Optimization algorithm for battlefield material supply support task planning

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ABSTRACT

Analyzed the main process, influencing factors, and key links of battlefield material supply support. Established an optimization model for material supply support task planning. Aiming at the characteristics of the model with multiple algorithm constraints, large decision-making planning scale, and multiple variables, proposed a strategy of step-by-step solution and gradual optimization of calculation, solved the problem of easy establishment of battlefield material supply support model but difficult solution. Provide theoretical and model algorithm basis for effectively improving the efficiency of wartime material supply and support and military economic benefits. Provide task planning model algorithm support for the construction of wartime logistics support information intelligent system.

Keywords: Battlefield material, supply support, task planning, optimization algorithm

1. INTRODUCTION

In a sense, war is about logistics and equipment. Battlefield logistics and equipment supply support are important components of logistics and equipment support [1], it is also an important component of joint operations. Whether the supply of battlefield materials can meet the needs of combat has a significant impact on the process and results of combat. Meanwhile, the war is about financial resources, pursuing the best material supply and ensuring military efficiency and economic benefits is also an important factor that must be considered. Only through scientific task planning and decision-making can we achieve the best military efficiency and economic benefits.

At present, research on battlefield material supply support both domestically and internationally focuses on planning and decision-making for a small number of types of materials and demand points. This type of problem has fewer decision variables and is easier to solve. The focus of Reference [3] is on optimizing the supply path of primary materials traversing each requirement point. Reference [4] mainly studies the optimization problem of mixed loading of multiple materials, supply center location selection and supply material quantity under uncertain supply and demand conditions. Reference [5] mainly adopts Monte Carlo simulation methods to assist planning and scheme design of material supply support tasks. This method has high randomness and uncertainty. It can be seen that for the complex material supply support problem with multiple types of materials and demand points and the doubling of decision-making variables during wartime, there is still relatively little research on optimizing decision-making. Regarding the above issues, and by establishing optimization models and gradually solving methods, the paper obtained the optimal battlefield material supply support plan.

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2. TASK PLANNING OBJECTIVES AND REQUIREMENTS

Material supply support is an important action for logistics and equipment support in joint operations [6]. The first requirement for its tasks is to meet operational needs, that is to deliver the required materials from the campaign warehouse to the field warehouse within the specified time. Secondly, it is important to consider its economic benefits, that is to complete material supply guarantee tasks at the lowest possible cost.

This article takes land operations as an example, using campaign warehouses distributed in different regions as the main material reserve and supply stations, material production factories and suppliers can be regarded as battle warehouses. Each campaign warehouses reserves different types and sizes of logistics materials, represented by campaign warehouse 1, campaign warehouse 2, ···, campaign warehouse n respectively. Material supply is mainly completed through military trucks. Its average speed is a constant value. In principle, all trucks are fully loaded, and its payload is known. Each campaign warehouse is equipped with loading equipment, and its average loading speed is known. Set only one vehicle can be loaded at a time and loading not waiting.

The demand points for battlefield materials mainly refer to various field warehouses, such as field oil depots, field supplies depots, ···, field general ammunition depots, etc. Material unloading is usually carried out by transport vehicles themselves. Its average unloading speed is known. Set only one vehicle can self-unloaded at a time and unloading not waiting.

During wartime, a material supply guarantee task is to Distributing the required materials from the campaign warehouse to the field warehouse within a specified time frame. The supply of materials from the field warehouse to the combat forces is mainly completed through self-pickup by each combat unit. The distribution of battlefield material supply and demand points is shown in Figure 1. The distance from each battle warehouse to the field warehouse is known. The road is wide enough to avoid traffic congestion. The overall requirement for task planning is in a material supply support task, such as 48 hours, calculate how many transport vehicles will be deployed, which route they are running on and how many times each will be transported. Under the condition that the truck does not wait, the total transportation volume (Unit: tons·kilometers) of material supply guarantee task is the smallest, at the same time, the minimum number of trucks dispatched. To achieve the lowest cost while ensuring the completion of material supply guarantee tasks.

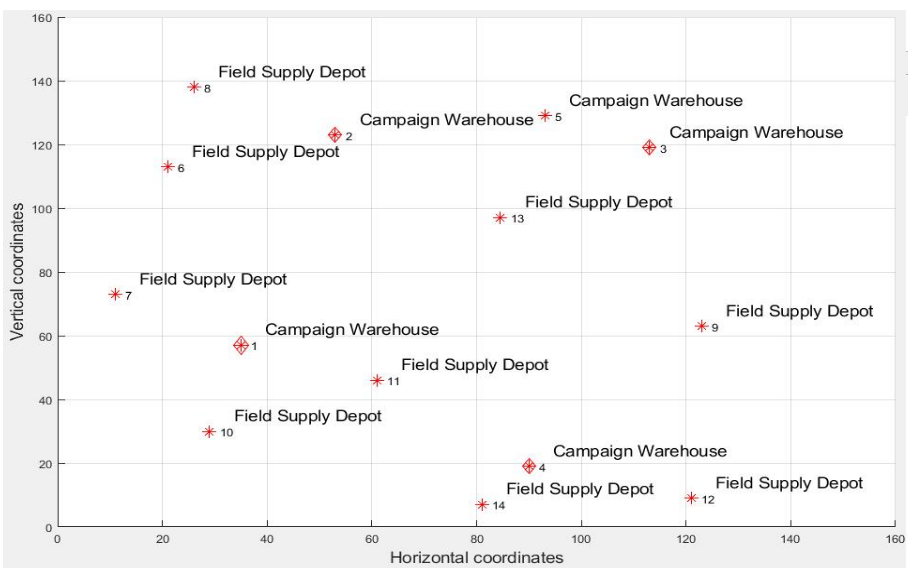

Figure 1. Location distribution of campaign warehouse and field supply demand points.

3. ANALYSIS OF TASK PLANNING ISSUES

The supply guarantee of battle field materials mainly involves the types and quantities of resource point material reserves, types and quantities of material requirements at demand points, material loading, transportation vehicles to be dispatched, selection of transportation and return routes, transportation, unloading and other main influencing factors, links, and processes. To facilitate problem research, first set the conditions and then conduct problem analysis.

3.1 Basic hypothesis

①Trucks are fully loaded and always traveling at 45km/h, regardless of the time it takes for the vehicle to start and brake, and it has a full load capacity of 5 tons.

②Each campaign warehouse is equipped with only one loading device, only one vehicle can be loaded at a time. The average speed of material loading is vehicle/19 minutes. Loading does not exist waiting.

③Material unloading is completed by the truck itself, and the material unloading speed is vehicle/10 minutes. Unloading does not exist waiting also, and only one vehicle can be unloaded at a time.

④During a material supply guarantee task, the route taken by each truck is uncertain. That is to say, which route the transport vehicle choose is random.

3.2 Symbol description

g_{ij} ---The total number of vehicles passing through the one-way path from the campaign warehouse j to the field warehouse i in a mission.

r_{ij} ---The total number of vehicles passing through the one-way path from the field warehouse i to the campaign warehouse j in a mission.

n ---Number of campaign warehouses.

m ---Number of field warehouses.

d_{ij} ---The distance from the field warehouse i to the campaign warehouse j .

t_{up} ---The time required to load a vehicle.

t_{down} ---The time required to unload a vehicle.

Q ---Total traffic volume.

N ---Total number of trucks required.

K_i ---Material demand for the field warehouse i .

M_j^x ---Supply volume of class x materials in the campaign warehouse j .

Other symbols are explained in the text.

3.3 Problem analysis

This problem is a complex optimization problem for vehicle scheduling in transportation systems. The problem requires the best transportation plan to be arranged within the specified task time, the plan requires the minimum total transportation volume, lowest cost. The plan includes the number of trucks dispatched and the specific route taken by each vehicle. Obviously, this is a large-scale and complex goal planning problem [7][8][9]. In order to facilitate the establishment of mathematical models and solutions, further analysis is conducted as follows:

(1) Establishment of Transportation Scheduling Matrix

The travel route of material supply and transportation trucks is bidirectional random. Multiple trucks transporting simultaneously constitute a complex transportation network. To facilitate the description of the truck's travel status, it is specified that the truck travel is divided into two directions [10]. The direction for transporting materials from the campaign warehouse to the field warehouse is specified as the forward direction(G direction), and the direction of returning from the field warehouse to the campaign warehouse is specified as the return direction (R direction).

Assuming there are m field warehouse material demand points, n campaign warehouse material supply points. Establish the following G matrix to describe the transportation status in the G direction.

$$G=\begin{bmatrix} g_{11} & g_{12} & \cdots & g_{1n} \\ g_{21} & g_{22} & \cdots & g_{2n} \\ \vdots & \vdots & & \vdots \\ g_{m1} & g_{m2} & \cdots & g_{mn} \end{bmatrix} \tag{1}$$

In the formula, g_{ij} represents the number of trucks passing through the one-way path from the campaign warehouse j to the field warehouse i within one task time. Wherein, $1 \le j \le n$, $1 \le i \le m$.

Similarly, the R -matrix can be constructed:

$$R=\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix} \tag{2}$$

In the formula, r_{ij} represents the number of trucks passing through the one-way path from the field warehouse i to the campaign warehouse j within one task time. The G matrix and R matrix are collectively referred to as the transportation scheduling matrix.

(2) Principle of Lowest Cost

To achieve the lowest cost of material supply and transportation, it is required to have the minimum total transportation volume and the minimum number of trucks dispatched at the same time. In fact, while achieving the lowest cost, it also achieves the highest efficiency. The total transportation volume is defined as the product of the total weight of materials loaded on the truck and the distance traveled. The mathematical formula is as follows:

$$Q=\sum_{i=1}^{m}\sum_{j=1}^{n} a d_{ij} g_{ij} \tag{3}$$

In the formula, d_{ij} represents the distance from campaign warehouse j to field warehouse i , a is the load capacity of the truck when fully loaded.

Obviously, due to the zero payload of the truck during its return to the campaign warehouse, its transportation volume is also zero. So the total transportation volume of trucks refers to the total transportation volume from the campaign warehouse to the field warehouse. At the same time as requiring the lowest cost and minimum total transportation volume, it is also required to dispatch the minimum number of trucks during the same support mission. Its characteristics are as follows:

①Maximize the utilization of transportation vehicles, i.e. trucks have almost no waiting time.

②The transportation vehicle is fully operational and can precisely complete the transportation task, that is to say, there are not many tasks that have been overfulfilled.

It is difficult to determine the loading, transportation, and unloading time of multiple transportation vehicles, but based on the above characteristics, it is easy to find the relationship between the number of transportation vehicles and other factors at a macro level. Due to all vehicles being in operation all the time, i.e. each transportation vehicle is in three states: loading, transportation, and unloading, so, abstract the working state of all transportation vehicles into the working state of one, as follows:

$$NT=\sum_{i=1}^{m}\sum_{j=1}^{n}[g_{ij}+r_{ij}]\bullet d_{ij}/v+\sum_{i=1}^{m}\sum_{j=1}^{n}[g_{ij}t_{up}+r_{ij}t_{dowm}]+t^{*} \tag{4}$$

In the formula, T represents the time of a talk, t^{*} is the total waiting time of all transportation vehicles during a task, so there is:

$$N=\frac{\sum_{i=1}^{m}\sum_{j=1}^{n}[g_{ij}+r_{ij}]\bullet d_{ij}/v+\sum_{i=1}^{m}\sum_{j=1}^{n}[g_{ij}t_{up}+r_{ij}t_{dowm}]+t^{*}}{T} \tag{5}$$

Based on the above analysis, to achieve the minimum transportation volume, minimum cost, and minimum use of vehicles, there should be no waiting time in principle. Therefore, the value of t^{*} can be approximated to zero.

(3) Elimination of Waiting Time

In order to eliminate waiting time as much as possible, when formulating transportation plans and scheduling control of transportation vehicles, adopt saturation scheduling criteria proposed by reference literature [11] to assist in dispatching transportation vehicles. This criterion essentially involves directing transportation vehicles to a route with the minimum degree of saturation:

$$\begin{cases} ch(i)=j\left|\begin{matrix}\min(D_j)\\ 1\le j\le n\end{matrix}\right. \\ ch(j)=i\left|\begin{matrix}\min(D_i)\\ 1\le i\le n\end{matrix}\right. \end{cases} \tag{6}$$

In the formula, $ch(i)$ represents the campaign warehouse code that the arranged destination where waiting vehicles in the field warehouse i for departure will go to. $ch(j)$ represents the field warehouse code that the arranged destination where waiting vehicles in the campaign warehouse j for departure will go to. D_j represents the saturation from the field warehouse to the campaign warehouse, D_i represents the saturation from the campaign warehouse to the field warehouse, the expression is as follows:

$$\begin{cases} D_j=d_{ij}(\frac{t^{'}}{t_{up}}+N_j)/vt_{up} \\ D_i=d_{ij}(\frac{t^{'}}{t_{down}}+N_i)/vt_{down} \end{cases} \tag{7}$$

In the formula, $t^{'}$ represents remaining loading or unloading time, N_j represents the number of transport vehicles to the campaign warehouse j , excluding vehicles being loaded. N_i represents the number of transport vehicles to the field warehouse i , excluding vehicles being unloaded.

4. PLANNING OPTIMIZATION MODELING

Based on the above problem analysis, for a battlefield material supply support task, establish the corresponding task planning model as follows:

$$\min Q=\sum_{i=1}^{m}\sum_{j=1}^{n}ad_{ij}g_{ij} \tag{8}$$

$$\min N = \frac{\sum_{i=1}^{m}\sum_{j=1}^{n}[g_{ij}+r_{ij}]\bullet d_{ij}/v+\sum_{i=1}^{m}\sum_{j=1}^{n}[g_{ij}t_{up}+r_{ij}t_{dowm}]+t^{*}}{T} \tag{9}$$

s. t.

$$\sum_{j=1}^{n} ag_{ij} \geq K_i \qquad (i=1\cdots m) \tag{10}$$

$$\sum_{i=1}^{m} ag_{ij} \leq M_j^1 \qquad (j=1\cdots n) \tag{11}$$

$$\vdots$$

$$\sum_{i=1}^{m} ag_{ij} \leq M_j^x \qquad (j=1\cdots n) \tag{12}$$

$$\left(\sum_{j=1}^{n} b_j g_{ij} a / \sum_{j=1}^{n} g_{ij} a\right) \in [y\% \pm z\%] \quad (i=1\cdots m) \tag{13}$$

$$\sum_{j=1}^{n} r_{ij} \leq \frac{T}{t_{down}} \qquad (i=1\cdots m) \tag{14}$$

$$\sum_{i=1}^{m} g_{ij} \leq \frac{T}{t_{up}} \qquad (j=1\cdots n) \tag{15}$$

$$g_{ij} \geq 0,\ \ r_{ij} \geq 0,\ also\ \ g_{ij}, r_{ij}\ \ is\ an\ \ \mathrm{int} \tag{16}$$

$$t^{*} \geq 0, \quad \lim t^{*} = 0 \tag{17}$$

$$\sum_{i=1}^{m}\sum_{j=1}^{n} g_{ij} = \sum_{i=1}^{m}\sum_{j=1}^{n} r_{ij} \tag{18}$$

In the formula:

①Formula (10) ensures that the material needs of each field warehouse are met during a mission.

②Formula (11) ~ (12) considers that the material inventory of each campaign warehouse is limited. M^x represents xth type of material. The supply of each type of material in each campaign warehouse should not exceed the reserve of that material.

③Formula (13) indicates that the proportion of water in the supplies must meet a certain proportion.

④Formula (14) (15) is a constraint on r_{ij} and g_{ij}, the upper limit should not exceed T/t_{down} and T/t_{up}.

⑤Formula (6) is a constraint on real-time scheduling to ensure that waiting phenomena are avoided as much as possible.

5. STEPS FOR SOLVING THE TASK PLANNING MODEL

The above battlefield material supply support task planning model is a large-scale and complex optimization decision-making model. The number of decision variables often exceeds 100. To reduce the difficulty of solving, a step-by-step solution method is adopted as follows:

Step 1: Calculate the number of vehicles from each campaign warehouse to each field warehouse by using the linear programming method. i.e. solve the G matrix.

Step 2: Determine the required number of loading equipment and the equipped battle warehouse based on the G matrix (assuming that each campaign warehouse can only be equipped with a maximum of one loading device).

Step 3: Based on the information provided by the G-matrix, calculate the number of vehicles returning from each field warehouse to each campaign warehouse, i.e. solve the R matrix.

Step 4: Based on G and R matrix, and the requirements for fully utilizing transportation vehicles, calculate the number of transportation vehicles required during a task cycle.

6. CASE ANALYSIS

Based on the established model and the steps of the model solving method, modeling and solving for a specific material supply guarantee task, verify the rationality of the model algorithm.

6.1 Basic conditions and task requirements

Located in a certain combat mission, request to transport the required materials from the campaign warehouses to field warehouses within 24 hours, to meet the needs of wartime supplies. The supply of materials from the field warehouse to the task force mainly takes the form of self-pickup, and not within the scope of task planning.

There are 5 battle warehouses distributed on the known battlefield, with 15 field warehouses configured, as shown in Figure 2. The distance between the campaign warehouse and each field warehouse is shown in Table 1.

Material supply guarantee is mainly implemented through truck transportation. It has a full load capacity of 5tons, and the average travel speed is 45 k/h. The types and quantities of materials required for each field warehouse are shown in Table2. The types and quantities of material reserves in the campaign warehouse are shown in Table 3. Among them, the distribution of provision should meet the requirements of water proportion of various field warehouses. The other parameters are the same as the parameter values when establishing the task planning model.

Fig. 2. Distribution map of campaign warehouse and field warehouse.

Table 1. The distance between the campaign warehouse and the field warehouse. Unit: kilo

	Campaign warehouse 1	Campaign warehouse 2	Campaign warehouse 3	Campaign warehouse 4	Campaign warehouse 5
Field warehouse1	87.9801	54.9459	22.8254	124.9933	76.3024
Field warehouse2	20.9029	41.8402	106.5835	54.4154	73.2100
Field warehouse3	56.2516	34.3332	84.8091	99.3542	88.4862
Field warehouse4	37.3415	43.7341	108.3507	73.3260	86.6295
Field warehouse5	75.1953	43.3038	67.0171	118.4784	92.2919
Field warehouse6	63.7777	29.1872	45.1400	104.3474	67.9692
Field warehouse7	80.7490	53.4966	84.9123	124.1533	106.0063
Field warehouse8	83.4550	72.1339	49.0882	98.1547	34.9285
Field warehouse9	29.3455	63.7841	122.2392	25.5548	70.7874
Field warehouse10	25.8414	43.3918	85.2338	40.1060	28.9214
Field warehouse11	90.1938	100.7279	105.2096	76.5346	47.2144
Field warehouse12	35.5990	32.3234	64.3028	61.0734	22.1020
Field warehouse13	59.4834	33.8740	34.5558	92.0222	42.5071
Field warehouse14	65.5067	86.1307	111.9743	42.8292	43.6555
Field warehouse15	58.8412	93.3177	150.6176	32.1708	93.7363

Table 2. Types, quantities, and requirements of materials required for each field warehouse within one task (24 hours) Unit: Ton

	FW 1	FW 2	FW 3	FW 4	FW 5	FW 6	FW 7	FW 8	FW 9	FW 10	FW 11	FW 12	FW 13	FW 14	FW 15
Provision/T	120.8			102.4						35.3					
POL/T							105.1				97.3				77.5
Ammunition/T			130.1					97.2	143.3				166.8	86.5	
Clothing and accouterments /T		55.8			70.8										
Barracks materials/T						30.9						45.3			
Water Proportion / %	$\in$[9.5%, 13%]														

FW represents the field warehouse

Table 3. Quantity of material reserves and proportion of water in provision. Unit: kilo

	Campaign warehouse 1	Campaign warehouse 2	Campaign warehouse 3	Campaign warehouse 4	Campaign warehouse 5
Provision/T	1530.5	1400.2	1600.7	1350.6	1200.7
POL/T	1121	199.5	1201	146	130.7
Ammunition/T	1178.1	1187.8	1177.9	1149.7	1167.2
Clothing and accouterments/T	1470.3	1550.3	1390.7	1200.6	1270.1
Barracks materials/T	1350.6	1270.3	1330.9	1230.1	1320.3
Water Proportion / %	11	10	9.3	12	11.6

6.2 Basic conditions and task requirements

Obviously, there are up to 150 decision variables, which can be modeled and solved according to the above modeling method and model solving steps as follows:

(1) Solving the G -matrix

$$\min Q = \sum_{i=1}^{15}\sum_{j=1}^{5} ad_{ij}g_{ij} \tag{19}$$

$$\min N = \frac{\sum_{i=1}^{15}\sum_{j=1}^{5}[g_{ij}+r_{ij}]\bullet d_{ij}/v + \sum_{i=1}^{m}\sum_{j=1}^{n}[g_{ij}t_{up}+r_{ij}t_{dowm}]+t^{*}}{T} \tag{20}$$

s. t.

$$\sum_{j=1}^{5} ag_{ij} \geq K_i \qquad (i=1\cdots 15) \tag{21}$$

$$\sum_{i=1}^{15} ag_{ij} \leq M_j^1 \qquad (j=1\cdots 5) \tag{22}$$

$$\sum_{i=1}^{15} ag_{ij} \leq M_j^2 \qquad (j=1\cdots 5) \tag{23}$$

$$\sum_{i=1}^{15} ag_{ij} \leq M_j^3 \qquad (j=1\cdots 5) \tag{24}$$

$$\sum_{i=1}^{15} ag_{ij} \leq M_j^4 \qquad (j=1\cdots 5) \tag{25}$$

$$\sum_{i=1}^{15} ag_{ij} \leq M_j^5 \qquad (j=1\cdots 5) \tag{26}$$

$$\left(\sum_{j=1}^{5} b_j g_{ij} a \Big/ \sum_{j=1}^{5} g_{ij} a\right) \in [10.5\% \pm 1\%] \qquad (i=1\cdots 15) \tag{27}$$

$$\sum_{i=1}^{15} g_{ij} \leq \frac{T}{t_{up}} \qquad (j=1\cdots 5) \tag{28}$$

$$g_{ij} \geq 0, \ \ also \ \ g_{ij} \ \ is\ an \ \ \text{int} \tag{29}$$

Substitute the corresponding parameter values into the solution to obtain:

$$G = \begin{bmatrix} g_{11} & g_{12} & g_{13} & g_{14} & g_{15} \\ g_{21} & g_{22} & g_{23} & g_{24} & g_{25} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ g_{14\,1} & g_{14\,2} & g_{14\,3} & g_{14\,4} & g_{14\,5} \\ g_{15\,1} & g_{15\,2} & g_{15\,3} & g_{15\,4} & g_{15\,5} \end{bmatrix} = \begin{bmatrix} 0 & 0 & 22 & 0 & 3 \\ 12 & 0 & 0 & 0 & 0 \\ 24 & 3 & 0 & 0 & 0 \\ 21 & 0 & 0 & 0 & 0 \\ 0 & 15 & 0 & 0 & 0 \\ 0 & 2 & 5 & 0 & 0 \\ 0 & 22 & 0 & 0 & 0 \\ 0 & 0 & 18 & 0 & 2 \\ 29 & 0 & 0 & 0 & 0 \\ 8 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 20 \\ 10 & 0 & 0 & 0 & 0 \\ 1 & 0 & 31 & 0 & 3 \\ 4 & 0 & 0 & 14 & 0 \\ 0 & 0 & 0 & 16 & 0 \end{bmatrix} \tag{30}$$

From the G matrix, it can be seen that the number of vehicles that should be arranged from each campaign warehouse to each field warehouse.

(2) Configuration of Loading Equipment for Each Campaign Warehouse

From the G matrix, each campaign warehouse has transport vehicles participating in material supply support tasks. Therefore, all should be equipped with loading equipment.

(3) Solving the R -matrix

$$\min W = \sum_{i=1}^{15} \sum_{j=1}^{5} d_{ij} g_{ij} \tag{31}$$

$$s.t. \begin{cases} \sum_{i=1}^{15} r_{ij} = \sum_{i=1}^{15} g_{ij} \ , \ j = 1, 2, \cdots, 5 & (32) \\ \sum_{j=1}^{5} r_{ij} = \sum_{j=1}^{5} g_{ij} \, , \ i = 1, 2, \cdots 15 & (33) \end{cases}$$

The solution results are as follows:

$$R=\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix} = \begin{bmatrix} 0 & 0 & 26 & 0 & 0 \\ 12 & 0 & 0 & 0 & 0 \\ 27 & 0 & 0 & 0 & 0 \\ 21 & 0 & 0 & 0 & 0 \\ 0 & 15 & 0 & 0 & 0 \\ 0 & 5 & 2 & 0 & 0 \\ 0 & 22 & 0 & 0 & 0 \\ 0 & 0 & 14 & 0 & 0 \\ 29 & 0 & 0 & 0 & 0 \\ 8 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 20 \\ 10 & 0 & 0 & 0 & 0 \\ 0 & 0 & 35 & 0 & 0 \\ 2 & 0 & 0 & 14 & 2 \\ 0 & 0 & 0 & 16 & 0 \end{bmatrix} \quad (34)$$

(4) Calculate the number of vehicles required for a task

According to formula 9, the number of vehicles required for a battlefield material supply support task can be calculated. According to the requirements, transportation vehicles should try to avoid waiting time as much as possible. Therefore, let $t^*=0$, $T=24$, other parameters are substituted based on the above calculation results, and the calculation results are as follows:

$$N=\frac{\sum_{i=1}^{15}\sum_{j=1}^{5}[g_{ij}+r_{ij}]\bullet d_{ij}/v+\sum_{i=1}^{15}\sum_{j=1}^{5}[g_{ij}t_{up}+r_{ij}t_{dowm}]+0}{24} =29 \quad (35)$$

The number of transportation vehicles, return vehicles, and participating supply on each transportation route has been calculated and determined. Then, dynamically schedule based on saturation, and the best battlefield material supply support task planning plan can be obtained.

7. CONCLUSION

Targeting the issue of battlefield supply support for multiple resource points, demand points, and types of materials, how to make effective task planning and optimization decisions faces a series of difficulties. Based on linear programming method, propose a strategy of step-by-step solution and gradual optimization of calculation, effectively solved the problem with multiple constraints, large-scale planning decisions, multiple decision variables and that is difficult to solve and calculate. Provide theoretical basis for optimizing the planning and decision-making of battlefield material supply tasks. Provide model algorithm support for the informatization of material supply guarantee and the construction of intelligent information systems.

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