The Marina Cold Chain Logistics Management System Based on Cost Weighted Shortest Path Algorithm

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Abstract. As an important form of modern transportation, cold chain logistics plays an important role in the modern logistics system. However, with the improvement of people's living standards, the requirements for cold chain logistics are higher and higher. The current transportation mode of cold chain logistics cannot meet the strategic requirements under the background of modern logistics. Based on this, this paper first studies the cold chain logistics system management model in marina areas, then analyses the application of the shortest path algorithm in the cold chain logistics management in marina areas, and finally studies the example of the cold chain logistics management in marina areas based on the cost weighted shortest path algorithm.

Keywords: Marina Cold Chain Logistics, Cost Weighted Shortest Path Algorithm

1. Introduction
As an important product of modern large-scale production and automatic mechanical devices applied to the field of transportation, cold chain logistics is an important part of cargo transportation[1-2]. As an important form of modern transportation, cold chain logistics plays an important role in modern logistics system. Cold Chain Logistics (short for CCL in this paper) has its special advantages. Using international standard containers as cargo carriers, it can achieve the standardization and speediness of loading and unloading operations, so as to facilitate door-to-door transportation[3-4]. Therefore, cold chain logistics develops rapidly in modern logistics system. With the rapid development of e-commerce and online shopping, the current transportation mode of CCL cannot meet the strategic requirements of modern logistics, and multi-objective transportation plan is the key to the current CCL transportation[5]. With the development of CCL, it is faced with the problems of reasonable location of logistics distribution center and reasonable distribution path. Therefore, it is of great significance to study the cost weighted shortest path computer algorithm for CCL management in marina areas to promote the optimization and healthy development of business costs.

2. Management model of CCL system in marina area

2.1. Linear planning of CCL system in marina areas
The analysis and planning of CCL system in marina areas need to be modelled, such as production layout and inventory control, transportation route planning and testing, etc[6]. The common logistics system model is wired planning, as shown in Formula 1 below.
The feasible region of linear programming is convex set, and the optimal solution of linear programming is on the pole. The transportation problems in CCL in marina areas are shown in Figure 1.

\[
\begin{align*}
\text{max(min)} & \quad z = C^T X \\
\text{s.t.} & \quad AX = b \\
& \quad X \geq 0,
\end{align*}
\]

(1)

The feasible region of linear programming is convex set, and the optimal solution of linear programming is on the pole. The transportation problems in CCL in marina areas are shown in Figure 1.

\[
\sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij} x_{ij} = \min
\]

(2)

\[
\begin{align*}
\sum_{j=1}^{n} x_{ij} &= a_i, & i &= 1, 2, \ldots, m \\
\sum_{i=1}^{m} x_{ij} &= b_j, & j &= 1, 2, \ldots, n \\
x_{ij} &\geq 0, & i &= 1, 2, \ldots, m \quad j = 1, 2, \ldots, n
\end{align*}
\]

(3)

If \( \sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_j \), that is, the total supply is equal to the total demand, it is a balanced transportation problem, otherwise it is an unbalanced transportation problem. For the latter, it can be transformed into the problem of balanced transportation.

2.2. Dijkstra shortest path algorithm

When all \( w_{ij} \geq 0 \), Dijkstra’s shortest path algorithm is the best way to find the shortest path from given point \( v_s \) to any point. If \( P \) is the shortest path from \( v_s \) to \( v_j \) in \( D \) and \( v_i \) is a point in \( P \), then the path from \( v_s \) to \( v_i \) is the shortest path from \( v_s \) to \( v_i \). The shortest path from \( v_s \) in \( D = (V, A, W) \) to all other vertices is arranged as follows according to its path length from small to large:

\[
u_0 \leq u_1 \leq u_2 \leq \ldots \leq u_n
\]

(4)

\( U_0 \) represents the length from \( v_s \) to itself, and the corresponding shortest circuit is recorded as:

\[
u_{k+1} = \min_{r, j \in X_k} \left\{ u_j + w(v_j, v') \right\}
\]

(5)

\[
u_{k+1} = \min_{r, j \in X_k} \left\{ u_j + w(v_j, v') \right\}
\]

(6)

\[
X_k = \{ v_s, v_1, v_2, \ldots, v_k \}, \quad \bar{X}_k = V \setminus X_k
\]

(7)
In $X_k$, the $u_i$ value is the shortest path length from $v_s$ to $v_i$.

3. Application of the shortest path algorithm in CCL management in marina areas

The rapid development of information technology promotes the delivery technology of CCL. CCL and distribution are closely combined with advanced information technology and mathematical model tools, by using various optimization methods to manage and even make decisions on each link of CCL distribution, the best cooperation is achieved. At the same time, the shortest path algorithm can adapt to the characteristics of modern CCL in CCL distribution, so as to reduce costs and improve economic and CCL benefits.

4. Application and algorithm of path selection in cost weighted shortest path algorithm

Dijkstra algorithm is usually used to calculate the minimum path between one point and other points. In the process of searching, it is just the same as the distribution mode from one center point to other points in the marina CCL system from near to far. Although other algorithms can also find the shortest path between each two points, but only the shortest path length between two points cannot mark the nodes of the whole path, which makes it difficult to find the path of CCL distribution in marina areas. It can be seen that Dijkstra algorithm has relatively stable performance and is suitable for network expansion and change because of selection, so it can be used as the basic algorithm for CCL distribution and transportation routes in marina areas.

4.1. Location of logistics center in marina area based on cost weighted shortest path algorithm

The shortest Dijkstra algorithm is the shortest path algorithm between vertices and the shortest path algorithm between all vertices. Dijkstra algorithm can make reasonable decision and analysis in the distribution and transportation of CCL in marina areas, and it is suitable to select a reasonable logistics center so as to minimize the total cost of CCL in marina areas. However, when choosing the logistics center, due to some constraints, the location of CCL in marina areas can only be in some specific areas. At the same time, the cost of CCL transportation in marina areas has a nonlinear relationship with the distance of logistics transportation. Dijkstra algorithm is an effective method to find the shortest path, but it can only find the shortest path from one vertex to other vertices. If it is used for the location problem of distribution center, the calculation process will be more complex if it has to be repeatedly used in this case, so it needs to weigh many factors to judge.

5. Case study of CCL management in marina area based on cost weighted shortest path algorithm

In order to verify the reliability and effectiveness of the cost weighted shortest path algorithm for CCL management in marina areas and intuitively reflect the characteristics of the cost weighted shortest path algorithm, it is assumed that there are three vector logistics transportation networks as shown in Figure 2 below to solve the most satisfactory CCL path in marina areas.

![Figure 2. Three vector logistics transportation networks](image)

The vertex in Figure 2 is represented by numbers and marked in the circle representing the vertex, where the thick and solid line circle represents the CCL route node, the adjacency of each vertex is represented by a line segment connecting two points, and the distance between the two points is marked beside the line segment. When two points are connected by multiple lines, the road network becomes a multiple road network with multiple sides. In order to solve this kind of problem, this kind of vertex can be divided into two vertices with a distance of 0, which can also solve the shortest path problem of CCL transportation cost in marina areas.
Dijkstra algorithm can solve the problem of the shortest transportation along the cost weighted marina CCL. Through the membership function of fuzzy objective, the objective function is integrated by the cost weight information based on the decision maker's preference information, and then the shortest path to find the integrated objective function is proposed, which provides an optimal compromise solution for the shortest path problem of CCL and transportation in marina areas based on the cost weight.

6. Conclusions
With the rapid development of e-commerce and online shopping, the current mode of transportation of CCL cannot meet the strategic requirements of modern logistics, among which the most short-circuit problem based on cost weighting is the key to the current CCL transportation in marina areas. In this paper, the model and algorithm of the shortest path marina CCL path optimization problem based on cost weighting are analyzed and studied. The application of the shortest path algorithm based on cost weighting to the location of logistics center in marina areas is analyzed, and finally the reliability and effectiveness of the algorithm based on cost weighting shortest path algorithm are verified by a case study.

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