ISSN : 0974 - 7435 Volume 10 Issue 21

2014

BioTechnology
An Indian Journal

FULL PAPER
BTAIJ, 10(21), 2014 [13411-13417]

Discussion on optimization model of vehicle scheduling in logistics enterprises:taking the first division of south xinjiang corps as an example

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ABSTRACT

As a key link of optimal resource allocation in logistics enterprises, vehicle scheduling problem is difficult in the researches of logistics domain due to various influencing factors. By analyzing common types of vehicle scheduling problem and combining the practical situation of logistics enterprises in south Xinjiang corps, this paper adopted the step-down research method by dividing route branches. Firstly, this study established relatively simple optimization model of vehicle scheduling by simplifying assumptions and research objects. Then, empirical analysis was also presented according to the real situation of South Xinjiang corps. And with lingo software programming, the scheduling results were obtained. The solving process is very convenient and the model results were in great agreement with reality. The related results have certain guiding significance for the resources' optimal allocation of local Logistics Enterprises.

KEYWORDS

Vehicle; Scheduling; Optimization; Model; Empirical; Analysis.

INTRODUCTION

In recent years, with the rapid development of economy and society, and the accelerating pace of economic globalization, importance of logistics in the economic and social development has become increasingly prominent, and gradually attracted people's attention. So that the comprehensive development level of a country's logistics has become an important symbol of the nation's comprehensive strength. In order to realize the sustainable development of the Logistics Enterprises of the production and Construction Corps in South Xinjiang, optimize the allocation of limited resources of logistics, the logistics scheduling problem of its logistics enterprises is researched. Do the optimal design about the logistics scheduling problem of the Logistics Enterprises in South Xinjiang Corps, not only for the development of modern logistics industry in South Xinjiang Corps, but also for the efficient and sustainable development of its economy, has important practical significance and the practical value.

The ultimate aim of the paper was to investigate strategic problem of sustainable development of modern logistics enterprises in south Xinjiang corps and achieve optimal allocation of limited resources in logistics enterprises. To achieve this aim, basing on the wide collection of policy documents, statistical data and research results related to modern logistics development, this research found out optimized decision method for the development of logistics enterprises in south Xinjiang by analyzing the data obtained in the investigation.

Transportation is capable of creating place utility and time utility of products. Hence, transportation decision is directly related to logistics cost and customer service level of enterprises. Transportation decision includes a wide range of contents, mainly: choice of transportation modes, choice of transportation routes and networks, choice of the number of deliveries and so on. Due to the special geographical location of south Xinjiang, there are limited transportation modes. Besides, as the most important problem in transportation decision, choice of transportation routes and networks is directly related to distribution cost as well as the time and accuracy of products delivered to customers. Moreover, the number of deliveries is directly related to distribution cost. Therefore, choice of transportation routes, that of transportation networks and that of the number of deliveries are the main problems in vehicle scheduling of logistics enterprises.

Choice of transportation routes can be divided into four types, that is:

Starting point is different from terminal point, via other nodes on the way.

Starting point is the same with terminal point, but via different nodes on the way.

There are several starting points and several terminal points, without intermediate nodes.

There are several starting points and several terminal points, with intermediate nodes.

This research is a sub project of "Research on vehicle and storage model and the optimization scheduling algorithm for the logistics enterprises of Xinjiang", which is supported by Doctor Foundation of the Xinjiang production and Construction Corps. There are main traditional operations research methods for solving logistics scheduling problem such as linear programming, integer programming, unconstrained optimization, nonlinear programming, dynamic programming[1] and so on. Among the methods, linear programming model can be used to deal with transportation decision problem in logistics, while storage theory can deal with the storage decision problem in logistics decision. In addition, assignment problem, loading problem, location problem etc. can be solved by integer programming.

To solve logistics scheduling problem, besides the traditional optimization algorithms of operations research, there are also modern optimization algorithms such as tabu search[2] ,simulated annealing[3], genetic algorithm[4] , ant colony algorithm[5] and so on. There are many similar research results, this is not list one by one.

Despite there are abundant achievements about model and algorithm for the scheduling problem of logistics enterprises, but the models and algorithms given above often should only be used for specific problem of some spatial and temporal region. According to the logistics scheduling problem, the unified standard method does not exist. In view of the scientific and reasonable scheduling problem of logistics distribution center, need to consider many aspects of regional economic and social development comprehensively. Because of the characteristics and differences of regional economic and social development, the scheduling problem of logistics center in different regions have their own specific research value.

South Xinjiang production and construction corps were established basing on the special geographical environment in Xinjiang in specific historical period. Now, south Xinjiang corps contain four divisions: the first division, the second division, the third division and the fourteenth division. There are fewer research objects in the corps. And the first division governs 16 regiments and its agricultural development is the most competitive and representative in the four divisions. Hence, the first division was taken as main research object of this study. Logistics service product is mainly the transportation of agricultural materials like cotton, chemical fertilizer, seeds and so on. Owing to fewer scheduling objects, scheduling problem in logistics service becomes relatively simple. Therefore, traditional linear programming model was adopted to deal with relevant problem.

There are many factors need to be considered for scientific scheduling problem of South Xinjiang Corps, such as the need for inventory, the need for transit, the type of vehicles, vehicle capacity, vehicle repair costs, staff wages, path selection, time constraints, whether the mixed loading, valuables or not, etc. Typical form of linear programming model is presented as follows:

$$\min \quad z = f(x) \qquad (1)$$

$$s.t.g_i(x) \le 0 \quad (i = 1, 2, \cdots, m) \tag{2}$$

Model consisting of both (1) and (2) belongs to constrained optimization, while unconstrained optimization is obtained if the model only consisting of formula (1). In the model, $f(x)$ is defined as objective function and $g_i(x)$ denotes constraint conditions.

ANALYSIS OF VEHICLE SCHEDULING

Generally speaking, the logistics resource of an enterprise is limited. To achieve long-term profit and development, profit maximization and optimal cost control (cost minimization) in operation have to be taken into account, as well as various demands of customers. Moreover, enterprises need to perfect their service quality by satisfying customer demands as much as possible and improve their comprehensive competitiveness by maximizing economic benefits. A common vehicle scheduling should comprehensively consider the following factors: the scheduling center of logistics, subcenters, the inventory (such as the first-level inventory and the second-level inventory, etc), vehicle types in the enterprise (including the capacity of varied vehicle types), the number of each type of vehicles, the route choice in scheduling process, workers' salary (workers driving different vehicle types are paid differently), and the cost of vehicle maintenance.

While, concerning more complex scheduling problem, customers' extra demands have to be considered as well, such as the time demand for goods (to ensure that goods can be supplied on schedule and satisfy customers' urgent demands for goods) and quality assurance of goods (some customers require that goods quality cannot be changed in the transportation process, including the preservation of perishable food and the protection of valuable goods from damage or deterioration). Furthermore, to save transportation costs when there are various types of goods, apart from choosing a shorter transportation route, various goods possibly need to be transported together, which is not acceptable for all the goods (for instance, it's not allowed to mix food with poisonous chemicals).

Therefore, scheduling problem, in which not only customer demands but also the minimized total costs for logistics enterprise have to be considered, is a complex allocation problem for limited resources with multiple constraints. To quantitatively analyze such a scheduling problem using model, the model will inevitably includes multiple variables and parameters. However, such a complex model is usually a nonlinear complex one through which the global optimization can't be achieved.

Actually, scheduling problem is usually a specific problem targeting certain type (or types) of goods and certain kind (or kinds) of demands. Hence, for scheduling problem in a specific situation, it doesn't need to consider all factors at the same time, including time limit, quality assurance and mixed loading. Instead, only one or two factors are to be considered. To present the universal method and procedure and make the relevant research more operable, it is necessary to properly simplify the optimal scheduling problem.

CONSTRUCTION OF MODEL FOR LOGISTICS SCHEDULING PROBLEM IN SOUTH XINJIANG CORPS

Model assumptions

1)There are no severe natural disasters in south Xinjiang in recent years.

2)Dispatching center is provided with adequate resources for scheduling and adequate transportation capability.

3) No time quantum is limited in scheduling process.

The construction of a simplified scheduling model

A simplified vehicle scheduling problem is presented first: there are p freights with volume q for each in resource point s. And c denotes freight rate per kilometer per ton, while w denotes total supply. Now there are m demand points, k routes and altogether a_i nodes on the route i. Moreover, the distance between logistics center s and the node j on the route i is $d_{ij}(i = 1, 2, \cdots, k;\ j = 1, 2, \cdots, a_i)$. It is presumed that altogether n vehicles are dispatched. And the number of vehicles dispatched to the route i is $n_i(i = 1, 2, \cdots, k)$,while that dispatched to the node j on the route i is $n_{ij}(i = 1, 2, \cdots, k;\ j = 1, 2, \cdots, a_i)$ .Besides, the demand of demand point i is $g_{ij}(i = 1, 2, \cdots, k;\ j = 1, 2, \cdots, a_i)$.

Basing on the data above mentioned, under constraint conditions that demand of each node is satisfied and cost is minimized, the optimal scheme with minimum total scheduling vehicles and shortest total journey is expected.

The number of dispatched vehicles n must be less than that of total vehicles, that is, $n \le p$.

The sum of the vehicles dispatched to all routes is equal to the number of dispatched vehicles. Hence,

$$\sum_{i=1}^{k} n_i = n(i=1,2,\cdots,k)$$

Supply of the node j on the route i is not less than demand. So,

$$n_{ij}q \geq g_{ij}\,(i=1,2,\cdots,k;\ j=1,2,\cdots,a_i)$$

All dispatched vehicle numbers of n, n_i and n_{ij} must be integers.

The minimum of costs Z was taken as objective function and the costs includes fixed royalty U and transportation cost T .Among the costs, workers' wages u_1 and maintenance charge of each vehicle u_2 and so on are contained in the fixed royalty.Hence, $U = u_1 + u_2 p$ is thus obtained. Transportation cost T depends on volume, freight rate and transport mileage.

Therefore, the objective function can be written as follows:

$$\mathrm{T} = \sum_{i=1}^{k}\sum_{j=1}^{a_i} n_{ij} q d_{ij} c(i=1,2,\cdots,k;\ j=1,2,\cdots,a_i)$$

Therefore, the objective function can be written as follows:

$$\mathrm{Z} = U + \mathrm{T}$$

$$Z = u_1 + u_2 p + \sum_{i=1}^{k}\sum_{j=1}^{a_i} n_{ij} q d_{ij} c(i=1,2,\cdots,k;\ j=1,2,\cdots,a_i)$$

In conclusion, optimization model was established as follows:

$$\min \quad Z = u_1 + u_2 p + \sum_{i=1}^{k}\sum_{j=1}^{a_i} n_{ij} q d_{ij} c(i=1,2,\cdots,k;\ j=1,2,\cdots,a_i)$$

$$s.t. \quad n \leq p$$

$$\sum_{i=1}^{k} n_i = n(i=1,2,\cdots,k)$$

$$n_{ij}q \geq g_{ij}\,(i=1,2,\cdots,k;\ j=1,2,\cdots,a_i)$$

n, n_i and $n_{ij}\,(i=1,2,\cdots,k;\ j=1,2,\cdots,a_i)$ are all integers.

Taking the first division in South Xinjiang corps as an example

The station of the first division is in Aksu, South Xinjiang, China. With its fame dating back to the ancient Silk Road, Aksu is an important hinge on Eurasian Continental Bridge and provided with frequent logistics transportation. As mentioned above, the first division governs 16 regiments. And Aksu was taken as logistics center, while all regiments were taken as logistics nodes for the research. To investigate the simplified scheduling model, this paper took the transportation scheduling of chemical fertilizer in the first division as an example.

Through the investigation and study on-the-spot for logistics company in Akesu area, we found that there are almost no own warehouse at the logistics company in the area for cost saving considerations. So, in the process of modeling, the stock and transshipment are not considered. In view of the transportation of fertilizer don't need fresh, and local farmers in planting season order their requirements as soon as possible on the crop fertilizer, so for the time requirements of scheduling transportation is not high, therefore it can be ignored. In addition, in view of the fact that the appearance of fertilizer packing relatively fixed and single, and the loading requirements is not high, so the mixed loading between different kinds of fertilizer had little effect on our scheduling problem, it is almost negligible. Because of fertilizer is not valuables, in the process of transportation, the wear or quality assurance is almost ignored. In addition, in order to simplify the problem, we give the assumption that the logistics company is only one type of car, the vehicle volume, a single repair expenses and worker salaries are fixed, under the premise of specified address for the order, the selection of shortest path in transportation as far as possible, in order to save transportation costs as low as possible.

Now, with the headquarter of a chemical fertilizer company in Aksu and its fertilizer supplied for 16 surrounding regiment farms, the company expects to achieve cost-optimal vehicle scheduling scheme. The following are corresponding assumptions. Presently, there are 120 transport vehicles of the same type in the company and the volume of each vehicle is 2 tons. Besides, average maintenance charge of vehicles is 50 yuan, while monthly total wages of the workers are 12000 yuan. And cost-optimal vehicle scheduling table was obtained basing on the simplified model established above. The distributing sketch map of the first division is as figure 1.In the figure, R denotes regiment farm.

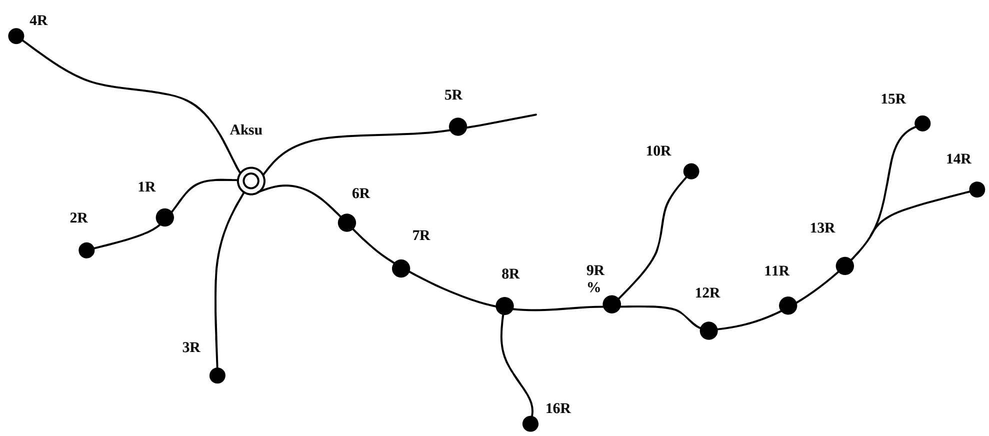

Figure 1: The distributing sketch map of the first division

Each regiment farm in the first division was numbered first according to route distribution and there were 5 branches. The regiment farm route distribution map of the first division is as figure 2. In the figure, R denotes regiment farm.

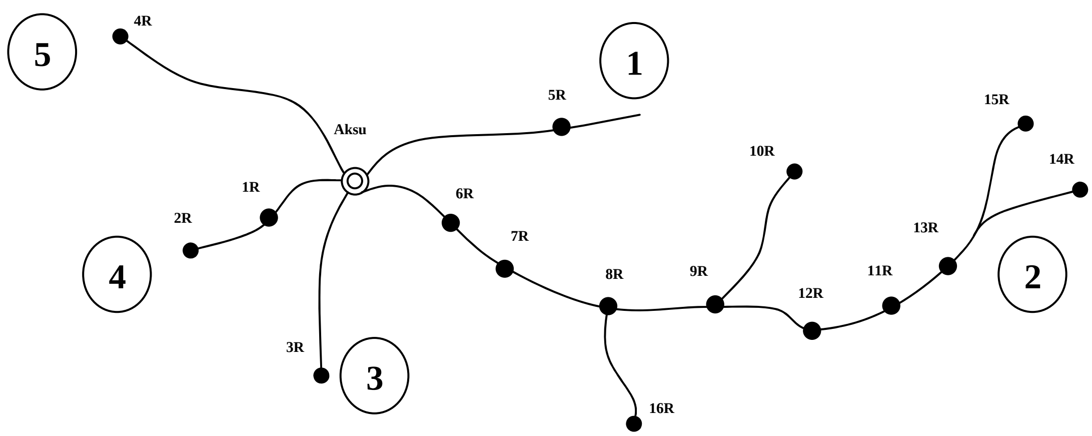

Figure 2 : The regiment farm route distribution map of the first division

TABLE 1 illustrates the route distribution of each regiment farm and the distance between each regiment farm and city center was demonstrated in TABLE 2. And the demand of each regiment farm in a quarter was demonstrated in TABLE 3.

TABLE 1 : Regiment farms distribution on each route

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Route 1	5										
Route 2	6	7	8	16	9	10	12	11	13	14	15
Route 3	3										
Route 4	1	2									
Route 5	4										

TABLE 2 : Distance between regiment farms of each route and headquarter (Unit: Km)

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Route 1	10										
Route 2	30	40	60	90	120	130	128	140	150	160	165
Route 3	70										
Route 4	20	30									
Route 5	100										

TABLE 3 : The demand of each regiment farm (Unit: ton)

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Route 1	20	0	0	0	0	0	0	0	0	0	0
Route 2	25	26	30	24	95	28	40	31	37	25	20
Route 3	20	0	0	0	0	0	0	0	0	0	0
Route 4	12	18	0	0	0	0	0	0	0	0	0
Route 5	15	0	0	0	0	0	0	0	0	0	0

The model above established was processed by lingo11 programming. The vehicle scheduling results were revealed in TABLE 4, and the numbers of vehicles required along the different routes were given in the table .

TABLE 4 : Scheduling table of the scheduling model (Unit: Car)

	1	2	3	4	5	6	7	8	9	10	11
Route 1	8	0	0	0	0	0	0	0	0	0	0
Route 2	8	8	6	8	10	7	6	5	6	5	5
Route 3	8	0	0	11	0	0	0	0	0	0	0
Route 4	5	6	0	0	0	0	0	0	0	0	0
Route 5	8	0	0	0	0	0	0	0	0	0	0

CONCLUSION

The results indicate that the number of vehicles could satisfy the demand of each regiment farm. Moreover, with the processing of lingo software, the demand was not only a scheduling scheme, but achieved maximum economic benefit. And the model is quite stable. In addition, the model is of great significance for wider application because only with suitable data change, more relatively complex problems can be solved. The model proposed can be used to solve more complex models by changing corresponding data according to the real needs, so this model shows wide application prospect .

A comparative analysis was conducted between the empirical results of the optimal model mentioned above and the real feedback data from the vehicle scheduling center of the logistics enterprise in South Xinjiang. It reveals that they are highly consistent. Hence, the empirical results of the optimal model have strong persuasion and they validate that the optimal model established is reasonable. The relevant modeling idea, method and procedure show certain universality and are expected to be widely applied in the establishment of quantitative optimal models for various real problems.

ACKNOWLEDGMENTS

This research is supported by Youth special funds for scientific and technological innovation of the Xinjiang production and Construction Corps (2011CB001), the doctor foundation of the Xinjiang production and Construction Corps (2013BB013),the doctor foundation of Tarim University (TDZKBS201205) and the national Spark Program Project(2011GA891010).Here, thanks to the relevant company and organizations.

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