Design and implementation of research on dispatching of earthquake emergency materials based on improved particle swarm optimization algorithm

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ABSTRACT

China is a high-incidence area of earthquakes, and earthquakes cause huge economic losses and casualties every year. Earthquake disasters have adverse effects on the economic and social development of any country in our country. In the post-earthquake rescue process, the dispatch of emergency rescue teams and materials is very important, which is the basis for rescue and disaster relief, response to emergencies, and disaster relief. This paper is based on the related application research of improved particle swarm optimization algorithm. The emergency material reserve is the key to improving the emergency material support capability and an important guarantee for responding to sudden disasters. Therefore, it is necessary to select the best site selection plan for the emergency material reserve. Based on the background of earthquake disaster, this paper analyzes and studies the location problem of emergency material reserve. At the same time, in order to improve the post-earthquake emergency rescue capability, the reasonable dispatch of post-disaster emergency supplies is particularly important. The purpose of this paper is to design and implement the technology involved in the research and dispatch of earthquake emergency materials. The final result of the research shows that the required quantities of emergency materials dispatch are 9.94 tons, 6.52 tons, 4.98 tons, 7.64 tons and 5.33 tons, respectively. The corresponding emergency material dispatch shortage ratios are 6.74%, 4.33%, 3.41%, 5.17% and 4.05%, respectively. The shortage ratio of emergency material dispatch changes with the change of the required quantity of emergency material dispatch. At the same time, this paper analyzes and researches the location of emergency material reserves, in order to improve the emergency rescue capability after the earthquake and reasonably dispatch the emergency materials after the disaster, which is particularly important.

Keywords: Improved particle swarm, optimization algorithm, earthquake emergency, material scheduling

1. INTRODUCTION

Due to frequent earthquakes, there is an urgent need to effectively ensure the supply of emergency supplies, and to strengthen the timely dispatch of emergency rescue teams without wasting time. The post-earthquake rescue work must take into account factors such as the shortage of supplies, the vague nature of the demand at the disaster site, the damage to the transportation road, the prolonged transportation time, the loss of the affected people, and the fairness of material distribution. Therefore, how to distribute the relief materials in a fair, reasonable and timely manner? It is very important to optimize distribution.

In recent years, many researchers have explored the design and implementation of earthquake emergency material dispatch research, and achieved good results[1]. For example, Modena C in the United States believes that a scientific, efficient, fair and reasonable distribution plan of emergency materials can help improve the effectiveness of emergency rescue, and an inappropriate distribution plan may cause secondary damage to disaster areas and increase the degree of casualties and property losses in disaster areas[2]. Mascarucci M of the United Kingdom believes that material rescue is the key to meeting the survival needs and recovery and development of the disaster victims[3]. At present, scholars at home and abroad have carried out a lot of research on the design and implementation of earthquake emergency material dispatch research. These previous theoretical and experimental results provide a theoretical basis for the research in this paper.

In this paper, under the background of improving particle swarm optimization algorithm, the design and realization of earthquake emergency material scheduling research, and through a series of experiments to verify the feasibility of the

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design and implementation of earthquake emergency material scheduling research. The results show that in the design and implementation of the earthquake emergency material scheduling research based on the improved particle swarm optimization algorithm, the average material satisfaction rate is higher than the minimum material satisfaction rate. The required materials can meet the minimum demand for disaster relief, so that the material distribution meets the scheduling results.

2. RELATED THEORETICAL OVERVIEW AND RESEARCH

2.1 Research on dispatching of earthquake emergency materials

(1) Earthquake Disaster Emergency Materials

Emergency materials are different from conventional materials in general non-disaster situations, and clarifying the characteristics of emergency materials will help to improve the scientificity and rationality of multi-cycle allocation of emergency materials. Whether the needs of the disaster victims for emergency materials can be met in a timely manner directly affects the overall effect of the emergency rescue work for earthquake disasters, which is related to the success or failure of emergency rescue activities[4]. Therefore, scientific analysis of emergency material needs in the rescue process is helpful for efficient and reasonable allocation of emergency materials, to meet the needs of disaster victims for emergency materials to the greatest extent, and to improve the overall rescue effect of multi-cycle distribution of materials.

(2) Disposition of emergency medical relief materials for earthquake disasters

When configuring emergency medical rescue materials for earthquake disasters, the following situations need to be considered: the number of emergency logistics centers and rescue points, the adequacy of emergency medical rescue materials, distribution conditions, supply and demand, etc.[5-6]. No matter what kind of situation, the primary goal of configuration is to meet the needs of emergency medical relief materials for each rescue point in the disaster area as soon as possible. According to the above situation, multiple emergency logistics centers and multiple rescue points are the most common conditions. From the perspective of supply and demand, it can be divided into two situations: sufficient and insufficient supply of emergency medical rescue materials. From the consumption of emergency medical rescue materials, it can be divided into two cases: continuous consumption and discontinuous consumption[7]. Therefore, it can be assumed that the situation when deploying emergency medical relief materials after an earthquake, it is usually multiple emergency logistics centers and multiple relief points, the supply of medical relief materials is divided into two situations, the sufficient and the insufficient, and the consumption continuity of medical relief materials is divided into two categories: Both continuous and discontinuous.

(3) Design and Realization of Research on Emergency Material Scheduling

After a public emergency occurs, the optimal allocation of emergency materials is conducive to the orderly development of disaster relief work. Only in the first time of the disaster event, according to the demand for materials in the disaster-stricken area and the supply of the current rescue center, the limited emergency materials will be transported through scientific methods, and then the disaster-stricken points will be distributed reasonably. Only in this way can the rescue work in the disaster-stricken areas be carried out smoothly, ensure the fairness and justice of the rescue work in the disaster-stricken areas, and further improve the disaster-relief capability of our country in the event of emergencies[8]. When predicting the demand of disaster relief materials, considering the characteristics of lack of information and fuzzy information in the initial stage of disaster relief, in order to improve the accuracy of emergency material demand forecasting, a symmetrical triangular fuzzy number is used to describe the influencing factors of demand forecasting, and a multivariate fuzzy linear regression-based method is established. Emergency material demand forecast model.

When constructing a multi-reserve point and multi-disaster-affected multi-material dispatch model, in view of the limited materials in the initial stage of disaster relief, the concepts of the urgency of the disaster area's needs and the disaster area's satisfaction are introduced. Relief materials are delivered to areas with severe disasters to improve the effectiveness of the materials[9-10]. For the transportation efficiency of disaster relief materials limited by vehicle capacity, an appropriate transportation route is designed with the shortest transportation route as the goal. Finally, the material distribution and distribution problems are integrated to build a material scheduling model, and the double ant colony algorithm is used to solve the model, which ensures the maximization of satisfaction and the shortest transportation path.

2.2 Theoretical introduction to improved particle swarm optimization algorithm

In the algorithm, the main change process of the particle's understanding, cognition and learning of itself is as follows:

first, the particle swarm understands the particle's grasp of the current state according to the inertia weight and the particle's own speed, and second is the particle's own thinking based on its own experience, grasp the distance and direction between the basis of its existing position and its own historical optimal position, and finally the information sharing and cooperation between particles. The particles that reach the optimal position communicate and share information[11]. The information sharing mechanism of PSO enables the behaviors of individual particles to learn and learn from each other, simulates the mutual cooperation and competition between individuals and groups in the group, and finally promotes the particle development of the entire group, and finally obtains the optimal solution.

The PSO optimization algorithm is to regard each motion state variable in the process of earthquake emergency material dispatch as a particle without size and weight, simulate the mutual cooperation and competition between individuals and groups in the group, and use the information sharing mode to make both individuals and groups move towards good direction of development[12]. The direction and distance are determined at a certain speed. The dynamic adjustment of the movement speed is mainly based on the individual learning group movement experience, and the flight speed is based on the individual learning group flight experience. Therefore, the improved particle swarm optimization algorithm can be more accurate for the real variables of the dispatching state of earthquake emergency materials. control.

3. EXPERIMENT AND RESEARCH

3.1 Experimental method

In addition to ensuring the rescue efficiency, emergency relief work should also consider the fairness issues caused by the disaster situation and population in different disaster-stricken areas during the deployment of materials. When determining the distribution of emergency materials at the disaster-stricken point, the ratio of the actual material quantity obtained by the disaster-stricken point j to the demand must be greater than or equal to the minimum satisfaction rate a, that is, h ≥ input. The formula for calculating the satisfaction rate of emergency supplies at disaster site j is as follows:

$$h_j = \frac{\sum_{i=1}^{n} f_{ij}}{q_j} \tag{1}$$

$$\mu_j = \frac{\left(\sum_{i=1}^{n} x_{ij} n_{ij}\right)}{d_j} \tag{2}$$

In the above formula, h is the emergency material satisfaction rate of disaster-affected point j; f is the sum of the resources actually allocated to demand point j by all supply points, and q is the expected material demand of disaster-affected point j. Among them, the numerator x_n is the total amount of materials actually allocated to the disaster site j, and the denominator d is the demand for materials at the disaster site.

3.2 Experimental requirements

In the process of emergency decision-making, the fair distribution of emergency supplies is extremely important, but whether the distribution is fair is often a relative concept. Proportional equity is reflected in the distribution of disaster relief materials in the same proportion of the demand for materials in the disaster area. Although it can make the distribution of disaster-stricken points relatively fair to a certain extent, it cannot be ignored that adopting this method will result in less or even no relief materials allocated to disaster-stricken points with lower demand, which will lead to another The distribution of such materials is unfair. The minimum satisfaction rate λ of emergency materials is set as a threshold for the satisfaction of each demand point to the actual resources obtained (the ratio of the actual acquisition of resources to the expected demand). If it is higher than the threshold, it is considered that the scheme can obtain the minimum fairness requirements for the masses, and the corresponding scheme is relatively fair.

4. ANALYSIS AND DISCUSSION

4.1 Analysis of influence of emergency priority on material scheduling results

Whether the scheme is feasible is judged by comparing and analyzing the error relationship between the required quantity of material dispatch and the shortage ratio in the design and implementation of the earthquake emergency material dispatch research. The experimental data are as follows:

From the data analysis in Table 1 and Figure 1, it can be seen from the results that in the five experimental groups, the

required quantities of emergency material dispatch are 9.94 tons, 6.52 tons, 4.98 tons, 7.64 tons and 5.33 tons respectively. The corresponding emergency material dispatch shortage ratios are 6.74%, 4.33%, 3.41%, 5.17% and 4.05%, respectively. Through the data comparison, it can be seen that in the process of design and implementation of the research on earthquake emergency material dispatch based on the improved particle swarm optimization algorithm, the shortage ratio of emergency material dispatch changes with the change of the required quantity of emergency material dispatch, and the two are positively correlated. Therefore, in order to control the shortage ratio of emergency material dispatch, it is necessary to control the required quantity of emergency material dispatch to meet the minimum demand for emergency material dispatch.

Table 1. Analysis of the impact of emergency priority on material scheduling results.

Data set	Required quantity (Ton)	Shortage ratio (%)
One	8.94	6.74
Two	6.52	4.43
Three	4.98	3.41
Four	7.64	5.17
Five	5.33	4.05

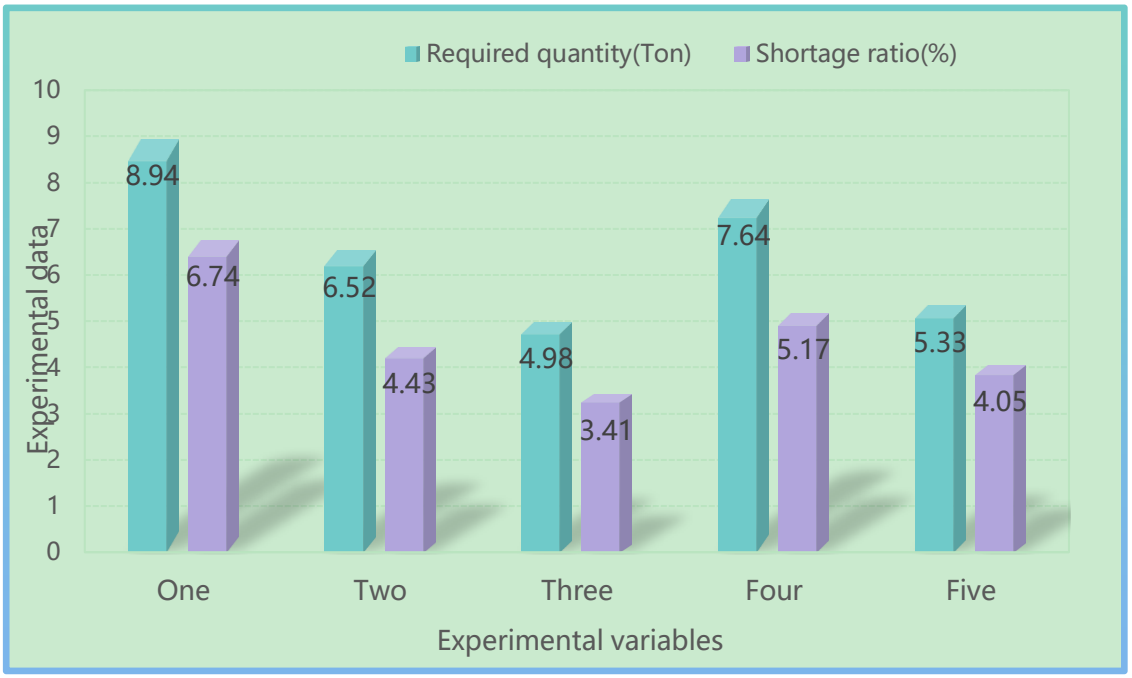

Figure 1. Analysis of the impact of emergency priority on material scheduling results.

4.2 Minimum material satisfaction rate analysis

Based on the improved particle swarm optimization algorithm, the design and realization of the minimum material satisfaction rate of the earthquake emergency material scheduling research are analyzed to judge the feasibility of the scheme. The experimental data is shown in the following Table 2.

As shown in Figure 2, through the data analysis of the design and realization of the minimum material satisfaction rate of the earthquake emergency material dispatch research based on the improved particle swarm optimization algorithm, the results are as follows, the minimum material satisfaction rate in the four sets of data is 0.454, 0.481, 0.419 and 0.432, and the average material satisfaction rates were 0.558, 0.571, 0.519 and 0.587, respectively. The results show that in the design and implementation of the earthquake emergency material scheduling research based on the improved particle swarm

optimization algorithm, the average material satisfaction rate is higher than the minimum material satisfaction rate. The required materials can meet the minimum demand for disaster relief, so that the material distribution meets the scheduling results.

Table 2. Analysis of minimum material satisfaction rate.

	Satisfaction rate minimum	Satisfaction rate average
First group	0.454	0.558
Second Group	0.481	0.571
The third group	0.419	0.519
Fourth group	0.432	0.587

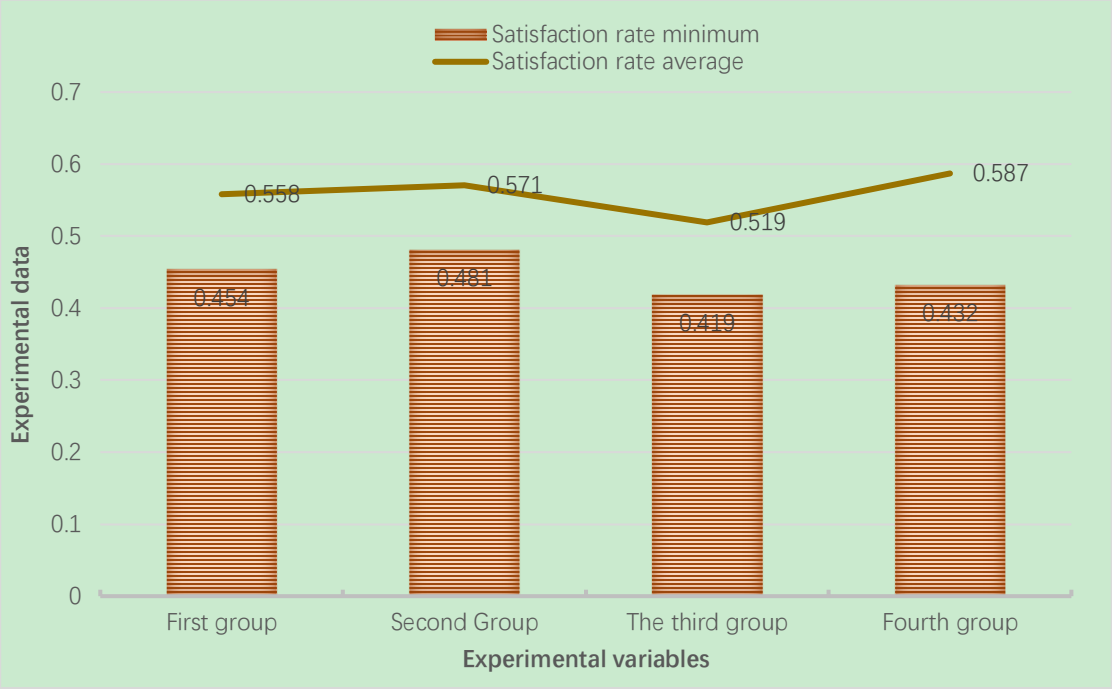

Figure 2. Analysis chart of minimum material satisfaction rate.

5. CONCLUSIONS

Based on the research background of the improved particle swarm optimization algorithm, this paper firstly analyzes and designs the design and implementation of the earthquake emergency material scheduling research on the basis of the algorithm. During the design and implementation of the research on earthquake emergency material dispatch based on improved particle swarm optimization algorithm, the proportion of emergency material dispatch shortage changes with the change of the required quantity of emergency material dispatch, and the two are positively correlated. Therefore, in order to control the shortage ratio of emergency material dispatch, it is necessary to control the required quantity of emergency material dispatch to meet the minimum demand for emergency material dispatch. In the experiment of the minimum material satisfaction rate analysis, the results show that in the design and implementation of the earthquake emergency material scheduling research based on the improved particle swarm optimization algorithm, the average material satisfaction rate is higher than the minimum material satisfaction rate. The results show that in the process of dispatching emergency materials for earthquakes, the required materials can meet the minimum demand for disaster relief, so that the distribution of materials can meet the dispatching results.

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