Optimizing Delivery Routes for Company Logistics

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Abstract:-

The optimization problem of vehicle distribution routing could be summarized as vehicle routing problem (VRP). The paper simply introduced logistics distribution VRP, established the corresponding optimization model of distribution routing by Dijkstra's Algorithm and Savings Algorithm based on MATLAB software, and verified the effectiveness of the combinational algorithm in accordance with example analysis. According to the results, Dijkstra's Algorithm and Savings Algorithm could optimize logistics distribution routing, effectively reduce distribution mileage and the number of the distributed vehicles, and thus achieve the goal of improving the distribution efficiency, reducing distribution costs, and relieving traffic pressure.

Introduction:-

As the core function of the logistics system, distribution is directly connected with terminal clients. The performance of the distribution function and its service level directly influence the logistics cost of companies and the satisfaction level of the client for the whole logistics service. The core part of distribution is the process of goods consolidation, sorting and delivery of distribution vehicles. Among this, the reasonable optimization of the distribution routes for the vehicles is significant for the speed, cost, and efficiency of the whole logistics transportation. Because that the transportation cost includes most cost of the logistics center and the urban transportation grows crowded in recent years, the significance of optimizing the route of the distribution vehicles is underpinned (Bardi et al., 2002). Logistics distribution centers play an important role in the goods transportation, aiming to reduce the transportation cost effectively.

Therefore, the route of the distribution vehicles and the schedule planning are very important operation decisions and normally they are a kind of vehicle routing problem (VRP).

Optimization methods for logistics distribution routes:- In past times, the study on VRP mainly focused on the heuristic solution, most of which were corrected from the heuristic solution of TSP. There are mainly three following methods:

(1) Route construction methods :- In the route construction methods, each two client will be connected till all clients are designated to one certain vehicle route. There are mainly two solutions: the first is to use the savings criterion to merger the existing routes and the second is to use the insertion cost to add single client to the vehicle route. C-W Savings Algorithm (Clarke and Wright, 1964) is the best-known heuristic solution for solving VRP, including two kinds which are parallel and sequential.

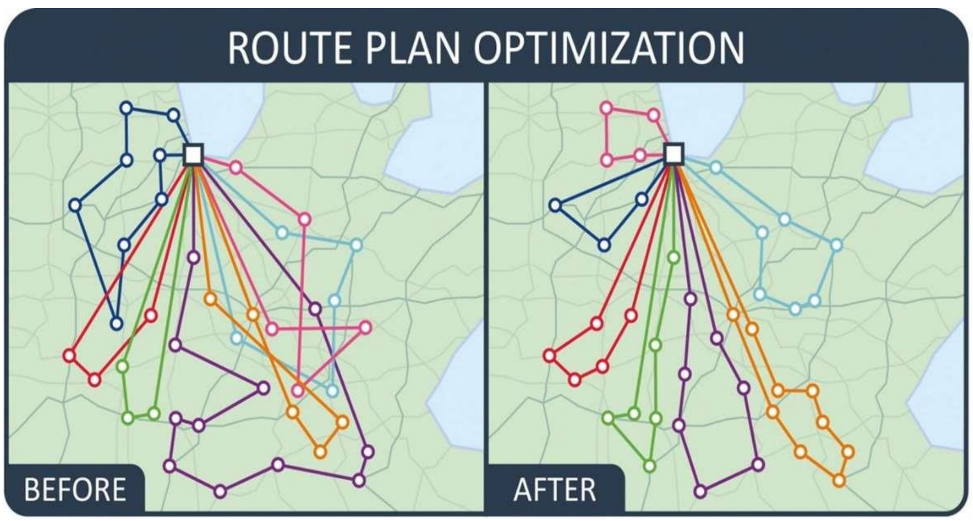
(2) Route improvement methods :- The route improvement methods begin with an initial feasible solution, chooses some lines to exchange, ensure that it is feasible solution after exchange and it can reduce the cost. This method originates from the heuristic solution proposed by Lin for the solution of TSP (Lin, 1965). Gaskell, Christofides and Eilon corrected this solution and applied it into VRP (Gaskell, 1967; Christofidesand Eilon, 1969).

(3) Complexity of road condition changes :- Road conditions many accidents will have a serious impact on road traffic. For example, accidents, road construction, infrastructure construction, abnormal weather, holidays and other events will reduce the road capacity or make it impassable. The traditional algorithm does not consider or deal with these influencing factors. The method is simple and rough, and the calculation accuracy of the influence value on the road condition is very low. In the route optimization, congestion and section gradient are taken into account, and the equivalent consumption is transformed into a flat road with a certain length, which is optimized by the traditional algorithm [31-33]. There is also a logistics distribution route optimization algorithm based on travel time prediction by using the historical average method to predict the road travel time [34-35]. The processing of these algorithms is relatively simple, and the complexity of road conditions is not fully considered.

Dijkstra's Algorithm:- Dijkstra's Algorithm was put forward by the Dutch computer scientist E. W. Dijkstra in 1959. It solves the problem of the shortest distance from a single starting point to other points in the directed graph and it is a method which calculates the shortest routes after finishing the weighted consideration. The calculating steps of Dijkstra’s Algorithm are shown as the follows:

Step 1: Divide all the knots in the graph into two sets of S and U: “the visited knots set” are put in S with the original condition of null set; “the not-yet-visited knots set” are put in U with the original condition of all distribution sites set.

Step 2: Change the starting point O (normally the logistics center) as a permanent label and move 957 from U to S. Set the starting point’s P(O)=NULL, the distant travelling cost of starting point L(O)=0, setting i=O; The distant travelling cost of all



other knots j: L(j)=∞. Thereinto, P(i) is the up-stream knot of knot i and Γ(i) is the collection of all i.

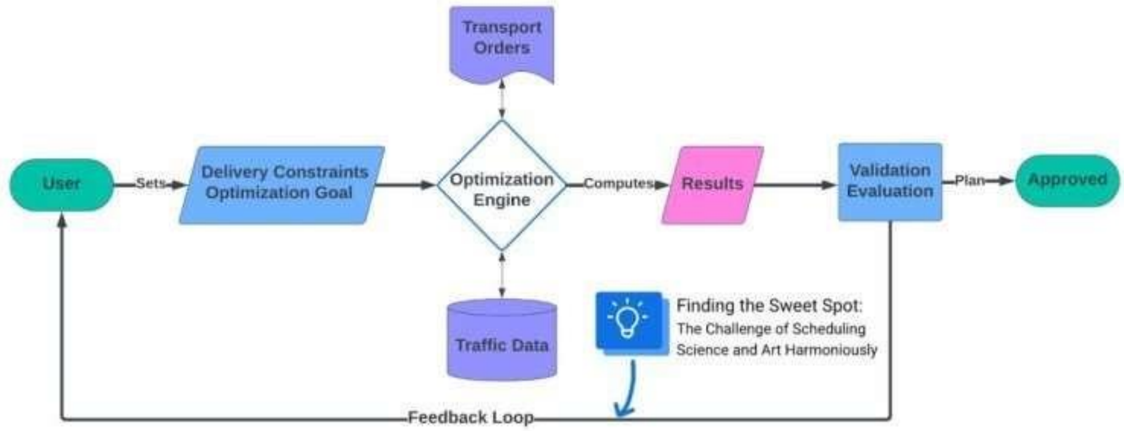
Step 3: Update all the knots which is labeled as temporary in Γ(i): L(j)=min[L(j), L(i)+w(i, j)], if L(i)+w(i, j)

LOGISTICS DISTRIBUTION VEHICLE ROUTING PLANNING MODEL:- All learning algorithms are learned through data. By analyzing the data characteristics of customer requirements, customer location information and demand information, we quantify the location information and demand information of customer nodes, and use the deep reinforcement learning method to design an end-to-end framework to solve the logistics vehicle routing problem [38]. In this method, the training strategy network and value network model only observe the reward signal and follow the feasibility rules to find the near optimal solution for the problem samples sampled from the given distribution. It can be simply explained as a parameterized probability estimation model based on attention mechanism or actor strategy network.

Case studies

The previous methodology has been applied to three scenarios in Spain. These scenarios, although fictitious in nature, are designed to mimic real-world conditions. As it is expected, the model results are more realistic with greater network detail. In the Pamplona case, all the streets in the historic center have been modeled, and the hub location has been considered in a suitable area where the City Council intended to install a hub.

The first scenario (S1, regional level) is focused on the region of Catalonia (Spain) due to its significance in Spanish logistic activities, mainly because of the freight transportation crossing the Pyrenees in direction to France and the rest of Europe (Ministerio de Transporte, 2021). The second scenario (S2, city level) is represented by the city of Barcelona, with a population of 1.6 million. Its logistic activity is important due to the great number of small, medium, and big companies operating in the city (more than 56,000), in an extension of about 102 km2, and also because of the tourism demand. Finally, the third scenario (S3, local level) corresponds to the Old Town of Pamplona (Navarra, Spain). The reason to model the Pamplona area is its saturated zone of shops and bars (around 1500) in the old city districts, in 1.4 km2. Furthermore, the city council is currently investigating the pedestrianization of some streets and studying how to change the freight distribution in the urban area, making this scenario a perfect example to be included in this work. The previous scenarios range from the regional level to the local level which can provide insight considering the importance of time or distance minimization depending on the context.



Furthermore, all the road networks have been modeled in QGIS (2023). The road network of Catalonia (S1) has a length of 12,000 km, modeled considering all national roads and highways within the region. In total, 92 nodes and 342 links have been modeled. In the Barcelona scenario (S2), the network is compound by 43 nodes and 197 links, including the main freight routes within the city and real restrictions and bans on major urban roads. Finally, the modeled network of Pamplona (S3) includes 115 nodes and 374 links, drawing a realistic map of the city center as all the roads, including real restrictions and bans, are also considered. Includes plots of the three scenarios showing the level of detail for each scenario. On the one hand, the region of Catalonia (S1) has been modeled using national roads and highways, representing a more strategic level, such as deliveries between cities. On the other hand, the scenario for Barcelona (S2) includes all the main roads of the city but excludes local streets. This scenario would represent deliveries between different parts of the city. Finally, the scenario for the Old Town of Pamplona (S3) includes all the streets, and this would be valid for a realistic representation of, for example, on-demand deliveries and last mile deliveries. Apart from the reasons given above, the old districts of Pamplona have been modeled in detail instead, because its simplicity in comparison to the metropolitan area of Barcelona. Moreover, this scenario might be useful for the city council of Pamplona to test urban transport and logistic policies.

Conclusion:- Most companies have great randomness in terms of the distribution routes choice in logistics distribution so that the distribution cost is high and the distribution efficiency is low. This paper takes the cold-chain warehouse & distribution center of Y Company as the example, uses Dijkstra's 964 Algorithm and C-W Savings Algorithm to optimize the distribution routes and utilizes the MATLAB software to deal with the problem of calculation difficulties with many knots. The software of MATLAB is easy to handle with and the results are easy to understand. Through the case analysis, it can be found that the distribution plan after optimizing can enhance the car loading rate, reduce the distribution cost, enhance the distribution efficiency, and meanwhile it has great social benefit for energy conservation, emission reduction, cutting down the environmental pollution, lightening the transportation pressure. Therefore, Dijkstra's Algorithm and C-W Savings Algorithm can solve the unreasonable transportation problems of the logistics companies such as roundabout distribution and meanwhile provide support for the achievement of city joint distribution.

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