



Research on Allocation of Emergency Supplies and Vehicles Based on Multi-Period Demand and Supply

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Abstract. To address the multi-period demand for relief supplies among disaster-affected populations following sudden emergencies, this paper proposes a hierarchical dispatching scheme for disaster relief materials, covering both dispatches between supply points and affected sites and dispatches among affected sites themselves. The proposed scheme is designed for post-disaster emergency material scheduling and explicitly accounts for vehicle dispatching preferences. This study makes the following assumptions:(1) after a sudden event, resources received from external regions arrive at multiple supply points in a time-staggered manner;(2) new demands from affected populations are generated at affected sites over multiple periods; and(3) under the hierarchical material dispatching framework, vehicle dispatching preferences are differentiated between supply points and affected sites. Based on these assumptions, an emergency material dispatching model is developed that integrates multi-period supply and demand satisfaction with coordinated allocation of materials and vehicles. Using post-earthquake emergency response operations in Dingri County, Shigatse Prefecture, Tibet, as an empirical case study, the paper examines the operational effectiveness, practicality, and potential advantages of the proposed hierarchical dispatching framework.

Keywords: supply allocation; vehicle dispatching preferences; secondary allocation; collaborative Scheduling.

1 Introduction

An emergency refers to an event that occurs suddenly, unexpectedly, and unpredictably within the operation of social systems, arising from a variety of factors, including natural, technological, or human causes. Effective response to such emergencies not only relies on the rapid reaction and evidence-based decision-making of government agencies but also requires the extensive participation of social organizations and the public. Through the implementation of comprehensive emergency plans, adequate supply provisioning, efficient information dissemination, and coordinated management mechanisms, it becomes possible to minimize losses and restore the normal functioning of society as quickly as possible.

A substantial body of research has been conducted by domestic and international scholars on emergency resource allocation. According to the stage at which disasters occur, existing studies can be broadly classified into pre-disaster preparedness and post-disaster response. Carmen and Turnquist^[1] investigated the pre-positioning of emergency supplies under disaster uncertainty. Uichanco and Joline^[2] examined the dependence of demand on typhoon outcomes based on uncertainty in typhoon trajectories, and proposed pre-allocating resources in affected areas to reduce post-disaster resource reallocation.

Emergency resource allocation involves multiple optimization strategies, including warehouse location, routing planning, and the scheduling of multiple transportation modes. Warehouse location is a common pre-disaster mitigation strategy in emergency resource allocation. Wang et al.^[3] established emergency warehouses under uncertain multi-disaster scenarios to address post-disaster emergency supply distribution. Wang et al.^[4] focused on emergency resource shortages in the early stage of disasters and developed a bi-objective model that considers both the time cost of material distribution and the impact of resource shortages in disaster areas, addressing emergency facility location and initial resource allocation. Routing planning plays a critical role in allocating resources among multiple demand points. Song et al.^[5] incorporated transportation risks caused by road damage into their study. Building on this work, Wang et al.^[6] further considered the reparability of damaged roads. Zhao et al.^[7] and Wei^[8] developed routing optimization models for resource allocation based on actual road conditions, employing genetic algorithms and ant colony optimization algorithms, respectively. Thomas et al.^[9] introduced time window constraints for emergency supplies and studied emergency material distribution and vehicle routing problems. With respect to transportation modes, for cross-regional and long-distance transportation, Zheng^[10] and Jia et al.^[11] considered the use of high-speed rail for emergency material delivery, while Tang^[12] and Zhang et al.^[13] explored railway-based supply of materials to disaster-affected areas. In addition, considering the specific characteristics of emergency resources—such as large demand volumes and hazardous attributes—some studies^[14–16] have applied rail transit for short-distance transportation. Due to wider road coverage^[17] and lower operating costs, many scholars^[18–20] continue to adopt road vehicles as the primary transportation mode in related studies.

Considerable research has also been devoted to the optimization objectives of emergency resource allocation. Bodaghi et al.^[21] aimed to minimize the total completion time of multi-resource emergency distribution. Zhao et al.^[15] simultaneously considered minimizing distribution time and cost while maximizing resource allocation satisfaction.

According to the characteristics of resource supply and demand, Wang et al.^[22] investigated periodic demand in disaster-affected areas, while Mu et al.^[23] conducted research based on multi-stage supply. A large number of studies, including those by Zhang et al.^[24], Liu et al.^[18], and Wang^[25], have focused on dynamic emergency resource supply and demand.

2 Method

This section describes specific strategies for the coordinated allocation of emergency supplies and vehicles, constructs corresponding models, and analyzes this emergency supply management system.

2.1 Allocation Strategy Description

Vehicles can be classified, according to their initial locations, into supply-point vehicles and disaster-site vehicles. In this study, transportation preferences are specified for vehicles based on their initial positions. Supply-point vehicles operate between supply points and affected sites as well as among supply points, and are responsible for serving all supply points and affected sites. Disaster-site vehicles operate among affected sites and primarily serve their initial demand points. Based on this dispatching strategy, material allocation and vehicle routing are jointly coordinated. Secondary distribution points are established within the disaster area to act as temporary storage facilities for reallocating supplies between supply points and affected sites, thereby enabling the delivery of materials from supply points to the final affected sites. Disaster-site vehicles are mainly provided by individuals within the affected area; they are large in number, widely and sparsely distributed across the disaster region, and possess considerable carrying capacity. These vehicles play a crucial role in alleviating transportation resource shortages in the aftermath of emergency events.

I Supply Points Characteristics

As shown in **Fig. 1**, the disaster-affected area contains multiple supply points and disaster-stricken affected sites.

Supply points serve as large-scale material storage and dispatch centers provided by the government, with material distribution achieved through the transportation of system-shared vehicle resources. Materials from supply points are transported to affected sites by supply points vehicles. Upon task completion, vehicles return to the supply point to await the next transport assignment. To balance vehicle capacity across supply points with material distribution demands and expedite delivery to affected sites, supply points vehicles can be reassigned between supply points. Similarly, to further balance vehicle capacity and material distribution across supply points, materials can also be reassigned alongside supply points vehicles between supply points. Vehicles reassigned from one supply points to another do not need to return to their originating supply points, so when vehicles travel between supply points, their transportation preference is correspondingly shifted to the destination supply point.

II Affected Sites Characteristics

Affected site vehicles operate exclusively among affected sites, with their transportation preference set to the initial disaster site. After traveling to other affected sites, these vehicles are required to return to their initial affected sites. Since disaster-site vehicles shuttle between affected sites, the directions of material flows among affected sites can be classified into two categories: (1) materials transported by

vehicles from the initial disaster site to other affected sites, and (2) materials transported by vehicles from other affected sites back to the initial disaster site.

Affected sites function as temporary supply points. After receiving supplies, they perform two types of distribution: (1) dispatching supplies to local residents; (2) allocating supplies to other affected sites via vehicles operating between affected sites. When a affected site lacks immediately available vehicles, supplies are stored in a temporary supply points until a vehicle becomes available to transport them to the required destination.

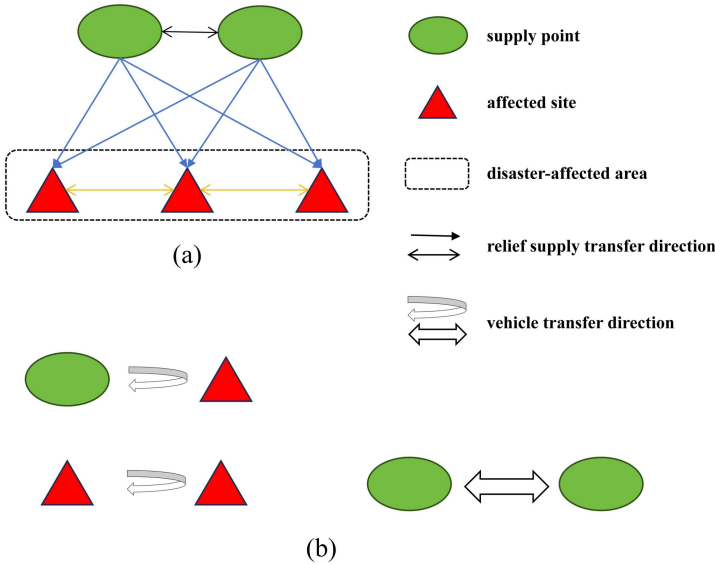


Fig. 1. Supply and Vehicle Dispatching Strategy Diagram. (a) Supply flow directions; (b) Vehicle flow directions.

2.2 Model Construction

2.2.1 Optimization Objective.

As shown in Table 1, the model notation is summarized. Equation (1) is the objective function, which accounts for the storage cost incurred when supplies wait at affected sites for vehicle transport, as well as the penalty for unmet demand at those locations, as shown in Equations (2) and (3). Equation (4) constrains public vehicles belonging to the supply points, prohibiting them from traveling empty from the supply points to a demand point or consecutively traveling empty between supply points. Equation (5) constrains dedicated vehicles belonging to demand points, preventing them from consecutively traveling empty between demand points. M is a sufficiently large parameter used to eliminate the impact of the number of dispatched supply points and demand-point vehicles on storage costs and unmet demand

outcomes, thereby ensuring the optimality of the objective values in Equations (1) and (2).

Table 1. Model notation description

Symbol	Definition
Sets	
S	The set of supply points that supply emergency materials to the affected sites in the disaster-affected area, where supply points $i, j \in S$
D	The set of affected sites where supplies needs arise as a result of the emergency, where affected sites $m, n \in D$
R	The set of supply types required in the disaster-affected area, where supply type $r \in R$
T	The set of time steps, $t \in T$
Parameters	
T_{ij}	The travel time of a public vehicle from supply points i to supply points j
T_{mn}	The travel time of a non-public vehicle from affected site m to affected site n
T_{im}	The travel time of a public vehicle from supply points i to affected site m
Parameters	
q_{itr}	The quantity of supply type r newly arriving at supply points i at time step t
d_{mtr}	The quantity of supply type r newly demanded at affected site m at time step t
v_r	The volume of a single unit of supply type r
V_1	The volume of a single unit of public vehicle
V_2	The volume of a single unit of non-public vehicle
$c_{1,r}$	The affected site storage cost per unit of supply type r per unit of time
$\lambda_{t,r}$	Impact factor of storage cost for supply type r at time step t
$c_{2,r}$	The penalty per unit of supply type r per unit of time for unmet demand at affected sites
$c_{3,r}$	The reward per unit of supply type r per unit of time for early fulfillment at affected sites
V_i^1	The volume of secondary distribution point i
Decision Variables	
x_{imt}^1	The quantity of public vehicles traveling from supply points i to affected site m at time step t
y_{imtr}^1	The quantity of supply type r transported from supply points i to affected site m at time step t
x_{mnt}^2	The quantity of non-public vehicles traveling from affected site m to affected site n at time step t
y_{mnr}^2	The quantity of supply type r transported from affected site m to affected site n at time step t
x_{ijt}^3	The quantity of public vehicles traveling from supply points i to supply points j at time step t
y_{ijtr}^3	The quantity of supply type r transported from supply points i to supply points m at time step t
f_{mtr}	The allocation quantity of supply type r at affected site j at time step t
Intermediate Variables	
G_{it}	The quantity of public vehicles at supply points i at time step t
g_{itr}	The quantity of supply type r at supply points i at time step t
H_{mt}	The quantity of non-public vehicles at affected site m at time step t
h_{itr}	The quantity of supply type r at affected site m at time step t
b_{mtr}	The quantity of unmet demand for supply type r at affected site m at time step t
l_{mtr}	The quantity of unmet demand for supply type r at affected site m at time step t that is subject to penalty.

p_{mtr}	The quantity of early-fulfilled demand for supply type r at affected site m at time step t that is eligible for reward.
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$$\min OBJ = \pi(O_1 + O_2) + O_3 + O_4 \tag{1}$$

$$O_1 = \sum_m \sum_t \sum_r c_{1,r} \times \lambda_{i,r} \times (h'_{m,t,r} f_{m,t,r} - y_{mnt}^2) \tag{2}$$

$$O_2 = \sum_m \sum_t \sum_r (l_{m,t,r} \times c_{2,r} \times p_{mtr} \times c_{3,r}) \tag{3}$$

$$O_3 = \sum_i \sum_m \sum_t x_{imt}^1 + \sum_i \sum_j \sum_t x_{ijt}^3 \tag{4}$$

$$O_4 = \sum_m \sum_n \sum_t x_{m,n,t}^2 \tag{5}$$

2.2.2 Constraints.

The model constraints are given in Equations (6) through (23).

Equations (6), (7), (8), and (9) specify the computation of the intermediate variables, including the quantity of supplies and the number of available vehicles at both the supply points and the demand points at time period t . Equations (10), (11), and (12) define the intermediate variables for the amount of unmet demand at each demand point, the corresponding penalty for unmet demand, and the reward for early satisfaction, respectively. Equation (13) ensures that the total amount of supplies received by the population at each demand point equals the required quantity. Equation (14) imposes capacity constraints on vehicles dispatched between demand points, allowing dedicated demand-point vehicles to travel empty on one-way trips. Equations (15) and (16) specify the transport capacity constraints for vehicles dispatched from the supply points to demand points, prohibiting empty travel in this process. Equation (17) imposes capacity constraints on vehicles dispatched between supply points, allowing vehicles to travel empty in this process. Equation (18) imposes a capacity constraint on the temporary storage of materials at disaster-affected sites. Equations (19) and (20) restrict the number of vehicles dispatched from the supply points to not exceed the number of available supply points vehicles, and the amount of supplies allocated from the supply points to demand points to not exceed the available supply points inventory. Equations (21) and (22) restrict the number of vehicles dispatched from each demand point to not exceed the number of available dedicated vehicles, and the sum of supplies allocated to local residents and redistributed to other demand points to not exceed the available supplies at that demand point. Equations (23) and (24) impose capacity constraints on vehicles transporting materials between supply points and prohibit empty travel.

$$g_{i,t+1,r} = g_{i,t,r} - \sum_m y_{i,m,t,r}^1 - \sum_j y_{jtr}^3 + \sum_k y_{k,i,t+1-T_{ki},r}^3 + q_{i,t+1,r} \tag{6}$$

$$G_{i,t+1} = G_{i,t} - \underset{m}{x_{imt}^1} - \underset{j}{x_{ijt}^3} + \underset{n}{x_{i,n,t+1-2T_{in}}^1} + \underset{k}{x_{k,i,t+1-T_{ki}}^3} \quad (7)$$

$$h_{i,t+1,r} = h_{i,t,r} - \underset{n}{f_{m,t,r}} - \underset{n}{y_{mnt}^2} + \underset{n}{y_{n,m,t+1-T_{nm},r}^2} + \underset{i}{y_{i,m,t+1-T_{in},r}^1} \quad (8)$$

$$H_{m,t+1} = H_{m,t} - \underset{n}{x_{mnt}^2} + \underset{n}{x_{m,n,t-2T_{mn}+1}^2} \quad (9)$$

$$b_{m,t+1,r} = b_{m,t,r} - \underset{n}{f_{m,t,r}} + \underset{n}{d_{m,t+1,r}} \quad (10)$$

$$l_{m,t+1,r} = \max \{b_{m,t+1,r}, 0\} \quad (11)$$

$$p_{m,t+1,r} = -\min \{b_{m,t+1,r}, 0\} \quad (12)$$

$$\underset{t}{f_{m,t,r}} = \underset{t}{d_{m,t,r}} \quad (13)$$

$$\underset{r}{(y_{mnt}^2 \times v_r)} \leq (\underset{r}{x_{mnt}^2} + \underset{r}{x_{n,m,t-T_{nm}}^2}) \times V_2 \quad (14)$$

$$\underset{r}{(y_{i,m,t,r}^1 \times v_r)} \leq \underset{r}{x_{imt}^1} \times V_1 \quad (15)$$

$$\underset{r}{(y_{i,m,t,r}^1 \times v_r)} \geq (\underset{r}{x_{imt}^1} - 1) \times V_1 + 1 \quad (16)$$

$$\underset{r}{(y_{ijr}^3 \times v_r)} \leq \underset{r}{x_{ijt}^3} \times V_1 \quad (17)$$

$$\underset{r}{h_{ir}} \times v_r \leq V_i^1 \quad (18)$$

$$\underset{m}{g_{it}} - \underset{m}{x_{imt}^1} - \underset{j}{x_{ijt}^3} \geq 0 \quad (19)$$

$$\underset{m}{g'_{i,t,r}} - \underset{m}{y_{i,m,t,r}^1} - \underset{j}{y_{ijr}^3} \geq 0 \quad (20)$$

$$\underset{n}{H_{m,t}} - \underset{n}{x_{mnt}^2} \geq 0 \quad (21)$$

$$\underset{n}{h_{m,t,r}} - \underset{n}{f_{m,t,r}} - \underset{n}{y_{mnt}^2} \geq 0 \quad (22)$$

$$\underset{r}{y_{imr}^1 \times v_r} \leq \underset{r}{x_{imt}^1} \times V_1 \quad (23)$$

$$y_{imtr}^1 \times v_r > (x_{imt}^1 - 1) \times V_1 \quad (24)$$

$$x_{imt}^1, y_{i,m,t,r}^1, x_{mnt}^2, y_{mnt}^2, x_{ijt}^3, y_{ijt}^3 \in Z \quad (25)$$

$$G_{it}, g_{itr}, H_{mt}, h_{mtr}, f_{mtr}, b_{mtr}, l_{mtr}, p_{mtr} \in Z \quad (26)$$

By introducing binary variables — each restricted to take values in $(\{0,1\})$ — together with a sufficiently large constant (M), the maximization constraint in Equation (11) is converted into an equivalent set of constraints that can be solved within the optimization model, namely Equations (27), (28), (29), and (30). Similarly, the minimization constraint in Equation (12) is transformed into an equivalent set of solvable constraints, expressed in Equations (31), (32), (33), and (34).

$$l_{m,t+1,r} \geq b_{m,t+1,r} \quad (27)$$

$$l_{m,t+1,r} \geq 0 \quad (28)$$

$$l_{m,t+1,r} \leq b_{m,t+1,r} + M(1 - \alpha) \quad (29)$$

$$l_{m,1+1,r} \leq M \quad (30)$$

$$-p_{m,t+1,r} \leq b_{m,t+1,r} \quad (31)$$

$$-p_{m,t+1,r} \leq 0 \quad (32)$$

$$-p_{m,t+1,r} \geq b_{m,t+1,r} - M\beta \quad (33)$$

$$-p_{m,t+1,r} \geq -M\beta \quad (34)$$

3 Results and Discussion

In January 2025, a magnitude 6.8 earthquake struck Dingri County in Shigatse, Tibet. Following the event, the Tibetan government immediately initiated emergency response operations to protect the health and safety of the affected population. In this study, townships Zhaxizong and Jiacao in Dingri County are designated as emergency supply supply points, while the townships and towns of Xiege'er, Gangga, Qudang, Kema, Rongxia, Cuoguo, Qu'luo, Changshuo, Nixia, Zhaguo, and Penji are identified as affected sites. Accordingly, an emergency logistics network comprising two supply points and eleven affected sites is constructed, as illustrated in **Fig. 2**.

The demand points require two types of supplies: bottled water and dry food, with total demands of 1,000 and 900 boxes, respectively. The updates of supply points supplies are shown in **Table 2** and **Table 3**. The latest dispatch times for these demands are shown in **Table A1** and **Table A2** in Appendix A. All table times are expressed in units of 10 minutes, and all table quantities of supplies are in boxes.



Fig. 2. Schematic map of township locations within Dingri County, Shigatse, Tibet.

Table 2. Updates of bottled water in the supply points.

supply points	Supply arrival time(time steps)	Supply arrival quantity(boxes)
Zhaxizong	0	200
Zhaxizong	30	300
Zhaxizong	75	100
Jiacao	0	100
Jiacao	30	200
Jiacao	40	100

Table 3. Updates of dry food in the supply points.

supply points	Supply arrival time(time steps)	Supply arrival quantity(boxes)
Zhaxizong	10	220
Zhaxizong	45	300
Zhaxizong	65	130
Jiacao	30	150
Jiacao	60	100

The results are obtained by solving the model using Gurobi. Taking Xiege'er as an example, the vehicle dispatching and resource allocation schemes from the supply points Zhaxizong and Jiacao are shown in **Table A1** in Appendix A, while the vehicle dispatching and resource allocation scheme for Xiege'er redistributing resources to other demand points is presented in **Table A2** in Appendix A. The quantity of resources redistributed from other demand points to Xiege'er is zero, indicating that resources are transferred only from Xiege'er to other demand points and not in the reverse direction. Treating Xiege'er as a temporary supply points, the routes through which resources are transferred are illustrated in **Fig. 3**.

In **Fig. 3**, both Zhaxizong and Jiacao transfer emergency supplies, namely bottled water and dry food, to Xiege'er. Due to the relatively short distance, 80% of the resources are transported from Jiacao to Xiege'er.

As a temporary supply points, Xiege'er maintains a storage level of zero at all times. This indicates that the supplies transported from the supply points to Xiege'er do not remain there; instead, a portion is immediately distributed to the local population, while the remainder is transported to other demand points either by vehicles stationed at Xiege'er or by vehicles that were pre-dispatched from other demand points to Xiege'er. This outcome is driven by the formulation of storage costs for demand points in the objective function, which prevents supplies from staying too long in temporary supply points where storage conditions are limited.

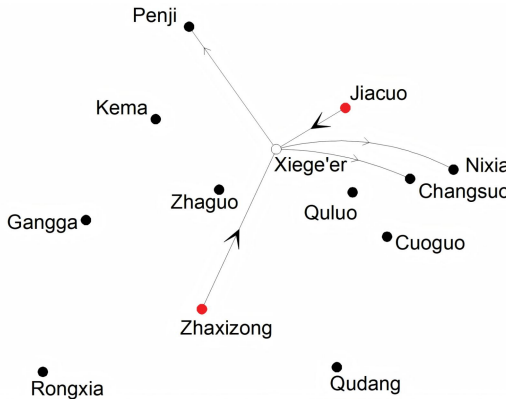


Fig. 3. Schematic illustration of material transfers among Xiege'er

As a disaster-affected demand point, the specific situation of unmet demand for the population in the Xiege'er area is shown in **Fig. 4**.

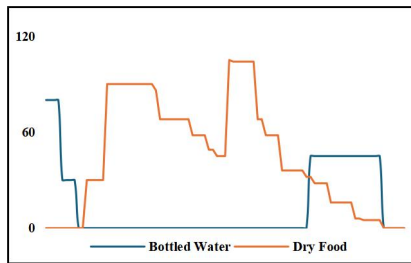


Fig. 4. Temporal Evolution of Unmet Demand at Xiege'er

The overall dispatching scheme is further analyzed as follows. The cumulative quantities of bottled water and dry food transported from the supply points Zhaxizong and Jiacao to the demand points are shown in **Fig. 5**. More than 80% of the dry food from Zhaxizong is transported to Gangga, which functions as a temporary supply points undertaking substantial redistribution tasks to other demand points. All bottled

water and dry food from Jiazuo are allocated to Xiege'er, and more than 90% of the supplies received by Xiege'er originate from Jiazuo, making Xiege'er, in effect, a subordinate supply points to Jiazuo.

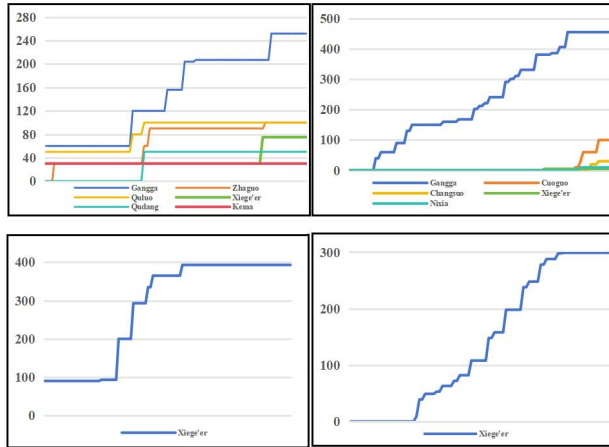


Fig. 5. Cumulative Delivery Quantities of Bottled Water and Dry Food to affected sites by supply points Zhaxi and Jiacao

The following section compares vehicle dispatching with and without inter-affected-site transfers. Vehicle dispatching between affected sites is defined as Experiment 1, while vehicle dispatching without inter-affected-site transfers is defined as Experiment 2. The average waiting times of supplies at affected sites in Experiments 1 and 2 are shown in **Fig. 6** and **Fig. 7**, respectively. Compared with the control group, Experiment 1 exhibits a significantly lower average waiting time, indicating a substantial improvement in resource allocation efficiency.

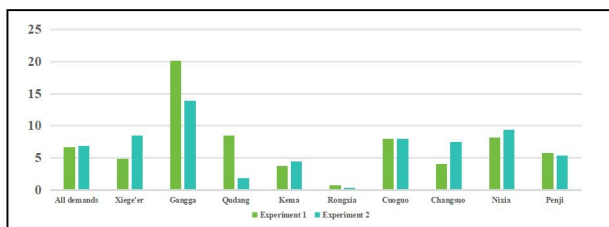


Fig. 6. Average Waiting Time of Bottled Water at Demand Points in Experiment 1 and Experiment 2

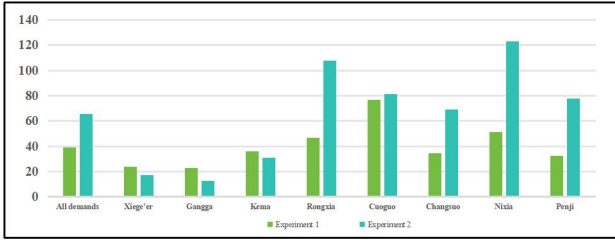


Fig. 7. Average Waiting Time of Dry Food at Demand Points in Experiment 1 and Experiment 2

As shown in **Table 4** and **Table 5**, compared with Experiment 2, Experiment 1 results in a reduction in unmet-demand penalty values and an increase in rewards for early demand satisfaction, indicating that the allocation scheme in Experiment 1 significantly mitigates health losses among affected populations.

Table 4. Penalty for unmet demand for bottled water, dry food and all demands in the Experiment 1 and Experiment 2

	Bottled water	Dry food	All demands
Experiment 1	20136	70762	90899
Experiment 2	20625	117472	138097

Table 5. Reward for early satisfaction of waiting times for bottled water, dry food and all demands in the Experiment 1 and Experiment 2

	Bottled water	Dry food	All demands
Experiment 1	10	24	34
Experiment 2	0	0	0

4 Conclusion

The main contributions of this study are as follows. We propose a hierarchical material dispatching strategy and introduce vehicle transportation preferences. Vehicles initially located at disaster-affected sites are used to transport supplies from secondary distribution points to other affected sites. Vehicles initially located at supply points are used to deliver materials to disaster-affected sites or to other supply points. The model considers both storage costs at temporary supply points and material losses suffered by residents due to unmet demand.

A case study of Dingri County, Tibet, is conducted. The results show that, compared with strategies without hierarchical dispatching and without transportation preferences for disaster-site vehicles, the proposed strategy improves operational efficiency and reduces losses among affected residents.

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Appendix A

Table A1. Dispatching results from supply points Zhaxizong andJiacuo to affected site Xiege'er.

Supply point	Time step	Number of dispatched vehicles	Number of dispatched supplies (bottled water, dry food)
Zhaxizong	0	1	(30, 0)
	75	2	(45, 5)
	0	3	(90, 0)
	23	1	(3, 9)
	24	3	(0, 30)
	26	1	(0, 10)
	30	4	(107, 4)
	32	1	(0, 10)
	36	4	(93, 9)
	Jiacuo	38	1
42		4	(42, 26)
44		1	(30, 0)
48		4	(0, 40)
50		1	(0, 10)
54		4	(0, 40)
56		1	(28, 0)
60		4	(0, 40)

	62	1	(0, 10)
	66	3	(0, 30)
	68	1	(0, 10)
	72	1	(0, 10)
	74	1	(0, 1)

Table A2. Dispatching scheme for secondary allocation at affected site Xiege'er

Supply point	Time step	Number of dispatched vehicles, (From Xiege'er, to Xiege'er)	Number of dispatched supplies (bottled water, dry food)
Changsuo	26	1, (1, 0)	(3, 5)
	33	4, (1, 3)	(57, 4)
	45	2, (0, 2)	(0, 9)
	57	3, (0, 3)	(0, 18)
	63	4, (0, 4)	(0, 24)
Nixia	3	3, (3, 0)	(40, 0)
	27	2, (0, 2)	(0, 12)
	29	2, (2, 0)	(0, 10)
	39	1, (0, 1)	(18, 0)
	41	1, (1, 0)	(0, 6)
	45	5, (5, 0)	(42, 16)
	47	2, (1, 1)	(30, 0)
	51	1, (0, 1)	(0, 4)
63	2, (0, 2)	(0, 12)	
Nixia	65	1, (0, 1)	(0, 6)
	69	3, (3, 0)	(0, 18)
	71	2, (2, 0)	(0, 10)
Penji	33	3, (3, 0)	(30, 0)
	59	2, (2, 0)	(28, 0)

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