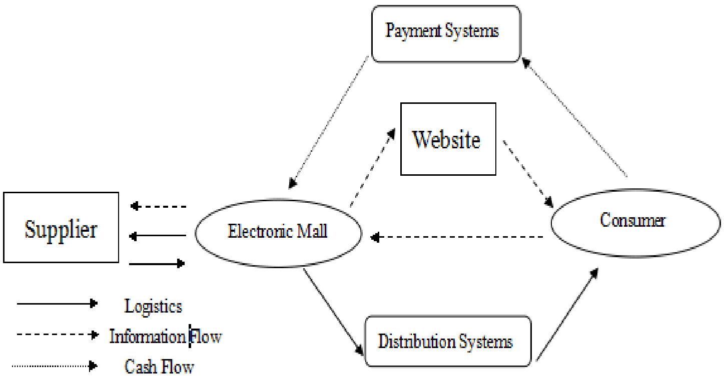

Figure 1. E-Commerce Structure

Shopping on Jingdong order goes through several steps: Customer orders, accept orders, confirm the order, the sellers shipped, sort, scan, transport, express package ,weigh and scan (a dot), delivery, and customer accepts products.

In order to facilitate the study, Jingdong products are divided into three categories as follows by the Activity Based Classification(*ABC*). *A* represents something with big volume and low value, such as clothing, *etc*. *B* represents general value products, such as digital products and some accessories, *etc*. *C* represents something with small volume and high value, such as gold and silver jewelry.

According to Eric statistics, the three types of products are divided as follows.

Table 1. Three Commodity Proportion in Jingdong

Category	Quantity	Value	Profit
A	80%	20%	20%
B	15%	20%	30%
C	5%	60%	50%

Taking gold and silver jewelry, clothing, and digital accessories as examples, Jingdong data in 2012 showed in Table 2.

Table 2. Part of the Commodity Sales in 2012 (Unit: Million)

Commodity	Dress and shoes（*A*）	Digital Accessories (*B*)	Jewelry (*C*)
Volume	87600	58400	43800

(Note: the above data was from the Erik, as of December 30, 2012)

First we can build a concept model as shown in Figure 2.

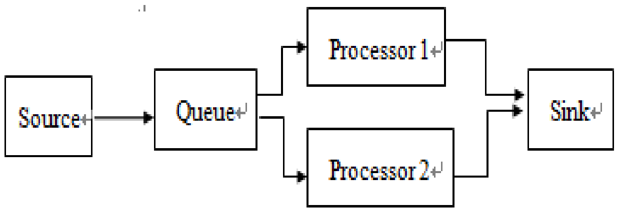

Figure 2. Flexsim Basic Simulation Structure

The concept model simulates the order system. Orders come from the source and enter the queue waiting for service. Then orders be processed in processor, and last into the sink.

Now establish the simulation model based on Flexsim. Put into three sources, a queue, a processor, a sink successively and connect them with A line in turn. Showing in Figure 3.

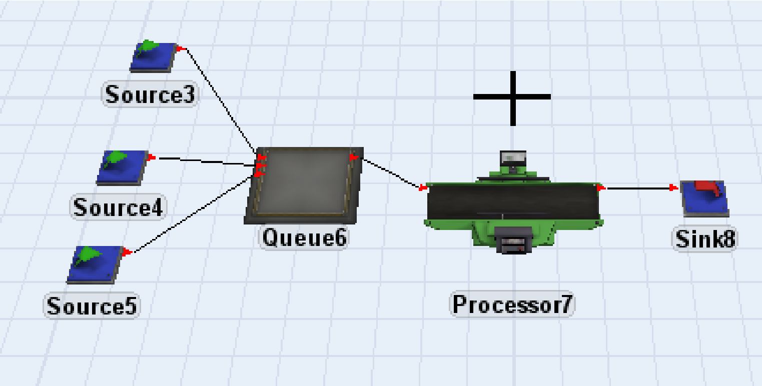

Figure 3. Model Structure

Supposing overall orders arrive infinite, and to FIFO (First in First Out) into the queue waiting for service, queue capacity is unlimited, the number of staff required for order processing is unknown, and service desk is single.

The three sources mean three different orders A and B and C. The queue connected sources is the place that orders wait processing. The processor said processing orders of service desk composed of people and machine equipment. Here simplified into machine equipment. It is responsible for orders of transmission, and hire, and performance. The last is sink, the absorption device, which means orders has been processed.

According to the statistics of Jingdong, describe three orders of the model as follows:

(1) Customer orders which is into the system are service objects, and order source is unlimited. Customer orders arrival is independent of each other, and order arrival interval is independent and identically distributed random variables. Orders arrival time is exponential (0, 120, 0). Orders B is exponential (0, 180, 0) and C reaches exponential (0, 240, 0).

(2)Service desk for service is independent for each order which subject to exponential (0, 60.0, 0).

(3)Orders have been processed to first come first served (FIFO).

The simulation time is set to a working model. Take 8 hours per day. Each run time of the model is 8 × 60 × 60 = 28800 seconds. Repeat 30 times and show in Table 3.

Table 3. Model Running Statistics Report

	Object	Source3	Source4	Source5	Queue 6	Processor7	Sink8
Time: 28800S	Class	Source	Source	Source	Queue	Processor	Sink
	content	0	0	0	175	1	1
	contentmin	0	0	0	1	0	1
	contentmax	0	0	0	178	1	1
	contentavg	1	1	1	96.41504	0.938515	0
	input	0	0	0	538	363	362
	output	261	151	126	363	362	0
	staytimemin	0	0	0	1636.597	60.01568	0
	staytimemax	0	0	0	9394.615	89.95309	0

	staytimeavg	0	0	0	5473.626	74.63355	0
	current	5	5	5	7	2	7
	since	28436.62	28598.41	28632.98	28109.98	28787.35	0

3. Result Analysis

The average residence time of the order is 5473.6s, and the average residence number of orders are 96.4, and the total number of processed orders are 362. If a represents a total orders profit of three orders. The calculated profit as follows:

Orders *A:(261-87) ×20%a=34.8a*

Orders *B* ∶ *(151-49) ×30%a=30.6a*

Orders *C* ∶ *(126-39) ×50%a=43.5a*

Total profit is *108.9a*

Processor processing times are *362/33=10.9*

If it will cost *b* to process one time by the processor , the final profit is *(108.9a-10.9b)* (ignore the machine depreciation losses).

Orders were classified in the model, but the operation is not smooth. The number of orders in the queue to be processed are 94, and there is a phenomenon of a large number of stuck. In addition, processing value of processor increases to93.8% which indicates a long period of high load state of the machine. It cannot reach so high when actually implements.

According to the chart and table data derived from the simulation model, it is not difficult to find where is the bottleneck: the queue backlog of orders for more, and a long residence time and processor for a long time in high load condition. By analysis, queue and processor is the bottleneck of the simulation model.

4. Optimization

4.1. Service Desk Optimization

The expected value of the total cost (the service charge and the waiting fee) is known in the stationary state [5-7].

$$Z = C'_s \bullet S + C_w \bullet L \quad (4\text{-}1)$$

Where *S* is the number of service desk, C's is the total cost of each service desk time within. The C_w for each customer in the system of residence time cost, L is the average numbers of customers in system (also can be replaced in a system waiting for the average number of customers L_q). Obviously, they vary with the S value, because C's and C_w are given, and the only change is the number of service desk S, so *Z* is a function of *Z (S),* and seek *S** makes *Z (S*)* minimum. Only integer values of S and *Z (S)* is not a continuous function. According to marginal analysis, and the *Z(S*)* is the minimum. We know that as follows:

$$Z(S^*) \le Z\left(S^* - 1\right) \quad (4\text{-}2)$$

$$Z(S^*) \le Z\left(S^* + 1\right) \quad (4\text{-}3)$$

Find *S*=1,2 in turn When *L* values, and adjacent to the *L*, because the number is known, according to the chatter in which inequality of interval can be set. The results of the analysis experiment are as follows.

When *S*=2, $72.74-45.68 \le \frac{C'_s}{C_w} \le 96.42-72.74$, and $27.06 \le \frac{C'_s}{C_w} \le 23.68$

When S=3, 45.68-30.46≤ $\frac{C'_s}{C_w}$ ≤72.74-45.68, and 15.22≤ $\frac{C'_s}{C_w}$ ≤27.06 （√）

When S=4, 30.46-13.35≤ $\frac{C'_s}{C_w}$ ≤45.68-30.46, and 17.11≤ $\frac{C'_s}{C_w}$ ≤15.22

Obviously, only when S equals 3 can meet the requirements. When S=3, and provided for 3 service desks in the case to ensure lowest cost and make the system run more smoothly, and the burden on the processor can be guaranteed within a reasonable range. But it is bound to increase the cost in this way. in the similar "double eleventh" during the peak time, more than two service stations can be fully utilized, but in the non-peak period, the two service stations are significantly higher, whether this optimization is desirable or not is to be a question.

Therefore, the order processing system is optimized by using the method of order queuing. The model will change the rule that order processed in queue. Queue the order classification in order to improve the sorting speed, so as to improve the processing efficiency to achieve the optimization goal.

4.2. Queuing Optimization

Changing the queuing rules in the model. Put three queues into the model so that different orders queue respectively and other entities remain unchanged. Connect them with a line and show in Figure 4.

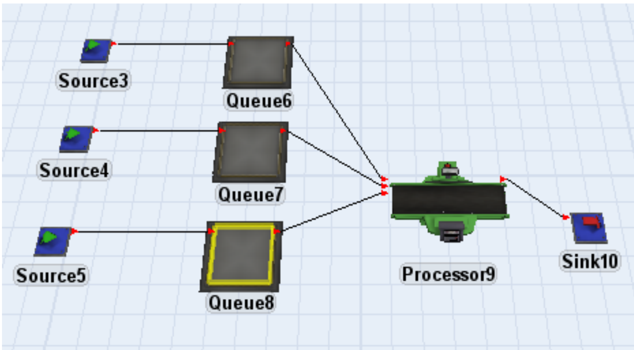

Figure 4. Model Structure

Reset the rules of queue of the temporary entity in the queue. Three orders arrive queue, and which the first order reaches a predetermined number, rowing in the front, then priority. When the three orders at the same time have reached a predetermined number, and according to the priority queue high priority first. The main procedures are as follows:

```
Setitemtype(item,duniform(1,3));
Colorarray(item,getitemtype(item));
Addlabel(item,"priority");
Setlabelnum(item,"priority",group_1);
if (content(current)>0&&content(current)<Max(content))
{int priority = getitemtype(item);
setrank(item,num);}
```

Set a priority of the three orders, where *A* for level 1, *B* for level 2 and *C* for level 3 (level 3 is the highest).

The time interval of the three orders as the same with before optimizing. Now set up orders *A* for the red temporary entity and orders *B* for the green orders, orders *C* for the Yellow. Orders *A* processing of target volume are 50 and B are 30, *C* are 20. Since the post-classification queuing treatment, the speed of sorting and picking will be faster than before. Making processor processing time follows exponential (0, 30.0, 0), running time is still 8x60x60=28800 seconds.

Other compilation and setting remain the same, repeat the operation after 30 times and show in Table 4.

Table 4. Model Running Statistics Report

	Object	Source3	Source4	Source5	Source6	Queue7	Queue8	Processor9	Sink10
Time:28800s	Class	Source	Source	Source	Queue	Queue	Queue	Processor	Sink
	content	0	0	0	19	14	32	1	1
	contentmin	0	0	0	1	1	1	0	1
	contentmax	0	0	0	21	34	58	1	1
	contentavg	1	1	1	12.85	19.752	32.88	0.73584	0
	input	0	0	0	241	164	132	472	471
	output	241	164	132	222	150	100	471	0
	staytimemin	0	0	0	769.4	1304.5	4867.02	30.0156	0
	staytimemax	0	0	0	2882.8	6564.6	11652.8	59.9530	0
	staytimeavg	0	0	0	1568	3675.3	8091.51	44.97329	0
	current	5	5	5	7	7	7	2	7
	since	28739.2	28798	28655	28739	28415	26093.7	28786.72	0

Statistics show that the average residence time of the orders *A* is 1568s and the average residence quantities are 13. The average residence time of the orders *B* is 3675s and the average residence quantities are 20. The average residence time of the orders *C* is 8091.5s and the average residence quantities are 33. Profit calculated as follows:

Total *A*: *(241-19)×20%a=44.4a*

Total *B: (164–14) ×30%a=45a*

Total *C: (132–32) ×50%a=50a*

Total profit is *139.4a*

Processor processing times are *11.1*.

4.3. Optimization Result

The statistical results of Table 5 were compared before and after the data.

Table 5. Comparison Table

Category	Daily Processing Order quantity	Total Profit	Processor Processin g times	Process or Idle Value	Processor Processin g Value	Average Residence Time of Order	Average Residence Quantity of order
Pre-optimiz ation	362	108.9a	10.9	6.1%	93.9%	5473.6	96.4
Post-optimi zation	471	139.4*a*	11.1	26.4%	73.6%	4444.8	66

The results of the optimization show that the daily processing orders increases from the original 362 to 471, and the profit is 139.4*a*, which is more than 108.9*a*. The processing times of processors are not significantly higher than 11 times. There is no obvious increase in the cost of processing so the first kind of optimization scheme has obvious advantages. From the processing value, we can see that the efficiency of the processor is much higher than the previous. The processor is busy for most of the time before optimization, and that means the cost will be higher. Meanwhile it is not reasonable that the actual workload can reach to 93.9%. The average residence time of the order is also reduced by 30.4.

After optimization, if ignore the slight increase of handling cost, the optimization makes the total profit increased by 30.5*a*.

5. Conclusion

This paper uses the Flexsim simulation method to establish the simulation model of the order system of Jingdong to improve the efficiency and solve the bottleneck problem. By studying the simulation of the order system of Jingdong, it is found that the efficiency of the order is closely related to the queuing rules. The order processing efficiency can be improved by changing the order rule. And put forward the problem of the system and the corresponding improvement plan and countermeasure. And the optimization of the low efficiency of the order system operation should take the time, cost and resource utilization as the evaluation index of the optimization effect. This method not only can improve the order system of the electronic shopping mall, but also can be used to evaluate the feasibility of the banking and other counter service in life.

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