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Reservation Model for Trucks with Missed Appointment Rate based on Credit Constraints

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Abstract

To optimize the missed appointment in the traditional reservation system of trucks, a two-stage truck reservation optimization model with credit constraints was established, with the goal of minimizing the average waiting time of a single truck in the decision-making period. The genetic algorithm was designed to solve the problem. By comparing the traditional reservation model with the optimized reservation model, the validity of the model was verified. The results showed that the truck reservation system with credit constrains could better control the arrival time of the trucks. The average waiting time at the gate reduced by 23.94-26.95% and the average waiting time at yard reduced by 11.17%-29.22% compared with traditional mode. The model reduces the rate of missed arrvial of trucks and improves the efficiency of port operation.

Keywords

Truck Appointment; Priority Service; Genetic Algorithm; Overbooking; Missed Appointment Rate.

1. Introduction

In recent years, the import and export trade in China has grown rapidly, and container throughput has also shown an upward trend year by year. There is a big imbalance between the tight infrastructure of the port and the fast-growing container volume. Long-term overload operation of the port will lead to bottlenecks in the resources of gates, yards and other links, and it is easy to fall into the dilemma of congestion. Port congestion reduces the port's operating efficiency and prolongs the waiting time of trucks (the word "trucks" in the text defaults to external trucks), which greatly increases the port's operating costs and the transportation costs of trucks.

In response to the congestion in the port, researchers have proposed some effective and feasible solutions to alleviate the congestion. Appointment service is one of them. Appointment service was used by Lindley et al. [1] in 1952 for research outpatient registration appointments, and then gradually applied to other fields. Many scholars at home and abroad have conducted research on the appointment rules in the appointment process and proposed a series of appointment strategies. Laganga [2] advocated that the correlation between the missed appointment rate and time should be considered. Raynes et al. [3] studied the characteristics of outpatient missed appointments and found that when the appointment lead time exceeds 6 days, the missed appointment rate will increase significantly. Therefore, the real-time appointment strategy came into being to reduce the uncertainty with a short lead time. Zhang Wensi et al. [4] clustered patients, predicted patients' behaviors of missed appointments and canceled appointments based on the different characteristics of different types of patients, and designed an optimal appointment scheduling mechanism with the goal of maximizing hospital revenue. Feldman et al. [5] used the maximum return of the hospital as the objective function to establish a model that considers appointment cancellation, missed appointments,

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and patient preference, and studied to improve the flexibility of patient appointment time and patient satisfaction.

In terms of truck appointment scheduling, port managers aim to improve port resource utilization and the efficiency of port operations. In previous studies, they tended to focus on the coordinated scheduling of trucks in the port, while ignoring the scheduling of external trucks. From the perspectives of truck queuing and carbon emissions, Giuliano et al. [6] found that due to the low utilization rate of the reservation system, there is no priority service in reserved trucks, which leads to the unconspicuous effect of reducing the queue for the truck reservations. Mutry et al. [7] found that the reservation strategy can effectively reduce the turnaround time and waiting time of the truck based on the analysis of the truck reservation data in Hong Kong Port, but the system only provides for take-out container trucks. Zeng Qingcheng et al. [8] used the BCMP queuing network to describe the unsteady process of the trucks at gates and yards for the first time, and used the point-by-point fixed fluid approximation algorithm PSFFA to calculate the queue length and optimized it. Fan Houming et al. [9] designed an appointment model for trucks with the goal of minimizing carbon emissions based on the principle of low-carbon and high-efficiency. Li Na et al. [10] realized the joint optimization of yard and crane configuration and reservation quota, and provided decision support for the resource input of the terminal. Yang Chang et al. [11] established a dynamic reservation feedback mechanism based on the arrival time sequence for the shortcomings of static reservations, and constructed an optimization model for the arrival time sequence of trucks, which reduced the turnaround time of trucks in the port. Xu Qiaoli et al. [12] make the truck arrivals steadily by using the method of estimation of backwardation. Jin Zhihong et al. [13] considered whether the container operation is balanced based on the reservation information, and proved that making full use of the truck reservation information can reduce the unevenness of the container operation. Guo Zhenfeng et al. [14] proposed a port mode based on vessels reservations, with the goal of minimizing the total waste cost of the truck fleet and the container crane, taking into account the interests of both the truck fleet and the terminals.

To sum up, the current related research is more comprehensive on the reservation mechanism and the scheduling of the trucks. In the truck reservation model, it is assumed that the trucks can arrive on time within the scheduled time table. However, in the actual operation process, due to many uncertain factors, it is common for trucks to miss appointments, and the fulfillment rate of appointment trucks will greatly affect the appointment model. It is necessary to restrict the credibility of truck drivers. Therefore, from the perspective of the credit of the truck reservation arrival and missed appointments, reservation truck scheduling model is established, considering service capacity of the arrival of trucks in gates and yards to balance truck arriving. It is of great significance to speed up the circulation of trucks in the port.

2. Credit - constrained truck reservation mechanism

In the reservation model with credibility constraints, it is stipulated that the difference between the arrival time of the trucks and the start time of the reservation period does not exceed 10 minutes as the arrival on time. When the truck is the first time to make an appointment, the average value of all customers' reputation is regarded as its reputation value; when the truck is from a truck company that has cooperated, its reputation value is according to the truck driver's historical performance behaviors.

This article divides customers which has already reserved in system into two categories based on their historical performance: the first category is customers with high credibility, denoted by a; the second category is customers with low credibility, denoted by b. When the port manager allocates resources, he performs differentiated services according to the credibility R. The credibility value of the customer with the highest credibility in all appointment records is R*, and the credibility threshold value range is (0,1). R is distributed in $[\gamma R^*, R^*]$ as the first type of customer, and distributed in $[0, \gamma R^*]$ is the second type of customer. The R value calculation method is the ratio of the number of arrivals on time to the total number of appointments in history. The higher priority trucks are given

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priority to obtain services. If the trucks that do not enjoy priority services are more sensitive to waiting time, they need to improve their own performance capabilities, and consciously reduce the rate of missed reservation times to improve their own credibility.

The priority of customers is mainly reflected the fact that customers with high credibility can not only choose to arrive at the port during the preferred time, but also have priority at the gate, that is priority to obtain services. However, its priority is not absolute. Newly arrived customers have to wait for the current trucks to complete the verification information before they can get the service.

In traditional appointment scheduling, researchers have not considered the rate of missed appointments, and managers set the appointment limit as a fixed quota. Therefore, when a customer misses an appointment, it is impossible to make timely adjustments to resources in the port, which reduces operational efficiency. For the occurrence of missed appointments, an overbooking strategy is added to reduce the cost of loss due to missed appointments. Overbooking has high operability and can effectively avoid the waste of resources caused by missed appointments. The compensation strategy adopted in this article is to postpone the unfinished trucks in this interval to the next interval, and the determination of the over-booked share is determined by the missed appointment rate and the reservation quota for this period.

3. Literature References Problem description and hypothesis

In the truck reservation model, the shipper or agent needs to make an appointment in the truck reservation system. The port operator considers his own capacity and the busyness of the yard, and provides multiple appointments during the decision-making period within a limited time period. According to the reservation quota of the truck, the truck driver selects their preferred arrival time according to his own conditions. Priority is given to customers with high credibility to assign their preferred arrival time, and through multiple information exchanges in the reservation system, the arrival time of each truck driver is finally determined. According to the reservation information, the port will formulate a gathering plan and release it to each yard. The yard allocates resources according to the final plan to start the operation.

In order to simulate the non-stationary state of the trucks entering the gate, this paper draws on the fluid approximation method of the study of traffic flow, and uses multiple representative subdivision hours to represent the arrival volume of the appointment interval and important indicators of queuing. In the case of the reservation system, the entire queuing network of the truck is divided into two part: the gate queuing system and the yard queuing system. According to the statistical test of the hourly arrival frequency distribution of trucks, the time interval of trucks entering the port obeys a negative exponential distribution. The trucks use multiple M(t)/M(t)/1 models in parallel at the gates. The yard queuing system adopts the M(t)/E(k)/c(t) model to reduce the vibration amplitude of arrivals and make the arrivals close to the expected value of the port.

In this paper, the minimum average waiting time of trucks is used as the objective function, and an optimization model of truck reservation quotas is constructed considering the missed appointment rate. By solving and optimizing the acceptable amount of reservations in a single time period, the excess reservation share is determined, and also analyzes the impact of different services provided by customers with different credibility on the model. The truck reservation model will be based on the following reasonable assumptions:

1) It is assumed that the truck company or truck driver rationally selects the appointment time period according to their own needs, and the selected time period is within the specified port time period;

2) Regardless of the situation in which trucks arrive in pairs, that is, the arrivals of truck drivers are independent of each other;

3) Assuming that all trucks need to be reserved for gate information registration, regardless of whether the trucks arrives without an appointment;

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4) The first type of customers (customers with high credibility) will be served earlier than the second type of customers (customers with low credibility). When multiple customers with the same priority in the queue, they obey the first-come, first-served rule. The service with the registered trucks cannot be interrupted;

5) In actual operation, since the number of service crane far exceeds the number of gates in service, it is assumed that the service intensity of a single crane is less than 1;

6) Only the waiting time required for the truck queuing is considered, and the waiting time extension caused by operations such as the overturning operation at the yard and the emergency situation of the field operation is not considered.

4. Model building

In order to facilitate modeling, the following symbols are introduced.

The subscript is explained as follows:

n: Decision days, n=1,2,...,N;

m: Appointment period. Dividing 24h into M appointment periods, m=1,2,...,M;

k: The subdivision of the appointment period. Each appointment period is equally divided into K time intervals, k=1,2,3,...,K;

g: Gate;

y: Yard;

a: Customers with high credibility are the first type of customers;

b: Customers with low credibility are the second type of customers;

i: The number of the gate service channel, i=1, 2,..., I;

j: Yard block area number, j=1, 2,..., J;

The variables are defined as follows:

$t_{\mathrm{g},k}$: The average waiting time of a single truck at the gate in the k time interval;

$t_{\mathrm{y},k}$: The average waiting time of a single truck at the yard in the k time interval;

t: The longest waiting time of a single truck;

$\lambda_{\mathrm{g},k}$: The number of trucks arriving at the gate in the k time interval;

$\lambda_{y,k}$: The number of trucks arriving at the yard in the k time interval;

$S_{n,m}$: The reservation quota for the m period on the nth day, a non-negative integer;

P: The arrival rate of reserved customers;

1-p: Missed appointment rate;

$X_{\mathrm{n,m}}$: The excess reservation share of the m period on the nth day;

m_{∂}: The truck driver makes an appointment for the time of congregation goods at the port;

m_{β}: The port congregation of goods period allocated by the port to the trucks;

H: The interval between the reserved collection port interval and the allocated time interval;

R: Credibility;

R^{*}: The customer's credibility value with the highest credibility;

$\lambda_{\mathrm{g,a},k}$: The number of customers a of the first type arriving at the gate in the k time interval;

$\lambda_{\mathrm{g,b},k}$: The number of customers b of the second type arriving at the gate in the k time interval;

$d_{g,i,k}$: The departure rate of trucks in the k time interval at gate i;

$\mu_{i,k}$: The average service rate of the i channel in the k time interval, i=1, 2, ..., I;

$\mu_{j,k}$: The average service rate of the j yard block in the k time interval, j=1, 2,..., J;

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$\rho_{g,a,k}$: The service intensity of the first type of customers in the k time interval at the gate;

$\rho_{g,b,k}$: The service intensity of the second type of customers in the k time interval at the gate;

$\rho_{g,i,k}$: The service intensity of gate i in the k time interval;

$l_{g,a,k}$: The average queue length of the first type of customers in the k time interval at the gate;

$l_{g,b,k}$: The average queue length of the second type of customers in the k time interval at the gate;

$l_{g,k}$: The average queue length of the truck at the gate in the k time interval;

$t_{g,a,k}$: The average waiting time of the first type of customers at the gate in the k time interval;

$t_{g,b,k}$: The average waiting time of the second type of customers at the gate in the k time interval;

$l_{y,k}$: The average queue length of the truck in the k time interval at the yard;

$l_{y,j,k}$: The average queue length of the j yard in the k time interval;

$d_{y,j,k}$: Departure amount of trucks in time interval k in area j of the yard;

V: Coefficient of yard service level change over time;

$\rho_{y,j,k}$: The service intensity of the yard in area j in the k time interval;

According to the above definition, the following set truck reservation model is established:

$$MinZ = \frac{\sum_{k=1}^{K}(t_{g,k} \cdot \lambda_{g,k} + t_{y,k} \cdot \lambda_{y,k})}{\sum_{k=1}^{K}(\lambda_{g,k} + \lambda_{y,k})} \tag{1}$$

$$\lambda_{g,k} = \frac{S_{n,m} \cdot p}{K}, n = 1,2,\ldots,N, m = 1,2,\ldots,M \tag{2}$$

$$t_{g,k} + t_{y,k} \le t, t \ge 0 \tag{3}$$

$$S_{n,m} \in N^*, 0 \le p \le 1, \lambda_{g,k} \ge 0 \tag{4}$$

$$\left|m_\alpha - m_\beta\right| \le H \cdot (1 - R), 0 \le R \le 1 \tag{5}$$

$$X_{n,m} = S_{n,m} \cdot (1 - p) \tag{6}$$

$$\lambda_{g,k} = \lambda_{g,a,k} + \lambda_{g,b,k} \tag{7}$$

$$\rho_{g,a,k} = \frac{\lambda_{g,a,k}}{\mu_{i,k}}, i = 1,2,\ldots,I \tag{8}$$

$$\rho_{g,b,k} = \frac{\lambda_{g,b,k}}{\mu_{i,k}} \tag{9}$$

$$\rho_{g,i,k} = \rho_{g,a,k} + \rho_{g,b,k} \tag{10}$$

$$l_{g,a,k} = \frac{\rho_{g,a,k}(1 + \rho_{g,b,k})}{1 - \rho_{g,a,k}} \tag{11}$$

$$l_{g,b,k} = \frac{\lambda_{g,b,k} \cdot \rho_{g,a,k} \cdot \rho_{g,i,k}}{\lambda_{g,a,k}(1 - \rho_{g,a,k})(1 - \rho_{g,i,k})} + \rho_{g,b,k} \tag{12}$$

$$l_{g,k} = \frac{\rho_{g,i,k}}{1 - \rho_{g,i,k}} \tag{13}$$

$$t_{g,a,k} = \frac{1}{\mu_{i,k}} + \frac{\rho_{g,i,k}}{\mu_{i,k} - \lambda_{g,a,k}} \tag{14}$$

$$t_{g,b,k} = \frac{1}{\mu_{i,k}} + \frac{\rho_{g,i,k}}{(\mu_{i,k} - \lambda_{g,a,k})(1 - \rho_{g,i,k})} \tag{15}$$

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$$t_{g,k}=\frac{\lambda_{\mathrm{g,a},k}\cdot t_{\mathrm{g,a},k}+\lambda_{\mathrm{g,b},k}t_{\mathrm{g,b},k}}{\lambda_{g,k}} \tag{16}$$

$$l_{g,k+1}=max(\,l_{g,k}+\lambda_{g,k}-\sum_{i=1}^{I}d_{g,i,k}\,,0),k=1,2,\ldots,K \tag{17}$$

$$d_{g,i,k}=\mu_{i,k}\rho_{g,i,k} \tag{18}$$

$$\lambda_{y,k}=\sum_{i=1}^{I}d_{g,i,k} \tag{19}$$

$$l_{y,k+1}=max(\,l_{y,k}+\lambda_{y,k}-\sum_{j=1}^{J}d_{y,j,k}\,,0) \tag{20}$$

$$d_{y,j,k}=\mu_{j,k}\rho_{y,j,k},j=1,2,\ldots,J \tag{21}$$

$$\rho_{y,j,k}=\frac{1}{1-v^2}(l_{y.j,k}+1-\sqrt{(l_{y,j,k})^2+2v^2l_{y,j,k}+1}) \tag{22}$$

$$t_{y,k}=l_{y,k}(\sum_{j=1}^{J}d_{y,j,k})^{-1} \tag{23}$$

Equation (1) is the objective function, which means that the average waiting time of the two types of customers during the decision-making period is the smallest; Equation (2) indicates that the actual number of trucks arriving at the gate in the k time interval; Equation (3) indicates that the waiting time of the trucks at the gate and the yard does not exceed the constant t, so as to limit the maximum waiting time of the truck; Formula (4) is the variable value constraint; Formula (5) indicates that customers with higher credibility can make reservations to the preferred time; Formula (6), X is rounded to determine the overbooked quota, 1-p is the missed reservation rate; Equation (7) indicates that the trucks that arrive at the gate in the k time interval are composed of two types of customers with different credibility; Equations (8) and (9) can be obtained according to the flow balance principle, the relationship between the service intensity of the service channel i in the gate at k time interval and the number of truck departure ; Equation (10) indicates that the service level in the gate at k time interval is the sum of the two types of customer service intensities; Equation (11) represents the relationship between the queue length of the first type of customers at the gate and the customer service intensity; Formula (12) represents the relationship between the queue length of the second type of customers at the gate and the amount of customer arrival and service intensity; Formula (13) represents the relationship between the length of the queue at the gate of in k time interval and the service intensity; Formula (14) calculates the average waiting time of the first type of customers in the k time interval according to the queuing model; Formula (15) calculates the second type of customers in the k time interval according to the queuing model. Equation (16) represents the relationship between the average waiting time of all trucks, the average waiting time of the two types of customers and the amount of arrival; Equation (17) represents the relationship between the queue length at the gate ,the amount of arrival and departure; (18) represents the amount of truck departures at the gate service at channel i in time interval k; Equation (19) represents the amount of trucks arriving at the yard in time interval k; Equation (20) represents the relationship between the yard queue length and the arrival and departure quantities; Equation (21) represents the number of trucks that complete the service in time interval k then leave the yard j area; Equation (22) represents the utilization level of the yard j block in k time interval; Equation (23) represents the average waiting time of the truck in the time interval k in the yard.

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5. Algorithm introduction

The issue is classified as NP-hard problem. Because of its complexity, the genetic algorithm is used as the solution algorithm. Genetic algorithm (GA) is a random search algorithm using natural selection and genetic law for reference. It adopts global search strategy and has little dependence on gradient information. The solutions obtained for complex discrete nonlinear problems have high fitness, wide applicability, easy operation, strong robustness and so on. In the selection of offspring population, the elite strategy and roulette are used together to achieve global convergence. It reduce the influence of the optimal solution with low fitness, and avoid the dilemma of the local optimal solution. The algorithm flow is shown in Figure 1.

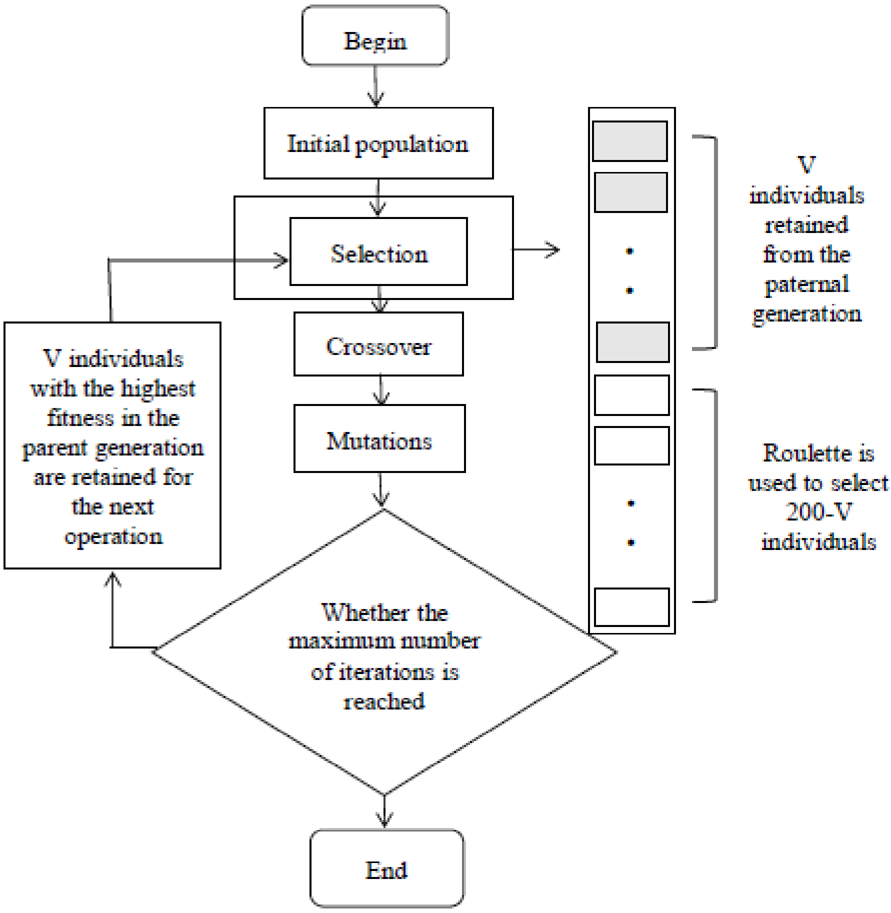

Figure 1. Flow chart of genetic Algorithm

1) Gene coding and the generation of the initial population. A set of reservation quotas $\{\lambda_{g,a,1}, \lambda_{g,a,2}, \dots, \lambda_{g,a,K}, \lambda_{g,b,1}, \lambda_{g,b,2}, \dots, \lambda_{g,b,K}\}$ is randomly generated as an individual, which represents the maximum number of trucks that can be reserved in each time period. The individuals of the initial population are generated by Monte Carlo method, and each individual contains 2N*M random numbers. The initial population is set at 200.

2) Calculate fitness. A single individual $\{\lambda_{g,a,1}, \lambda_{g,a,2}, \dots, \lambda_{g,a,K}, \lambda_{g,b,1}, \lambda_{g,b,2}, \dots, \lambda_{g,b,K}\}$ can calculate the actual arrival amount $\lambda_{g,t}$ in each time period through equation (7), and the arrival rate p is randomly generated; The average waiting time of trucks in the gate $t_{g,k}$ and the yard $t_{y,k}$ can be calculated by equations (16) and (23). Then substitute it to formula (1) to obtain the average waiting time Z of a single truck in the reservation period as the fitness value. For individuals who do not meet the constraints (3)-(5), their fitness value is added with a larger number Q to reduce the crossover probability. The fitness function is $f = Q - Z$.

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3) Selection and crossover. A select group of individuals from the paternal population can exchange some genes through two pairs of chromosomes. The resulting new individuals may combine the excellent gene fragments of the parent and have a higher adaptability. The introduction of an elite strategy ensures that some of the genes with the highest fitness will not be lost in the crossover process. The first V individuals in the parent generation are selected directly into the mating pool, and the other 200-V self-carried individuals use the roulette method to determine the probability of being selected. Two-point crossover is used to adjust the individual fitness value through the crossover probability p_c.

$$p_c = \begin{cases} p_{max}\ , f^* > f_{max} \\ p_{max} - \dfrac{\Delta p(f^* - \bar{f})}{f_{max} - \bar{f}}, f^* > f_{max} \end{cases}$$

Among them, p_{max} is the maximum crossover probability, $p_{\min}$ is the minimum crossover probability, Δp is the difference between the maximum crossover probability and the minimum crossover probability, the greater fitness of two individuals in the crossover process is $f*$, the maximum fitness in the population is $f_{\max}$, $\bar{f}$ is the population's Average fitness value.

4) Mutations. The mutation rate is set to 0.05, and the amount of change is set to 3.

5) Algorithm termination condition. Whether the evolutionary algebra reaches the preset maximum number of iterations of 300, if it is true, the algorithm ends and the optimal reservation quota is obtained, otherwise, step 2 is performed.

6. Numerical example

In this paper, the data of Shenzhen Port is selected for case analysis. The port has 8 gate service channels, 12 yard blocks, the average service rate of the gate $\mu_{i,t}$= 40 vehicles/h, and the average service rate of the yard $\mu_{j,t}$= 25 vehicles/h. The extension of the decision-making period can reduce the waiting time of trucks. When the decision-making period exceeds 5 days, the average waiting time will not decrease significantly. Set the number of decision-making days to 5 days, 24 appointment periods in a day, and an appointment period of 1 hour. The total number of appointment periods is 120.

The arrival of the trucks through 100 groups samples is shown in Figure 2. It is found that the model in this paper can better describe the important indicators of queues.

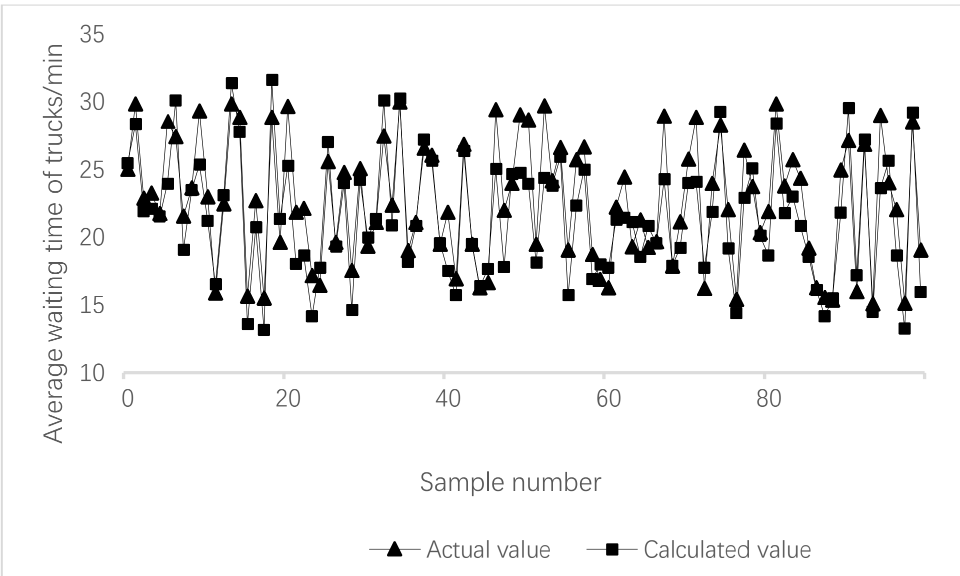

Figure 2. Comparison between the actual value and the calculated value of the average queuing time

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Generating 200 initial populations, with a mutation rate of 0.05 and iterating for 300 generations. As shown in Figure 3, comparing the changes in the arrival of trucks in the three cases, it can be clearly seen that the use of the reservation strategy has limited the number of trucks arriving, making the arrival of trucks relatively stable, but there are still large fluctuations. After adding the constraint of credibility, the arrival of trucks is more stable, basically floating in the range of [100,120], and there is no sharp increase or decrease in the number of trucks arriving at the port. This shows that the reservation system has a control effect on the number of truck arrivals, and the reservation model that considers the reputation is more effective than the traditional reservation mechanism.

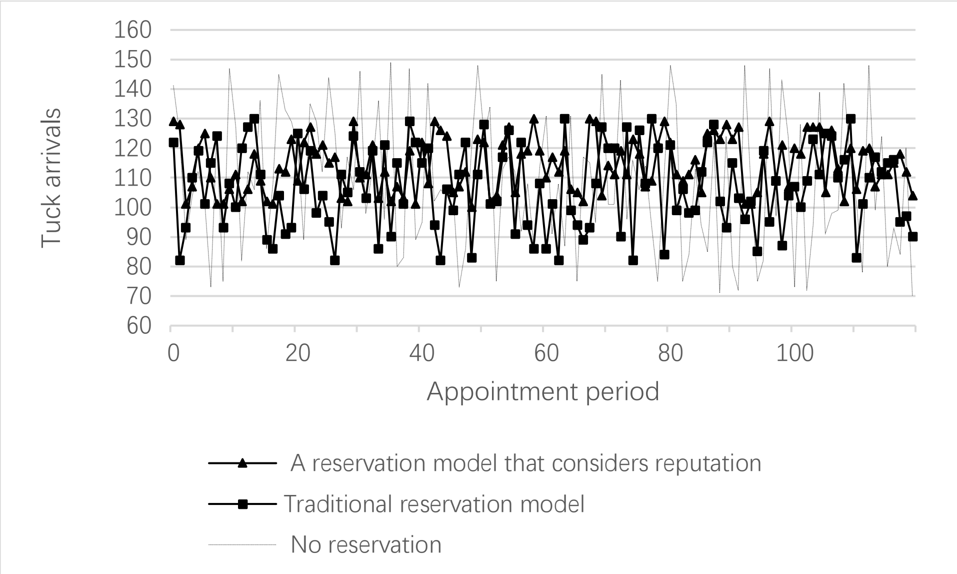

Figure 3. Comparison chart of arrivals in three modes

In order to compare the efficiency of the traditional reservation model and the optimized reservation model under different reservation arrivals, we set the reservation arrivals as 90, 100, 110, and 120 respectively. The specific efficiency comparisons are shown in Table 1.

Table 1. Efficiency comparison under different arrival quantities

No.	Scheduled arrivals	On-time arrival rate(%)		Average waiting time at gate			Average waiting time at yard			Yard efficiency improvement rate
		Traditional reservation	Cedibility reservation	Traditional reservation/ min	Cedibility reservation/ min	Reduced proportion	Traditional reservation/ min	Cedibility reservation/ min	Reduced proportion	
1	90	84.35	90.76	4.97	3.78	23.94	12.35	10.97	11.17	11.53
2	100	80.6	89.31	5.64	4.12	26.95	13.32	9.86	25.98	10.54
3	110	83.58	93.74	5.77	4.23	26.69	13.21	9.35	29.22	12.88
4	120	85.83	90.76	5.76	4.33	24.83	12.89	9.75	24.36	11.97

It can be found that when the appointment model under the constraint of credibility is implemented, the truck driver's ability to arrive on time is improved. The reservation model under the credibility constraint improves the stability of the model. Compared with the traditional reservation mode, the average waiting time at the gate is shortened by 23.94%-26.95%, and the average waiting time for trucks at the yard is shortened by 11.17%-29.22%. Due to the addition of over-booking rules and compensation measures that consider missed appointments, the operating capacity of the yard has also been improved, reducing the waste of yard resources caused by missed appointments. Therefore, the appointment model that considers the rate of missed appointments under the constraint of credibility is effective.

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7. Conclusion

In the case that there is an appointment mechanism for trucks, the credibility is added on the basis of respecting the arrival preference of the trucks. At the same time, considering the service capabilities of the gates and yards, a reasonable truck arrival plan is formulated, which effectively reduces the non-stationary trucks congestion. This paper establishes a mathematical model for the queuing of trucks. Experiments show that the appointment strategy that considers the missed rate under the constraint of reputation is more effective in controlling the arrival of trucks, reduces the waiting time of gates and yards, and improves the port's operational capabilities. Elite strategy combined with roulette also enables the genetic algorithm to converge to the global optimal solution faster. The priority service rule based on reputation under the reservation strategy provides a reference basis for the trucks reservation mechanism, and it is more in line with the needs of actual operations.

At the same time, there are many reasons for the missed appointment of trucks, such as the relative position, appointment lead time, and the urgency of truck operation. It is the future of this article to describe and accurately predict the different reasons for the missed appointement.

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