Landscape Architecture and Regional Planning
2018; 3(4): 72-78
http://www.sciencepublishinggroup.com/j/larp
doi: 10.11648/j.larp.20180304.11
ISSN: 2637-4358 (Print); ISSN: 2637-4374 (Online)

Path Optimization of Drug Recovery in Guangzhou Pharmaceutical Company

Wei Liu, Yaou Xue*, Ling Sun

College of Transport & Communications, Shanghai Maritime University, Shanghai, China

Email address:
18355128418@163.com (Yaou Xue)
*Corresponding author

To cite this article:
Wei Liu, Yaou Xue, Ling Sun. Path Optimization of Drug Recovery in Guangzhou Pharmaceutical Company. *Landscape Architecture and Regional Planning*. Vol. 3, No. 4, 2018, pp. 72-78. doi: 10.11648/j.larp.20180304.11

Received: December 20, 2018; **Accepted**: January 10, 2019; **Published**: January 28, 2019

Abstract: In order to optimize the VRPSDP problem with time window restriction that occurs simultaneously in drug distribution and recovery. Based on the background of Guangzhou Pharmaceutical Company, then set up the path optimization model of single distribution center with time window, and using the improved saving algorithm to find the initial solution, and using tabu search algorithm software to optimize the model combined with the Matlab. It shows that this optimization has certain practical significance for the model and algorithm of VRPSDP problem design in pharmaceutical enterprises.

Keywords: Drug Recycling, Reverse Logistics, VRPSDP, Saving Method, Tabu Search Method

1. Introduction

Due to the serious waste of medicines in the pharmaceutical industry, which has a serious impact on the environment, logistics enterprises need to recover medicines.

Liu Rui [1] discussed the current situation and development dilemma of drug recycling in Harbin, and felt that reverse logistics of medicine had a profound impact on environmental protection, social interests and corporate interests, and put forward the incentive measures for the government to formulate relevant policies. Liu Ting [2] studied the behavior of pharmaceutical companies, government and customers in reverse logistics of drug recovery in China. Based on the assumption of incomplete information and limited subjective rationality, she established a tripartite game model and suggested that the government take different measures in different periods. Cheng Xiao [3] put forward the concept of economized logistics and its causes, discussed the necessity of building economized logistics, and introduced to realize economic logistics of drugs from four ways: information communication, vehicle routing optimization, drug recovery, and the establishment of reverse logistics center of medicine. Tong, Alfred Y. C. [4] said that in some cases, various drug disposal methods have adverse effects on the environment. In many countries, there is no standard agreement on the disposal of unused drugs and waste of drugs and some pharmacies refuse to accept unused drugs. It's essential to establish formal drug disposal agreements. Matilda Persson [5] recommends that Sweden return unused medicines to pharmacies, and more and more Swedes know how to deal with unused medicines correctly. Returning unused medicines is more important to the environment than to safety. Hejrani Sasan [6] talks about that once any object is considered as medical waste, it must be closely monitored through strict procedures and timely treatment from the beginning, and proposes an innovative way to model the reverse logistics network of medical waste, tracking data on the basis of minimizing costs and risks.

But usually the cost of distribution accounts for more than half of the operating cost of an enterprise. Distribution is an important part of the logistics flow process. Distribution involves transportation and storage from the distribution site to customers, with creating space and time benefits for enterprises. Therefore, in the process of logistics flow, especially for distribution, improving speed becomes the key to the activity, and creating the highest service quality and the lowest logistics cost with the shortest path and fastest speed is the enterprise's pursuit direction, while the cost required for recovery will be higher. Therefore, it is recommended to synchronize distribution and recovery. Based on the above analysis, the main goal of this study is to establish a model and solve the actual problems of Guangzhou Pharmaceutical Company and improve the transportation routes of vehicles, so that enterprises can not only reduce transportation costs but also ensure service quality, and provide reference for enterprises to optimize the routes in logistics distribution and recycling.

2. Research Background

China is the third largest pharmaceutical market in the world. The output value of biochemical pharmaceutical industry has also increased significantly. Since 2013, The total profit growth rate of pharmaceutical manufacturing industry has declined slightly in 2014 and now gradual increased. It shows that the remarkable benefit and high quality growth of the pharmaceutical industry which closely related to people's life, and urbanization and medical system construction also improve the development of the pharmaceutical industry [7].

With the development of third party logistics, pharmaceutical logistics has also made rapid improvement, the role for pharmaceutical companies is obvious, such as improvement of medical order management ability, reduction of drug storage time and improvement of fund utilization efficiency and so on. At the same time of the country's health development plan, the biomedical industry is booming, the end market scale is becoming larger and larger, the industry competition is fierce, the system reform is constantly deepening, the cost of drug enterprise reduction is imminent, and the key is the cooperation of pharmaceutical logistics.

Nowadays, a green image is becoming more and more important to enterprises. As far as manufacturing enterprises, manufacturing industry has the potential to cause harm to the environment, as well as the ability to create renewable resources. An enterprise's green supply chain can create a huge profit space, and reverse logistics is one of its key links, reuse or reproduction will often bring new opportunities.

However, in terms of development in recent years, China's pharmaceutical logistics is still in the initial stage. The inefficient supply chain of medicine and the high cost of drug transportation are the main reasons that hinder the progress of medical logistics. About 30% of the drug distribution problems are related to cold chain logistics, while the popularity of cold chain logistics is only 10% in China [8]. In the reverse logistics stage, that is, the drug return link, the probability of drug refrigeration becomes lower. As a result, there is a great threat to the quality of returned medicines. In addition, returns from logistics enterprises, hospitals and retail pharmacies mainly consist of all kinds of dismantled drugs, which lead to the quantity of one-time returns is less, the variety of returns is more, and the returns are unplanned, the mixing is serious, and the logistics cost enterprises are difficult to bear. Therefore, pharmaceutical enterprises operate according to their own transport and warehousing rules and are unwilling to invest too much money to improve reverse logistics. In the process of scattered drug recycling, many of the legally disassembled drugs may be in inappropriate storage conditions and the operation of popularization, which provides more opportunities for fake and inferior drugs to enter the regular drug distribution channels [9].

3. Current Situation of Drug Distribution in Reverse Logistics of Guangzhou Pharmaceutical Company

3.1. General Situation of Guangzhou Pharmaceutical Company

Guangzhou Pharmaceutical Company has a widely trusted drug supply chain service and customer experience-centered service concept [10]. In many times of crisis, it ensured the stability of the medical supplies market, adhered to the concept of energy conservation and environmental protection, responded to the government's call, took the lead in implementing "garbage classification" in pharmaceutical enterprises, strongly supported the "family expired drugs recycling" behavior, and also widely publicized in the field of medicine. In particular, it appealed to pharmaceutical enterprises to join the drug after-sales service mechanism, and recommended that the relevant state supervision fill in the blanks of regulations on drug recycling in a timely manner and trigger more people, social organizations and enterprises to join on the enterprise behavior and system level.

In 2005, Guangzhou Pharmaceutical Company took the lead in introducing the "Family Expired Drugs Recovery (Free Replacement) Mechanism", which burned up the expired drugs recovered in the previous period. In 2006, Guangzhou Pharmaceutical Company launched "Never Expire" pharmacies to replace expired drugs for consumers in order to meet the urgent needs of safe drug use environment and the growing concern of consumers. The service of recovering expired drugs from families has covered more than 30 provinces, municipalities and autonomous regions in the country, and nearly 200 cities in the country. In the ten years since its established, the "free replacement mechanism for household expired drugs" has cost tens of millions of dollars annually, with more than 1100 tons of expired drugs recovered [11].

3.2. Analysis of Distribution and Recovery of Guangzhou Pharmaceutical Company

Although Guangzhou Pharmaceutical Company is currently a mature enterprise in the pharmaceutical industry at present, there are still many problems to be improved, especially in the circulation process, the circulation links are intersected, separated and blocked. As a result, the logistics cost is difficult to reduce, measure and control comprehensively, which hinders the expansion of enterprise logistics services.

With the fierce competition in the pharmaceutical industry and the personalized needs of customers, the development trend of pursuing high service quality, Guangzhou pharmaceutical company's market scale is constantly expanding. But logistics cost accounts for a certain proportion of enterprise sales, and generally speaking, the distribution rate is 60 % - 70 %, the lowest is only about 30 % [12]. In recent years, enterprises have carried out drug recovery services and are expanding its business scope. However, in terms of transportation, the arrangement is not uniform, the waiting time for vehicles is too long, and transportation is delayed, which result in low distribution efficiency and low customer satisfaction. Without strengthening the checking and calculation of transportation costs, arranging transportation routes reasonably, choosing transportation forms, designing and integrating drug transportation, distribution and recycling are not implemented at the same time, and the flow direction is not reasonable and transportation is not reasonable, resulting in low utilization rate of vehicles, excessive waste of human resources, conflicting logistics links, low work efficiency, high logistics cost, too long drug stagnation time and low customer satisfaction.

4. Optimizing Route of Reverse Logistics Distribution in Guangzhou Pharmaceutical Company

4.1. Problem Description and Optimization Model Design

Taking the pharmacies of Guangzhou Pharmaceutical Company in Putuo District of Shanghai as a representative, seven stations of pharmacies in Putuo District were selected. Among them, 1, 2, 3 and 4 pharmacies were the drug recycling points of Guangzhou Pharmaceutical Company in Putuo District. The company had a large distribution site H in Shanghai to distribute uniformly to the outside. When there were pharmacies ordering or recycling demand, the order of distribution is arranged, the distribution route is decided, and the distribution and recovery are completed according to the drugstore demand and recycling volume and geographical location, so as to minimize the total transportation cost. The distance between drugstores as follows. Customer demand, recovery, service time and specified time window are shown in the table below. The vehicle capacity limit is 8 tons, the first start cost is 200, the transportation cost per unit distance is 10, the unit cost when the vehicle arrives early is 2, and the unit cost when the vehicle arrives late is 3.

Hypothesis: Vehicle travel time is only related to the distance traveled. Average vehicle speed is 40 km/h. Vehicle travel time between two points is available: $t_{ij} = D_{ij}/40$.

Table 1. *Distance between nodes.*

node	0	1	2	3	4	5	6
0							
1	12.9						
2	9.2	5.7					
3	11.9	3.6	4				
4	11.4	3.5	5.7	2.3			
5	12.7	8.6	8.3	5.1	6		
6	10.6	2.1	1.6	3.5	4.7	8.4	
7	9.2	3.6	1.1	3	5.1	7.2	1.9

Table 2. *Demand, recovery, service time and prescribed time window of each drugstore.*

Pharmacy	1	2	3	4	5	6	7
U_i	3	2	1.5	4	3	5	2
V_i	2	2	1	3	0	0	0
St_{ik}	2.5	2	2	1.5	0.2	1	0.2
$[Et_i, Lt_i]$	[1,3.5]	[2,6]	[2,4]	[3,4]	[0.5,4]	[1,4.5]	[3,6]

4.1.1. Basic Assumptions

(1) The distribution stations have the same type of vehicles.

(2) Vehicles departing from the distribution site need to return to the distribution site after the completion of distribution and recycling.

(3) Each drugstore is served by only one car.

(4) Drugstores have strict time requirements and need to consider transportation under specified time windows.

4.1.2. Model Parameter

N: The pharmacy is numbered 1, 2, 3, 4, 5, 6, 7, The drugstore collection is $N = \{1, 2, 3, 4, 5, 6, 7\}$, Among them, the drugstore with recycling service is 1, 2, 3, 4.

M: Distribution center number is 0, Distribution centers set is $M = \{0\}$.

K: Vehicle collection in distribution center, $k = \{1, 2, \dots n\}$.

R: Vehicle carrying capacity.

A: Vehicle start-up cost.

D_{ij}: The distance between node i and node j. $i, j \in N \cup M$.

C_{ij}: Unit transportation costs of node i and node j. $i, j \in N \cup M$.

t_{ij}: The time of vehicle k driving from point i to point j. $i, j \in N \cup M$.

t_{jk}: The moment when the vehicle k actually arrives at the j drugstore, $j \in N$.

Et_j: The earliest time allowed for vehicles to arrive at j drugstore, $j \in N$.

Lt_j: The latest time allowed for vehicles to arrive at j drugstore, $j \in N$.

St_{jk}: Time of vehicle k service j drugstore, $j \in N$.

α_1: Cost factor per unit time of early arrival of vehicle k.

α_2: Penalty factor of unit time for vehicle k late arrival.

U_j: Demand for pharmacy j. $j \in N$.

V_j: Recovery of pharmacy j. $j \in N$.

P: Total drug storage in distribution center.

Q: Total drug recycled in distribution center.

A_k: Load of vehicle k in distribution center.

B_{jk}: Vehicle k reaches customer j, but has not yet been delivered to customer j, the remaining amount of drugs in the vehicle which has not yet been distributed, $j \in N$.

E_k: After vehicle k returns to the distribution center, the total amount of recovered drugs loaded in the vehicle.

F_{jk}: After the vehicle k is distributed to customer j, the total amount of the recovered drugs loaded in the vehicle, $j \in N$.

Decision variables are set:

$$x_{ijk} = \begin{cases} 1 \text{Nodes i to j are transported directly by vehicle k} \\ 0 \text{ otherwise} \end{cases}$$

$$y_{jk} = \begin{cases} 1 \text{Drugstore j served by vehicle k} \\ 0 \text{ otherwise} \end{cases}$$

The problem is described by a 0-1 non-linear integer programming model as follows:

$$\min TC = \{\sum_{k\in K}\sum_{i,j\in M\cup N} C_{ij}D_{ij}x_{ijk} + A\sum_{k\in K, j\in N} max(y_{jk}) + \sum_{j\in N}\sum_{k\in K} \partial_1 y_{jk} max\{(Et_j - t_{jk}), 0\} + \sum_{j\in N}\sum_{k\in K} \partial_2 y_{jk} max\{(t_{jk} - Lt_j), 0\}\} \quad (1)$$

Constraints:

$$\sum_{k\in K}\sum_{i\in M\cup N} x_{ijk} = 1 \;\forall j \in N \quad (2)$$

$$\sum_{k\in K}\sum_{j\in M\cup N} x_{ijk} = 1 \;\forall i \in N \quad (3)$$

$$\sum_{i\in M\cup N} x_{ijk} = y_{jk} \;\forall j \in N, k \in N \quad (4)$$

$$\sum_{i\in M\cup N} x_{ijk} = \sum_{j\in M\cup N} x_{ijk} \;\forall j \in M \cup N, k \in N \quad (5)$$

$$t_{jk} = \sum_{i\in M\cup N} (t_{jk} + St_{ik} + t_{ij}) x_{ijk} \;\; \forall j \in M \cup N, k \in N \quad (6)$$

$$A_k \le R, B_{jk} \le R, F_{jk} + B_{jk} \le R \;\forall j \in N, k \in N \quad (7)$$

$$\sum_{i\in N} U_i \le P \quad (8)$$

$$\sum_{j\in N} V_i = Q \quad (9)$$

$$\sum_{k\in K, j\in N} \max(y_{jk}) \le n \quad (10)$$

Formula (1) is the objective function, which includes vehicle travel cost, vehicle waiting cost and penalty cost for late arrival; (2) - (4) indicates that the vehicle arriving and leaving the same customer can only be one vehicle and can only start from one node; (5) indicates that the number of vehicles arriving and leaving each customer is the same; (6) indicates that the number of vehicles arriving and leaving each customer is the same; (6) indicates the time when vehicles arrive at customers; (7) indicates the actual load of all vehicles is below their rated load; (8) indicates the demand of customers can not exceed the storage of warehouses; (9) the recovery of pharmacies is equal to the total recovery of warehouses; (10) indicates the total number of vehicles used can not exceed the total number of existing vehicles.

4.2. Problem Solving

4.2.1. Determining the Initial Feasible Solution

For the tabu search method, the initial solution will affect the quality and convergence speed of the algorithm. Therefore, it is necessary to choose a better initial solution for the tabu search method.

This paper considers the vehicle routing optimization problem under the time window restriction, which is carried out at the same time with distribution and recycling. The simple saving algorithm is used to optimize the route of customers and distribution centers, which may lead to the service of the following nodes is not within the time window restriction and increase the cost. Therefore, this paper avoids this problem by improving the saving method.

(1) Calculating the value of distance savings $s(i,j)$.

$$s(i,j) = D_{i0} + D_{0j} - D_{ij}, M = \{s(i,j) | s(i,j) > 0, \text{且 } i,j \in N, i \ne j\} \quad (11)$$

(2) For each $s(i,j)$ in M, the values are arranged from large to small.

(3) If $M = \emptyset$, then terminate, Otherwise, judging the corresponding (i,j) of $s(i,j)$ in M. If any of the following requirements are met:

i) Neither node i and node j is present on the formed route.

ii) In the formed routes, node i and node j are both present, but they are not interior points, that is, they are not connected with distribution sites.

iii) In the formed routes, node i and node j are in different routes, but they are not interior points, and one point is the end of the line, the other is the starting point of the line.

Then go to (4), otherwise go to (7).

(4) Calculate the total demand Q_i and total recovery P_i of drugs on the connecting node i and node j. If Q_i and P_i are satisfied $Q_i \le R, P_i \le R$, then proceed (5), otherwise, transfer to (7).

(5) Calculate EF_j,

$$EF_j = t_{ik} + St_{ik} + t_{ij} - t_{jk} \quad (12)$$

That is, the time that the vehicle arrives at point j later (or earlier) than the vehicle on the original planned path on the path connected by node i and node j.

i) If $EF_j = 0$, it means that the arrival time of the vehicle at point j is the same as that on the original line. Transfer to (6).

ii) If $EF_j < 0$, It indicates that the arrival time of the vehicle at point j is earlier than that of the original planned route. Then calculate Δ_j^-,

$$\Delta_j^- = \min_{r\geq j}\{t_{rk} - Et_r\} \quad (13)$$

That is to say, on this path, when the node behind note j does not need to wait, the vehicle can advance the maximum amount of time. If $\Delta_j^- \geq |EF_j|$. Go to (6), otherwise go to (7).

iii) If $EF_j > 0$, it means that the arrival time of the vehicle at point j is later than that of the original planned route. Then calculate Δ_j^+,

$$\Delta_j^+ = \min_{r\geq j}\{Lt_r - t_{rk}\} \quad (14)$$

That is to say, on this path, when arriving at point j, the arrival time of the latter node is not delayed, that is, when the latter node does not violate the time window constraint, the vehicle can be allowed to delay the maximum amount of time to arrive. If $\Delta_j^+ \geq EF_j$, transfer to (6), Otherwise, go to (7).

(6) Connect point i and point j. Calculating the new arrival time of the vehicle at the mission point and turn to (7).

(7) Order $M = M - s(i,j)$, Transfer to (3).

The initial feasible solution obtained by the improved saving method achieves the best for limitation on the time window, which lays the foundation for the later tabu search algorithm.

4.2.2. Tabu Search Algorithm

(1) Neighborhood Generation in Tabu Algorithms

In this paper, vertex switching method is used to re-exchange vertices between two lines or within the lines to integrate the lines. The steps are as follows: Firstly, two arbitrary points within or between lines are randomly selected. Secondly, the following judgments are made:

i) If the two selected vertices are customers or the first one is customers and the second one is distribution center, the two vertices are interchanged.

ii) If the first vertex is the distribution center and the second vertex is the customer, then it is judged whether the distribution center is the starting point of the route. If so, the vertex is not exchanged. If not, the positions of the two vertices are exchanged.

(2) Determining Taboo Objects, Taboo Length and Termination Criteria

After each iteration, the local optimal solution (i. e. the solution with the smallest evaluation value) is put into the tabu table as the tabu object, and a constant l is selected as the tabu length according to the scale of the problem, and the number of N in the field is selected as the candidate solution. Furthermore, the termination criterion is used to stop the iteration when the iteration reaches the specified number of steps T.

Table 3. *Tabu search algorithm parameter setting table.*

Parameter	Significance	Value
T	Iterative steps	400
N	Number of neighbors searching the current solution each iteration	50
l	Tabu length	6

(3) Main steps of tabu search algorithm

Step1. Initialization. By assigning value to $D_{ij}(i,j \in M \cup N)$、U_j、$V_j(j \in N)$, the initial solution x_0 is obtained from the improved saving method. $localbestjiezhi$ is used to assign localbestjie values. $Sbest$ and $Ebest$ for assignment of suboptimal feasible solutions and objective function values, x is the solution of dividing the neighborhood in iteration, and the upper bound of the evaluation value of the solution is:

$$M = \left(\sum_{r=1}^{k}[T(r) + \partial_1 E(r) + \partial_2 L(r)]\right) \times \left[y\sum_{i\in N}(U_i + V_i) + 1\right] \quad (15)$$

After initialization, the tabu list $H = \{x_0\}$, Iterative steps $t = 0, Sbest = x_0, Ebest$ is the evaluation value of $x_0, x = x_0$. Go to Step 2.

Step2. When the number of iteration steps t is less than the defined number of iteration steps T, $localbestjiezhi = M, localbestjie = \phi, n = 1$, Go to step 3, otherwise go to step 6.

Step3. when n is less than the number of candidate solutions N,

i) carrying out vertex exchange method on x to obtain the adjacent position x_1 of x.

ii) When $x_1 \notin H$, Find x_1 evaluation value.

When the evaluation value $< localbestjiezhi$, $localbestjie = x_1, localbestjiezhi =$ The evaluation value of $x_1, n = n + 1$. When the evaluation value $> localbestjiezhi, n = n + 1$, Go to i).

When $x_1 \in H$, $n = n + 1$, Go to i).

Otherwise, go to step 4.

Step4. If $tjiezhi \leq Ebest$, make $Sbest = localbestjie$, $Ebest = localbestjiezhi$, Go to Step 5.

Step5. If the taboo length is less than l, put $localbestjie$ at the back of the tabu list, $t = t + 1$, Go to Step 2. If the taboo length is longer than l, put $localbestjie$ at the back of the tabu list, Taboo list first lifted ban, $x = localbestjie$, $t = t + 1$, Go to Step 2.

Step6. Output $Ebest$ and $Sbest$.

4.3. Result Analysis

According to the improved saving method, the initial solution is $x_0 = (01602470250)$. According to the tabu search algorithm, the final route is $x = (01570234060)$. The following distribution schemes are available:

Table 4. *Distribution Scheme Obtained by Saving Method.*

Vehicle	Distribution route				
Vehicle 1	0	1	6	0		Total
Distribution distance	0	12.9	15	25.6		25.6
Arrival time		1	3.55	4.82		
Delay time		0	0	0		0
Vehicle 2	0	3	4	7	0	
Arrival time	0	11.9	14.2	19.3	28.5	28.5
Distribution distance	0	2	4.06	5.69	6.12	
Delay time		0	0.06	0		0.06
Vehicle 3	0	2	5	0		
Distribution distance	0	9.2	17.5	30.2		30.2
Arrival time	0	2	4.21	4.73		
Delay time		0	0.21	0		0.21

Table 5. *Distribution Scheme Obtained by Tabu search method.*

Vehicle	Distribution route					
Vehicle 1	0	1	3	7	0	Total
Distribution distance	0	12.9	16.5	19.5	28.7	28.7
Arrival time	0	1	3.59	5.67	6.1	
Delay time		0	0	0		0
Vehicle 2	0	2	6	0		
Arrival time	0	9.2	10.8	21.4		21.4
Distribution distance		2	4.04	5.31		
Delay time		0	0.04	0		0.04
Vehicle 3	0	4	5	0		
Distribution distance	0	11.4	17.4	30.1		30.1
Arrival time		3	4.65	5.92		
Delay time		0	0.15	0		0.15

As can be seen from the above table, the transportation mileage of the distribution plan obtained by the saving method is 84.3 km, the delay time is 0.27 hours, and the transportation cost is $f(x_0) = 845.45$ yuan. The transportation mileage of the distribution plan obtained by tabu search method is 80.2 km, the delay time is 0.19 hours, and the transportation cost is $f(x_0) = 802.57$ yuan.

After the initial solution was improved by tabu search method, the transportation cost was obviously reduced, the time of delayed arrival at the drugstore was shortened, the customer satisfaction was improved, and the effect was more obvious.

Therefore, the final distribution plan is:

(1) Distribution Center 0 - Drugstore 1 - Drugstore 3 - Drugstore 7 - Distribution Center 0. Transportation mileage is 28.7 kilometers, time consumption is 5.4 hours, delay time is 0, distribution goods are 6.5 tons, and recycling is 3 tons.

(2) Distribution Center 0 - Drugstore 2 - Drugstore 6 - Distribution Center 0. Transportation mileage is 21.4km, time consumption is 3.54 hours, delay time is 0.04 hours, goods are delivered 7 tons, and 2 tons are recovered.

(3) Distribution Center 0 - Drugstore 4 - Drugstore 5 - Distribution Center 0. Transportation mileage is 30.1 km, transportation time is 3.2 hours, delay time is 0.15 hours, distribution goods are 7 tons, and recovery is 3 tons.

5. Summary

Guangzhou Pharmaceutical Company has the advantages of good management and sufficient funds. The turnover rate of assets and the growth rate of business are rising. Therefore, its development potential will not be limited by funds. It has a good development platform, which can expand the pharmaceutical market and seek new breakthroughs with its good brand image and influence. But even if with sufficient funds, no enterprise is willing to pay a high price to improve its already good image. Therefore, the rapid increase in costs brought by new services for drug recovery restricts the better development of the enterprise. Based on a large number of references, this paper proposes a measure to reduce the cost of recovery, that is, on the basis of providing recovery services in some drugstores, the VRPSDP problem of vehicle distribution and recovery with time window restrictions is considered. By integrating distribution and recovery transportation, the rationalization of transportation path is achieved and value benefits are generated.

The traditional transportation route problem, mostly based on the single process of distribution or recovery, is prone to the problem of no-load of vehicles, resulting in improper use of vehicles and reduced utilization rate, which not only consumes unnecessary resources but also puts more pressure on the environment. In real life, we prefer to carry out drug recovery while distribution, combining forward and reverse logistics, avoiding secondary transportation at the same node as much as possible and reducing the number of no-load vehicles so as to reduce transportation costs.

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